Perugia, Italy July 2-13, 2007

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EARTH: OUR CHANGING PLANET

IAMAS

INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC SCIENCES

ASSOCIATION SYMPOSIA AND WORKSHOPS

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Compiled by Lucio Ubertini, Piergiorgio Manciola, Stefano Casadei, Salvatore Grimaldi

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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.

MS002 **Symposium** **(4897 - 4910)**

Convener : Dr. Keith Alverson, Dr. George Kiladis

Global Observing Systems, Past, Present and Future (ICCL)

MS003 **Symposium** **(4911 - 5054)**

Convener : Dr. George Isaac, Prof. Teruyuki Nakajima

Aerosols, Radiation and Clouds (IRC, ICCP, ICACGP)

MS004 **Symposium** **(5055 - 5145)**

Convener : Prof. George Kallos
Co-Convener : Dr. Alcide Di Sarra, Prof. Charlie Zender

Mineral Dust Cycle and its Impact on Clouds and Radiation (ICCP)

MS005 **Symposium** **(5146 - 5167)**

Convener : Dr. Gabor Vali
Co-Convener : Dr. Cindy Morris

Biological Ice Nucleators in the Atmosphere at the Crossroads of Physics and Biology (IAMAS/ICCP)

MS006 **Symposium** **(5168 - 5196)**

Convener : Dr. Paul Field, Dr. Alexei Korolev, Dr. George Isaac

Ice Microphysics: Theory and Measurement (ICCP) merged with MW001

MS007 **Symposium** **(5197 - 5229)**

Convener : Dr. Eyal Heifetz
Co-Convener : Dr. Nili Harnik

Theoretical advances in atmospheric dynamics (ICDM)

MS008 **Symposium** **(5230 - 5270)**

Convener : Dr. Craig Bishop

Ensembles and Probabilistic Forecasting (ICDM)

MS009 **Symposium** **(5271 - 5297)**

Convener : Dr. Istvan Szunyogh

Dynamics and Predictability of Severe Weather Events (ICDM)

MS010 **Symposium** **(5298 - 5360)**

Convener : Dr. George Kiladis

Dynamics of Convectively-Coupled Equatorial Waves and the Madden-Julian Oscillation (ICDM)

MS011 **Symposium** **(5361 - 5386)**

Convener : Prof. Carlos Mechoso
Co-Convener : Prof. Richard Grotjahn

The Dynamics of Eastern Tropical Oceans and Subtropical Highs (ICDM)

MS012 **Symposium** **(5387 - 5397)**

Convener : Dr. Parvadha Suntharalingam, Dr. Dylan Jones

Impacts of Biosphere-Atmosphere Interaction on Atmospheric Composition from Synoptic to Annual and Decadal Timescales

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MS013 **Symposium** **(5398 - 5434)**

Convener : Dr. Kenneth Gage

Topographic Effects on Weather and Climate (ICDM)

MS014 **Symposium** **(5435 - 5458)**

Convener : Prof. Meinrat O. Andreae

Interactions of Land Cover and Climate (ICCL)

MS015 **Symposium** **(5459 - 5519)**

Convener : Dr. Lisa Alexander
Co-Convener : Dr. Xuebin Zhang

Extreme Weather and Climate Events: Past Occurrences and Future Likelihoods (ICCL)

MS016 **Symposium** **(5520 - 5589)**

Convener : Dr. Filippo Giorgi

Downscaling to Local and Regional Scales (ICCL)

MS017 **Symposium** **(5590 - 5614)**

Convener : Dr. Natalia Andronova

Climate Sensitivity and Climate Feedbacks: Progress and Remaining Questions (ICCL)

MS018 **Symposium** **(5615 - 5640)**

Convener : Prof. Marvin Geller

The Role of the Stratosphere in the Climate System (ICMA, IRC, ICCL)

MS019 **Symposium** **(5641 - 5730)**

Convener : Prof. Kevin Hamilton

Middle Atmosphere Science (ICMA)

MS020 **Symposium** **(5731 - 5769)**

Convener : Prof. Werner Schmutz

Solar Activity and its Influences on the Earth's Weather and Climate (IRC)

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MS002 **4897 - 4910**

Symposium
Global Observing Systems, Past, Present and Future (ICCL)

Convener : Dr. Keith Alverson, Dr. George Kiladis

This symposium is for submitted contributions addressing the topic of the Union Symposium "U03 on Global Observing Systems, Past, Present and Future". It will concentrate on the societal benefits of Earth observations in the context of the many global programs contributing to the Global Earth Observing System of Systems (GEOSS), including the Global Climate, Terrestrial and Ocean Observing systems (GCOS, GTOS, GOOS) and the Integrated Global Observing Strategy (IGOS) Partnership. Presentations on any aspects of Earth System Observations, but particularly those clearly resulting in societal benefits, are welcome

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MS002 **Oral Presentation** **4897**

Schumann Resonances as a Passive Global Monitoring Tool of Global Thunderstorms

Mrs. Olga Pechony
Geophysics and Planetary Scienses Tel Aviv University

Colin Price

Schumann resonances (SR) are global electromagnetic resonances, excited by lightning discharges in the cavity formed by the Earth surface and the ionosphere. SR are observed in the power spectra of the natural electromagnetic background noise, as separate peaks at extremely low frequencies (ELF) around 8, 14, 20, 26 and 32 Hz. Schumann resonances provide global coverage and serve as a relatively low-cost passive remote sensing tool of thunderstorms activity around the globe. From the very beginning of SR studies, they were used to track global lightning activity [Holzer, 1958; Balser and Wagner, 1962a; Nickolaenko and Rabinovitz, 1995; Nickolaenko et al., 1998; Heckman et al., 1998]. Owing to the connection between lightning activity and the Earth's climate, it has been suggested that SR may be used to monitor global temperature variations [Williams, 1992] and variations of upper water vapor [Price, 2000; Price and Asfur, 2006]. It was suggested that extraterrestrial lightning may also be detected and studied using SR [Nickolaenko and Rabinowicz, 1982, 1987; Pechony and Price, 2004]. SR has been used for research and monitoring of the lower ionosphere on Earth and suggested for exploration of lower ionosphere parameters on celestial bodies [Nickolaenko and Rabinowicz, 1982; Sentman, 1990]. More recently, Schumann resonances are used for monitoring transient luminous events sprites and elves [Huang et al., 1999; Boccippio et al., 1995; Price et al., 2002; Sato et al., 2003; Sato and Fukunishi, 2003]. Today there are many SR measuring stations around the globe and long-term records are available for several years. One of the long challenged problems in utilizing SR experimental data for global monitoring and climate research is the significant influence of the source-observer (lightning-receiver) distance (SOD) on the records. Recently Pechony and Price [2006] showed that this problem can be resolved using the correction technique originally suggested by Sentman and Fraser [1991] for removing the local ionosphere influence. In this technique simultaneous measurements at two distant stations are used to infer the unbiased global record. The information retrieved from modeled SR records can also be successfully used to correct experimental data. Utilizing the SOD correction technique it is therefore possible today to effectively use Schumann Resonance records as a passive global monitoring tool on Earth and other planets.

Keywords: schumann resonance, lightning, climate

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MS002 **Oral Presentation** **4898**

Worldwide glacier monitoring present state and current challenges

Dr. Michael Zemp
World Glacier Monitoring Service University of Zurich, SWITZERLAND

Richard Armstrong, Wilfried Haeberli, Martin Hoelzle, Andreas Kaeaeb, Jeff Kargel, Frank Paul, Bruce Raup

Glaciers are an inherent component of cold mountain culture and landscape, a unique source of fresh water for agriculture and industry, an important economic factor of tourism and hydro-power production, an essential component of current and possible future rises in sea level and a potential source of serious natural hazards. Due to their proximity to the melting point and strong reaction to climate change, glaciers are among the most essential variables required for global climate monitoring. Worldwide collection of information about ongoing glacier changes was initiated in 1894 with the foundation of the International Glacier Commission at the 6th International Geological Congress in Zurich, Switzerland. Today, the World Glacier Monitoring Service (WGMS; http://www.wgms.ch) continues to collect and publish standardised information on ongoing glacier changes. WGMS is a service of the Commission for the Cryospheric Sciences of the International Union of Geodesy and Geophysics (CCS/IUGG) and maintains a network of local investigators and national correspondents in all the countries involved in glacier monitoring and is in charge of the Global Terrestrial Network for Glaciers (GTN-G) within the Global Climate/Terrestrial Observing System. GTN-G aims at combining (a) in-situ observations with remotely sensed data, (b) process understanding with global coverage and (c) traditional measurements with new technologies by using an integrated and multi-level strategy. This study gives an overview on the present state and challenges of GTN-G, i.e., of the current front variation and mass balance monitoring programmes as well as of the world glacier inventory. Systematic observations of glacier front variation and mass balance started in the second half of the 19th and 20th century, respectively. At the turn to the 21st century, annual front variation and mass balance measurements were reported from about 750 and 100 glaciers, respectively. A first attempt to compile a world glacier inventory was done in the 1980s (mainly from aerial photographs and maps), when information on glacier location, area, length, orientation, elevation and classification of over 71000 glaciers were collected, corresponding to about 44% of all glaciers and ice caps worldwide. In close cooperation with the National Snow and Ice Data Center (NSIDC; http://www.nsidc.org) and the WGMS, the Global Land Ice Measurements from Space (GLIMS; http://nsidc.org/glims) project was designed to continue this task with space-borne sensors. The ongoing trend of worldwide and fast, if not accelerating, glacier shrinkage, on the century time-scale, is of a non-periodical nature and may lead to the deglaciation of many mountain ranges in the coming decades. To keep track of these fast changes in nature and to assess corresponding impacts on landscape evolution, fresh water supply and natural hazards, monitoring strategies will have to make use of the rapidly developing new technologies (remote sensing and geoinformatics) and relate them to the more traditional methods. Such challenges of historical dimensions, both in nature and in science, can only be faced by a strong, operational monitoring service that has a well organised international structure and a secure financial basis from national and international funding, independent of any short-term scientific project money.

Keywords: glacier, monitoring, climate change

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MS002 **Oral Presentation** **4899**

Seasonal and spatial variability of the mixed layer depth over the North Indian Ocean using ARGO observations

Dr. M.M. Ali
Department of Space National Remote Sensing Agency

Mixed layer depth (MLD), a quasi-homogeneous layer of density, is an important parameter for both oceanic and atmospheric process studies as this is the layer that directly interacts with the atmosphere. Besides, this parameter also has important bearing on submarine communications. Ocean mixed layer is not as well understood or observed as the atmospheric boundary layer due to the lack of sufficient number of temperature and salinity in situ profiles from which MLD can be computed. The deployment of Argo floats gave an opportunity for such a study, particularly, over the otherwise data sparse Indian Ocean region. We used the temperature and salinity profiles from Argo observations in the north Indian Ocean, spanning 0-25 N and 40-100 E, during 2002-2006. Density gradient criterion has been used to estimate MLD. Diurnal variation of the base of the mixed layer could be as large as 10-30 m due to the internal tides. Since different Argo floats pop up during different times of a day, a criterion has been used to take care of these diurnal oscillations. These individual observations have been averaged on seasonal basis to study the temporal and spatial variability of MLD in the north Indian Ocean. Somali region has the highest temporal variability due to the changes in the wind magnitude. Similarly, Arabian Sea has less variability compared to the Bay of Bengal. The variability in these locations mainly reflects the changes in the wind magnitude and the net heat loss. We also studied these temporal and seasonal changes in MLD in relation to the available altimeter derived sea surface height anomalies.

Keywords: mixed layer depth, argo floats, seasonal spatial variation

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MS002 **Oral Presentation** **4900**

An integrated, operational global ocean observing and hazard warning system

Dr. Keith Alverson
Ocean Observations and Services Intergovernmental Oceanographic Commission IAMAS

The Global Ocean Observing System (GOOS) has been in existence for over a decade. During this first decade, GOOS has been primarily engaged in planning observational strategies and developing the international governance structures required to facilitate multi-national ownership and development of the system. The most important challenge now facing GOOS is to complete and sustain an integrated, global system with clear user benefits. Substantial progress has been made, with more than 50% of the in-situ open ocean observing system for climate already in the water, including buoys, moorings, floats, tide gauges and repeat hydrographic lines. Real time, operational warnings for tsunamis and other ocean hazards such as storm surges, based on this GOOS observational backbone, are now widely available as clear societal benefits. However, despite progress substantial challenges remain. Broadly speaking, the oceanographic research community is neither ensuring their observations fully contribute to, nor that their research fully benefits from the sustained, operational system. At the same time, current levels of national governmental contribution to the system, and existing mechanisms for coordinating these contributions, are insufficient. New modalities for both increasing research community participation and governmental commitments will be presented. The talk will begin with a brief overview of the status of the global ocean observing system, then highlight milestones achieved and conclude with an overview of key future challenges. References: Alverson, K. and D.J. Baker Taking the Pulse of the Oceans, Science, 314:5806, p. 1657, 2006. Alverson, K. Watching over the worlds oceans, Nature, 434, 19-20, 2005.

Keywords: goos

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MS002 **Oral Presentation** **4901**

Implementation of IndOOSA sustained ocean observing system in the Indian Ocean for climate research

Prof. Gary Meyers
CSIRO Marine and Atmospheric Research IAPSO

The scientific rationale and technical implemen tation plan for IndOOS was published by the Intergovernmental Oceanographic Commission through its Perth Regional Office and th e International CLIVAR Project Office. The CLIVAR /GOOS Indian Ocean Panela co nsortium o f scientists fro m majo r oceanographic agencies around the worldprepared th e pl an and is coordinating the i mplementation. This presentati on will provid e an overview of the scientific ration al, the societal rationale and the progress toward implementation to date. The main science driver for IndOOS is improv ed description, understanding, modelling and ability to pre dict the ph ysical structure of the Indian Oc ean associated with stro ng mo des o f climate variatio n, including the m onsoons, intra-seasonal variat ion, the Indian Ocean zonal dipole m ode and decadal v ariation. The challenge in designing IndOOS was to ge t adequate observations to address outstanding scientific questions, while containing the cost to a doable level. The plan calls for an integrated deployment of all the proven technologies that can be maintained in th e open ocean for lon g periods of time , in an arrange ment that take s advantage of the synergies between different types of in strumentation. The key new element in the Indian Ocean is a basin-scale mooring array that is now about 1/3 implemented. Widely distributed A rgo floats, XBT lines and othe r instruments pr ovide a frame work for large scale moni toring aro und t he array. Ocean-state estimation integrates the streams of data for research and applications.

Keywords: india ocean, currents, climate

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MS002 **Oral Presentation** **4902**

WDC integrated global data and delivery tools in support of GEOSS biodiversity and ecological societal benefits

Dr. John Hill
World Data Center for Biodiversity and Ecology ICSU

Thomas Hermann, Thomas Lahr, Gladys Cotter

The Global Earth Observation System of Systems (GEOSS) is addressing the challenging global data and information requirements of the worlds p ressing bi odiversity and ecological issues (e.g., invasive species, huma n/wildlife dise ases, losses in biodiv ersity, and climate change). Nu merous globa l geophysical data sets are being created, but are no t integrated. Integrated and updated data allow for the creation of valued added products and a ssociated analyses. The World Data Center for Biodiversity and Ecology (WDCBE), under the a uspices the Inte rnational Co uncil fo r Sciences (ICSU) Wo rld Data Center System , is working with the GEO Secretar iat to build the framework and partnerships f or integrating, up dating, and ac cessing global biodiver sity, ec ology, an d geoph ysical data f or use by the scientific and c onservation co mmunity. WDCBE is f ocusing on the: 1) distribution of data and results from the Millennium Ecosystem Assessment, 2) deve lopment of web-enabled capab ilities (tools) t o improve the efficiency of digital data input and resulting accuracies , 3) acquisition, integration and accessibility of key global data sets (e.g., protecte d areas, global biodiversity assess ments, Important Bird Areas [IBA], Gl obal Biodiversity In formation Facility [GBIF] specimens and observations, ecoregions/ecosystems, and geospatial data [e.g., topography, h ydrology, land co ver, land co ver change, census]), and 4) cr eation of long-term data sh aring and anal ysis partnerships with leading international biodiversity and ecological informatic s an d con servation organ izations. WDCBE, th rough the USGSs Global Integrated Trends Anal ysis Netw ork (GITAN), assist s partner organizations build capacity and capabilities to achiev e core objectives, primarily by dire ctly engaging stakeholders through the internet to improve the quality and com prehensiveness of their data s et(s). The following tools ar e being designed, developed, tested, and depl oyed to fulfill these needs: Global Data Tool Kit (GDT) - an on-line polygo n tool t o facilit ate entry and/ or valida tion of digital data (e.g., pr otected areas, species distributions, ecosystems). Users can also p ull down data sets that are associated w ith these polygons (e.g., lan d cov er, ecosystems , species) for analysis and d ecision making. Rapid Land Cover Mapping Tool - an o n-line technique to manually int erpret imagery fo r mapping (e.g., land co ver, land co ver change, and ecosystems). Integrated Taxonomic Information System (ITIS) - a taxonomic crosswalk to operationally compare, integrate, an d apply global biodiversity data se ts. It also provid es the museum community with a methodology and data to validate specimen data, while at the same time provides the greater user community with histo rical observatio ns to increase the spat ial accuracy of species distributions. These capabilities allow countries, conservation managers, and scientists to better: refine species distributions, create Key Biodiversity Area s (KBA), create species lists for protected areas, evaluate protected area management effec tiveness, map ecosystems, and conduct G AP analy ses in preparation for the Convention on Biodiversitys (CBD) 200 6 and 2010 ta rgets. Pilot projects are being conducted in Paraguay and the United States.

Keywords: biodiversity, bioinformatics, ecoinformatics

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MS002 **Oral Presentation** **4903**

The World Data Center for Glaciology Boulder and National Snow and Ice Data Center Data at Age 30: A Vision for the Future

Mr. Ron Weaver
National Snow and Ice Data Center University of Colorado Boulder IAHS

Clark Judy, Julia Collins

In 2007 the 50th anniversary of the International Geophysical Year, the WDC Glaciology Boulder (WDC) celebrates its 30th anniversa ry. It does so in a data and computing env ironment unim aginable at its beginning. The reach of the Internet, and more specifically the protocols it supports (such as HTTP and FTP) enable options for data management and access that were impossible at the WDCs inception. The mass storage capability and computing power availabl e today is unpar alleled and shows no signs of slowing. This changing cyberinfrastructure allows the WDC and the National Snow and Ice Data Center (NSIDC) to explo re new way s o f thinking abo ut ho w a data center can serve its users. We are also challenged by evo lving cryo sphere research ques tions, priorit ies and the needs of the science community for data a nd data products. Increasingly, cryosphere research requires an interdisciplinary approach. Not only do users need help navi gating the expanding volume s of data available at any one data archive, they also must find data in the ever expanding distri buted data landscape where relevant data might literally be stored half a world away. Wh at changes might ne ed to take place in our data archive and d elivery paradigm in order to support the next generatio n o f research challenges? Our assessment suggests the following will prob ably be necessary: from simple archiving and distribution to enabling access and synthesis; from a search and order in an off/near -line environment to a interactive discovery and application environment; from discipline-specific to suppo rting interdisciplinary work as a priority; from a preservation metadata focus to pr oviding the discover y metadata re quired to support data subsetting, regridding, and reformatting; from being an independe nt source of d ata to providin g data in a "virtual data center" environment, which requires the delivery of data products in interoperable formats. NSIDC's challenge is to evolve in a manner that permits flexible responses to changes in use r access patterns, tools and requested data f ormats, while at the same ti me maintaining the integrity of the data ce nter holdings and plan for long term da ta st ewardship, all in the highly volatile agenc y funding climate. This paper will present our current assessment of the above challenges and offer some suggestions on how the WDC/NSIDC wi ll proceed in the coming years of the IPY and p ost-IPY era. It is possible that some of our observations a re a ppropriate to the GEO and GEOSS efforts of the international data community.

Keywords: ipy, data management, cryosphere

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MS002 **Oral Presentation** **4904**

The GlobGlacier project

Dr. Espen Volden
Earth Observation Science and Applications Eurpean Space Agency

Frank Paul

The main objectives of the GlobGlacier project are to: * Define EO based services for glacier monitoring based on the user requirements; * Integrate latest EO technology with state of the art ground-based observations; * Demonstrate and implement the services for the members of the User Group; * Validate the services; * Maintain a database of GlobGlacier products through the GLIMS database; * Thereby contribute to new scientific results in the domain of climate change detection, sea level contribution, climate modelling and hydrological modelling. The GlobGlacier services will cover glaciers from all over the world. The information products to be developed and demonstrated in the project will respond to the operational needs and requirements of a certain number of users who are actively involved in the project. Additionally, these products will provide an answer to the requirements of the GCOS implementation plan for UNFCCC, which defined Glaciers and Ice Caps as one of the Essential Climate Variables. The products will also contribute to fulfilling the response to this implementation plan from the Committee on Earth Observation Satellites (CEOS): Satellite Observation of the Climate System - CEOS Response to the GCOS Implementation Plan.

Keywords: glaciers, satellite, climate change

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MS002 **Oral Presentation** **4905**

Global Infrasound Research

Dr. Milton Garces
Infrasound Laboratory University of Hawaii, Manoa IAVCEI

Henry E. Bass, David Mccormack, Paola Campus

New interest in infrasound monitoring spurred by the International Monitoring System (IMS) has led to the installation of a number of infrasound projects devoted to specific applications. These applications include monitoring volcanic eruptions, extreme weather, large ocean swells, bolides and tsunamis. Each of these events are different in terms of source mechanism but they have a common feature (other than destruction) - the emission of long-ranging sound with frequencies below the perception of human hearing, or infrasound. There is strong evidence to support the claim that infrasound can supplement existing warnings systems to improve preparedness and provide scientists with an additional tool for remote monitoring of atmospheric events. Some research groups are even using infrasound created by volcanic activity to do infrasound tomography of the atmosphere. The new emergence of interest in infrasound has led to the creation of an International Infrasound Consortium. The consortium will provide members with data from a larger area of the earth's surface to support their particular scientific interest. Treaty restrictions still limit access to IMS data but when allowed, data from those stations coupled with data from local networks provide increasingly comprehensive coverage of the earth. At this time, data standardization is not as routine as more mature consortia but the scientists in the field are working towards that goal.

Keywords: infrasound, network, monitoring

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MS002 **Poster presentation** **4906**

Global Forum For Climate Changes and Observing Systems for Geo-Disasters Mitigation : Case Study

Prof. Narendra Kumar Choudhary
Reearch IAPSO- CGSI IAPSO

Director, Dr.A.G.Bhole,, Dr.R.C.Bhattacharjee, Prof.S.P.Yavalkar

The Global Forum for Disaster Manageme nt, GFDM wa s inaugurated in Mexico city,Mexico during th e fourth World Water for deve loping the global obse rving systems on geo-disasters and climate changes .In recent pas t the co mmunities aro und the wo rld witnessed n umber o f disasters like Tsun ami, earthquakes , cyclo nes , hurricanes , Forest fires , flash floods due to glob al climate changes etc . The tsunami traged y along the south Asian coast changed th e lives of million s of af fected people in Asian countries . Several NGO's aro und the world played an important ro le in provisi on of immediate rehabilitation for the victims of the tsunami in wh ich global observing systems provided siginificant information and support to the communitie s and societies . Recognizing t he social resp onsibility, ISDR along with oth er organ izations h as provided immediate reh abilitation m easures for tsu nami-affected people in our country . For life to return t o norm al for the tsun ami-affected population, systematic-scientific and t echnology-based efforts are needed. Also rehabilitation work should f ocused on cos t-effective methods for tsunami rehabilitation. This gl obal forum for disaster managem ent will e xamine, among other items, the relation between the socio-ec onomic dimension and scientific and technological methods and relevance to early rehabilitation programme in various parts of th e world .ISDR along with Muktainagar-Taluka Education society , Open University geological society, Switzerland has accepted the responsibility o f providing nec essary infrastructure an d Institutional help fo r Glo bal fo rum fo r disaster management with the support from the global observing systems for conducting research and development and work related to natural disaster management such as tsunami reha bilitation. This presentation is based on the lesson learned from th e GFDM - Geo-disaster management and mitigation in the Asia - Pacific region through the N GOs and ac ademic and rese arch institutions for social and ecological management during post disaster period .

Keywords: global observing systems, global climate changes, geo disasters mitigation

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

MS002 **Poster presentation** **4907**

The value of targeted observations

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Graeme Kelly, Carla Cardinali, Jean-Noel Thepaut

Data-assimilation experiments have been performed for different seasons and weather regimes, to assess the value of observations taken in target regions identified using singular vectors (SVs) or in random areas. These regions have been located either in the Pacific or the Atlantic Oceans, and the value has been measured considering the relative forecast error reduction in downstream areas, specifically a North-American region for targeted observations taken in the Pacific Ocean, and a European region for targeted observations taken in the Atlantic Ocean. Overall, results have indicated (i) that observations taken in SV-target areas are more valuable than observations taken in randomly selected areas, (ii) that it is important that the daily set of singular vectors are used to compute the target areas, and (iii) that the value of targeted observations depends on the region, on the season, and on the baseline observing system used as a reference. More precisely, results have indicated that if the baseline observing system is data void over the ocean, then the average value of observations taken in SV-target areas is very high. Considering for example winter 2004, SV-targeted observations over the Pacific (Atlantic) reduce the day-2 forecasts error of 500 hPa geopotential height forecasts in the verification region by 27.5% (19.1%), compared to 15.7% (14.9%) for observations taken in random areas. By contrast, if the baseline observing system is data rich over the ocean, then the average value of observations taken in SV-target areas is rather small. Considering for example winter 2004, it has been estimated that adding SV-targeted observations over the Pacific (Atlantic) would reduce, on average, the day-2 forecasts error in the verification region by 4.0% (2.0%), compared to 0.5% (1.7%) for observations in random areas. These average results have been confirmed by single-case investigations, and by a careful examination of time series of forecast errors. During this talk, extracts from these experiments will be shown, and their relevance for future targeting campaigns will be discussed.

Keywords: targeting, observations, assimilation

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MS002 **Poster presentation** **4908**

The australian integrated marine observing system

Prof. Gary Meyers
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The Integrated Marine Observing System (IMOS) is a set of equipment distributed in the oceans around Australia and data-information services to facilitate research and applications. Collectively the equipment will contribute to meeting the needs of marine research in Australia in both open oceans and coastal oceans. The value from this infrastructure investment lies in the coordinated deployment of a wide range of equipment aimed at deriving critical data sets. These, in turn, become the infrastructure for a wide range of research and applications at a variety of scales. The infrastructure also contributes to Australias role in international programs of ocean observing. IMOS was initiated in 2007 with an investment of $A55.2M by the Department of Education, Science and Technology under auspices of the National Cooperative Research Infrastructure System, and a nearly equal contribution in matching funds. The range of observations includes three open ocean projects (Argo floats, Enhanced ships of Opportunity and a Southern Ocean Mooring), three coastal physical projects (moorings, glider floats and radar towers) and three coastal biological projects (passive acoustic listening stations, acoustic screens and instrumentation of the Great Barrier Reef).

Keywords: ocean observations, biophysical, australia

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MS002 **Poster presentation** **4909**

Stabilization of energy exchange between Earth and its environment - space, is the main task to solve ecological problems of the planet

Prof. Ikram Kerimov
Scientific Centre of Seismology, Azerbaijan Director, Prof. Dr. IASPEI

Seymur Kerimov

1. IKRAM KERIMOV 2. Seymur Kerimov 1.ScientificCenterofSeismologyof the Presidium of NationalAcademy of Sciences, AzerbaijanRepublic2.Se ismotech Globe B .V., Netherlands The problem of global ecological changes is the most imp ortant and demanding for human so ciety today. All othe r problems appear non mate rial compared to cata clysms anticipated by scientists. The cause and consequence r elationship o f upco ming ca tastrophe as well as preve ntive measure s against it are explained and presented by us differently from those that exist currently in a scientific world. Our major conclusion says that for the last 50-60 years some processes on the Suns sur face have artificial character. The level of Sun radiation that hit the Eart h is artificially increased, and the energy exchange between the p lanet and sp ace its environment, is br ought out of balance. The planet i s tensed as a consequence of technogen processes, and such agitation is similar to source-tension adherent to a pre-earthquake period. S ome ti me ago, our con clusion regarding such pre- earthquake tensio n was instrumental in understanding of the earthquake mechanics. We realized that the earthquake zone is not only the source of seismic radiance, but a lso abso rbs wave energ y form the environment in a wide range of frequencies and amplitudes. Moreover, the further the processes develop the more and more energy it consumes from the environment. From the very moment of its inception, the source of tension behaves like a n energ y p ump that consiste ntly deve lops i t energy taken from the e nvironment, and, thus, accumulating energy in itself. Consumption of external energy leads, in turn, to increase of own vibro processes within a source and, conse quently, to ev en bigger consumption of e xternal energy. Hence, a peculiar auto- vibration system earthquake source energy field of Earth sets its elf up, which assists in creating a major im pact. We may presume that the effect when one space object is attracte d to other is explained not only but its gravitational fi eld, but its stressed state, own vibration processes, that increase or decrease it pulling force. Uncontrolled tech nogenic activity o f human race has lead to artificial agitation of the Earth, which is in a constant energy exchange with the space environment, and aided in bringi ng it in disbal ance and incr ease of space energy acquisition: as a re sult, artificially enlarged level of energy taken by the globe and decrease the level of released energy. Establishment of the international seismological and geophysical network would help to detect the so urces of mentioned induced neg ative processes, to manage the states of the medium and to step to stabilize and balance natural processes.

Keywords: global, planet, network

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MS002 **Poster presentation** **4910**

Overview of Seven Years of Spore Dosimetry Biomonitoring in Southern Brazil

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Pabulo Henrique Rampelotto, Andr Passaglia Schuch, Damaris Kirsch Pinheiro, Nobuo Munakata

In the last seven years, a monthly biomonitoring of solar radiation using spore dosim etry has bee n performed by the Exobiology and Biospher e Laborato ry fro m the Brazilian So uthern R egional Space Research Centre CRS/INPE, at the Southern Space Observatory SSO/ CRS/INPE, (29.4S, 53.8W), in So Martinho da Serra, RS, Brazil. Because a receiving of lowers ozone concentrations from Antarctica, know as ozones secondary effects as well a yea rly increa sing of the skin ca ncer cases in south of Brazil, questions about the real damages of the solar radiation on live systems has been constantly inquired. In this work, a c ollection of m onthly exposures involv ing S pore Inactivation Doses - SID (lethality of Bacillus subtilis strain TKJ6312) in correlation with UV radiation obta ined by Brewer sp ectrometry has presented values about r ~ 0.90. Therefore, the Sp ore dosimetry has been considered as a potential biosensor of the active biogenically radiation and presented a high sensibility to seasonal variations.

Keywords: exobiology biosphere, biomonitoring, spore dosimetry

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MS003 **4911 - 5054**

Symposium
Aerosols, Radiation and Clouds (IRC, ICCP, ICACGP)

Convener : Dr. George Isaac, Prof. Teruyuki Nakajima

The general uncertainties related to aerosols, radiation and clouds remain among the largest problems in understanding global climate and estimating global change. This symposium invites papers reporting on recent advances in scientific understanding achieved through improved measurements (e.g satellite remote sensing), field studies, parameterizations and numerical modeling, and climate simulations. Key topics are expected to include: 1) aerosol physics and chemistry, 2) radiation effects and interactions, and 3) clouds and cloud physics.

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MS003 **Oral Presentation** **4911**

Use A-train satellite data to study interactions between cloud, aerosol and precipitation

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Conventional remote sensing products of cloud and aerosol suffer from the following limitations for studying the aerosol indirect effects (AIE): 1) lack of synergy in observation time and location and mismatch can lead to false relationship; 2) aerosol optical depth is a column quantity, whereas retrieved cloud particle size represents a thin layer of cloud tops. 3) precipitation is often indirectly inferred from LWP with large uncertainties. These limitations may be overcome or lessened with the constellation of the A-train sensors by taking full advantage of the synergy between measurements made by, among others, MODIS, CLOUDSAT and CALIPSO. To demonstrate the concept, our study is limited to boundary layer water clouds. From the multi-spectral channels of the MODIS, we can retrieve the vertical profiles of cloud droplet effective radius (DER). Using the DER data, MODIS AOD, and CALIPSO aerosol extinction data, we will test a hypothesis that the AIE is more significant to the DER at the cloud bottom than at the top. In combination with CLOUDSAT, we will test another hypothesis that the DER and the AIE are dictated by the stage of cloud development. As such, simple correlation between aerosol loading and DER is not sufficient to reveal the real AIE. With the ample satellite data, we shall be able to differentiate clouds into different categories and study their AIE respectively. Towards achieve these objectives, new remote sensing algorithms will be developed.

Keywords: aerosol, cloud, precipitation

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MS003 **Oral Presentation** **4912**

Characterization of tropical convection in Southern India with wind profilers and scanning Doppler weather radar

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Radar Development Unit Director IAMAS

R. Rangarao, V. K. Anandan

Mass movement of convective storms app roaching Gadanki is monitor ed using the Doppler weath er radar (DWR), which have a coverage in excess of 400 km. Routinely, volume scan is performed using the DWR, to cover the height range of 20 km to l ook at the convective storms with the contiguous elevation steps of 10. The DWR produces t he moments of time series namely Z, V and s. The Indian MST radar located at Gadanki is a wind profiler used to measure both clear air velocities an d hydrometeor velocit ies in the limited exten d of 15 off-zenith, 10 km overhead at 20 km height. MST radar in terms of power spectra over that region as well as the moments data are collected continuously over the region. The vertical velocit ies uniquely meas ured by the MST ra dar gives a clear indication of convective activity. This in co njunction with the di fferent data products generated by the DWR like the vertically integrated liquid level an d constant altitude plan position in dicator at different altitude levels especially for r adial velocity a nd spectrum width also provides the signature of convective activity. The paper presents the results from the convection ca mpaigns conducted during September and October in 2002 and 2003.

Keywords: convection, mstradar, dopplerweatherradar

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MS003 **Oral Presentation** **4913**

Study of aerosol and cloud interactions over North Eastern China

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In this work aerosol and cl oud interactions o ver No rth Eastern Chin a are studied using surface meteorological data, aircraft data, and satellite data. Analysis of observed precipitation, MODIS data and meteorological sou nding data over eastern central Ch ina shows that the precipitation in this region is significantly reduced during the last 40 years and this reduction of precipi tation is strongly correlated to the h igh con centrations of aerosols. M eteorological sou nding data indicates that t he atmospheri c stability in the troposphere has been incr easing during the last 17 ye ars. It is spec ulated that t he aerosol layer in the lower troposphere aff ects the radiative processes, which lead t o changes i n atmospheric stability. The enhancem ent i n the atmospheri c stability tends to depress upward motion and precipitation in this regi on. Using a large amount of aircraft measu rements of cl oud droplet siz e distributions, the relationship between clou d spec tral relative dispersion and cloud droplet number concentration i s studied. The results indicate that th e value of cloud spect ral relative dis persion varies between 0.2 to 0.8 when the cloud drop let numbe r concentratio n is lo w (about 50 cm- 3), and converges to wards a narro w range o f 0. 4 to 0. 5 when the clo ud number co ncentration is higher . Because th e distribu tion of t he clou d droplet siz e is an i mportant parameter in estimating the first indirect radiative effect of aerosols on the climate system, the uncertainty in the corresponding radiative forcing can be reduced by 10-40% under high aerosol loading.

Keywords: aerosol, cloud, china

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MS003 **Oral Presentation** **4914**

Controlling Factors of Aerosol Radiative Forcing in Asia

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Toshihiko Takemura, Akiko Higurashi, Takashi Y. Nakajima, Kentarou Suzuki, Takamichi Iguchi, Daisuke Goto

We like to present a comprehensive analysis of data from UNEP ABC (Atmospheric Borwn Cloud)/ EAREX05 (East Asian Regiona l Experiment 2005) cond ucted in March-April of 2005 to study controlling factors of aerosol raditive forcing. For EAREX05 and planned EAREX07, multi-country scientists made an effort to establish a mo nitoring netwo rk o f atmo spheric bro wn clo uds, i. e., aero sols, and related atmospheric properties. Lidar, skyradiometer , and p yranometer have been set at t hese sites along with aerosol samplers. The analysis of data from these sites depicts systematic differences in the scale height of aerosol layer that can produce an error i n the ev aluated radiative for cing. The land surface albedo and the single scattering albedo of aerosol are also important parameters in our discussion.

Keywords: aerosol, radiativeforcing, abc

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MS003 **Oral Presentation** **4915**

Approximation of cloud drop distributions by analytical functions

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David Mechem, Zena Kogan

Cloud microphysical retrievals and parameterizations rely heavily on the knowledge of the shape of drop size distributions (DSDs). Many investigations assume that DSDs in the whole, or parts of the drop size range, may be approximated by known analytical functions. The most frequently employed approximations are gamma, lognormal, Khrgian-Mazin, and Marshall-Palmer type functions. At present, little is known about the accuracy of each of these approximations, especially their ability to successfully simulate the higher moments of the DSD. We present results from an evaluation of the applicability and accuracy of DSD approximations using a combination of lognormal and gamma-type functions for stratocumulus and shallow convective clouds. The DSDs are generated using the latest version of the CIMMS LES explicit microphysics model (SAMEX) in simulations of cases observed during the ASTEX, DYCOMS-II and RICO field projects. Special emphasis in the analysis is placed on the fidelity of representing the higher moments of the drop spectra, such as precipitation flux and radar reflectivity.

Keywords: clouds, microphysics, parameterization

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MS003 **Oral Presentation** **4916**

How much they are in confusion! surface temperature, solar global radiation, sunshine duration, cloud amount and pan evaporation over China

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Tadahiro Hayasaka, Sai-Chun Tan, Biao Wang, Shou-Guo Ding, Zhi-Hua Chen, Hui-Zheng Che

Trends in surface temperature, solar radiation, sunshine duration, cloud amount and pan evaporation over the mainland of China during the past 40 years from 1961 to 2000 were evaluated synthetically based on observations. The results show that the surface temperature increased, while ground solar global radiation, sunshine duration, cloud amount and pan evaporation decreased from 1961 to 1990 or so. However, a notable feature is that the decreasing trend of all the above parameters have been stopped and turned to an increasing in 1990 or so, which was called reversion by some researchers. Some paradoxes will be found from the trends of the above parameters during the past 40 years, which mean the analysis results delineate a contrary situation among the measurements. First, in general, the surface global solar radiation should increase with a decrease in cloud amount. Second, while surface temperature was increasing, pan evaporation increased. Finally, the temperature increased while the surface solar radiation decreased. The above paradoxes inspired us to explore the causes behind the phenomena from the various points of view, for example, the relationship between cloud amount and other radiative properties such as cloud optical depth and cloud height, etc., the indirect effects of aerosols on the climate, and other meteorological factors such as wind field. There may be some other reasons and further study is necessary to explain the above paradoxes in the future.

Keywords: solar global radiation, trend, china

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MS003 **Oral Presentation** **4917**

Potential Radiative Forcings to the Surface Shortwave Radiation

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Kazuaki Kawamoto

The global dimming and brightening of surface shortwave irradiance have been discussed for recent several years. The trend of surface shortwave irradiance over China for 1960s-2000 was studied with pyranometer data after the quality control processes, and the dimming and brightening properties were found also in China. The spatially averaged surface shortwave irradiance in China decreased by 15W/m2 until around 1990, and then increased slightly. We analyzed the factors such as clouds, water vapor, and aerosols related to the irradiance trend by applying a simple radiative transfer calculation with aerosol data published by scientific papers and cloud data of International Satellite Cloud Climatology Project (ISCCP). The sensitivities of shortwave irradiance due to possible changes in clouds, water vapor, and aerosols, which we define as potential radiative forcings (PRF) are dependent on the combination of changes in these factors. Therefore contributions of these factors to the radiative forcing must be evaluated quantitatively by considering the factors spatial and temporal variations. The results suggest that cloud optical thickness change is able to highly affect PRF while the effects due to cloud amount and water vapor change are quite small. Aerosol optical thickness change is also important even for cloudy sky conditions if aerosols are absorptive.

Keywords: aerosols, clouds, shortwave radiation

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MS003 **Oral Presentation** **4918**

Some Measurement Results Derived from 3 Aeronet Sites in Beijing

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X.H. Fan, X.A. Xia, P. Goloub, Z.Q. Li, P.C. Wang, W.X. Zhang

In order to monitor the aerosol loadings, to identify the anthropogenic and natural aerosols and their direct effects, and to validate the satellite remote sensing products in the Beijing region, three Aeronet sites have been set up at IAP/Beijing (39.97689 N, 116.38137 E; 92 m), Xianghe(39.75360 N, 116.96150 E; 36.0 m), and Xinglong (40.39639 N, 117.57833 E; 970 m) successively since April 2002, August 2004, and March 2006. These 3 sites, only about 70 to 130 km away from each other, are expected to be representative for different types and degrees of pollution. In this paper, monthly, seasonal and annual statistics of the aerosol optical thickness(AOT) at 440nm, Angstrom exponent and water vapor content derived from CIMEL sun photometers at three Aeronet sites in the Beijing region are compared and analyzed. Some preliminary results are summarized as follows: (1) The lifetime of atmospheric aerosols is short. In Beijing, AOT always breaks down after cold font pass or rainfalls, and then accumulates for a few days in the stable weather condition. Thus, mean daily τ_a440 exhibits large day-to-day variations in all seasons. (2) Beijing also shows a remarkable seasonal cycle of warm season peaks and cold season low values of τ_a440. At the same time, as one of metropolitans influenced by both local pollution and dust storm events from the north/west of China, high daily average τ_a440 (>1.5) occur during any time of the year. Monthly average τ_a440 are always high (>0.6) from March to October. The yearly mean τ_a440 is up to 0.70. (3) The annual cycle of Angstrom wavelength exponent showed a spring minimum associated with dust storms; however, the monthly mean α440 870 are always greater than 0.8 even for the peak dust season, suggesting that while desert dust contributions to total aerosol optical thickness are significant in spring, fine mode pollution aerosol contributes to the optical thickness during the entire year too. (4) The maximum of daily average α440 870 has a weak decreasing trend as τ_a440 increases. (5) Since water vapor can be condensed on hygroscopic aerosols, there are positive correlations between the water vapor content and AOT in four seasons.

Keywords: aerosol, optical, properties

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MS003 **Oral Presentation** **4919**

Column-integrated aerosol optical properties and aerosol effects on surface solar radiation in eastern China

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Z. Li, P. Wang, H. Chen, M. Cribb

One years worth of aerosol a nd surface sola r radiation data from September 2005 to August 2006 are obtained at Taihu, the second super site of E ast Asian Study of Tropospheric Aerosols: an International Regional Experiment (EAST-AIRE). Aeros ol optical properties are derived from observatio ns by a CIM EL sun p hotometer. The aerosol data are used togeth er with surface i rradiance data to estimate quantitatively aerosol effects on surface s hortwave radiation (SWR) and photosynt hetically active radiation (PAR), which is fulfilled using a par ameterization method. Annua l aerosol optical depth at 500 nm is 0. 78 an d ann ual Angs trom wavelength expo nent is 1. 21. Aero sol single scattering albedo and aerosol asymmetry factor in the visible is 0.93 and 0.71, respectively. Both parameters are moderately larger than corresponding ret rievals in north ern China. A nnual mean aerosol direct radiative forcing at the surface (A DRF) is 40.2 W m-2 and 2 0.0 W m-2 in the shortwave and in the visible spectrum , respectively. A distinct seasonal ADRF pattern is re vealed. The seasonal ADRF is 48 .0, -40.2, -40.5 , -32.6 W m-2 in spring, summer, fall and winter in the shortwave. It is -24.2, -20.5, -19.7, -15.4 W m-2 in the visible spectrum. Seasonal ADRF in the shortwave per unit AOD vari es from 50 W m-2 in winter to 68 W m-2 in summer. Aerosol direc t radiative forc ings estimated from observations are in god agreement with calculations using a radiative transfer model.

Keywords: aerosol, forcing, china

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MS003 **Oral Presentation** **4920**

Optical properties of trade-wind cumuli: observations and modeling

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ICCP ICCP IAMAS

Sally Mcfarlane, Joanna Slawinska, Hanna Pawlowska

Optical proper ties of sh allow warm c louds, su ch as stratocumulus an d shallow cu mulus, play an essential role in the Earth's radiative balance. Su ch clouds are more important th an deep clouds because the reflection of solar radiation by shallow clouds by far outweig hs their effect on the thermal radiation. Mor eover, it is well established that clim ate sensitivity in various climate models is tie d primarily to ch anges of these sha llow clouds. Cloud depth and local va lues of the liquid water content (LWC) and eff ective radius (re) are relevant parameters. Because these clouds are signi ficantly diluted by entrainment, microphysical transformations resulting from cloud dilution is the ke y issue. This pa per will first prese nt results from ground-based remote sensing of optical pr operties of tra de-wing cu muli over the Naur u ARM site usi ng the techniq ue develo ped in McFarlane et al. (J. Geophys. Res. 2002). The d ata s how that cumuli over Naur u a re indeed significantly diluted and that the effective r adius shows large spatial variability, with the frequency of occurrence relatively narrow near t he cloud base, and gradually widening aloft. Available colu mn data for LWC and re allow derivation of the pdf of the optical thickne ss. The pdf s hows that clouds with optic al thickness in the range 5 to 10 are mos t frequent, but there is a long tail with thickne sses up to 100. In the second part, results from large-eddy simulations of trade-wind cumuli, wi th the emphasis on t heir optical pr operties, will be discussed. The results are in general agree ment with the observations and they confi rm critical r ole of microphysi cal transformations during entrainment and mixing for the mean optical properties of a cloud field.

Keywords: cumulus, radiation, observations

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MS003 **Oral Presentation** **4921**

A regional climate chemistry model and its preliminary application on effect of the tropospheric sulfate and ozone on cliamte of China

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L Zhang, S Li

The regional climate model (RegCM) and a tropospheric atmosphere chemistry model (TACM) was coupled, thus a regional climate chemistry model system (RegCCMS) was constructed, which was applied to investigate spatial and temporal distribution of tropospheric ozone and sulfate aerosol, radiaitive forcing as well as their climatic effect over China. TACM was designed on the basis of a regional acid deposition model(NJURADM) with modified gaseous chemistry, including improved chemical mechanism, prediction-correction quasi- steady-state approximation algorism with high precision and efficiency and time-varied photodissociation rate. Investigations show that the maximum of monthly average surface tropospheric ozone and sulfate aerosol in summer were 125 ppb and 8 μg/m3, respectively. The average direct radiative forcing due to sulfate aerosol is 0.92 W/m2, which is strong in three regions over Southwest, South and East/Central China. The average indirect forcing of sulfate aerosol was 0.2 W/m2, showing strong value along coastal regions of China. The average climate forcing of tropopheric ozone is 0.39 W/m2. In some regions of China, both sulfate aerosol and ozone show strong forcing than IPCC(2001) reported. In general, the warm effect of ozone is much weaker than that of sulfate aerosol, therefore, the net forcing is negative, which cools the average surface air temperature about 0.2˚. The air temperature shows strong reduction over Southwest China, where cooling of 0.57˚ is found due to the bi-effect of sulfate aerosol and ozone.

Keywords: sulfate, ozone, climate effect

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MS003 **Oral Presentation** **4922**

Bulk microphysics schemes suitable for assessing the indirect impact of atmospheric aerosols

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Clouds and their impact on transfer of solar and Earth's thermal radiation are the most challenging aspect of climate and climate change. This is because interactions between radiation and clouds involve microscopic properties such as phase (i.e., liquid versus solid), size, and concentration of cloud and precipitation particles. With the advent of cloud-resolving and "superparameterized" general circulation models, representation of cloud microphysics becomes the key issue. Arguably, new approaches are needed for cloud microphysics that on one hand are computationally feasible (such as bulk schemes), but on the other provide information not only on the mass of cloud condensate and precipitation (i.e., their local mixing ratios), but also on particle sizes, the latter important for the radiative transfer. This paper will first present development and validation of a two-moment bulk microphysics scheme for warm clouds, with the emphasis on droplet nucleation, drizzle/rain development, and transformations due to entrainment and mixing. The latter has recently been shown to have critical impact on mean properties of a cloud field, such as the area-averaged albedo. In the second part, a new two-moment three-variable bulk ice scheme will be discussed, with the emphasis on a novel approach to represent diffusional as well as riming growth of the ice particles. Both these schemes are being developed with the overall goal to apply them in numerical simulations aiming at quantifying indirect effects of atmospheric aerosols in "superparameterized" general circulation models.

Keywords: microphysics, indirect effects

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MS003 **Oral Presentation** **4923**

Tropical high clouds: variations and radiative effects

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This study uses measurements of multiple Tropical Rainfall Measuring Mission (TRMM) sensors, namely Clouds and the Earths Radiant Energy System (CERES), TRMM Microwave Imager (TMI) and Visible and InfraRed Scanner (VIRS), during January to August 1998 to estimate variations and radiative effects of tropical oceanic high clouds including both deep convective systems (DCSs) and individual cirrus clouds (ICCs). The variations and interrelationships of DCSs and ICCs are very complicated. There is little or even negative correlation between occurrences of ICCs and DCSs in small spatial and short temporal scales, in which the two types of clouds cannot grow and expand simultaneously. When spatial and temporal domains are increased, ICCs become more and more dependent on DCSs because the origination of many ICCs and the moisture supply in the upper troposphere for ICCs to grow are from DCSs, resulting in significant positive correlation between the two types of tropical high clouds in large spatial and long temporal scales. This result suggests that the decrease of tropical high clouds with sea surface temperature (SST) from some model simulations is likely caused by restricted spatial domains and limited temporal periods. This study also finds that both precipitation and rainfall efficiency increase with SST. Despite increasing rainfall efficiency, the cloud area coverage rises with SST at a rate of ~2.8%/K in tropical oceans. Large increases in the boundary layer moisture, accompanying more moisture transported to the upper troposphere for cirrus-anvil cloud formation, may be a key reason for the high cloud change. The radiative feedback owing to the change in the tropical high cloud area coverage with SST appears small and only about 0.14 Wm-2 per Kelvin. These results may have great potential in testing current climate models.

Keywords: clouds, rediation, precipitation

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MS003 **Oral Presentation** **4924**

Temporal and chemical variability of aerosols at a rural area in Canada

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An air quality study was conducted at a suburban- rural site in Quebec, Canada duri ng the summe r (June-July) an d fall (October -November) of 2006, wi th a focus on the aerosol chemica l composition, physical properties and their relationship to the gas phase ammonia. The site was located in a rural area about 60 km upwind (under typical meteoro logical co nditions) of a ma jor urban centre. Submicro n aerosol partic les were sampled for their chemical co mposition and chemical size distrib ution using an Aerodyne Aerosol Mass Spectrometer with a high re solution time-of-fl ight mass spectrometer (HR-T oF AMS) on a 10-min time resol ution. Particle number size distribution was measured using a TSI Scanning Mobility Particle Sizer (SMPS) at a 5 min res olution. Particle mass measurements were c onducted using a TEOM run ning at 5 min resolution. Gas phase me asurements of NH3 were made using a modified TECO NOx sys tem that converts NH3 to NO for dete ction. The results from the study show that the chemical comp osition of aero sols is highly depend ent on air mass history. Air masses with the most urban influence, consisted of organic material co ntributing approximately 2/3 of the total particle mass, followed by sulfate, nitrate an d ammonium. Furthermore, the results indic ate that agriculturally emitted NH3 has meas urable impacts on the chemical constituen ts of the particles, and in regional episodes the impact is the s trongest. A recently develope d princi pal component analy sis tool is applied to the AMS data to deline ate the covari ance of the i ndividual m/z fragments. This an alysis r esulted in the deconvolution o f fo ur majo r co mponents that can be cha racterized as mostly sulfate but co ntaining some organics, a nitrate component that also co ntains some organics, an oxygenated organic component, a nd a n on-oxygenated organic compon ent. Interpretations of re lative c omponent mass spectra and possible processes involved in their formulation will be discussed.

Keywords: aerosol, chemistry, pca analysis

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MS003 **Oral Presentation** **4925**

The Pacific Dust Experiment (PACDEX): Overview of the experiment and summary of missions

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The Pacific Dust Experiment (PACDEX) is an airborne experiment designed to follow the atmospheric transport of dust and pollution across the Pacific Ocean during a spring dust event during April and May of 2007. PACDEX will utilize the NCAR/NSF G-V aircraft as a primary sampling vehicle, with supporting information from ground and satellite data. The experimental plan makes use of long-range multiple aircraft missions to sample portions of the dust and pollution at various travel times from the source over a one week period. In addition to characterizing the aerosol, trace gas, and radiative properties of the plume, PACDEX will examine the interaction of the plume with both cold and warm cloud regions by using in situ sampling of ice and water size distributions, together with measurements of Cloud Condensation Nuclei and Ice Nuclei near the clouds. Several numerical models will be used for both forecasting and in post-mission studies to explore the evolution of the plume and its interaction with clouds. This is the first time that a dust event will be sampled just before a dust event and across its entire transection across the Pacific Ocean. Hence, we hope to obtain unique insights in to long range transport of dust and soot and their impacts on clouds and radiation in the Pacific Ocean and North America. In this presentation we describe (a) the science team for PACDEX and their roles in the project, (b) An overview of the major instruments and data products, (c) a summary of the missions that were accomplished, and (d) An overview of preliminary results and observations from the project.

Keywords: dust, pollution, clouds

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MS003 **Oral Presentation** **4926**

Aerosol Pollution Impact on Precipitation

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Over the past fifty years a great deal has been lear ned about the role of aerosol pollution in modifying clouds. It is clear that increased CCN from polluti on leads to increased drop concentrations and in ma ny cases to a de crease in drop let sizes. However, the link between these changes and the resulting precipitation on the ground has been more difficu lt to quantify. The few measurements that are available cann ot always sep arate the effe cts of me teorological fact ors from th e micr ophysical on es. There are a f ew recent pape rs suggesting that poll ution suppresses orographic precipitation. On the other hand, a number o f studies in urban regio ns show little correlation be tween air po llution and precipitation or in some cases increases in prec ipitation d ownwind of ur ban areas. In 2003 the WMO and IUGG recognized the potential danger of decrea se in precipitation due to aerosol pol lution and passed resolutions aimed at focusing attention to this issue. As a follow up to this resolution the WMO and IUGG for med an intern ational forum composed of a number of ex perts to review the state of t he science and to identify areas that need further stud y. In February 2007 a final report on this subject was submitted to the WMO and to the IUGG. This lectur e will outline some of the finding s and some of the recommendations.

Keywords: aerosols, precipitation, clouds

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MS003 **Oral Presentation** **4927**

Solar brightening over Europe a consequence of strong aerosol decline is coming to an end

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The rapid temperature increase of 1 C over mainland Europe since the 1980s is considerably larger than expected from anthropogenic greenhouse warming. Solar radiative forcing, recentl y termed solar brightening, a nd water vapo ur feedback, apparently adde d to the temperature rise. Here we show evidence for a substantial decline of aer osols above Europe, which led to a significant increase of solar radiation reaching the ground. Aerosol optical depth (AOD) measurements at six rural locations from the North Sea to the central Alps, show aerosols de creasing by more th an 60 percent since 1986 a nd presently stabilizing at very low AOD levels. Concurrent, solar radiation measured under cloud-free skies averaged over twenty-five Swiss radiation stations below 1000 m a.s.l., shows statistically significant increase of 0.8 0.4 Wm-2decade-1 between 1981 and 2005, which reduces after 1995. The strong AOD decline and co nsequent solar brightening is respo nsible for about 20 to 40 percent of the temperatur e rise since 1980, whereas the observed current aerosol stabilization brings solar brightening to an end, and will likely reduce future temperature rise to levels congruent with greenhouse warming.

Keywords: aerosol trends, radiative forcing

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MS003 **Oral Presentation** **4928**

Kinematic collision statistics in a turbulent suspension of sedimenting inertial droplets

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Over the last 10 years, quite a few studies have emerged in both engineering and atmospheric literature concerning the collision rate of particles in a turbulent flow. These studies suggest that the collection kernel of cloud droplets can be enhanced by several effects of air turbulence, including (1) the enhanced relative motion due to differential acceleration and shear effects; (2) the enhanced average pair density due to local preferential concentration or clustering of droplets; (3) the enhanced settling rate by turbulence; and (4) the enhanced collision efficiency. Although with a deliberate effort to accurately represent the dissipation-range background turbulent flow, most of the studies in the engineering literature, however, have failed to address the problem within the relevant parameter space. For the cloud droplets, the two key physical parameters are the droplet inertial response time and the still-fluid droplet terminal velocity. With respect to the dissipation-range motions of the underlying turbulent flow, the nondimensional settling velocity is typically one order of magnitude larger than the nondimensional inertial parameter (i.e., the Stokes number). This implies that the gravitational sedimentation determines the interaction time between the cloud droplet and the small-scale flow structures. Most of the published results on droplet clustering and collision rate from numerical simulations and theoretical studies have assumed no sedimentation, and as such are not directly applicable to cloud droplets. Here we analyze the statistics of droplets suspended in a simulated turbulent flow with nondimensional settling velocity and Stokes number similar to cloud droplets. These include single-droplet statistics such as the mean settling velocity and velocity fluctuations of droplets, and pair statistics such as radial relative velocity and radial distribution function (both at contact and at finite separation). Specifically, we will quantify the relative enhancement of these collision-related properties by air turbulence. The main focus is how the statistics behave with a strong gravity effect and a finite inertial effect. The numerical results will be compared to available experimental observations.

Keywords: collision coalescence, collision kernel, kinematic statistics

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MS003 **Oral Presentation** **4929**

Tripleclouds: an efficient method for representing cloud inhomogeneity in 1D radiation schemes by using three regions at each height

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Clouds play an important role in the radiation budget of the earth, and hence reasonable representations of clouds in weather and climate models are imperative if they are to provide realistic forecasts. Despite this, general circulation models (GCMs) tend to use the plane-parallel approximation in their cloud schemes. This divides each vertical level into two regions: one containing the cloud as a homogeneous block, and the other containing the clear sky. Neglecting the cloud inhomogeneity is known to have significant effects on the way the clouds interact with radiation. Here, we propose a new, alternative method of representing inhomogeneity in clouds that is appropriate for use in a GCM and only slightly increases computer run time. Known as Tripleclouds, the clouds in each vertical level of a model gridbox are represented by three regions as opposed to two. Two of these regions represent the cloud: one represents the optically thinner half of the cloud, while the other represents the optically thicker half. The third region is used to represent the clear sky. The performance of this new method is tested and calibrated using data from the 94GHz vertically-pointing radar at Chilbolton. Its sensitivity to GCM-relevant quantities, such as vertical resolution, horizontal gridbox size and solar zenith angle, are also investigated. The Tripleclouds method is then compared to more traditional methods: namely, the plane-parallel method, and a scaling factor method, which uses the plane-parallel approximation and then multiplies all the optical depths by a constant factor. Tripleclouds is found to significantly reduce the biases introduced by using the plane-parallel method, and is also found to be applicable for a range of different vertical resolutions, horizontal gridbox sizes and solar zenith angles. It is also found to halve the random errors from other methods such as the scaling factor method, and does not suffer the effects of random noise, as in the Monte-Carlo Independent Column Approximation.

Keywords: inhomogeneity, overlap, bias

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MS003 **Oral Presentation** **4930**

Transformation of aerosol chemical composition during transport over East China Sea

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East Asia is one of the regions emitting atmospheric pollutants due to the increase of energy consumption, which cause the high concentration of aerosol in this region. In order to study aerosol concentration and its chemical transformation around the East China Sea region, we set up two aerosol mass spectrometers at Fukue (32.8N, 128.7E) and Cape Hedo(26.9N, 128.3E), in the west side of Japan, and monitored aerosol simultaneously in the spring of 2006. At the same time we measured aerosols using a filter sampling method at Qingdao (36.5N, 121E), too. Back trajectory shows that sulfate was high when air mass transported over East China Sea from China, while it was relatively low when air mass transported from Pacific region. The concentration is primarily determined by the air mass history and the residence time in the region where air mass passed (regions considered here are China, Japan, Korea, South East Asia and Pacific Ocean regions). At both Fukue and Cape Hedo, the major chemical compositions are sulfate and organics in fine aerosol. The ratio of organics to sulfate in fine aerosol was higher than unity at Fukue while it was lower than unity at Cape Hedo. This indicates that chemical composition was very different in the southern part from in the northern part of East China Sea, which might affect the formation of clouds. Among the back trajectories, we picked up air masses which reached Cape Hedo via the Fukue region. For these air masses, sulfate concentration and SO2 mixing ratio at Fukue and Cape Hedo were compared with respect to the transport time of air mass from Fukue to Cape Hedo. (This is a sort of Lagrangian analysis of chemical transformation during transport.) The results show that sulfate increased while SO2 decreased. This indicates that conversion of SO2 to sulfate occurred during transport in the same air mass. We have shown the aerosol aging through our observation using a Lagrangian analysis.

Keywords: eastchinasea, chemicalcomposition, ams

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MS003 **Oral Presentation** **4931**

A global view of aerosol indirect radiative effects on clouds and climate

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Aerosols affect climate dire ctly by scattering and absorption of sh ortwave an d th ermal radiation . In addition, aerosols modify the radiation budget indirect ly by acting as clo ud condensation nuclei and ice nuclei (Lohmann and Feicht er, 2005). The cloud al bedo enhancemen t (Twomey ef fect) of warm stratiform clouds refers to an increase in cloud droplet number concentration for a constant liquid water content that increases cloud albedo. In addi tion to the cloud albedo effe ct, the more and smaller cloud droplets in polluted stratiform clouds decrea se the precipitation formation, presumably increasing cloud lifetime. Both of them parti ally set off gr eenhouse gas warming. Be cause clouds in mid-latitude s originate predominately via the ice phase, changes of t he properties of ice nuclei are of crucial importance for the hydrologi cal cycle. An i ncrease 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 gr ow in an enviro nment of high supersatur ation with respec t to ice, quickly reaching preci pitation size, and with that can tu rn a non-precipitating into a pre cipitating clou d (glaciation effect). In this ta lk, I will discus s the multitude of aeros ol e ffects on cl imate. Reference: Lohmann, U. and J. Feichter, 2005: Global indirect aerosol effects: A review. Atmos . Chem. Phys., 5, 715-737.

Keywords: indirect aerosol effects, climate modellierung, aerosol radiative effects

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MS003 **Oral Presentation** **4932**

Atmospheric Radiative Heating Under Different meteorological Condition

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Bing Lin

By considering cloud properties and meteorological parameters, Cloud and Earth Radiant Energy System (CERES) project estimates radiation at top-of -atmosphere (TOA) and surface using measurements from its three broadband channels. From these fluxes, ATMOsphere radiation (ATMO) fluxes, especially those under different cloud types and clear sky, ar e estimated in current study. Clouds are classified into nine types (deep convection, cirrostratus, cirrus, nim bostratus, altostratus, altocumulus, stratus, stratocumulus,and cumulus) base d on cloud top press ure and optical depth as defined by the International Satellite Cl oud Climatol ogy P roject (I SCCP). CERES Single Satellite Fo otprint (SSF) data product with cloud and radiation information are used in this study. The global mean for ATMO is about -115W/m^2. Under high an d thick clouds, the A TMO fluxes are muc h higher a nd re ach more tha n 150W/m^2. High and thick clouds usually ar e ice or ic e over water cloud s. They reflect more radiation back to the sp ace. Therefore, there are les s net ra diation fluxes at TOA and s urface, but they ret ain more ATMO due to lim ited transmission through these clouds. The ATMO differences calculated between cloudy and clear conditions within each 1 by 1 degree grid boxes show clearly the atmospheric heating and cooling effects for high a nd low clouds, respectively. The mid dle level clouds do not show significant effects compared to clear skies. The di urnal variatio ns and regio nal differences are also studied.

Keywords: radiative, heatflux, cloudtype

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MS003 **Oral Presentation** **4933**

Towards the Evaluation of Cloud-Aerosol Interactions using Super-Droplet Method

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Towards the quantitative evaluation of the indirect aerosol forcing on the climate change, we are extending and verifying Super-Droplet Method. Super-Droplet Method is a novel, particle-based simulation model of cloud microphysics, which is able to readily and efficiently incorporate various processes of cloud microphysics, such as, several sorts of soluble/insoluble CCNs, and their chemical reactions. In this talk, we will present the recent progress and our future prospects.

Keywords: super droplet method, cloud resolvingmodel, cloud microphysics

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MS003 **Oral Presentation** **4934**

Aerosol Processing in Mixed-Phase Clouds

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Ulrike Lohmann, Ernest Weingartner

Cloud droplets con densate on aerosol particles an d can scave nge further interstitial particles via collisions. Aqu eous-phase chemistry modifies the comp osition of these clou d-borne pa rticles, e.g. by sulfate production in the liquid phase. The c loud droplets can either form precipitation a nd remove the cloud-borne pa rticles from th e atmosphere, freeze to ice crystals, or evaporate and re lease the cloud-borne particles back to the i nterstitial phase. Thes e processes modify the aerosol size distribution. In mixed-phase clouds, many droplets evapor ate when freezing sets in (Bergeron-Finde isen process), which reduces the fraction of activated par ticles. We have incorporated a representation of in-drople t and in-crystal particles into the aerosol-climate model ECHAM5-HAM, a model that predicts aerosol mass and number concentrations and the aerosol mixing state (Stier et al., 20 05). It is coupled to a double-moment cloud microphysics scheme (Lohma nn et al., 2007). Single colum n model studies for different cases of the CLACE campaigns in the Swiss Alps (Verheggen et al., 2006) investigate the differences in aerosol pr ocessing in mixed-phase clouds with lo w, medium and high ice mass fractions. The mod el results are compared to the measured total and inters titial aerosol size distributions and fractions of activated particles (Henning et al., 2004). References: S. Henning et al., Aerosol partitioning in natur al mixed-phase clouds, Geophys. Res. Lett. 31 (L06101), doi: 10.1029/2003GL019025 (2004) U. Lohmann et al., Cloud microphysics and aerosol indirect effects in th e global climate model ECHA M5-HAM, manu submitted to Atmos. Chem. Phy s. (2007) P. Stie r et al ., The aerosol-climate model ECHAM5-HAM, Atmos. Chem. Phys. 5, 1125-1156 (2005) B. Verheggen et al., Aerosol activation in mixed phase clouds at the high alpine site Jungfraujoch, manu submitted to J. Geophys. Res. (2006)

Keywords: aerosols, clouds

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MS003 **Oral Presentation** **4935**

EARLINET-ASOS, an european research infrastructure for the aerosol study at continental scale

Dr. Gelsomina Pappalardo
CNR-IMAA CNR-IMAA

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At present, the knowledge of the ae rosol distribution is not sufficient to properly estim ate the role of aerosols in cha nges of the global and regional en vironmental conditions and climate. The improvement of the observation system for aerosols will provide a high co ntribution to almo st all ar eas of societal benefits listed in the GEOS S (Global Earth Observ ation System of Systems) Implementation Plan. Advanced laser remote sensing is the most appropriate tool to close the observational gap, because it is in particular the information on the vertical distribution that is lacking. EARLINET, the European Aerosol Research Lidar Network, is the first aerosol lidar ne twork, established in 2000, with th e main goal to provide a comprehensive, qu antitative, and statistically significant data base for the aerosol d istribution on a continental scale. EARLINET is a coordinated network of stations using advanced lidar methods for the vertical profiling of aerosols. At present, 25 stations distributed over Europe are part of the network. The network activity is bas ed on scheduled meas urements, a rigo rous quality a ssurance pro gram addressing both instruments and evaluation algorithms, and a standard ised data exchange format. All the network stations perform measurement s simultaneously at three fixe d dates a wee k, so allowing to collect unbiased data. Lidar observations are routinely performed on a re gular schedule of one daytime measurement per week around noon, when the boundary layer is usually well developed, and two night time measurements per week, in low backg round light conditions, in order to perform Raman extinction measurements. Further observations are de voted to monitor special events such as Saharan dust outbreaks, forest fires, ph otochemical sm og an d volcan o eru ptions. EARL INET-ASOS (Advan ced Sustainable Observation System) is a five ye ar EC Project started on 1 March 2006. It is based on the EARLINET infr astructure and will contribut e to the impro vement o f continuing o bservations an d methodological developments that are urgently needed to provide the multi-year contine ntal scale data set necessary to assess the i mpact of aerosols on the European and global environment and to support future s atellite missions. The main objectives of the EA RLINET-ASOS project are: - to extend the development of the European Aerosol Res earch Lida r Network as a world- leading instrument for th e observation of the 4-dimensional spatio-temporal distribution of aerosols on a continental scale; this will result in accurate, well -defined, and easi ly accessible data pr oducts to be used in science an d environmental services. - to enhance the operation of the network with the aim to foster aerosol-related process studie s, validation of satellite sensors, model d evelopment and validation, assimilation of aerosol data into operational models, and to bu ild a compreh ensive climatol ogy of th e aerosol distribution. Acknowledgments The financial suppo rt o f this wo rk by the European Commission under grant RICA-025991 EARLINETASOS is gratefully acknowledged.

Keywords: aerosol, lidar, network

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MS003 **Oral Presentation** **4936**

Cloud forcing in coupled climate models: dignosis of problems and a way forward

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The study exa mines links bet ween radiative properties of clouds and e nvironmental va riables that ar e measured globally. In particular, we consider as pr edictor variables upper tropospheric humidity (UTH), precipitable water (PW), and static stability (SS), with respect to longwave and s hortwave components of cloud radiative forcing (C RF). The satellite ob servations are subdivi ded into regimes based on predictor varia bles, as has been done in several re cent studies using ve rtical velocity and sea surf ace temperature (SST). The two humidity variables are very skillful in disc riminating SW and LW clo ud forcing, and the joint distribution of PW and UTH is also relatively compact. The results are compared to those from a r epresentative subset of IPCC AR4 GC M calculations, in wh ich UTH is sa mpled in a way equivalent to that of the satellites providin g the observed data. The simulated and observe d relationships between CRF and the humidity variables ar e found to differ significantly, especially for the NCAR CCSM3, indicating likely problems in m odel representations of ph ysical processes. Regions of l ow UTH but high PW are also much too abundant, and contribute strongly to an overall negative bias of net CRF. We also examine doubled-CO$_2$ simulations and discuss implications of the r esults for cloud feedback.

Keywords: cloud forcing, climate sensitivity, climate models

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MS003 **Oral Presentation** **4937**

Shortwave radiative impacts from aerosol effects on marine shallow cumuli

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The net shortwave radiative impact of aerosol effects on model-simulated shallow marine Cumulus fields is investigated. Increased aer osol concentrations are associated not only with smaller dr oplet sizes but also reduced cloud fractions and cloud dim ensions resulting from a pos itive entrainment- evaporation feedback. The two counteracting radiative impacts resu lt in a net negative shortwave cl oud forcing (i.e. a cooling) that increases by -13 to -20 W m^-2 per 1000 cm^-3 increase in aerosol concentration, depending on solar zenith angle. Although the first (Twomey) aerosol indirect effect is dominant, the reduction in cloud fraction re duces th e magn itude of th e cooling from one-half to t wo-thirds of th at from the Two mey effect alo ne. This is a significant enough reduction that cl oud frac tion redu ctions should be considered in tandem with the Twomey e ffect because both eff ects depend on droplet size. Three-dimensional radiative transfer effects can alter the fluxes by 10% t o 20% fr om values calculated at the pixel level using plane-parallel radia tive tran sfer theory. Cloud s usceptibility values were not strongly affect ed by three-d imensional radiative transfer effects, however. A popular two-stream radiative transfer approximation to the susceptibility was found to perform well, encouraging the use of satellite reflectance data for quantifying the susceptibility of these small clouds.

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MS003 **Oral Presentation** **4938**

Warm rain microphysics parameterisations that include the effect of turbulence

Dr. Charmaine Franklin

The effect of turbulence on warm-rain initiation, specifically the conversion of cloud droplets to rain drops, has long been recognised as an important problem in cloud physics. Recently a cloud droplet collision kernel has been developed that includes the effects of turbulence on small collector droplets in turbulent flow (Franklin et al. 2007, JAS). The effect of turbulence on the droplet collision kernel increases with both increasing radius ratio of the interacting droplets and with the eddy dissipation rate of turbulent kinetic energy. These increases range from fairly modest values to almost 10 times the gravitational geometric collision kernel. The effect of turbulence is significant on the microphysical properties of clouds; using the turbulent kernel in solutions of the stochastic collection equation with a liquid water content of 1 g kg-1 and an initial mean droplet radius of 10 microns, shows that after 30 minutes 17% of the mass is contained in drops with radii greater than 100 microns for a flow with a mean dissipation rate of 100 cm3 s-2 and this increases to 52% for a dissipation rate of 1500 cm3 s-2, compared to only 6% for the purely gravitational case. An autoconversion parameterisation has been developed by solving the stochastic collection equation with the turbulent collision kernel for a wide range of liquid water contents, number concentrations and relative dispersions of the drop size distribution. The new parameterisation agrees well with other existing models for high liquid water contents and consequently high autoconversion rates. A well known problem with many autoconversion parameterisations is the large underestimation of the autoconversion rate for low liquid water contents; the new model tends to overcome this problem and produces higher autoconversion rates than many of the existing models for cases with low liquid water contents. Parameterisations that include the effect of turbulence have also been developed for the cloud water conversion rate due to accretion and the rate of change of the number concentrations of cloud droplets due to the processes of autoconversion, accretion and self collection.

Keywords: cloud microphysics, turbulence, autoconversion

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MS003 **Oral Presentation** **4939**

Observational evidence for the radiative impact of aerosols in modifying the sea surface temperature

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A large aerosol plume was formed over the eastern part of tropical Indian Ocean during September-November period of 1997 because of the transport of smoke aerosols from the intense forest fires occurred over Indonesia due to the increased dryness caused by meteorological anomalies associated with the most intense ElNino of the 20th century. The effect of this plume on the radiation balance in this region is studied using the aerosol optical depth (AOD) derived from NOAA-AVHRR data during this period and a smoke aerosol model developed by integrating the insitu observations of aerosol properties during this smoke event reported in the literature, with the properties of different aerosol species obtained from the OPAC model. Over the equatorial Indian Ocean east of ~90E the AOD is greater than 0.7 during September 1997. By October, the smoke aerosol plume started advancing towards west when AOD exceeding 1.0 is observed upto ~80E in the equatorial region. The decay of the plume started by November, even though AOD exceeding 0.7 is widely observed over the eastern tropical Indian Ocean in this month also. The AOD over the region resumed its normal value (<0.2) by December. Regional distribution of the aerosol direct radiative forcing (ADRF) is estimated using the AVHRR-derived AOD and the SBDART radiation transfer model, incorporating the radiative properties of smoke aerosols. Over the eastern tropical Indian Ocean, the monthly mean ADRF at the surface increased from about 50 Wm-2 in September to about -100Wm-2 in October and later decreased to about 70Wm-2 in November. Clearly, these extremely high values of ADRF will substantially reduce the surface heating and hence should reflect in the sea surface temperature (SST). However, as a result of the Indian Ocean dipole phase, SST over the easternmost parts of tropical Indian Ocean was already below its normal value by about 1-2 K since July 1997. However, a significant decrease in SST (by ~2 K) compared to September is observed during October 1997 over the eastern tropical Indian Ocean, which appeared like a cold pool extending westward from the coast of Sumatra. The spatial distribution of this cold pool matches well with the spatial distribution of high ADRF at the surface. A similar feature with relatively lower intensity is observed in November 1997 also. By December 1997, the cold pool reduced substantially. It is important to note that while the exact magnitude of the decrease in SST caused by the large ADRF alone might be difficult to assess because of the influence of various other features such as the ocean circulation, phase of Indian Ocean dipole, the thermal inertia of the ocean, and wind stress, the present observations unambiguously provide a direct evidence for the impact of ADRF on SST. The reduction SST associated with the increased ADRF might have also contributed positively for the intensification of the positive phase of Indian Ocean dipole.

Keywords: aerosol radiative forcing, sea surface temperature, indian ocean

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MS003 **Oral Presentation** **4940**

Rotational Raman Lidar measurements for the characterization of stratosphere-troposphere exchange mechanisms

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Donato Summa, Rossella Ferretti

A UV Raman lidar system (B ASIL) is operational at DIFA-Univ. of Basilicata (Potenza-Italy). The system was recently involved in LA UNCH 2005 the Intern ational Lindenberg campaign for assessment of humidity and cloud profiling systems and its impact on high- resolution mo delling - held fro m 12 September to 31 October 2005. During this period BASIL collected approx. 250 hours of measurement s distributed over 13 Intensi ve Observation Peri ods (IOPs) and 25 days. One sp ecific IOP was continuously run between 1-3 Octo ber 2005, covering a dry stratosphe ric intrusion episode associate d with a tropopause folding event and the subsequent onset of perturbed weather co nditions that leaded to the development of clouds and precipitations. Tropopause folds are the domi nant and most efficient mechanism of stratosphere-troposphere exchange (S TE) in th e middle latitu des [1]. In truding stratospheric air forms filame ntary features in ozone and water vapour profiles [2]. The use of water vapour to trace intruded stratospheric air al lows to clearly identify a dry structure (approx. 1 km thick) originated in the stratosphere and descending in the free troposphere down to ~ 3 km. A similar feature is present in t he temperature field, with lower temp erature values observed within the dry air tongue . Relative humi dity measure ments reveal values as small as 0.5-1 % within the in truded air. Th e stratospheric origin of the observed dry layer has been verified by the application of a Lagra ngian trajectory m odel. The subsidence of the in truding heavy dry air is m ost probably resp onsible for the gravity wave activity observed beneath the dry laye r. Lid ar measureme nts have been compared with forecasts from a MM5 mesoscale model. Comparisons in term of water vapour reveal t he capability o f the model to forecast the deep penetration into the troposphere of the dry intruded la yer. Global and mesoscale forecasts of potential temperature and pote ntial vorticity are compared with those estimated from lidar measurements. C omparisons of lidar and model data will be discussed in detail at the conference. References 1. Holton, J. R., et a l., Stratosphere-troposphere exchange, Rev. Geophys., 33, 403439, 1995. 2. Appenzelle r, C., and H. C. Davies, Structure of strat ospheric intrusions into the troposphere, Nature, 358, 570 572, 1992.

Keywords: lidar, tropopausefoldingevent

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MS003 **Oral Presentation** **4941**

One year of global cloud and aerosol profiling from CALIPSO

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The CALIPSO satellite carries a two-wavelength polarization lidar designed foraerosol and cloud profiling, along with two passive imagers. CALIPSO was launched on April 28, 2006 and has been acquiring lidar observations since early June, 2006. Using a linearly polarized laser and polarization-sensitive receiver, the instrument allows the unambiguous discrimination of cloud ice/water phase and the identification of non-spherical aerosols. Data from CALIPSO provide the opportunityfor development of the first global climatology of aerosol vertical distribution. Asa member of the A-train, CALIPSO data is being used to verify cloud retrievalsfrom passive sensors in the A-train. CALIPSO was developed within the frameworkof a collaboration between NASA and CNES. This talk will discuss initial results and applications of CALIPSO data.

Keywords: aerosol, cloud, lidar

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MS003 **Oral Presentation** **4942**

Assessment of the dehydration-greenhouse feedback over the Arctic during winter for 2 winter months and 2 atmospheric circulation regimes.

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Marianne Peltier-Champigny, Alexandru Stefanof, Jean-Pierre Blanchet, Rodrigo Munoz-Alpizar, Patrick Grenier

The effect of pollution-derived sulphuric acid aerosols on the aerosol-cloud-radiation interactions is investigated over the Arctic for the months of February and March. Observations suggest that acidic aerosols can decrease the heterogeneous nucleation rate of ice crystals and lower the homogeneous freezing temperature of haze droplets. Based on these observations, we hypothesize that the cloud thermodynamic phase is modified in polluted air mass (Arctic haze). Cloud ice number concentration is reduced, thus promoting further ice crystal growth by the Bergeron-Findeisen process. Hence, ice crystals reach larger sizes and low-level ice crystal precipitation from mixed-phase clouds increases. Enhanced dehydration of the lower troposphere contributes to decrease the water vapour greenhouse effect and cool the surface. A positive feedback is created between surface cooling and air dehydration, accelerating the cold air production. This process is referred to as the dehydration-greenhouse feedback (DGF). Simulations performed using an arctic regional climate model for February-March 1985 and 1995 are used to assess the potential effect of the DGF on the Arctic climate. Results show that the DGF can have an important effect on cloud, atmospheric dehydration, and temperature over the Central and Eurasian Arctic, which is the coldest part of the Arctic. The importance of the DGF feedback process is evaluated for 2 atmospheric circulation regimes (positive vs negative NAO) and 2 months (February and March). The main results of this study will be shown in this paper.

Keywords: arctic, aerosol, cloud

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MS003 **Oral Presentation** **4943**

Aerosol-Cloud Interactions in a Mesoscale Model: Sensitivity to Collision-Coalescence and Aqueous-Phase Chemistry

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Henry Leighton

The feedbacks between the aerosol, cloud microphysics and cloud chemistry are investigated in a mesoscale model. The model is added simple bulk aqueous-phase sulfur chemistry fully coupled to the aerosol and microphysics, both described by explicit bulk double-moment parameterizations. A case of summertime stratocumulus cloud system is simulated at high resolution (3-km grid spacing) and the evolution of an observed continental aerosol spectrum that changes during the course of the simulation as a result of cloud processing is examined. The results demonstrate that the bulk approach to the aerosol and droplet spectra represents correctly the feedbacks in the coupled system. The simulations capture the characteristic bimodal aerosol size spectrum resulting from cloud processing with the first mode consisting of particles that did not participate as cloud condensation nuclei and the second mode, in the region of 0.08-0.12-μm radii, comprising the particles that were affected by processing. New information is revealed about the impact of the two main processing pathways and about the spatial distribution of the processed aerosol. One cycle of physical processing produced a relatively modest impact on the processed particle mean radius of the order of 3-5% that was comparable to the impact of chemical processing, while continuous physical recycling produced a much larger impact as high as 30-50%. A strong constraint on the chemical processing was found to be the initial trace-gas concentrationsand the assumption of bulk chemical composition. Simple tests,with slower depletionofthe primary oxidant and including droplet chemical heterogeneity effect, favor stronger sulfate production (via the H2O2 reactionin the former case and viatheO3 reaction in the latter case) and show larger impact on the processed particle mean radius of similar magnitude, 10-20%. Spatially, the impact of processing is found initially in the downdraft regions below cloud and at later times at substantial distances downwind. It is shown that cloud processing can either enhance or suppress the number of activated drops in subsequent cycles.

Keywords: aerosol, oxidation, collision coalescence

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MS003 **Oral Presentation** **4944**

Changes in cloud and precipitation formations by anthropogenic aerosols in Asian region

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To analyze the effects of atmospheric aerosols on the climate system, a global aerosol climate model, SPRINTARS, has been used, which is coupled to a atmospheric general circulation model (AGCM) with mixed layer ocean. An increase in the aerosol number concentration has the effect on cloud microphysics by forming smaller and numerous cloud droplets reducing precipitation and increasing cloud lifetime. On the other hand, the insolation of the Earth surface is reduced by the aerosol-induced effects, resulting in decreases in the surface temperature, evaporation, and availability of water vapor to form clouds. This study analyzes changes in cloud and precipitation due to anthropogenic aerosols especially in the Asian region where economy has rapidly developed recently. SPRINTARS is driven by the AGCM developed by the Center for Climate System Research (CCSR)/University of Tokyo, National Institute for Environmental Studies (NIES), and Frontier Research Center for Global Change (FRCGC). The model predicts mass mixing ratios of the main tropospheric aerosols, that is, carbonaceous (black and organic carbons), sulfate, soil dust, and sea salt, and the precursor gases of sulfate, that is, sulfur dioxide and dimethylsulfide. The aerosol transport processes include emission, advection, diffusion, sulfur chemistry, wet deposition, dry deposition, and gravitational settling. The radiation scheme in CCSR/NIES/FRCGC AGCM is extended for the aerosol direct effect related to scattering and absorption by aerosol particles considering refractive index in each wavelength, size distribution, and hygroscopic growth of each aerosol. The cloud droplet number concentration is calculated for the aerosol indirect effect with the aerosol particle number concentration as well as the size distributions and chemical properties of each aerosol species, updraft velocity, and saturation condition of the water vapor. A change in the cloud droplet number concentration affects the cloud droplet size and precipitation rate, leading to a change in the radiation budget. The simulation indicates that the liquid water path increases and the precipitation decreases due to the indirect effect of anthropogenic aerosols all over the Asian region, especially along the coast, with a given sea surface temperature. If the mixed layer ocean model is coupled, on the other hand, both the liquid water path and precipitation decrease by a reduction of the solar radiation at the surface mainly due to the aerosol direct effect, leading to a decrease in evaporation of water vapor from the surface. In the South Asia, this can be also because a large amount of black carbon aerosols evaporates cloud water due to the aerosol semi-direct effect. However, the liquid water path still increases in the East Asia by the strong aerosol second indirect effect due to abundant anthropogenic aerosols even with change in the hydrological cycle. The simulated precipitation is in general agreement with measured century-scale variations in East and South Asia considering the aerosol effects.

Keywords: aerosol, climate, asia

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MS003 **Oral Presentation** **4945**

PBL Aerosols SE of Mexico City during MILAGRO 2006: biomass burning and windblown dust and its impact on photolysis frequencies

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During the Mexico City MILA GRO campaign 2006 airbor ne investigation of aerosols and ultraviolet actinic radiation have b een performed using an ultralight aircraft as a mobile platform. The area investigated covered the rur al area southeast of Mexico C ity, the Chalco Va lley, Huexca and Atlixco south of the volcano Popocatepetl, east of Paso di Cortez to the airport of Puebla and the pass between Puebla and Mexico City north of th e volcano Ixtachiuatl. The C halco valleyis the main ventingvalley of the Mexico C ity basinto the south.Intense biomass burning was obs erved on both slopes of th e volcanoes leading to stron g pyrocumulus cloud production in the northern part of th e national reserve and above the motorway Puebla-Mexico. Fine pa rticle (> 10 nm) num bers reached u p to 80000/cm3 close to the b urning plumes with significa nt reduc tion to ~ 30-40000/cm3 in the Chalco valley were coarse particles (> 300 nm) dominated the total mass. Dust devils tran sporting coarse particels up to elevations of more than 400 0 m a.s.l. were freque ntly observed. Particles and air ma sses or pollution sourcesin the area can be c haracterized b yaerosol si ze distributions and/or spectral absorption from multiwavelength aeth alometer measu rements as well as f rom ozone m ixing ratios an d meteorological data measured on bord. The aerosol impact onphotolysis ratesand air chamistry is derived from vertical profiles of actinic radiation in the JO1D and JNO2 spectral regimesat 300 nm and 380 nm. Profileswer e flown on b oth sides of th e volcano ridge, south of Popocatepetl and above Tenango del Aire where aircraft measurements were supported by Ceilometer aerosol vertical profiles.

Keywords: aerosol optical properties, photolysis rates, biomass burning

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MS003 **Oral Presentation** **4946**

In situ calibration of CIMEL sun-sky photometers through applications of the SKYRAD improved Langley plot method (SKYIL).

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The SKYIL method is a well-tested in-situ procedure for the daily determination of the solar calibration constants, specifically created for the PREDE sun-sky radiometers. It was applied to three CIMEL instruments located at Valencia and El Arenosillo (Spain), and at Singapore, the last one being part of AERONET network (Holben et al., 1998). The different mechanical and electronic characteristics of the PREDE and CIMEL radiometers were taken into account and the SKYIL method was adapted to the characteristics of the CIMEL instrument. The method can be used only if the CIMEL radiometer has previously been calibrated using a standard lamp for the diffuse radiance. The iterative procedure for the determination of the solar calibration constants was applied to the available dataset, and the results were compared with the available sets of experimental calibration constants determined with the standard Langley plot method. Concerning the instrument located at Valencia, a marked influence of the external temperature on the retrieved time-patterns of the calibration constants was highlighted, although the temperature dependence of the diffuse radiance measured at 1020 nm was investigated through laboratory tests and subsequently corrected, and the direct solar irradiance measurements taken at the same wavelength were also corrected following the Holben et at. (1998) procedure. The use of a Fourier analysis allowed the definition of a yearly frequency due to the seasonal temperature oscillations, as well as a diurnal component. Subsequently, a generalized least square method was set up in order to remove the two components of the calibration constants. The same analysis was performed for the El Arenosillo and Singapore instrumental datasets, with the aim of checking possible effects of the external temperature on the field measurements. The analysis of the temperature dependence is not a part of the SKYIL method. During the present study, it was necessary to perform such analysis, because the results obtained by applying the SKYIL method to the CIMEL data, were found to be of worse quality than those obtained when the method was applied to a Prede instrument (Campanelli et al., 2004), which does not require any temperature correction. Once the temperature correction was performed, the accuracy of the method was evaluated, finding that it is within 2.1% and 1.0%, depending on wavelength. This is an important result, since the nominal uncertainty affecting the solar calibration constant values given by the AERONET calibration method (of 1 - 2%) and the uncertainty produced by the SKYIL method turn out to be similar. The time-trend of the calibration constant values retrieved by the SKYIL method was compared with that calculated in the experimental calibrations. The agreement was consistent with the experimental errors In conclusion, the SKYIL method was found to be suitable for being used to determine the solar calibration constants also for CIMEL instruments, provided that the radiometer has been previously calibrated for the diffuse radiance. A further step of the present investigation will be the application of the method to several CIMEL sun-sky radiometers belonging to the AERONET network, because a calibration method independent of the AERONET system would be very useful to diagnose the condition of a sky radiometer, whose data analysis is sensitive to small errors in the measured data. Using an independent method, the variation of the calibration constant due to instrumental drift can be quickly identified, so that appropriate corrections can be applied to data, starting exactly from the period in which the deviation occurred. Although limited to three instruments only, the present study furnished interesting results. For these reasons, it is worthwhile continuing investigations for better applying the SKYIL method to the AERONET database. Simultaneously, the application of the present methodology is recommended for CIMEL instruments involved in other networks, such as the recently created Spanish

network RIMA, and can be co mpared to other in situ procedures, like t he Kciclo method (Cachorr o et al., 2004). References M. Ca mpanelli, T. Nakajima and B. Olivieri, Deter mination of the solar calibration constant for a sun-sky radiom eter: Proposal of an in situ pr ocedure, Appl. Opt., 43, 651 659 (2004). B. N. Holben, T. F. Eck, I. Slutsker, D. Tanr, J. P. Buis, A. Setzer, E. Vermote, J. A. Reagan, Y. Kaufman, T. Nakajima, F. Lavenu, I. J ankowiak and A. Smirno v, AERONET - A federated instrume nt network and data archive f or aerosol cha racterization, Remote Sens. Environ., 66, 1 16 (1998). Cachorro, V., C. Toledano, A. M. De Fruto s, M. So rribas, J. M. Vila plana, R. Vergaz a nd B. A. De La Morena. T he PHOTONS-AERONET sites in Spain. Calibrati on proble ms and KCICLO cor rection method. Opt. Pur. y Apl., 37, 3401 3406 (2004).

Keywords: sun skyradiometer cimel prede, aerosol, calibration

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MS003 **Oral Presentation** **4947**

3D radiative aspects of the increased aerosol optical depth in the vicinity of clouds

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To characterize aerosol-cloud interactions it is important to correctly retrieve aerosol optical depth in the vicinity of clouds. It is well reported in the literature that aerosol optical depth increases with cloud cover. Part of the increase comes from real physics as humidification; another part, however, comes from 3D cloud effects in the remote sensing retrievals. In many cases it is hard to say whether the retrieved increased values of aerosol optical depth are remote sensing artifacts or real. In the presentation, we will discuss how the 3D cloud affects can be mitigated. We will demonstrate a simple model that can assess the enhanced illumination of cloud-free columns in the vicinity of clouds. This model is based on the assumption that the enhancement in the cloud-free column radiance comes from the enhanced Rayleigh scattering due to presents of surrounding clouds. A stochastic cloud model of broken cloudiness is used to simulate the upward flux.

Keywords: aerosol, clouds, 3d

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MS003 **Oral Presentation** **4948**

Atmospheric Brown Clouds (ABCs) : New perspectives on the Regional Impacts of Atmospheric Solar Heating

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It is now well recognized that ABCs are a major global problem in air pollution and climate change. New data have revealed that, due to fast long-range transport, trans-oceanic plumes of atmospheric brown clouds (ABCs) containing tiny particles intercept sunlight, cause large surface dimming, cool the surface, enhance atmospheric solar heating, warm the air and disrupt regional rainfall patterns and lead to large scale drying in some regions and increase in rainfall in others. It now seems that the surface cooling effect of ABCs may have masked as much as 50% of the global warming due to GHGs. Another potentially major negative impact of ABCs is that the solar heating of the atmosphere by soot can accelerate the atmospheric warming by greenhouse gases and thus contribute significantly to the observe retreat of the Himalayan glaciers and stabilization of the atmosphere. Furthermore, the solar heating can lead to stabilization of the tropical atmosphere during the long dry season, with implications for the tropical general circulation. Instrumented UAVs with several of them stacked at different altitudes are giving new insights into atmospheric solar heating by ABCs. These in conjunction with Lidar measurements from CALYPSO satellite Lidar are enabling us to infer solar heating by ABCs and estimate their impact on regional climate.

Keywords: aerosol regional climate, global dimming, uavs

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MS003 **Oral Presentation** **4949**

An evaluation of the surface radiation budget over North America for a suite of regional climate models and ECMWF reanalysis

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Downwelling longwave and shortwave radiation are the 2 main terms in the surface energy balance that control the evolution of surface temperature and mois ture. Systematic biases in the r epresentation of the surface radiation budget can lead to severe errors in a number of key near surface climate variables (e.g. so il mo isture, sn ow co ver an d sea-ice amounts). It is therefore important that climate models accurately simulate these quantities . In this presentation we evaluate the surface radia tion budgets of three RCMs (R egional Climat e Models) nee d to be ev aluated over entire North Amer ica. The models used in this study are: CRCM (The Canadi an Regi onal Cli mate Model), GEM-LAM (Regional version of Global Envir onmental Multiscale Model) and RCA3 (Regional model of Rossby Centre, Sweden). The observations are derived from six different measur ement sites within the SURFRAD (Surface Radiatio n Budget) network, coordinated by NOAA. These sites represent a cross-section of various climate types over North A merica. While surface base d radiatio n observations offer accuracy at hightemporal resolution, they do not al low full evaluation of th e simulated SRB across the entire Nort h America. We evaluate 3 dif ferent gridded data sets against the SURFRAD observations to de termine the best surrogate observational dataset for evaluation of the RC Ms over the entire domain o f interest. The gridded data s ets used in thi s evaluation are: ER A40 - global reanalysis of ECMWF, NARR - regional reanalysis of NCEP and the S RB derived from the IS CCP s atellite project.In this work, we present a comparison of the mean seasonal and diurnal cycles of sur face radiation between the three RCMs, a nd surface observations. This aids in identifying in what sky situation simulated SRB error arise. We present results for t otal sky conditi ons as well as overcast and clear sky co nditions separately. Thro ugh the analysis of probability density functions (PDF) we show the impact of varying cloud cover on th e simulated and observed surface radiation budget.

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MS003 **Oral Presentation** **4950**

ECOWAR/COBRA: a research contribution to spectrally resolved observations of the Earth emission spectrum in the water vapour rotational band (17-50 micron) to test models of atmospheric radiative transfer

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Rohini Bhawar, Giovanni Bianchini, Alessio Bozzo, Maria Rosaria Calvello, Massimo Carlotti, Marco Cacciani, Francesco Castagnoli, Vincenzo Cuomo, Paolo Di Girolamo, Luca Di Liberto, Tatiana Di Iorio, Alcide Di Sarra, Francesco Esposito, Giorgio Fiocco, Da

There is a growing interest in the far infrared spectral region (17 to 50 micron) of the Earth emission spectrum, since this portion of the spectrum contains the characteristic, and fundamental, molecular rotational band for water vapour. Water vapour is, indeed, the main greenhouse gas in the atmosphere and it plays an important role in the mean and upper troposphere influencing the Earth radiative energy balance. Spectrally resolved observations and knowledge of radiative transfer for clear and cloudy skies in the water vapour rotational band are important to test climate models and ultimately resolve some of the contentious arguments about global change. The relevance to the Earth energy budget of the spectral region 17 to 50 micron has been put forward by many authors. Nevertheless, a) the spectral absorption properties of water vapour, in addition to its vertical distribution, have received very poor attention, and b) the far-infrared portion of the atmospheric emission spectrum has been largely unexplored and very few measurements have been made in the past. Nowadays, it is largely recognized that the lack of validation of far infrared model continuum and line parameters under atmospheric conditions is hampering a substantial progress in our ability to correctly parameterize water vapour optical properties in climate models. The ECOWAR (Earth COoling by WAter vapouR emission) or COBRA (an Italian acronym for analysis of the water vapour continuum absorption in the H2O rotational band) project is an experimental field campaign that contributes to bridge the knowledge gap about optical properties of water vapour in the far infrared through an observational programme. This work will review the status of ECOWAR/COBRA and its results at the end of the main steps of the programme (campaign in January 2007 and in March 2007). ECOWAR/COBRA is a co-ordinated project among four University research teams (University of Bologna, Potenza and Roma), two institutes of the National Research Council (IFAC Florence and IMAA Tito Scalo) and INGV (National Institute of Geology and Vulcanology). The seven proposing teams blend expertise both in experimental and theoretical Atmospheric Sciences, therefore ECOWAR/COBRA has set up an end-to-end methodology which allows us not only to record the observations, but also to analyse them in order to validate atmospheric radiative transfer models and test the quality of water vapour continuum and line parameters. COBRA consists in a series of field campaigns aiming at sensing the water vapour rotational band. The observations will be then used a) to test models of atmospheric radiative transfer in clear and cloudy skies, within the water vapour rotational band, b) to test spectral absorption properties of water vapour in the rotational band from 200 to 600 (cm-1) c) to demonstrate the capability of the aforementioned band as a temperature and humidity sounding system, especially to improve the height discrimination of water vapour concentration. The project plans to integrate observations from the ground to those from satellite platforms, which should allow us to properly define the thermodynamic state of the atmosphere, and, hence, provide the ancillary information to reconstruct the down-welling and up-welling spectral radiance, along with the radiative diabatic effects in clear and cloudy sky. The main field campaign will take place at a mountain site in the Alps, Testa Grigia (or Plateau Rosa, 45.9N, 7.7E,

elev. 3500 m) in March 2007 and will last approx imately 20 days. At this site the following instrumentation will be deployed: a series o f Fourier Transform Spectrom eters, covering the range 100 to 1100 (cm-1), a m icrowave radiometer f or water va pour profiling, one Raman Lidar systems for the profiling o f atmo spheric aero sol, temperature, and wate r vapo ur. Furt her info rmation abo ut clo ud optical properties and coverage, temperature and water vapour profiles, will be obtained through MIPAS (Michelson Interferometer for Passive Atmosphe ric Sounding) spectrometer onboard ENVISAT/ 1 (Environmental Satellite) platfo rm (European Sp ace Agency). Acknowle dgement: wor k supported by MIUR, PRIN2005 project # 2005025202

Keywords: radiation, far infrared, water vapour rotational band

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MS003 **Oral Presentation** **4951**

Long-term radiative effects of asian aerosol and dust

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Long-term variability of aerosol optical properties as well as their direct radiative effects was investigated using the ground-based aerosol measurements and a radiative transfer (RT) model calculation at Gosan supersite in Jeju, Korea from 2001 to 2006. From the 6-year AERONET dataset, our analysis of seasonal and monthly cycle of aerosol optical depth (AOD) showed a maximum value of about 0.4 in spring and summer and a minimum of 0.2 in autumn. Especially, a peak of monthly mean AOD was apparent in June due to synoptic meteorological patterns, aerosol hygroscopic growth, and smoke aerosols by regional biomass burning. CRM (Column Radiative Model)- 2.1.2, a stand- alone version of the radiative transfer model implemented in NCARs community climate model, CCM-3.6, was employed for the evaluation of aerosol direct radiative forcing (ADRF) at surface and top of atmosphere (TOA). A method of determining the values of aerosol optical properties as input parameters was utilized for the ADRF calculation from the AERONET dataset. The mean ADRF in the springtime was evaluated to be -19.2 W/m2 at TOA and -36.6 W/m2 at the surface. Springtime ADRF from RT model calculation was compared with the ground-based radiation measurements during the ACE-Asia IOP in 2001and the ABC-EAREX2005 IOP in 2005. In addition, ADRF comparisons were included in this study between at Gosan supersite and in other regions worldwide.

Keywords: aerosol, optical property, radiative focing

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MS003 **Oral Presentation** **4952**

In-situ measurements of liquid water content profiles in mid-latitude stratiform clouds

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Statistical characteristics of 584 liquid water profiles collected mainly in midlatitude supercooled stratiform frontal clouds during five field campaigns are presented. It has been found that the majority (55%) of liquid layers have thickness less 500m and the depth of the liquid layers decreases with decreasing temperature. The profile of thin cloud layers is usually close to quasi-adiabatic, whereas for thick clouds the vertical distribution of LWC is approximately constant with an average LWC value close to 0.14g m-3. Good agreement was observed between cumulative distributions of LWP derived from in-situ LWC profiles and those inferred in previous experiments from ground-based 37 GHz radiometers. Deep frontal liquid layers usually have LWC profiles with multiple local maxima in the vertical. Such profiles may be explained by a multi-cellular circulation, with a characteristic vertical dimension of such cells of the order of a few hundred metres.

Keywords: lwc, profiles, lwp

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MS003 **Oral Presentation** **4953**

Effect of hygroscopic seeding on warm rain

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To estimate the effect of cloud condensati on nucle i (CCN) on precipit ation accurately, hybrid cloud microphysical model comp osed of pa rticle method in parcel model an d bin method in grid model wa s developed. Our model estimates the maximum values of supersaturation and the number concentration of cloud droplets by using the parcel model with Lagrangian framework. And our m odel estimates condensation, coalescence, b reakup, sedim entation, and advection of cloud droplets and raindrops b y using two-moment bin meth od on the grid poin ts with semi-Lagrangian or Eu relian fra mework. In our hybrid microphysical cloud m odel, each grid point has a parcel model to est imate t he activation of nuclei. In the case that the r elative humidity of th e grid point reaches 100% for the first time, or the case that relative humidity of the grid point is larg er than 100% and cloud water on the windward side of the point does not exist, air parcel including CCN and vapor starts to ri se from the windward side of the point. When droplets condensed on CC N grow en ough to be disting uished from e mbryo, which can not become cloud droplets, the cloud droplets size di stribution, the mixi ng ratio of vapor and potenti al temperature in the parcel are given to the grid po ints. Ti me changes due to growth by condensation and coalescence on grid points are calculated in the semi- Lagrangian framework by using the two - moment bin method developed by Chen and Lamb (1994) to minimiz e numerical diffusion of cloud droplet size distribution. There are 71 bins for radii between 1 mm and 3.25 mm. Coalescence efficiency developed by Seifert et al. (2005) is used to esti mate coalescence and breakup. The time steps f or growth by condensation and coalescence are 0.5 seco nds. To estimate multi-coales cence in one time step properly, two kinds of scheme are used. One is general stochastic coalescenc e for rare lucky coalescence of large dro plets, the o ther is c ontinuous co alescence for frequent co alescence of a large droplet and small droplets f ollowing to Chens doctor al t hesis. If only general stochastic coales cence scheme is used, very short time step (0.01 s) is needed. The dynamical framework of this study wa s based on the model designed to test the warm rain microphysical model in Case 1 of the fifth WMO Cloud Modeling Workshop (Szumowski et al . 1998). Th is dynamical cloud model predicts an evolvin g flow for 150 minutes and performs a two-dimensional advection of the temperature and water variables (domain: 9 km x 3 km, dx and dz: 50 m, dt: 3 seco nds). As an applica tion of this model, numerical experiments to estimate the effect of hygroscopic s eeding on precipitation was carried out. The result s show that 10-minute seeding of NaCl particles with 1 or 2.5 -micron-radius under t he cloud base for small-updraft cloud is not effective in increasing rain fall. More research on optimal seeding particles and optimal seeding duration will be presented.

Keywords: cloud microphysics, ccn, seeding

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MS003 **Oral Presentation** **4954**

Submicron aerosol size distributions, hygroscopicities and CCN spectra measured at Gosan and Seoul, Korea

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This study presents submicron aerosol size distributions and hygroscopicities, total particle (i.e., condensation nuclei, CN) concentrations (NCN), and CCN spectra (NCCN) measured at a coastal site at Gosan in Jejun Island and Seoul. The Gosan site was used as one of the key locations to monitor the influence of Asian continental outflow during ACE-Asia in April-May 2001 and Atmospheric Brown Clouds East Asian Regional Experiment in March-April 2005 (ABC-EAREX 2005). With the population of more than 10 million, Seoul represents a polluted mega city. The Gosan and Seoul measurements were made in August and October, 2006, respectively, for two weeks each. The instruments include a TSI SMPS-3936L10 for aerosol number size distributions (10 nm < diameter < 300 nm), a TSI CPC-3010 (diameter > 10 nm) for total particle concentrations, a DMT CCN counter for CCN concentrations at 5 supersaturations (S) (0.2- 1%), and the two DRI CCN Spectrometers for complete CCN spectra from 0.02 to 1% S. Aerosol hygroscopicity was also measured by setting up an H-TDMA system. On average the NCN and NCCN at 1% S were, respectively, 4765 cm-3 and 2140 cm-3 at Gosan and 15765 cm-3 and 3527 cm-3 in Seoul. The average hygroscopic growth factors (GF) (wetted diameter/dry diameter) for 100 nm diameter dry particles were 1.56 and 1.32 for Gosan and Seoul, respectively. The GF showed a tendency to increase with dry particle diameters. More detailed analyses will be shown at the conference.

Keywords: submicron aerosols, cloud condensation nuclei, aerosol hygroscopicity

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Possible Abnormal SW Flux Observation over Tibet and Its Impact on Cloud-Radiation Interaction- Case Study on Observation at YBJ Station

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Since November 2005, a set of surface meteorological instruments are implemented at Tibet Plateau Yangbajing (YBJ, 30.1N , 90.5E, 4300 ABL) Cosmic Ray Observation field site. The main purpose is to observe meteorological parameters in general and to understand the possible interaction between cosmic rays and the atmosphere. During the observation, we found that in winter months, abnormal short wave (SW) fluxes in day time, i.e. , the observed surface SW flux exceeds the solar direct flux downward to the ground when without atmosphere, are often existed . The appearances of abnormal flux are accompanied with inhomogeneous cloud distribution and have typical diurnal variation. By synthetic analysis of SW flux observation, cloud distribution observation with all sky images and scanning sky infrared thermometer which are developed by present authors, the statistical relationship between abnormal SW flux, cloud fraction, cloud type and their possible climate impact will be presented.

Keywords: sw flux, cloud radiation inteaction, tibet

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MS003 **Oral Presentation** **4956**

Correlation between retrieved black carbon aerosol and carbon monoxide from satellite remote sensing

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Aerosol directly and indirectly affects the Earths climate by scattering and absorbing radiation and by altering the cloud microphysics. Despite the fact that these effects are different from one type to the other, there have been limited researches in classifying aerosol types from satellite remote sensing due to the difficulty in classifying chemical components from the columnar measurements of radiances from space. Not only aerosol type classification but also gas to particle conversion of aerosol is one of the difficult problem in aerosol study. Based on recent aerosol retrieval algorithm and pollutant gas measurements of satellite, it became possible to estimate correlation of aerosol and pollutant gases on global scale. In this study, retrieved black carbon aerosol by MODIS-OMI algorithm (MOA hereafter) (Kim et al., 2007) and four-channel algorithm (Higurashi and Nakajima, 2002) from Moderate Resolution Imaging Spectroradiometer (MODIS) and Ozone Monitoring Instrument (OMI) and carbon monoxide from Measurements Of Pollution In The Troposphere (MOPITT) are used to estimate correlation of black carbon aerosol and carbon monoxide column density. Monthly distribution of black carbon aerosol from MOA shows similar pattern with carbon monoxide column density. Especially, black carbon aerosol over biomass burning region such as South America and South Africa is well detected from MOA and enhanced carbon monoxide density is measured by MOPITT during springtime of southern hemisphere.East Asia is also affected by black carbon aerosol and high carbon monoxide density which are mainly from anthropogenic activity and biomass burning during springtime.

Keywords: black carbon aerosol, carbon monoxide, satellite remote sensing

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MS003 **Oral Presentation** **4957**

Modeled sensitivity of Aerosol burden, optical properties, and CCN production to uncertain physical assumptions.

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In this work w e discuss how a few b asic assumptions related to particle size and vertical distribution, can influence the model-calcu latedproperties of aeros ol-climate interactions in a global climate model. The model is C AM-Oslo, which is a version of the NCAR CAM3 extended witho ur own aero sol scheme. Aerosol particl es and their interactions wi th clou ds and radiation constitute a major s ource of uncertainty in climateprojec tions due to natural an d a nthropogenic for cing. Retrievals of remotely sensed aerosol properties have increased considerably in lateryears. If retrievals are use d to tune bulk model-calculated aerosol pr operties the s catter betwee n model results may be under-estimated. Forexample, the same mass column of a particulate constituent can produce vastly different interactions with radiation and cloud micr ophysics.Number size dist ributions, the inter nal mixing stat e, the relative humidity, or the water vapour super-saturat ion are im portant elements i nthis. The vertical distribution profile can also stro ngly influence the aero sol physic al properties. Finally, even if we knew the mass, thesize-distribution and the mixing state of anth ropogenic aerosols, t he properties of the nat ural background ae rosols influence the impact ofanthropo genic aerosols on climate. Unfort unately, in-situ measurements or relevant l aboratory studies are too fe w to c onstrain the relevantprocess-specifi c uncertainties in the models. Hence we discuss th e implied range of aerosol impact s due to these uncertainties. We findconsiderable differences in aerosol optical properties an d impacts on clou ds between our t est calculations with CAM-Oslo. A decrea se in theefficiency of convective scavenging and vertical transport give higher aerosol burdens and re duced solar radiation at the ground and moreabsorption on the top of the atmosphere. Change s in sea-salt num ber distribution give significant changes in CCNs and in-direct forcing,with much smaller impact on total aerosol mass. We also find that although changes may be small on a globally averag ed they can besignificant regionally. For example , treating primary emitted sulphate as sulphuric acid gas instead of accumulation mode particles reduces theanthropogenic optical depth over Europe up to 25%, compared to only 6% globally.

Keywords: aerosol, size, effects

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MS003 **Oral Presentation** **4958**

Cloud vertical structure observed from ship-based and space-borne radar and lidar

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We observed the cloud vertical structure using shi pborne cloud radar and lidar. Since 2 001, we have performed ship-based experiments using the Rese arch Vessel Mirai operated JAMS TEC (Japanes e Maritime Science and Technology Center). The obse rvational areas incl ude Tropical Western Pacific Ocean, Indian Ocean, Western Paci fic Ocea n near Jap an and Antarctic. Cloud analyses derived from synergy use of radar and lidar observations showed that t here were two local maxima of cirrus cloud frequency of o ccurrence at 7 and 10.5km o ver the Western Pacific Ocean near J apan and there is a single maximum o f the cirrus frequency at 12km o ver th e Tropical Wes tern Pacific Ocean. Estimated drizzle frequency in the form er area is about 10% , while the rain gauge measurements indicated the frequency of 2%. The discrepancy can be explained by the evaporation of the particles. The estimated drizzle frequency in the Tropics is larger in the Tropics (17%) than in the mid-latitude case. The number of layers co uld be also studied. Single, double, triple, and quadruple (or more) cloud la yers [%] had a 60, 27, 9, and 3 probability of occurrence, respectively, when clouds present in mid-latitude. We found more multiple structures in the Tropics and t he same statistics [%] are 57, 28, 11 and 5. The average number when clouds existe d was 1.54/1.63 in the mi d-latitude / in the Tropics, respectively. The observed vertical stru cture of clou ds was comp ared to clouds in the aerosol transport model SPRINTARS, w hich is based on the CCSR -NIES At mospheric General Circulation Model. The clo ud fraction, radar reflectivity factor, and lidar b ackscattering coefficient were simulated by the model and compared to those by the observations using height-time cross-sections where the radar sensitivity was taken into acc ount. The ove rall pattern of cloud fr action was well reprodu ced, alth ough th e model underestimated (overestimated) mean cloud fraction below 8 km (above 8 km) in the mid-latitude. The discrepancy between the obs erved and the simulated cloud fraction in becomes larger in th e Tropics, i.e., the model significantly overes timated cloud fraction. The correcti on of attenuation due to wate r vapor and precipitation is crucial for the estimation of the model cloud fraction in the Tropics. The cloud microphysics in the model could also be validated through comparison of derived model radar a nd lidar signals in grid mean with obs ervations. The model overestimated ice par ticle s ize above 10km, while simulated particle sizes in water clouds of 10 microns were smaller than observed. Cloud microphysics is retrieved by radar/lidar algorithm (Okamoto et al., 2003). More frequency of small particles and small IWC were found in the Tropics than in the mid-latitude. The peak value of effective radius is 65 and 110 microns in the Tropics and the mid-latitu de, respective ly. Similar analysis using CloudSat/CALIPSO/MODIS data over the same cruise area is also presented.

Keywords: clouds, radar, lidar

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MS003 **Oral Presentation** **4959**

Comparative analysis of ISCCP clouds between MIROC GCM, satellitedata, and global cloud resolving model NICAM

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Cloud feedback is the largest uncertainty in models estimates in climate sensitivity. Intensive studies for IPCC AR4 showed that the distribution of low clouds are the most different between models in their simulations of current climate and they differ most in clouds response to models global warming simulations. In this study, we focus on seasonal cycle and conduct comparative analysis of clouds in MIROC GCM with those from satellite data, using ISCCP simulator. Although our model succeeds in reproducing cloud distribution in low, middle and high level fairly well, it tends to create thick clouds. Results from several sensitivity studies are shown. Results from global cloud resolving model will also be shown.

Keywords: isccp, cloud, seasonal cycle

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MS003 **Oral Presentation** **4960**

Spatial and temporal variability of aerosols over the Mediterranean Basin based on 6-year MODIS data

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Atmospheric aerosols, both natural and anthropogenic, are very important to the climate of the Earth-atmosphere system, since they perturb its radiation energy budget directly by scattering and absorbing radiation and indirectly by acting as cloud condensation nuclei and in doing so modify cloud microphysical and optical properties. However, there is large uncertainty regarding the aerosol radiative forcing and hence, the assessment of global climate change. This is due to their rapidly changing microphysical and optical properties and the small lifetime varying from seconds to weeks. Aerosol optical properties are among the most important determinants of aerosol climatic effects. Therefore, monitoring these properties is essential for better understanding the climatic role of aerosols and minimizing the associated uncertainties. The Mediterranean basin is a unique area in terms of suspended particulate matter. In this area the aerosol direct radiative forcing takes maximum values due to the accumulation of aerosols, which is favoured by the meteorological conditions prevailing over the eastern Mediterranean, and because of the small cloudiness and prolonged exposure to solar radiation. The Mediterranean Sea is one of the areas with the highest aerosol optical depths in the world. All these, together with the fact that Mediterranean is a climatically sensitive region make the eastern Mediterannean basin an ideal region to study aerosol properties and radiative/climatic effects. Lately, sophisticated satellite-based instruments have improved drastically the observation of aerosols, providing accurate data with complete spatial coverage for the study region. In this study, we investigate the temporal and spatial distribution of aerosols in the broader area of the Mediterranean basin, using 6-year (2000-2006) daily satellite aerosol data taken from the MODerate resolution Imaging Spectroradiometer (MODIS) instrument onboard the Terra and Aqua satellites. The aim is to provide an accurate characterization of aerosol properties in the study area based on the most contemporary available data enabling complete spatial coverage. This study updates similar ones that have been performed based only on previous generation satellite data, on surface-based measurements, or on contemporary satellite data but of short temporal coverage. Our study period also allows the detection of possible changes in aerosol loads and properties occurring in the study region, which can have severe effects on the regions climate. The study is performed by using 18 different aerosol products derived from MODIS-Terra Level-3 daily mean atmospheric data product, gridded over the Mediterranean region at 1x1 latitude-longitude resolution, for the period from 1 March 2000 to 28 February 2006. Emphasis is given on the variability of Aerosol Optical Thickness (AOT) at 0.55 microns, over both land and ocean, as well as on mean annual and seasonal values at the geographical cell level. The 6-year regional average value of AOT is found to be equal to 0.260.09. Large AOT values are apparent over large urban areas as well as over regions affected by transport of desert dust from the northern Africa deserts. Moreover, the inter-annual variability and trends of AOT is investigated at both the geographical cell and mean regional scales. Overall, the regional mean aerosol optical thickness is found to have decreased over the period 2000-2006 by -18% in relative percentage terms. Similar analyses are also performed for the rest of the 18 aerosol parameters, namely the ratio of small-mode AOT at 0.55 μm (fine fraction), the Angstrm exponent, the mass concentration, the effective radius, and the asymmetry factor. For many parameters, e.g. AOT, the aerosol properties are investigated at numerous wavelengths, providing thus an insight on the type of aerosols in the study region. Our investigation shows that the overall decreasing trend of aerosol optical depth is mainly attributed to decreasing loads

of fine aerosol particles of anthropogenic origin. Moreover, the decreasing trend of AOT trend occurs mainly in the western parts of the Iberian, Italian and Balkan peninsulas (and adjacent sea surfaces), as well as in the southern Anatolian peninsula. Our analysis indicates that the decreasing AOD trend is possibly related to the increasing precipitation, associated with decreasing NAO index during the study period.

Keywords: aerosol, mediterranean, modis

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MS003 **Oral Presentation** **4961**

SMART-COMMIT Observations and Deep-Blue Retrievals of Saharan Dust Properties during NAMMA

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Monsoon rain falls sustain the livelihood of more than half of the worlds population. The interaction between natural/anthropogenic aerosols, clouds, and precipitation is a critical mechanism that drives the water cycle and fresh water distribution. Analyses of the long-term trend of July-August precipitation anomaly for the last 50 years in the 20th century depict that the largest regional precipitation deficit occurs over the Sahel, where the monsoon water cycle plays an important role. Thus, it is of paramount importance to study how dust aerosols, as well as air pollution and smoke, influence monsoon variability. The NASA African Monsoon Multidisciplinary Activities (NAMMA) was conducted during the international AMMA Special Observation Period (SOP-3) of September 2006 to better comprehend the key attributes of the Saharan Air Layer (SAL) and how they evolve from the source regions to the Atlantic Ocean. The SAL occurs during the late spring through early fall and originates as a result of low-level convergence induced by heat lows over the Sahara that lifts hot, dry, dust laden air aloft into a well mixed layer that extends up to 500mb. This is crucial for understanding the impact of SAL on the key atmospheric processes that determine precipitation over West Africa and tropical cyclogenesis. Results obtained from the synergy of satellite (Deep-Blue) and surface (SMART-COMMIT) observations will be presented and discussed how the physical, optical and radiative properties of the dust in the SAL evolve from the continental to the marine environment.

Keywords: surface observation, monsoon, saharan dust

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MS003 **Oral Presentation** **4962**

Assessment of the Arctic dehydration/greenhouse feedback using measurements from the A-Train satellites.

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Sulfates, especially from human activities, represent a major aerosol species in the Arctic lower troposphere during the polar night, and they are believed to significantly impact the hydrological cycle. One of their effects, the dehydration/greenhouse feedback (DGF), consists of an acceleration in the dehydration of air masses entering the Arctic due to an increase in precipitating diamond dust events compared to ice fog formation, and the resulting decrease in the water content greenhouse effect may lead to a climatologically significant surface cooling. In this communication, we present results from a study of the correlation between the humidity and the sulfate-to-aerosol ratio fields in the High Arctic for the winters 2003 to 2005. Water vapor mixing ratio profiles are retrieved from the Atmospheric InfraRed Sounder (AIRS) measurements, whereas aerosol concentrations are simulated using the Northern Aerosol Regional Climate Model (NARCM). The magnitude of the DGF mechanism may also beinvestigated using CloudSat and CALIPSO (C/C) datasets, which provide high-resolution information on the aerosol and ice crystal fields. We present preliminary results using C/C datasets, which will be explored further during the International Polar Year.

Keywords: sulfates, arctic, cooling

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MS003 **Oral Presentation** **4963**

Decadal variations of surface solar radiation: Insights from GCM simulations and data analyses

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Surface-based radiation observations sugges t that surface solar radiation, after decade s of dimming, reversed into a brightening since the mid 1980s at widespread location s. As potential explanation for these variations, both changes in clouds a nd aeroso l from air po llution have been p ut fo rward. An analysis of sy nop and satellite-based cloud data ov er Euro pe suggests, t hat changes in cloud amount cannot explain the distinct reversal from solar dimming to b rightening seen over Europe. This points to aerosol direct/indirect effect as a key explanation for the dimming to brightening transition.Changes in surface solar radiation may also leave their imprint in the diurnal temperature range. Trends in diurna l temperature ranges over glob al land s urfaces have therefore been analyzed. They show, after decades of decline, a di stinct tendency to level off si nce th e mid 1980s. This suggests a sig nificant shift in the surface radiative forcings, in line with the concept of an ab sence of dimming since the m id 1980s.In an attempt to simulate the dimming and brightening, a special version of the ECHAM model series is used, which includes a sophisticated interactive treatmen t of ae rosol and their emission histories (EC HAM5 HAM). The model is shown to be capable of reproduc ing the reversal fro m dimming to brightening in cloud-free conditions in many parts of the world, in line with observational evidence.This again points to aerosol effects as major source of the observed changes.The simulations further sug gest a distinct latitudinal dependence of the transition from dimming and brightening. While most of the extratropics show a reversal from dimmin g to brightening during the 1980s in these model simulations, dimming is simulated to continue up to the present day in parts of the low latitudes. This is favoured by a transition from increasing to decreasing sulfur and b lack carb on e missions in industrialized countries since the 1980s, which are mostly situated in the extratropics. The developing countries, on the other hand, more located in low latitudes, show a continuing increase in aerosol emissions, contributing to the continuing dimming in these areas. The re are not eno ugh direct ob servations in the tropics to str ictly verify this latitudinal dependence of solar dimming and brightening. However, the available observations are not in conflict with this hypothesis. Also, the abovenoted levelling off of th e diurnal temperat ure range in th e mid 1980s after decades of decrease is more evident in the extratropics than in the tropics, supporting a more distinct change in sur face solar for cing in mid a nd higher tha n in low latitudes. Related references:Wild, M., and Co-authors 2005: From di mming to brightening: Decadal c hanges in solar radiation at the Earths surface. Science, 308, 847-850.Wild, M., Ohmura A., Makowski, K., 2007: Impact of global dimming and brightening on global warming. Geophys. Res. Lett. 34, L04702 , doi:10.1029/2006GL028031.Norris, J.R., and Wild, M., 2 007: Trends i n direct and i ndirect aerosol radiative effects over Europe inferred from observed solar dimming and brightening, J. Geophys. Res. (in press).

Keywords: solar radiation, global dimming, aerosol effects

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MS003 **Oral Presentation** **4964**

Remote sensing of cloud sides of deep convective clouds

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The formation of droplets starting from cloud condensation nuclei through the liquid phase mechanisms to the formation of ice crystal s is reflected i n the vertical profile of c loud properties. Insights into these microphysics are crucial to understand the o nset of precipitation or any aerosol effect. In- situ measurements are limited in their tempora l and spat ial extent and applied mainly to s hallow types of clouds. S atellite measu rements from passive sen sors are con centrating on clou d top s wh ile vertica l profiles of precipitation size drops are retrieved from radar measurements by CloudSat. These data still leave a ga p, especially in our understa nding of the development of deep convection where in-situ data is sparse and remote meas urements difficult to interpret.The CLAIM-3D (cloud aer osol interactio n mission in 3-D) passive clou d side viewing sensor co ncept is planned to beco me a new means o f measuring th e vertical profi le of cl oud mic rophysical properties. We pr esent results that confirm the capabilities of this concept with respect to deep convection including liqui d, ice and mix ed phase cloud regions. 3D c loud microph ysical in formation from the Go ddard Cumulus Ensemble m odel is used as input into a 3D Monte Carlo radiative trans fer model. Sensor o bservations in fo ur no tional channels in the visible, ne ar-infrared, and infrared spectral region are simulated. It is demonstrated that this dat a set of simulated radiances and given cloud microphy sics presents the basis for a Bay esian retrieval algorithm to derive a profile of cloud phase and effective particle size.

Keywords: cloud remote sensing, deep convection, microphysics

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MS003 **Oral Presentation** **4965**

Simultaneous high-resolution observation of scattering layers in the lower troposhere using a Raman/Mie lidar and a VHF radar with the range imaging technique

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An atmospheric lidar is sensitive to atm ospheric mo lecules and particles such as cloud particles and aerosols. On the o ther hand, atmospheric radars used for detecting clear-air turbulent echoes such as VHF/UHF wind profilers are sensitive to fluctuations of refractive index due to atmospheric turbulence. We have carried o ut simultaneo us high- resolution lidar and radar observations, and comparedthe scattering layers observed with both instruments. A Raman/Mie/Rayleigh lidar at Shigaraki MU observatory, Shigaraki,Japan (34.9N, 136.1E) was used as a lidar system. The laser usedin this system is a Nd:YAG laser with 532 nm output of 600 mJ and50 Hz. Backscattered light is received by a telescope with a diameter of 82 cm. Two elastic channels (532 nm) for Mie/Rayleigh scatter , twochannels for pure rotational Raman sc atter, and another channel for water vapor vibrational Raman scatter are used. Backscatte r ratio, ext inction coe fficient, water vapor mixing ratio, and rotational temperature can be measured. The minimum height and time resolution of the data aquisition system is 9 m and 10 s ec, respectively. The MU ra dar (Mi ddle- and Upper-atmosphere Rad ar)at the sam e observatory with 1 MW peak power at 46.5 MHz was ut ilized as a VHF ra dar. This radar has an active phased array antenna with a diameter of 103 m. Mi nimum pulse lengt h is 1 us, corresponding to a n initial height r esolution of 1 50 m.Frequency doma in Interferometric Im aging (FII), or range imaging technique with five frequencies between 46.0 and 47.0 MHz was used to improve this height resolution. Distributionof radar reflectivity was estimated with the Capon metho d, which pro vides a height resolution of 20 - 30 m or better for higher SNR. Tem poral resolution was about 5 - 15 sec.The scattering layers revealed b y the radar were compar ed with various parameters derived from the lidar. It was found that vertical gradients of backscatter ratio and water vapor mixing ratios corresponded well with the peaks of radar reflectivity. Moreover, the time hei ght variation of peak of these gradients with the lidar agrees well with th e excursion of the peak s of radar signal intensity. The height difference between the peaks by two techniques was within 30 m . It is the first t ime that the correspondence between the scattering layers observed by a VHF ra dar at such a hig h vertical resolution and th e quantity dq/dz (and also backscatte r ratio, which is less e xpected) is so clearly establis hed. The very good c orrelation between t he vertical gradien t of lidar backscatter ratio and the radar reflectivity suggests the capability of the FII technique to monit or the thin layered structures. Finally, it is st ressed that it is now possible to study the thin stabl e or turbulent layers in the troposphere by combined radar and lidar measurements.

Keywords: aerosol, radar imaging, raman lidar

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MS003 **Oral Presentation** **4966**

Impact of a new parameterization for inhomogeneous mixing on simulated cloud evolution and aerosol indirect effects

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The accurate prediction of cloud droplet number in LES and cloud resolving models is a formidable challenge. The process of inhomogeneous mixing, in which droplets evaporate completely in centimeter-scale filaments of sub-saturated air during turbulent entrainment [Baker et al., QJRMS, 1980], is unresolved at even LES scales. Despite the large body of observational evidence in support of the inhomogeneous mixing process affecting cloud droplet number [most recently, Brenguier et al., JAS, 2000], it is poorly understood and, until now, a diagnostic parameterization for this process has not been available. We present a parameterization of unresolved subsaturation fluctuations (S) based on new PDF model of cloud mixing and evaporation [Jeffery & Reisner, JAS, 2006]. In this approach the subgrid subsaturation variance is parameterized as a function of Damkoheler number---the ratio of mixing and evaporation time-scales---and subgrid cloud-fraction. The shape of the subsaturation PDF is assumed to obey two different analytic forms: a Gaussian distribution for small variances and a S-1 distribution at large variance. In the large Damkoheler number limit, this S-1 PDF form predicts extreme inhomogeneous mixing where cloud evaporation reduces droplet number but not size. We investigate the impact of our new evaporation parameterization in cloud LES simulations that use a Lagrangian droplet tracking model where each droplet experiences a stochastic subsaturation drawn from the Gaussian or S-1 distribution. Our studies address the following questions: (i) How does the inhomogeneous mixing process affect cloud radiative properties? and (ii) What is the impact of inhomogeneous mixing on aerosol indirect effects?

Keywords: inhomogeneous mixing, cloud evaporation, stochastic droplet modeling

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MS003 **Oral Presentation** **4967**

Diurnal Evolution of Aerosol Optical Properties and Morphology at Pico Tres Padres, Mexico City: A Phenomenological Analysis

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Aerosol optical properties affect planetary radiative balance and therefore climate. The optical properties are related to chemical composition, size distribution, and morphology, which also have implications for human he alth and environ mental degrad ation. Du ring the MI LAGRO field campaign , we measure d ensemble aerosol absorption and angle- integrated scattering in Mexico City. These meas urements were performed using the Los Al amos aerosol photoacoustic instrument with an integrate d nephelometer (LAPA) operating at 781 nm. The LAPA wa s mounted on-board the Aerodyne In c. mobile laboratory, which hosted a wide variety of gaseous and aeroso l instr uments. During the campaign, the Aerodyne mobile laboratory was moved to different sites, capturing the influence of spatial and temporal parameters including locati on, aging, elev ation, and sources o n ambient air pollutio n. The LAPA operated almost continuously between the 3rd and the 28th of March 2006. During the same period we collected ambient aerosols on more than 100 Nuclepore f ilters for scanning electron microscopy (SEM) analysis. Filter samples were collec ted during specif ic pollu tion events and different times of the day. Subsequently, SEM images of selected filters were taken to study particle morphology. The elemental composition of a few individ ual particles w as also qualitatively assessed by energy dispersive X-ray spectroscopy. Between March 7th and 19th the laboratory was sampling air close to the top of the Pico Tres Padres, a ~3000 m high mountain on the north si de of the Mexico City. Daily changes of aerosol loading and pollutant conce ntrations follo wed the ex pected diurnal variatio ns o f the bo undary la yer height. Here we report a preliminary a nalysis of aerosol absorption, scattering, and mor phology at Pico Tres Padres fo r three specific days (9th, 11th an d 12th of March 2006). The single sc attering albedo (ratio of scattering to total extinction) during these three days showed a characteristic dr op in the tens-of-minutes-to-hour time fra me immediately fo llowing the growth of the boundar y l ayer above t he sampling site. Later in the day the single scattering albedo grew steadily to reach a maximum in the late afternoon. Th e SEM image s show a wide variety of aerosol shapes incl uding fractal-like chain aggregates (p ossibly soot), spherical particles (possi bly tar balls), cylin ders, and irreg ular non-fractal shapes. The increased afternoon single sca ttering al bedo in the hottest part of the day qualitatively correlated with a relative incr ease in spherical part icles that typically are not str ongly li ght absorbing relative to fractal- like chain a ggregates that are ty pically strongly light absorbing. These changes i n optical properties and/or mor phology can be explaine d by multiple mech anisms such as the col lapse of fractal-like chain aggregates d ue to thermal effects an d/or condensation of volatile compounds, coating by organic compounds, and photochemical secondary organic particle formation. Elemental analysis of a few individual particles yielde d a relative large ca rbon abu ndance combined with smaller fractions of oxygen, silicon, metals, and other elements.

Keywords: pollution, soot, climate

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MS003 **Oral Presentation** **4968**

The Scale Dependence of Cloud Microphysical Parameters

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Many cloud microphysical parameters vary as a function of the distance or area over which they are averaged. For example, the values of cloud liquid water content, cloud droplet concentration, and ice particle concentration change as the averaging distance increases over scales of 100 m to 30 km and greater. Even the grid averaged relative humidity will depend on the scale being considered. Observations from a large in-cloud data set obtained by Environment Canada will be used to illustrate the scale dependence. Whenever cloud microphysical parameters are needed for model parameterizations, model verifications, and remote sensing retrievals or validations, the effects of scale dependence should be considered.

Keywords: clouds, scale

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MS003 **Oral Presentation** **4969**

Remote Sensing the Vertical Profile of Cloud Droplet Effective Radius, Thermodynamic Phase, and Temperature as a tool for the Study of Cloud-Aerosol Interaction

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Cloud-aerosol interaction is no longer simply a radi ative problem, but one affecting the water cycle, the weather, and the total ener gy bala nce including the spa tial and temporal distribution of latent heat release. Information on the vertical distribution of cloud droplet microphysics and thermodynamic phase as a function of temperature o r height, ca n be co rrelated with details of the aerosol field to provide insight on how these particles are affecting cloud properties and its consequences to cloud lifetime, precipitation, water cycle, and general energy balance. Unfortunately, todays experimental methods still lack the obser vational tools that can characterize the true evolution of th e cloud microphysical, spatial and temporal structure in the cloud droplet scale, and then link these characteristics t o environmental factors an d properties of th e clou d con densation n uclei. Here we wil l sh ow a n ew experimen tal approach (the cloud scanner suite of instruments) th at pr ovides microphysical information that is still missed in current experiments and remote sensing measurements. Cloud scanner measurements can be performed from aircraft, ground, or satellite by scanning the side of the clouds from the base to the top, providing us with the unique opportunity of obtaining snapshots of th e cloud droplet mi crophysical and thermodynamic states as a functio n o f height a nd br ightness temp erature in clo uds at severa l development stages. The bri ghtness tempe rature profil e of the cloud side can be dire ctly associated with the thermodynamic phase of the droplets to provide information on the glaciation temperature as a function o f different ambient co nditions, a erosol concentration, and type. A new su ite o f aircraft instruments combining rainbow and cloud s ide meas urements has been built and is b eing used for detailed aircraft measureme nts of cloud microphysical properties. Ver tical profiles of cloud drople t effective radius, and t hermodynamic p hase will be sh own as a function of temperature for co nvective clouds measured in during the CLAIM experiment in 2005. Details of these vertical profiles as a function of temperature reveal several details of the cloud thermodynamic structure and microphysics. Accurate water droplet effective radius and effective variance derived from cloud rainbow measurements will also be presented and discussed.

Keywords: cloud, aerosol, interaction

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MS003 **Oral Presentation** **4970**

Estimate of radiative forcing and regional feedback of asian biomass bruning aerosols during the period of trace-P

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The regional radiative impact of biomass burning aerosols in Asia is estimated using the new and detailed emission data during the experimental period of Transport and Chemical Evolution over the Pacific (TRACE-P) in March, 2001. Integration of the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5), USA NOAA Hybrid Single-Particle Lagrangian Integrated Transport model (HYSPLIT) and a solar radiative transfer model (CLIRAD-SW) allow us to simulate the spatial and temporal distributions of black carbon (BC) and organic carbon (OC) aerosols from biomass burning in the South Asian region. It also allows us to estimate further their aerosol optical properties and radiative forcing. We find an anticyclone over Bay of Bengal dominates the transport of pollutants of South Asian region. The monthly mean surface concentration of OC and BC is 1.2 μg m-3 in this region. Western Myanmar has the maximum value, with the concentration reaching 14.1 μg m-3. The monthly mean all-sky direct shortwave radiative forcing ranges from -1.65 to 1.42 W m-2 at the top of the atmosphere and from -0.03 to -9.06 W m-2 at surface, resulting in an increase of the atmospheric heating rate from 0.01 to 0.3 C day-1. Owing to the spatial distributions of the AOD (Aerosol Optical Depth) ratio (OC/BC) and the surface albedo, there is a strong gradient of heating rate near the source regions, which may modify local circulations. Overall, biomass burning aerosols result in less solar irradiance reaching the Earths surface, but greater heat in the lower atmosphere. We suggest such an effect will affect the dynamic and thermodynamic processes in the atmosphere and further impact the regional hydrological cycle and rainfall. In this study, the regional feedback due to biomass burning aerosol forcing will be addressed.

Keywords: biomass burning aerosols, radiative forcing, black carbon

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MS003 **Oral Presentation** **4971**

Fine particles in Beijing: seasonal variation, secondary composition and regional pollution

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Beijing is a mega-city with 15 million popula tions. Along with urbanization and rapid increase of vehicle number a nd e nergy co nsumption, the features o f ai r pollution in Beijing are cha nging from coal-combustion pollution to multi-pollutions. A co mbination of primary emissions and secondary conversion leads to fine particle polluti on. The seasonal ch anges i n both primar y emissions of pollutants and climate features, like heating supply in winter, dust storm in spring, active photochemistry process in summer, and biomass burning more in late summer and fall, cause obvious seasonal variations of PM2.5 in Beijing. Beijing has not solved primary air polluti on caused by SO2, NO and PM10, fine particle and O3 as seco ndary po llution has been s evere, results in regi onal air po llution like regio nal haze episodes and elevated oxidant concentrations in the Beijing areas.

Keywords: fine particle, secondary composition, regional pollution

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MS003 **Poster presentation** **4972**

Impact of opencast coal mining on the air environment

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Socio-economic developmen t of any cou ntry deman ds rapid industrialisation in spite of its adverse effects such as environmental degradation, migration and concentration of population at certain pockets of a region. In pursuit of socio-economic development, most of the countries adopted new technologies and changes in existing technologies, that is, techno logy transfer. This t echnology transfer has led to increased o pencast mining with highly m echanised s ystems, which has resulted in environmenta l degradation in various sectors. Air environ ment is deteriorated due to dust pollution and gaseous emissions from mining activities. Water resources ar e polluted by acid mine drainage a nd suspended solids. The highly mechanised operat ions in the minin g area lead to noise po llution. Deforestation and changes in land use patterns are some of t he other adverse impacts of opencast mining. This calls for the study of e nvironmental impacts related to open cast mining. Enviro nmental deterio ration due to large-scale coa l mining, transportation and small scal e util isation activit ies in the Manuguru Coal belt area of Andhr a Pradesh has become a ma tter of conc ern like any other industrial area in India. The study area, Manuguru region consists of two o pencast (OC) mines and thr ee underground mines. The Manuguru OC-II is the bigges t mine yielding about 60% of the total coal production of the area, and is mainly responsible for the environmental degradation in the area. Hence, it is necessary to assess the environmental status of the study area based upon the air quality data, wastewater characteristics and noise levels in the stud y ar ea. Air aro und an o pencast coal mine is po lluted due to vario us unit operations like drilling, blasti ng, removal of over burd en or coal, tran sportation of over bu rden or coal, operations at coal handling plant etc. Air qualit y study undertaken in the area co vering impo rtant locations has e vinced that po llution has bee n increasing over the y ears and its impact will be certainly adverse in th e coming years. Seasonal and diur nal var iation o f air pollutants namely suspend ed particulate matter, sulphur dioxide and oxides of nitrogen is presented in the paper. Overall air quality is also obtained f rom the Oak R idge Air Quality Index. The probable environmental impacts of mining on the air environment are predicted with the help of available data.

Keywords: oraqiindex, coalmining, airqulaityassessment

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MS003 **Poster presentation** **4973**

Insitu radiation observations in southern TamiL Nadu, India and implication on habitat and environment

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The radioactivity even in minor qu antities will build up in human body and subse quently, lead to unknown and unpredictable health complications in particular those related to sustainable development, agricultural production, habitat, ecosystem a nd forest. Detection and quan tification of ra dioactivity has become significant in recent years with the r ecognition of the importance and urgency of environmental problems aro und the wo rld. With the incre ased public co ncern o ver rad iation safety, the studies on natural background radiation areas provide a good scope for evaluating biological effects caused by low-level radiation exposures on a long-term basis. In or der to map high b ackground radiation zones and to study proven ance of radioact ivity in sou thern Tamil Nadu, in situ measurements of radioactivity using portable radiat ion survey meter, analysis of sedi ment samples and delineatio n o f high backgro und radiation zones in the so uthern Tamil Nadu r egion were carried out. This paper presents a study report of Radioactivity surveys (in-situ radiation measurements) conducted in Kanyakumari district of southern Tamil Nadu using portable gamma radi ation survey meters to map the distribution of natural radioactivity. Detailed radiation exposure rates at cl osely spaced intervals have been obtained along the beach secto rs from Thengap attanam to Kanyak umari and the surro unding hinterlands. A very high intrinsic an omalous radioactivity >26 Gy/h has been observed in the hinterlands within a fresh quarry and weathered boulders in the syenite rock body aro und Puttetti in the western Kanya kumari district of southern Tamil Nadu. Over the weathered hillocks in the hinterlands adjacent to the coast around Inayam, Kuru mpanai and Midalam, the in- situ radi ation measureme nts have also exhibited hig h radioactivity ranging from 4 t o 22 Gy/h whi ch is sign ificantly higher than the radiation exposure rates (RER) observed along the beach sectors at variou s locations from Chavara to Tuticorin (1 to 14 Gy/h). The observed r adiation levels are presumabl y the high est concentration in so uthern India and it is the first time that such a high intrinsic radiogenic source in the hinterlands is reported in southwest coast of India. The presence of radioactivity in this region can affect the bio logical condition of the inhabitants. People living in a region of high natural background ra diation are expected to receive significant radiation, which may get ac cumulated in the huma n body. Inhalation of Thoron and Radon gases emerging out of these mi nerals may cause conc ern for health disorders. The southern p art (Kanyakumari district) is thickly populated as comp ared to no rthern portion (Tirunelvelli district) . According to 2 001 Census of India, total p opulation living in the region is 44 lacs with a population density 701/ km2 and 400-500/ km2 in Kanyakumari and Tirunelvelli districts respectively. The male and female population living in Kanyakum ari district is almo st equal but number of females in Tirunelvelli district is mor e than males by about 55 000. Thic k population lives in and aroun d the area in Kanyakumari district where high na tural radiations are obs erved. Dens e population is e xposed to the natural radiation from the beach placers since ages. People living in the region are expected to receive significant radiation, which may get accumulated in the human body . Public co ncerns o f radiatio n exposure of sa fety in high background area s are of great social relevance. Significant radiation doses will certainly enter the human body as most of the people have the habit of sitting and sleeping on the floor.

Keywords: radiogenic source, radiation exposure rate, in situ radiation measurement

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MS003 **Poster presentation** **4974**

Aerosol optical properties estimation using a MFRSR at So Paulo city

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Aerosol particles interact wit h solar radiation, affecting at mospheric and surface radiati on balances. In order to estim ate quantitatively the effect of aero sols on the radiation field, the knowledge of their optical propert ies is cru cial. A n ew approach to re trieve aerosol optic al properties from global an d diffuse spectral irradiance measurements usi ng a M ulti-filter rotating shadowband radiometer (MFRSR) is proposed. From the difference between global and diffuse spectral irradiance, the direct component is calculated, which is used to estimate aerosol optical depth through Beer's law, as usual. A multi-variate linear regression is used to estimate asymmetry factor from Ångström exponent calculated at different wavelengths, based on AERONET retrievals. The fraction of diffuse to direct (DDR) spectral irradiances is used to retrieve single scattering albedo (ssa). Numerical tests w ith the radiative transfer code SBDART show ed that the natural lo garithm of DDR inc reases linearly with single s cattering albedo. Thus, simulations studies were performed to test th e quality of using these linear relationships to retrieve single scattering al bedo, using MFRSR measure ments. A Mie code was us ed to estimate asymmetry factor, single scattering albedo and aerosol optical depth for distinct aerosol size distribution and complex refractive indices. Comparisons between th e original single scattering albedo and the estimated from the linear r elationships resulted in diffe rences lower than 3% or a bout 0.02. This approach was applied to real measurement s perf ormed with a MFRSR collocated with an AERONET radiometer at Sao Paulo city from 19 Aug ust to 28 September 2004. In this period , 47 AERONET retrievals were available. AERONET single scatteri ng albedo was retrieve d from measur ements of sky radiances perf ormed when solar zenith angle was around 53° to 76°. MFRSR performs global and diffuse irradiance measureme nts ev ery 1 minute. Therefor e, in order t o compare the results, MFRSR single scatterin g albedo estim ates were averaged , considering 15 minutes before and after AERONET measurement times. Good cor relation was observed for the four wavelengths, although MFSRS results are systematically lower than the AERONET retrievals . Other periods will be analy zed as well as the possible reasons for this underestimation of MFRSR single scattering albedo retrievals.

Keywords: aerosol optical properties, single scattering albedo, mfrsr

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MS003 **Poster presentation** **4975**

The Analyses of Precipitation Acidity and Chemical Composition In Industrial Estate Located In North Bank of the Yangtze River, Nanjing

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59 precipitation samples wer e collected on an e vent basis from Septem ber 2005 to A ugust 200 6 a t Nanjing University of Information Science & Technology, which is in the no rth part of Nanjing. The pH value and electric conductivity were measured. Concentration of ion and cations were determined by ion chromatography. And draw a conclusion as fo llows: The value of pH r anged from 4. 17 ~ 8.34; The frequency of acid rain was 49. 2%; The electric conductivity changed in a range o f 1. 1 ~ 42.5msm-1. Anions in the r ain co ntained F-, Cl-, NO2-, NO3-and SO42-, especially SO42-and NO3- were primary; Cations were Na+, K+, M g2+, Ca2+, NH4+, an d NH4+, Ca2+ took the most part. They all varied with season time. The annual ratio of SO42-/NO3- was 4.21, so the acid rain here belonged to sulphate-dominated type. The dominant atmospheric pollutant in this industrial estate was SO2, discharging form the process of burning coal.

Keywords: precipitation, anions and cations, correlation coefficient

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MS003 **Poster presentation** **4976**

Validation of concentrations of lead-210 in high altitude simulated by MOCAGE

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One of the ma in difficulties of climate m odelling is to correctly simulate t he negative regional aerosols impact on the Earth global warning. A first step to address this issue is to evaluate the tropospheric vertical distrib ution of subm icronic aerosol (including su lphate and organic aerosol). Lead-210 is particularly interesting to st udy the dynamic tran sport of Ch emistry and T ransport M odels (CT M), because it is an excellent passive tracer of a tmospheric circulation. Hence, it is a simple representant o f atmospheric submicronic aerosol and its transport is well correlated wit h the sulphate aerosol one. Simulations of the concentrations of this tracer have been made for the years 2002 and 2003 with th e recent three-dimensional Chemistry and Tra nsport Model MOCAGE (Model Of atmospheric Chemistry At larGE scale). I t is a multi- scale model, from th e global domain (2x2) do wn to the regional one (0.25x0.25). The meteorological analyses come from ARPEGE, the Mete o-France's forecasting model. The simulations results are validated by comparison with the CARBOSO L project observed data. Six stations were instrumented a nd have co llected atmo spheric aero sol (ino rganic versus o rganic) data at various points of Europe (Azores, Aveiro on Portuguese coast, Puy de Dome 1500 m France, Schauinsland 1500m Germa ny, Sonnblick 3000 m A ustria, K-pustka Hungary plain). A particular attention is pai d to the c onvection simulation by th e model. Thus the results analysis focuses on high altitude sites, where the convec tion induces a strong seasonalit y of the lead-210 concentration (maximum in summer, minimum in winter).

Keywords: sulphate, model validation, europe

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MS003 **Poster presentation** **4977**

Retrieval of aerosol optical properties over Beijing from polarized signals of PARASOL

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Based on the analysis of AERONET (AErosol RObotic NETwork) and PARASOL (Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar) aerosol products, the optical properties of tropospheric aerosol and its seasonal variation over Beijing and Xianghe are investigated. The sensitivity of polarization to aerosol optical parameters such as refractive index, effective radius, optical depth and ground albedo are evaluated through vector radiative transfer model and surface polarized reflectance model. A more reliable retrieving algorithm is proposed in this paper, the results are compared with those of the operational retrieving algorithm of PARASOL group and the ground in-situ measurements, which show that our results agree better with the in-situ measurement.

Keywords: parasol, polarization, aerosol

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MS003 **Poster presentation** **4978**

Numerical study for the vertical distributions and optical properties of Asian dust and anthropogenic aerosols over Japan

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Asian tropospheric aerosols (dust, sulfate, carbonaceous aerosols, and sea salt) transport and their optical properties (aerosol optical thickness (AOT), extinction coefficient, and single scattering albedo) during 2003-2005 (from 1 June, 2003 to 30 May, 2005) were simulated using a regional-scale chemical transport model (CFORS). CFORS model results were intensively examined with the Mie scattering Lidar and Skyradiometer optical observations. It was shown that simulated aerosol fields accurately capture many observed important features including several high AOT levels associated with the continental outflow and aerosol vertical profiles. In these comparisons, we found that many dense aerosol layers were transported over Japan in the vertically wide range, especially during spring. To clarify the typical vertical characteristics of Asian aerosol layers during spring, aerosol scale heights for dust and spherical aerosols (including sulfate and carbonaceous aerosols) were also evaluated from the Lidar observation and CFORS model results. It was shown that dust layers have higher scale heights over Japan compared with spherical aerosols. Further analysis of the simulated three month averaged aerosol scale height and AOT fields shows this vertical characteristic more clearly and also show that dust scale height gradually increase along the ridge of its horizontal AOT distribution, whereas spherical scale height maintains the altitude level of 2-3km. Therefore, we found that Asian dust is mainly transported while increasing its transport altitude and that spherical aerosol are mainly transported within the boundary layer.

Keywords: numerical model, aerosol transport, vertical distribution

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MS003 **Poster presentation** **4979**

Radiative effects of NO2 and aerosols in the atmosphere of large city

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Urban development is a vital source for NO2 generation. Its content can significantly increase the solar irradiance absorption in the troposphere over industrial regions. At the same time, the retrieval of NO2 tropospheric content is quite challenging. In this study, first, we compare NO2 content in the atmosphere of Moscow megalopolis revealed from different methods: from ground concentration together with model and experimental vertical profiles, from satellite data, from direct CIMEL sun photometer measurements, and from a combination of two co-located CIMEL AERONET instruments in Moscow (Meteorological Observatory of Moscow State University) and at Zvenigorod (Institute of Atmospheric Physics) located 50 km to the west. A distinct signature of NO2 absorption in spectral dependence of optical thickness differences has been revealed from the two CIMEL datasets in Moscow and in Moscow suburb. Using the obtained NO2 as well as aerosol properties from CIMEL data in Moscow, we study the amount and spectral features of solar irradiance attenuation due to both factors. For this purpose a 8-stream DISORT model as well as ground broadband measurements in different spectral ranges are used. To eliminate cirrus clouds influence on aerosol retrievals in addition to the standard cloud-screening algorithm we use screening of high level clouds from 1-hour visual cloud observations. The difference in aerosol properties from simultaneous aerosol measurements after correcting on NO2 content in Moscow and at Zvenigorod is analyzed for various atmospheric conditions. We discuss possible urban effects of Moscow megalopolis on aerosol properties and solar irradiance in different spectral ranges. The effects of NO2 and aerosol on solar irradiance are compared to those obtained using aerosol parameters from AERONET version 2 aerosol retrievals with climatic correction on NO2 content.

Keywords: aerosol, irradiance, no2

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MS003 **Poster presentation** **4980**

Cloud Water and Related Hydrological Cyle over China: A Climatic Analysis Using ISCCP Data During 1984- 2004

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Using cloud water path (CWP) data from the International Satellite Cloud Climatology Project (ISCCP), climatic features of CWP are analyzed. Combined with GPCP precipitation data, cloud water cycle index (CWC) is also calculated. The climatic distributions of CWP are found to be dependent on large-scale circulation, topographical features and water vapor transport and similar distribution features are found in CWC except in Sichuan Basin. Influenced by the Asia monsoon, CWP over China exhibits very large seasonal variations in different regions. The seasonal cycles of CWC in different regions are consistent and the largest CWC occurs in July. The long-term trends of CWP and CWC are investigated, too. Increasing trends of CWP are found during the period and the largest increase is found in winter. The decreasing trends of CWC dominate most regions of China. The differences in long-term trends between CWP and CWP suggest that, CWP only can influence the variation of CWC partly and the other factors need to be involved in cloud water cycle researches. This phenomenon reveals the complexity of hydrological cycle related with cloud water.

Keywords: isccp, cloud water path, hydrological cycle

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MS003 **Poster presentation** **4981**

Chemical apportionment of direct aerosol radiative forcing at the surface: a new approach

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Shortwave direct aerosol radiative forcing at the surface as well as aerosol optical depth were estimated and chemically apportioned on the basis of ground-based aerosol and radiation measurements at th e Gosan super-site in Korea during the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia) in April 2001. An aerosol optical m odel and a ra diative transfer model were employ ed to calculate the aerosol extinction coefficient and radiative flux at the surface, respectively. The calculated scattering and absorption coefficients for sub10 micrometer ae rosols agreed well with measured scattering an d absorption coe fficients with root mean square e rrors of 23.6 and 3.0 /Mm, respectively. The modeled direct and diffuse irradiances at the surface were also in good agreement with the measured direct and diffuse irradiances. In this study we found that the 17-day mean aerosol radiative forcing of -38.3 W/m2 at the s urface is attributabl e to mineral dust (45.7%), water-soluble compon ents (sum of sulfat e, nitrate, ammonium, and water- soluble organic carb on (W SOC)) (26.8 %), an d elemen tal carbon (EC) (26.4%). However, sea salt does not play a major role. For the cases of Asian dust and s moke episodic events on 26 April 2001, a diurnal average d forcing of -36.2W/m2 was contributed by mineral dust (-18.8W/m2), EC (-6.7W/m2), and wa ter-soluble components (-10.7Wm _2). The resul ts of this stud y suggest that water-soluble and EC components as well as a mineral dust component are responsible for a large portion of the aerosol radiative forcing at th e surface in the continenta l outflow region of East Asia.

Keywords: aerosol, radiative forcing, aceasia

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MS003 **Poster presentation** **4982**

Evaluation of Aerosol Particle Size Distribution (APSD)

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Particle size distribution is an important characterist ic of a erosol. Observation of light scattered on the aerosol particle s at several wavelengths mig ht be us ed for determination of APSD, since properties of the scattering depend on the wavelength and particle radius. Multiwavelenght lidars provide opportunity for remote se nsing of APSD. A common assumption to t his problem is that the aero sol c onsists of spherical liquid droplets of known index of refraction [1]. Due to that the APSD can be related to the extinction c oefficient and the scattering coefficient of aerosol using Mie theory [2,3]. In our approach both coefficients are substituted directly to the system of equations describing the range-corrected lidar signals [4]. Thanks to that in the equations only the APSD is unkno wn. Then we find the particle siz e distribution using the minimi zation technique. Such approach allows to ommit the application of th e Klett method [5] of lidar equation solution (that is comm only applied). Therefore it does not require s using of a doubtful lidar ratio (a relation between extinction and backscatter coefficients). Moreover the knowledge about aerosol properties at a reference di stance is not nece ssary as well. The method is simpler than the regularizat ion technique [6]. We use this appr oach for in terpretation of ou r experimental data concerning changes of the aerosol particle size distribution in convective atmosphere. The work was supported by Polish Ministry of Science and Education, grant 2 P0 4D 06927. References 1. K. Ernst, G. Karasiński, A. Pietruczuk, T. Stacewicz, (2 003) Retriving the atmospheric aerosol size distribution by means of multi wavelength lidar. SP IE Proc. 5258, 156159. 2. H. C. Van de Hulst, Light Scattering by Small Particles (John Wiley & Sons, New York 1957) 3. C. F. Bohren, D. R. Huffma n, Absorption and Scattering of Light by Small Partic les (Joh n Wiley & Son s, New York 1 999) 4. R. M. Measures, Laser Remote Sen sing Fundamentals and A pplications (Krieger Publishing Co mpany, Flo rida 1992) 5. F. G . Fernald, J. D. Klett, Appl. Opti cs 23, 6 52 (1984) 6. C. Bckmann, (2001) Hybrid regularization method for the ill-p osed inversion of multiwavelength lida r data in the re trieval of APSD. Appl. Opt. 40, 13291342.

Keywords: particle size distribution, multiwavelenght lidar, convective atmosphere

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MS003 **Poster presentation** **4983**

Study of anthropogenic aerosol effects on the climate using GCM

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Aerosol particles have a major impact on the climate change through causing air pollution, reducing solar radiation, changing cloud properties and so on. Fossil fuel usage has been increasing with growing industrial activity especially over Asia. Then this rapid increase in fuel usage has resulted in an increase of density of aerosol concentrations. It is important to investigate how these aerosols in the air affect the climate. In order to investigate aerosol impacts on the climate, aerosol transport model is used. This model, called SPRINTARS [Takemura et al., 2000, 2002, 2005], is coupled with CCSR/NIES/FRCGC Atmospheric General Circulation model [Numaguti et al., 1995] and treats carbonaceous, sulfate, mineral dust and sea salt aerosols from various emission sources. It is said that the increase of aerosol particles impact on the radiation budget by directly absorbing and scattering the solar radiation and by indirectly modifying the optical properties [Twomey, 1974] and lifetimes of clouds [Albrecht, 1989]. Then investigation of radiation budget variation is important for estimating aerosol effects. Initially variations of radiation budget are analyzed using surface observation data and model simulations. Because aerosol particles change the amount of sunlight that reaches the ground by scattering and absorption of solar radiation, we calculated the information of change in the atmosphere from the analysis of trends in surface radiation. Next aerosol effects on the cloud field and these cloud change effects on the radiation budget are investigated. It is found that aerosols impact on the dynamical field through radiation budget change. This study focused on the climate change in East Asia, where industrial activity is growing rapidly.

Keywords: aerosols, gcm, asia

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MS003 **Poster presentation** **4984**

Human impact on direct and diffuse solar radiation during the industrial era

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We estimate direct and diffuse solar surface radiation changes during the industrial era and contribute to the understanding of the observed global dimming and the more recent global brightening. Using a multi-stream radiative transfer model, we calculate the impact of changes in ozone, NO2, water vapor, direct and indirect aerosol effects, and contrails and cirrus on solar irradiances at the surface. Our results show that dimming is most pronounced in Central Africa, South East Asia, Europe, and Northeast America. We calculate that human activity during the industrial era accounts for a decrease in direct solar radiation at the surface of up to 30 Wm-2, equivalent to a 30% to 40% reduction, and an increase in diffuse solar radiation of up to 20 Wm-2. The large change in North America is mostly due to contrails and cirrus from aircraft traffic and the direct aerosol effect, while surface solar radiation in South East Asia is mostly influenced by direct and indirect aerosol effects. In this study we have shown that the spatial variability is large in our model results and further that some of the causal mechanisms of global dimming have a spatial resolution that cannot be fully resolved in global models. The observed brightening is found to be largest in many high latitude measurement sites in accordance with our model results, and it is likely that stratospheric ozone is one of several contributors. A contributor to the global dimming is NO2 with a regional pattern but shown here for the first time to have a non-negligible impact on the global solar radiation. We find the physical processes that lead to the changes in direct and diffuse solar radiation to be remarkably different and we explain which mechanisms that are responsible for the observed changes.

Keywords: aerosols, globaldimming, brightening

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MS003 **Poster presentation** **4985**

Vicarious calibration of GMS-5/VISSR for estimation of radiation budget

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Clouds play an important role in the radiation balance and energy balance of the Earth surface and at the top of the atmosphere. In order to estimate the impact of clouds on the global climate, it is necessary to estimate the physical properties of clouds at high spatial and temporal resolutions. GMS-5/VISSR (Geostationary Meteorological Satellite/Visible and Infrared Spin-Scan Radiometer, hereafter VISSR) is a geostationary satellite enabling observations every hour. The geostationary satellite has a big advantage for estimation of radiation budget because of highly time-resolved data. One of key factors in the estimation is a sensor calibration. The GMS-5/VISSR has some issues in the calibration procedures. In this study, we have developed a vicarious calibration technique based on the original sensor information of GMS-5/VISSR, using the radiative transfer code RSTAR6 (system for transfer of atmospheric radiation). The atmospheric parameters were supplied in the analysis, by MODIS data for aerosol and cloud using REAP (Retrieval of Aerosol Optical Properties) and CAPCOM (Comprehensive Analysis Program for Cloud Optical Measurement) algorithm, respectively, and by objective analysis data JRA-25 for temperature, pressure, water vapor and by TOMS ozone data set. The albedo in the sea surface was decided from the wind velocity of sea surface, and land surface albedo in Australia used a standard product of the MODIS data (16day mean product). Aerosol optical characteristics in the land region used the ground observation data (Sunphotometer). The stripe noise by sensitivity difference between four detectors were enough small. The high-speed estimation algorithm for a long-term analysis of radiation budget on Refined-VISSR was developed. An example of radiation budget analysis has been performed using R-VISSR data set in APEX (Asian Atmospheric Particle Environmental Change Studies) field experiment period. This study was performed based on a collaboration of Center for Climate System Research, University of Tokyo and Meteorological Satellite Center, Japan Meteorological Agency. Aerosol optical characteristics data by ground observation in Australia provided by GAW PFR network, at the Australian Bureau of Meteorology (BoM). The authors would like to acknowledge Mr. Christoph Wehrli (PMOD/WRC, Davos, Switzerland) and Dr. Bruce W Forgan (BoM).

Keywords: vicariouscalibration, vissr, radiationbudget

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MS003 **Poster presentation** **4986**

Characteristics of aerosols over the Zhongshan Station, East Antarctica and the human pollution

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Three years of bulk, high-volume aerosol samples were collected over Zhongshan Station in the Eastern Antarctica. Instrumental Neutron Activation A nalysis (INAA), Scanning Electro n Microscopy plus Energ y Dispersive X-ray (SEM-EDX) and Transmissio n electron microscopy plus Energy Dispersive X-ray (TEM - EDX) were applied respectivel y to obtain var ious chemical species and ph ysical features for aerosols. A graphical technique were applied to the INAA data and fiv e elements Se、Co、Sb、Zn、Cr were high ly enriched, and they might come from the petrol eum burning for p ower generation, heating a nd equipment operation. The SEM-EDX and TEM-EDX ph oto also showed besides sea salt and crustal aerosols, there were particle s from biomas s burnin g, sh owing that human activities has obviously affected on the local environments in Antarctica.

Keywords: aerosol, antarctica, huaman pollution

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MS003 **Poster presentation** **4987**

Modeling studying the role of bacteria on ice nucleation processes

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Certain bacteria have been recognized as efficient ice nuclei at temperatures above -10 C. Inhabiting plants, soils and ocean surfaces, these ice-nucleating bacteria were found in almost all climate regions, even in the polar-regions. These ice-nucleating bacteria are readily disseminated into the atmosphere and have been observed in clouds and hailstones; bacteria thus should play a more important role than any other ice nuclei in ice formation of clouds at temperatures above -10C. High concentration of ice crystals exceeding background ice nuclei were often observed in the warm-based cumulus clouds, which were caused mainly through collisions of graupels with cloud droplets (riming process). The formation of graupels is responsible for ice multiplication process under suitable conditions. The initiation of graupels highly depends on the initiation process of ice crystals at relative warm temperatures (growing stage of cumulus clouds). Thus, we hypothesize the ice-nucleating bacteria plays a key role in graupel formation and the subsequent ice multiplication process. A 1.5-D non-hydrostatic cumulus cloud model with bin-resolved microphysics was developed to investigate the interaction between aerosols and clouds. The ice nucleation process by bacteria was simulated and the relationship between this process and graupel formation was determined. On one important aspect of the global aerosol indirect effect, this finding will improve estimation accuracy of radiation budget of the Earth with the aerosol-climate model.

Keywords: ice, bacteria, modelling

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

MS003 **Poster presentation** **4988**

Solar irradiance changes in Switzerland since 1981

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Within the MeteoSwiss automatic me teorological n etwork ANET Z global solar irradia nce, also cal led shortwave downward radiation (SDR) is mea sured at 54 stations since 1981. These measurements have been elaborately homogenized and qu ality checked. With this database we investigate trends in sola r irradiance, which will help to understand the rapid temperature rise in Europe. Solar irradiance under all situations increased about 2.3 (+/-2.5) Wm-2/decad e from 1981 to 2005, also called solar brightening. The increase is significant smaller in the alpine region (stations abov e 1000 m a.s.l.) than in the lowland. The statistical signifi cant increase at the lowland stations is mainly caused b y the extreme summer 2003 and its reduced cloud amount, which is also confirmed by the increased number of cloud-free situations at these stations. SDR increa sed at cloud-free situations 0 .9 (+/-0.4) Wm-2/decade at the lowland st ations for the respective tim e period. The positive trend i n clear-sky sol ar irradiance is likely due to t he aerosol red uction, observed in Central Europe. MODTRAN mo del calculatio ns sho w, that the effect of the reduced aerosol conce ntration on changes in solar irradiance is more than 5 times larger than the effect of the increased amount of water vapor.

Keywords: global radiation, solar brightening

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MS003 **Poster presentation** **4989**

Correlative measurements of aerosols and water vapor profiles over Athens, Greece during 2006-2007 in the frame of EARLINET-ASOS

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Tropospheric aerosol particles play a crucial role in the Earths radiation balance, directly by scattering and absorbing solar radiation and indirectly by acting as cloud condensation nuclei. Moreover, aerosol hydration has important consequences on the Earths radiation budget as the water vapor is a very strong greenhouse gas. Correlative measurements of vertical profiles of tropospheric aerosol optical properties (backscatter and extinction coefficient, lidar ratio and color ratio) and water vapor using a combined elastic-backscatter-Raman 6-wavelength (355, 387, 407, 532, 607 and 1064 nm) lidar system, have been performed over Athens (37.9o N, 23.6o E, 220 m asl.), Greece, during 2006 and 2007 in the frame of the European Aerosol Research Lidar Network (EARLINET-ASOS: 2005-20011) project. Water vapor mixing ratio measurements are retrieved from simultaneous inelastic H2O and N2 Raman backscatter lidar signals at 387 nm (from atmospheric N2) and 407 nm (from H2O). The aerosol optical properties are retrieved from simultaneous elastic (at 355, 532 and 1064 nm) and inelastic N2 Raman backscatter lidar signals at 387 and 607 nm. The aerosol and water vapor (mass mixing ratio) profiles were obtained in the lower and middle troposphere typically from 500 m up to 5000 m asl. The high quality of the aerosol lidar data has been previously assured by extensive inter-comparison at software and hardware level, within the frame of the EARLINET (2000-2003) project. The high quality of the water vapor Raman lidar data has been assured by extensive intercomparisons between the lidar and local radiosonde data. A large amount of the aerosol profiles has been recorded by the elastic lidar system during daytime and by the Raman lidar system during nighttime. A preliminary analysis of nearly one year lidar measurements (aerosol and water vapor vertical profiles), using trajectory air mass cluster data, showed a good correlation between the aerosol backscatter coefficients, the lidar ratio, the aerosol color ratio and the relative humidity, depending on the origin the air masses (continental and maritime ones). Acknowledgements: This work was funded by the European Commission under grant RICA-025991 EARLINET-ASOS.

Keywords: earlinet, raman lidar, athens greece

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MS003 **Poster presentation** **4990**

Study of cloudiness influence on solar radiation measures in the South of Brazil at the Southern Space observatory

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A suitable evaluation of the solar p otential is requ ired f or planning and decision ma king in energy policies, especially in develop ing countries in orde r to establish the best use and management of its energy reso urces. Co mputational mo dels have estimated solar irra diation values and ground measurements have been used to improve them as well as to keep an accessible and reliable database. With this purp ose, the SON DA project ha ve installe d, thro ughout B razilian te rritory, several sites to acquired solar irradiation data. One of them is located at the S outhern Sp ace Observatory SSO/CRS/INPE MCT, (29S; 53W), in So Martinho da Serra, Brazil where solar and aeolic data have been used to assess the renewable energy potential of the Southern region of Brazil. The solar radiation that reach the top of atmosphere suffer absorption and scattering processes caused by aerosols, atmospheric gases and clouds. This pap er aim to stud y th e in fluence of clou diness on th e fraction of solar radiation that reac hes the ground. A empiric model was developed correlating solar irradiation values measured by a CM 21 Pyrhanometer (Kipp & Zonen) with opaque and thin cloudiness fractions esteemed by a Total Sky Im ager TSI-440 (YES, Inc) during the spring and summer s easons. It was used fifteen minutes averages to minimize e ffects of cloud y cover variance. The results are important for a better knowledge of the influe nce t hat differe nt cloudy thickness can offer on surface solar irradiation and to improve ra diative transfer models. Studies investigatin g the in fluence of clo udiness, during autumn and winter seasons and in specifics ti mes of the day, on solar radiation should be made in the next step.

Keywords: aerosols, radiation, clouds

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MS003 **Poster presentation** **4991**

Impact of aerosol competition effects on global cloud fields using a general circulation model

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Interactions between aerosols and clouds are very complex and yet are not understood fully; hence their treatments are different among atmospheric general circulation models (AGCM). In this study, we focused on an aerosol activation process, which means that hygroscopic aerosols grow into cloud condensation nuclei (CCN). This process is determined by mainly four parameters: aerosol number concentration, aerosol size distribution, aerosol chemical component, and updraft velocity in a cloud [e.g. Pruppacher and Klett, 1997]. Additionally when aerosols are activated in a circumstance, aerosols compete among them to get water vapor. However, these complex relationships are not reflected on most of AGCMs. Therefore we investigated an influence of the aerosol competition effect to global cloud microphysics fields, using a global three dimensional aerosol transport model (SPRINTARS), coupled with Center for Climate System Research (CCSR)/National Institute for Environmental Studies (NIES)/ Frontier Research Center for Global Change (FRCGC) AGCM [Takemura et al., 2005]. In this study, meteorological conditions are nudged by NCEP re-analysis data. In the aerosol activation process, we used two parameterizations: single-component aerosol parameterization [Abdul-Razzak et al. (1998)] and multiple-component aerosol parameterization [Abdul-Razzak and Ghan (2000)]. Both parameterizations can calculate the supersaturation ratio, but only the latter includes the competition effect among different aerosol components. Thus the comparison of results from two parameterizations allowed investigating an impact of the aerosol competition effect on global cloud fields. Firstly we picked up aerosol parameters such as aerosol optical thickness and mass concentrations for estimating aerosol distributions. Secondly, for estimating the impact on cloud fields, we also picked up cloud microphysical parameters such as cloud droplet effective radius (Re) near the top of water clouds and the cloud optical thickness. Furthermore, these parameters were compared to satellite observations and ground measurements. Two results of aerosol distributions were different but both their magnitudes lie within the range of measurement uncertainty. In contrast, there are large differences in values of Re and cloud optical thickness from model and observation. With the multiple-component aerosol parameterization, the magnitude of Re near the top of water clouds change abruptly near the coastal areas with large Re in the ocean region, which is much larger than Re simulated with the single-component aerosol parameterization. These changes could be explained as follows. Large particles such as sea-salt aerosols decrease supersaturation and the activation ratio of small particles such as sulfate aerosol is reduced dramatically, and consequently the CCN concentration decreases and the Re increases. In conclusion, introduction of the aerosol competition effect can reproduce the clear land/ocean contrast of Re and the magnitude of the water cloud optical thickness observed by satellite remote sensing.

Keywords: aerosol, modeling

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MS003 **Poster presentation** **4992**

Modeling short-range interactions in a hybrid simulation of turbulent collision of cloud droplets

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Understanding the turbulent collision rate of cloud droplets requires accurate modeling of both the interaction of droplets with the background air turbulence and the local aerodynamic interaction among droplets. Most previous numerical studies of particle or droplet coagulation in turbulent flows focus on the motion of small (point) particles in response to the carrier-fluid turbulence. Collision rates are given in terms of the geometric collision kernel ignoring short-range hydrodynamic or aerodynamic interactions and the effect of attractive van der Waals force. Recently, local aerodynamic interactions of particles have been included in a hybrid direct simulation approach of turbulent collision of sedimenting particles (J. Atmos. Sci. 62: 2433-2450, 2005). The basic idea of the approach is to combine direct numerical simulation of the background air turbulence with an analytical representation of the disturbance flows introduced by droplets. The approach allows the disturbance flows to be coupled with the background air turbulence through an approximate implementation of the no-slip boundary conditions on each droplet. While this method represents a first consistent approach for a turbulent suspension of aerodynamically-interacting droplets, it could not accurately represent the near-field lubrication force as the treatment for aerodynamic interaction is roughly equivalent to the first order approximation of the general multipole expansion method for Stokes flows. Here we study efficient ways to include higher-order terms in the multipole procedure. We propose to include at least the Faxen terms, a force dipole (stresslet), and torque as done in the context of Stokesian dynamics simulations. We are currently developing a simplified procedure by combining a second-order multipole procedure, which is accurate for large separations, and leading-order asymptotic representations of the lubrication force at small separation. For intermediate separations, we use polynomial fitting that matches, at the two matching points, both the value and local gradient of the multipole solution and the asymptotic representation. We will discuss how this accurate representation can be used to compute the collision efficiencies of droplets in both still and turbulent airflows.

Keywords: collision coalescence, hydrodynamic interaction, simulation

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MS003 **Poster presentation** **4993**

A fully resolved simulation method for turbulent collision of cloud droplets

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The collision-coalescence of sedimenting particles and droplets in a turbulent gas presents a challenging computational problem. Most previous numerical studies of particle coagulation in turbulent flows focus on the motion of individual point particles in response to the carrier-fluid turbulence. Collision rates are given in terms of the geometric collision kernel ignoring particle-particle hydrodynamic or aerodynamic interactions. More recently, we extended the point particle representation to include some aspects of local aerodynamic interactions of droplets in direct simulation of turbulent collision of sedimenting particles (J. Atmos. Sci. 62: 2433-2450, 2005). The approach consists of direct simulation of the undisturbed turbulent flow and an analytical representation of local small-scale disturbance (Stokes) flows induced by the particles. While this method represents a consistent approach for a turbulent suspension of aerodynamically-interacting particles, it does not resolve fully the boundary condition and flow at the scale of droplet size. Here we report on a fully resolved simulation approach for colliding particles suspended in a viscous fluid. We adopted the computational approach developed by Prosperetti and co-workers (J. Comp. Phys. 210: 292-324, 2005) in representing the particle-fluid interactions. In this approach, the fluid flow is represented on a regular mesh and a local analytical Stokes flow representation is used to simulate the interaction of a spherical particle with the fluid flow in its neighborhood. Particle Reynolds numbers up to a few hundreds could be handled by this approach and the particle size may overlap with the flow length scale. This paper will focus on the development of the numerical method when applied to two situations. The first is the gravitational collision of two sedimenting droplets and the second is the turbulent collision of droplets in a random suspension. Specific implementation issues such as accurate treatment of far-field boundary conditions and incorporation of sub-grid lubrication force will be discussed, along with results designed to establish the validity of the approach.

Keywords: collision coalescence, moving boundary, simulation

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MS003 **Poster presentation** **4994**

Effects of turbulent collision Kernel and initial size dispersion on rain initiation

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The growth of cloud drop lets from roughly 10 micron s in radius to driz zle size (roughly 100 to 300 microns in radius) is impo rtant to the understanding of warm rain initiation . Here we study ho w the nature of collection kernel and the initial siz e dispersion affect the warm rain initiation time. Guided by results from direct simu lation of tu rbulent collisi on o f clou d droplets, we h ave developed a comprehensive turbulent collection kernel in terms of the inertial response time and terminal velocity of droplets, and the governing p arameters of a ir turbulence such as the diss ipation-range scales and rms fluctuation velocity. Results of the growth process are obtained by solving the kinetic collection equation (KCE), and are compared to these based on a hydrodynamical gravitational kernel without effects of air turbulence. The spectral widt h of the init ial size distribution is quantified by a relative ra dius dispersion parameter defined as the r atio of the st andard deviation to the me an droplet radius. By using information of local mass conversion rat es, we find that the rain initiati on pr ocess can be unambiguously divided into three phase s, namely, th e autoconversion phase, the accretion phase, and the larger hydrometeor se lf-collection phase. Th e boundaries between these sequential phases are identified. A moderate enhancement of collection kernel by turbulence is found to have a significant impact on the autoconversion phase of the growth. The time evolutio ns of radar reflectivity and mass-weighted mean radius are e xamined to pr ovide vari ous ways of qu antifying th e rain initiation t ime. Despite the very stro ng no nlinearity for the autoconversion phase, we find that the growth time is mainly related to the initial m aximum autoconversion rate and the ra dius dispersion parameter, which may be viewed as the two most important i nput parameters to KCE. We will discuss the implications of this finding and attempt to provide some explanatio n of th e observed c orrelation. We will also exp lore the relationship between other measures of the growth time and the KCE input parameters.

Keywords: rain initiation, turbulent collision kernel, size dispersion

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MS003 **Poster presentation** **4995**

Results of simulation microphysical and optical characteristics of marine and coastal aerosol

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Extinction of radiation in the marine bo undary layer is dominated by scattering and absorption due to atmospheric aerosol . This is important to optica l retr ievals from satellite, remot e sensing at environmental monitoring, backscatter of light to space (including climate forcing), cloud properties etc. In unpolluted regions the gre atest effects on near shore scattering extinction will be a result of sea-s alt from breaking waves and v ariations in relative hum idity. The role of b reaking waves appears to be modulated by wind, tide, swell, wave spectra an d co astal condition s. These influences will be superimposed upon aerosol generated by op en ocean sea-salt aerosol that varies with wind speed. The focus of ou r study is th e extinction and optical effect s due to aerosol in a spec ific coastal region. This involves linking coastal physical properties to oceanic and meteorological parameters in order to develop predictive algorithms that de scribe 3-D aer osol structure and variability. The aerosol microphysical model of the marine an d coastal atmosph ere surfac e layer is considered. Th e model i s made on the basis of the long-term experimental data re ceived at rese arches of aero sol sizes distribution function (dN/dr) in the band particles sizes in 0.01 - 100 k. The model is developed by present time for the band of heights is 0 - 25 m. Bands of wind speed is 3 - 18 m/s, s izes fetch is up to 120 km, RH = 40 - 98 %. dN/dr of the model is characterized by the four modified lognormal functions with modal radiuses, equal r1 = 0,03; r2 = 0,24; r3 = 2; r4 = 10 k [1]. The model distinctive feature is parameterization of amplitude and width of the modes as f unctions of fetch and wind s peed. In the paper the dN/dr behavior depending at change meteorolog ical para meters, heights abo ve sea level, fetch (X), wind speed (U) and RH is show. T he received results ar e compared to available microphysical models NAN and ANAM. On the basis of the developed model with usage of Mie theory for spheres the description of the last version of developed code MaexPro 5.0 (Marin e Aerosol Extinction Profiles) for spectral profile s of aerosol ext inction coefficients α(λ) calculations in the wavelength ba nd, equal λ = 0.2 - 12 m, with step Δλ = 0.0001 m is pres ented. Also α(λ) profiles for various win d modes (combi nations X an d U) calculated by MaexPro 5.0 code are given. Results of α(λ) profiles calculations are presented at chang e RH = 40 - 98 % and heights H = 0 - 25 m. The calculated spectrums of α(λ) profiles are compared with experimental data of α(λ) received by a transmission meth od in various g eographical areas. References [1]. G. Kaloshin, J. Piaz zola. T he Coastal Aerosol Microph ysical Mode l, Proc. of the 23rd International Laser Radar Conf., Nara, Japan, pp. 423-426(2006).

Keywords: aerosolsizesdistribution, windspeed, fetch

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MS003 **Poster presentation** **4996**

The code MaexPro for calculation atmospheric aerosol extinction in the marine and coastal surface layer

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In the report description of the last version of MaexPro code (Marine aerosol extinction Profile) for calculation spectral and vertical profiles of aerosol extinction coefficient α(λ) , aerosol sizes distribution, area distribution, volumes distribution, modes aerosol extinction spectra is submitted. Code MaexPro is a computer program under constantly development to estimate of EO systems signal power at a location place in which a fetch is key entrance parameter [1]. The program carries out calculation α(λ), as functions of atmospheric effects using standard meteorological parameters, aerosol microphysical structure, a spectral band and a height of the sensor location place. Spectral behavior α(λ) can be submitted as graphically, and as tables. Commands overplot for superposition or change of figures; profiles extrapolation; a lens; all kinds of possible copyings; the data presentation, convenient for an input in code MODTRAN, and etc. are stipulated. The code MaexPro is a completely mouse-driven PC Windows program with a user-friendly interface. Calculation time of spectral and vertical profiles of α(λ) depends on the necessary wave length resolution, radius of aerosol particles and the location place height, and does not exceed tens seconds for each new meteorological condition. Other calculations characteristics, such as aerosol sizes distribution, area distribution, volumes distribution, modes aerosol extinction spectra, are performed in a few seconds. References [1] G. A. Kaloshin, S. A. Shishkin, S.A. Serov. Development of the code MaexPro for calculation atmospheric aerosol extinction in the marine and coastal surface layer. Atmospheric and Oceanic Optics, 2007 (in press)

Keywords: extinction, scattering, fetch

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MS003 **Poster presentation** **4997**

Empirical model for estimation of diffuse solar radiation for the Southern Region of Brazil

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Southern Regional Space Research CenterCRS-INPE IAMAS

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The study o f incident so lar radiatio n in the terrestri al surface has direct implications in meteorology, especially in th e studies on th e climate and i ts changes, affecting directly the agro business, as well as the efficiency of architectural projects and impacting several other sectors of the human knowledge and activities. F orecasting of inci dent solar radiation ha ve a vital importanc e in the operation of hybrid systems for power generation, allowing an efficient management of power plants and the optimized use of solar en ergy, con tributing on th e econ omy of ot hers energy resources. This work describes the development of an empirical model to estim ate the diffuse solar irradiati on from measurements of the global solar ra diation and cloud co ver. Models to estima ting diffuse irr adiation in surface are ver y valuable due to the c omplexity and the large costs involved in its measu rement. The empirical m odel presented here was developed and validate d by using gro und data acquired in a SOND A measurement site (Brazilian Database System for Enviro nmental Data toward to the energy sector (www.cptec.inpe.br/sonda) inst alled and in operation at t he S outhern Sp ace Observator y SSO/CRS/INPE-MCT (29S, 53 W), So Martinho da Serr a, RS, Brazil, since 2004. The model presented a bias mean errorof -0,001 and a root mean square error of 0,096. It was observed that diffuse irradiation grows when northerly wind brings biomass burning aerosols from Brazilian Central and Northern regions during the dry season, from May to October. For the dry season, the bias error grows up to a mea n of 0,041 and the root mean square error reaches 0,111.

Keywords: aerosols, radiation, diffuse solar radiation

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MS003 **Poster presentation** **4998**

Aerosol optical depth: current status of the gaw sun photometer network

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A global network of aerosol optical depth (A OD) observations was started in 1999 by the World Optical Depth Researc h and Calibration Center (WORCC) at PMOD/WRC in collaborati on wi th GAW global stations. The accurate determination of AOD is import ant in modelling the effects of aerosols in GCMs. WORCC acts as a data collec tion and processing hub for t his network. Q uality controlle d data for all stations have been delivered as hourly averages to the World Data Center for Aerosols (WDCA) in Ispra, Italy. At present, 9 global GAW stations operate precision filter radiometers (PFRs) for the determination of AOD at 4 wavelengths. PFRs are a ne w generatio n of sun p hotometers design ed fo r lo ng-term stability and m onitoring. These stations are located at sites displaying a wide-range of climatic zones and altitudes. This work will present an overview of multi-wavelength AOD measurem ents during th e 1999 2005 per iod at GAW stations. Results will also be d iscussed with respect to the PFR reference group operating at Davos, Switzerland to which all global GAW stations are directly traceable.

Keywords: aod, gaw, sun photometer

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MS003 **Poster presentation** **4999**

Optical properties of Arctic aerosol in spring based on sky-radiometer and micro-pulse lidar measurements at Ny-Alesund, Svalbard

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Tropospheric aerosol has a potential to change the gl obal climate by the direct and indirect effects on the radiation balance in the planetary atmosphere. Aerosol optical properties are essential for the direct effect of aerosols. A sky-radi ometer (Prede , POM-02) and a micro- pulse lidar (MPL, NASA- upgraded SESI model) have been operated for six years to present at Ny-Alesund, Svalbard to observe aerosol optical properties and vertical structures. Aerosol optical properties, such as optical thi ckness, single scattering albedo and refracti ve index at se lected wavelengths, and the volume size di stribution are retrieved from measurement s of the direct solar be am and the sky r adiance distribution by the sky-radiometer. The vertical structure of aerosol layers and their temporal variations are observed by MPL. Preliminary results from the Arctic measurements, particularly focused on haze events in spring season, will be shown and discussed in this paper.

Keywords: aerosol, arctic, optical properties

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MS003 **Poster presentation** **5000**

Numerical study the relative contributions of liquid and ice phases in precipitation formation during floods in Carpathian

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The 3-D nowacasting and forecasting numerical models that have been developed in UHRI for modeling of the winter and summer frontal cloud systems were modified by topography and carried out for numerical simulation of the frontal rain bands and convective cloud clusters connected with heavy rainfalls during floods in Carpathian. Detail description of an evolution of cloud particles (cloud drops, rain drops, crystals, ice nuclei, etc.) are used to study widespread clouds and convective cloud clusters with long-lasting and heavy convective rainfalls with different mechanisms of cloud and precipitation formation. Models of frontal cloud systems passed over the Carpathian region of Ukraine and caused strong precipitation during floods were constructed. Evolution of cloud and precipitation of a different physical nature on different stages of investigating synoptical process that determined weather over target area were calculated. The calculated schemes were develop and numerical experiments with different variation of vertical motions, different mechanisms of ice, and liquid water, and mixing cloud formation, and precipitation formation were carried out. There are found that increasing of activity of coagulation and sublimation processes can to increase strong precipitation as well as decrease it. Coagulation processes can to increase or decrease precipitation intensity but they do not play crucial role in formation of heavy rainfall. Cloud and precipitation particles at condensation and sublimation processes without coagulation were in clouds more long time and take on itself more moisture and caused more strong precipitation. Numerical experiments with clouds of different phase states (liquid water, mixing, ice) shown that strong precipitation may to product the mixing and liquid water clouds. Ice clouds product the long-lasting rain with weak intensity. Increasing of ice formation mechanism did not cause the catastrophic precipitation. Artificial increasing of ice concentration from natural to the enormous concentration (reached to 2-3 orders of natural values) can to cause the disastrous precipitation. Increasing of drop concentration did not caused catastrophic precipitation. There was found that the inter sources of moisture do not due the strong precipitation. The free for condensation vapor, clouds and nuclei arrived into investigation area from neighbor regions from different directions and caused the strong precipitation. Most heavy precipitation have place when different sources of moisture meet and coupled.

Keywords: heavy precipitation, liquid and ice phase, carpathian mountains

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MS003 **Poster presentation** **5001**

Influense of biomass burning at aerosol optical thickness on Southern Brazil from 1997 to 2006

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Determination of aerosol optical thickness (AOT) through Langley Method was lately applied to Southern Brazil using Brewer Spectrophotometer MKIII #167. This equipment is installed at Southern Space Observatory OES/CRSPE/INPE MCT (29.44S, 53.82W) located at São Martinho da Serra RS, Brazil, and it performs the total column gas trace measurements as ozone and sulphur dioxide for five specific wavelengths: 306.3, 310.1, 313.5, 316.7, 320.1 nm. The AOT were calculated from January 1997 to December 2006. Data analysis showed some seasonal variation for all analyzed wavelengths, however with different behaviors for morning AOT and afternoon AOT. For the mornings, the maximum occurs on the month of June probably due to the high humidity associated with the winter. For the afternoons, two maximums were observed, one on August and another on December. The afternoons maximums were associated with biomass burning: on December probably due to local events of biomass burning and on August probably due to air masses come from biomass burning events occurred in Brazilian Central Region.

Keywords: aerosol, biomass burning, southern brazil

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

MS003 **Poster presentation** **5002**

Correlation analisis of long-term variation of cloudiness, aerosol pollution and total solar radiation in Tbilisi

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Results of correlation analysis of the long-term variation of cloudiness, aerosol pollution and radiation fluxes in Tbilisi (41.72 degrees latitude, 44.8 degrees longitude, 430 m a.s.l.) are presented. The following parameters were considered: mean annual values of total (G) and lower (L) cloudiness, aerosol optical depth of the atmosphere (Ta), annual sums of direct (S), diffuse (D), total (Q) radiation, annual sums of long-wave radiation balance (Bg) and radiation balance (B). The data for 1954-1990 were analyzed. The statistical characteristics of specified above parameters are presented. For example the following results are obtained. All the above-indicated eight time series are autocorrelate. The values of autocorrelation coefficient with a Lag = 1 year change from 0.85 for Ta to 0.31 for G. The coefficient of linear correlation R between the G, L, Ta, S, D, Q, Bg, B and years varied from -0.70 for B to + 0.89 for Ta. The values of Kendalls and Spearmens rank correlation coefficient varied from -0.56 to +0.69 and from -0.73 to +0.89 accordingly. Thus, the clearly expressed trends of the Ta (positive trend, fifth order polynomial), S and Q (negative trend, fifth order polynomial), B (negative trend, sixth order polynomial), G (negative trend, fourth order polynomial) and L (positive trend, fourth order polynomial) are observed. The time series of D and Bg do not have a trend and are close to the random. The trend + background and random components of Ta, S, Q, B G and L are estimated. The share of the random component of their total values respectively amounted: 25.5 %, 13.3 %, 7.2%, 13.9 %, 8.0 % and 16.0 %. The correlations between the real values of the above-indicated eight time series, and also between their random components are studied. In particular it is shown that the correlation between the random components of the studied parameters is often higher than between their measured values. For example, value of R between G and Ta, S, D, Q, Bg, B and L for real data correspondingly is equal:-0.30, -0.21, 0.05, -0.06, 0.32, 0.17 and 0.26. The same for the random components (time series of D and Bg are random) is equal: -0.24, -0.62, -0.01, -0.42, 0.29, -0.02, 0.75. The given results will be used for the multidimensional regression analysis of the inter connections between the above-indicated atmospheric parameters.

Keywords: cloudiness, aerosols, radiation

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MS003 **Poster presentation** **5003**

Observations of radiative flux divergence and vertical temperature structure evolution

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Radiative flux divergence (RFD) plays an importan t role in the thermodynamics of the atmospheric boundary laye r, but direct observations of RFD ar e extremely rare. During the Met eor Crater field experiment (METCRAX) in October 2006, the evolution of the stable boundary layer wa s studied within the idealized circularly symmetric topography of the impact crater near Winslow, Arizona. To investigate the role of RFD in the formation of diurnal surface-based inversions and cold-air pools, incoming and outgoing lo ngwave radiative fluxes were measured with carefully inter-compared pyr geometers at 4 levels between 0.5 and 8.9 m above ground over the ce nter of the crater floor. During daytime, when a shallow superadiabatic surface layer develops, radiative heating caused by convergence of the longwave fluxes was o bserved throughout the lo west 10 m of the atmosphere, with heatin g on the order of 500 Kd-1 in the 0.5 to 2 m layer and heating on the or der of 50 Kd-1 in the 5 to 8.9 m layer. During nighttime, under stable co nditions, o ur observations show a sign change in the radiative heating rate profile near the ground. Radiative heating i s observed in the 0.5 to 2 m layer, while radiative coolin g occurs in the layers above, reaching values of 50 Kd-1 between 5 and 8 .9 m. This poster presents the direct observations of radiative heating and cooling together with the observed temperature tendencies. It further discusses the relationship between the diurnal variation of longwave radiative flux divergence and the evolution of the vertical temperatur e structure near the gro und, as well as the possible effects of surrounding topography.

Keywords: boundary layer, radiative flux divergence

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MS003 **Poster presentation** **5004**

Global atmospheric chemistry: integrating over fractional cloud cover

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A new approach defined here allows for the averaging of photochemistry over complex cloud fields within a grid square and can be readily implemented in current global models. As diagnosed from observations or meteorological models, fractional cloud cover with many overlying cloud layers can generate hundreds to thousands of different cloud profiles per grid square. We define a quadrature-based method, applied here to the problem of averaging photolysis rates over this range of cloud patterns, which opens new opportunities for modeling in-cloud chemistry in global models. We select up to four representative cloud profiles, optimizing the selection and weighting of each to minimize the difference in photolysis rates when compared with the integration over the entire set of cloud distributions. To implement our algorithm, we adapt the UCI fast-JX photolysis code to the cloud statistics from the ECMWF forecast model at T42L40 resolution. For the tropics and midlatitudes, grid-square-averaged photolysis rates for O3, NO2, and NO3 using four representative atmospheres differ by at most 3.2% rms from rates averaged over the hundreds or more cloudy atmospheres derived from a maximum-random overlap scheme. Further, bias errors in both the free troposphere and the boundary layer are less than 1%. Similar errors are shown to be 10-20% for current approximation methods. Errors in the quadrature method are less than the uncertainty in the choice of maximum-random overlap schemes. We apply the method to the averaging of photochemistry over different cloud profiles and outline extensions to heterogeneous cloud chemistry.

Keywords: atmospheric chemistry, fractional cloud cover, photodissociation

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MS003 **Poster presentation** **5005**

Satellite observations of the deep convective cloud characteristics over the Indian Subcontinent and surrounding oceanic regions

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Convective clouds play a major role in the the hydrological cycle as well as the vertical transport of energy and wavter vapour in the troposphere. Role of convective cluds in the generation of atmospheric waves are als o well recognized. The imp act of cl ouds, however, depends on thei r physical and microphysical properties, all of wh ich sh ow large va riations in both time and space. In the present study, quantitative estimates of the spati o-temporal variations in dee p convective events over t he Indian subcontinent, Arabian Sea, Bay of Bengal, and tropical Indian Oce an are carried out using the daily data obtained from the Advanced Ver y High Resolution Radiometer (AVHRR) onboa rd NOAA-POES during the per iod 1996-2005. The s horter period as well as th e month ly, seasonal, a nd interan nual variations in the total and deep convective cloud amounts and the assoc iated cloud top temperatures over different regions are investigated. Pixels havi ng thermal IR brightness temperature (BT) less than 245K are considered as deep convective clouds an d those having BT< 220 K are con sidered as very deep convective clouds. Pres ent observations show that deepest convective clouds ar e encountered mostly o ver no rth Bay of Bengal during the Asian su mmer mon soon season wh en the regional mean cloud top temperature is as low as 200K. Over the Head Bay of Bengal (HBoB) from June to September, more than 50% of the obse rved clouds ar e of deep convective type and more than h alf of these de ep convective clouds are very d eep convective clouds . Histog rams of th e cl oud top temperatu res du ring this period show that over HBoB the most probable cloud top temperature for deep convective clouds is ~205K while that over southeast Arabian Sea (SEAS) is ~220K. This indicates that most probably the cloud top over HBoB is ~2 km higher than that over SEAS during the Asian summer monsoon period. Another remar kable feat ure observed during this period is the significan tly low values of de ep convective clouds observed over the south Bay of Bengal close to Srila nka, which ap pears as a lar ge pool of reduced cloud amount surrounded by regions of la rge-scale deep convection. Over both SEAS and HBoB , th e total, deep convective and very d eep convective cloud amounts a s well as their corresponding cloud top temperatures (or the alti tude of the cloud top) undergo large seasonal variations. Overall, the deep convective cloud amount is minimum (<10%) during J anuary-March period. Ampli tude of th e season al variation is con siderably small over the eastern e quatorial Indian Ocean where the cloud amount is generally large al l through the year. However, a s mall increase in cloud amount is observed dur ing the Septe mber-November period in th is region. The amount of deep and very deep convective clouds and their respec tive cl oud top temp eratures show large periodic variations, with maximum am plitudes in two bands: o ne around 30-60days and the o ther around 5-16 days.

Keywords: deep convection, clouds, indian ocean

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MS003 **Poster presentation** **5006**

Observations of semi-transparent Cirrus clouds over the Indian subcontinent using KALPANA-1 VHRR Data

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The radiative impact of semi-transparent cirrus clouds (STC) is quite different from that of the other clouds. Hence the estimation of the amount of STC is of critical importance in assessing the overall cloud radiative forcing over a given region. The tropical region where the convective activity is very strong, is expected to have the largest amount of STC. It is also well recognized that the overall radiative impact of clouds over the tropical Indian Ocean and Bay of Bengal is considerably different from that over the other regions. The Very High Resolution Radiometer (VHRR) onboard the Indian geostationary satellite KALPANA-1 located at 74E makes the observations at two infrared channels, viz ~6.7 micrometer (called water vapour band where absorption due to water vapour is very high) and 11.5 micrometer (called thermal IR band), in addition to the visible band observations. The potential of a combination of the brightness temperatures observed in the thermal IR and water vapour bands in detecting the semi-transparent cirrus clouds is well recognized. This method, however, assumes that the emissivity of cirrus is same at both these IR bands, and the difference between the observed brightness temperatures in these two bands (referred hereafter as Ti and Tw respectively) is resulting from the measurement uncertainties and the semi- transparency of the clouds. Following this conventional method, pixels with Ti>270K for which Tw<240 K are considered as STC. This study shows that largest amount of semi-transparent cirrus clouds are observed over the eastern tropical Indian Ocean throughout the year where its amount generally exceeds 30%. During the winter season (November-February), high amount of STC (20-30%) are mainly confined to the inter-tropical convergence (ITCZ) region. During the Asian summer monsoon season (June-September), the amount of STC exceeds 30% over a very wide region over the Indian subcontinent, Bay of Bengal, southeast Arabian Sea and tropical Indian Ocean. Over the Indian Ocean south of ~15S, STC amount is negligible during the Asian summer monsoon season, but generally significant during the other seasons. On an average, the seasonal variation in the amount of STC observed in the present study is in good agreement with the seasonal variation of lidar-derived cirrus cloud amount reported over Gadanki (13.5N, 79.2E). In the present study, an attempt is also made to detect STC above the middle and upper level clouds by modifying the conventional threshold criteria. Though the characteristics of the spatial and temporal distribution of STC remained unaffected by this improvement, it is seen that the overall STC amount increases by ~20% over the eastern tropical Indian Ocean during the Asian summer monsoon season.

Keywords: thin clouds, semitransparent cirrus, indian ocean

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MS003 **Poster presentation** **5007**

LIDAR observations of aerosol compared to global transport model results

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In this study we compare aerosol observations made by the Asian Dust LIDAR network to calculations made by a global aerosol transport model (SPRINTARS). LIDAR observations provide a powerful tool to study atmospheric aerosol, but a systematic intercomparison of observed and simulated LIDAR profiles has, to our knowledge, not appeared in the literature. The SPRINTARS model simulates sources, transportation and sinks of five major aerosol species (carbonaceous aerosol, mineral dust, sea salt, soot and sulfate) and is well suited to simulate the complex mixtures of aerosol over South-East Asia where biomass burning, industrial pollution and sand storms all contribute to large atmospheric loads. Model calculations where performed for March and April 2004 and 2005, just before and during the season in which large amounts of dust are swept into the atmosphere over the Chinese deserts. The Asian Dust network consists of several stations (12 where used in this study), mainly in China, South Korea and Japan. Observations are made at two wavelengths (532 and 1064 nm), every 15 minutes, 24 hours a day, 7 days a week. The network is therefor highly suited for intercomparison with model calculations, in particular with respect to the temporal evolution and height distribution of both pollution and dust events. Additional AOD observations by the SKYNET and AERONET networks of skyradiometers are also considered in this study. A first analysis shows that the SPRINTARS model is capable of predicting several of these events. Due to the limited vertical resolution (20 layers), the height distribution in the simulation is more diffuse than in the observations. The height of the boundary layer tends to be overestimated by the model. Furthermore, when comparing observed LIDAR backscatter to simulated backscatter, it appears there is a problem with the assumed scattering properties, especially at 1064 nm. In particular the backscatter properties of dust (currently based on Mie calculations) may need to be revised. Our ultimate goal is to develop an assimilation system for SPRINTARS that incorporates observations from both ground stations (skyradiometers and LIDARs) and satellites. Consequences for such an assimilation system dervied from the present study will also be discussed.

Keywords: model, lidar, aerosol

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MS003 **Poster presentation** **5008**

Airborne spectral radiation measurements in the Saharan dust plume

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Airborne irradiance measurements have been conducted in the Saharan dust plume during the SAMUM experiment 2006 in Morocco. Using a newly developed spectroscopic setup (an extension of that described by Wendisch et al. [1]), datasets of upwelling and downwelling irradiance between 300 and 2200 nm have been obtained for 13 flights in different dust scenarios and at different altitudes within the dust plume. A non-linear extrapolation algorithm [2] using dust and atmospheric input data (from other SAMUM participants) is applied to account for radiative interaction in the atmospheric layer beneath the aircraft. Thus, the spectral surface albedo is calculated from the irradiance measurements at flight altitude. The resulting surface-albedo map is then compared to the surface-albedo product of satellite instruments such as MISR and MODIS. This survey will contribute to an improved assessment of the quantitative performance of such retrievals in separating surface from atmospheric signal, as well as the validity of certain model assumptions in the satellite retrieval of aerosol and surface albedo.

Keywords: saharan dust, irradiance, surface albedo

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MS003 **Poster presentation** **5009**

Retrieval of minor constituents in a cloudy atmosphere with remote sensing millimeter wave measurements

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We know very little about the atmospheric chemistry in presence of clouds, because optical path through the cloud itself prevents remote sensing observations. The cloud effects on the radiative transfer are to increase the atmospheric optical depth and to introduce the scattering source function contributes. In the millimeter and submillimeter wave region the absorption effect is reduced for ice particle clouds and the scattering effect becomes important only for the larger particles composing the cloud. The millimeter and sub-millimeter wave region can be used to study the atmospheric chemistry in the presence of clouds. The effect of the clouds depends on particle phase, on radius and on numerical density of the particles composing the cloud. A theoretical retrieval analysis is made to assess conditions in which retrieval is possible. We find that in most cases an atmospheric continuum model is sufficient to describe the radiative transfer in cloud, however, in a few cases, that will be specified, a model that takes into account the scattering contribution is needed.

Keywords: clouds, limb sounding, retrieval

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MS003 **Poster presentation** **5010**

Determination of atmospheric aerosol properties from MFRSR measurements

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Multi-Filter Rotating Shadow-band Radiometer (MFRSR) is widely used for measurements of spectral aerosol optical thickness (AOT) in visible range. MFRSR measurements constitute a valuable global dataset with contributions from hundreds of instruments deployed worldwide. The major programs running MFRSR networks in the U.S. include DOE Atmospheric Radiation Measurement (ARM) Program, USDA UV-B Monitoring and Research Program, NOAA Surface Radiation (SURFRAD) Network, and NASA Solar Irradiance Research Network (SIRN). The information content of MFRSR data exceeds the traditionally derived spectral AOT and Angstrom parameter. We present an updated version of MFRSR data analysis algorithm that provides more detailed characterization of atmospheric aerosol properties. In particular, it is able to partition the spectral AOT into fine and coarse modes and to determine the fine mode effective radius. Our recent sensitivity study demonstrated that for a typical accuracy 0.01 of AOT measurements the trade-offs between the spectral aerosol extinction and NO2 absorption effectively prevent a conclusive estimate of NO2 column from the data and may bias aerosol size retrievals. This prompted us to adopt a constrained version of the retrieval algorithm that uses climatological amounts of NO2 and takes ozone columns from TOMS satellite measurements. The NO2 climatology was compiled using recent SCIAMACHY satellite retrievals. We will demonstrate the performance of our method using the data from the vast MFRSR dataset from the local network at the U.S. Southern Great Plains (SGP) run by the DOE ARM Program. This network consists of 21 instruments located at SGP's Central and Extended Facilities and covers the area of approximately 3 by 4 degrees in northern Oklahoma and southern Kansas. We will also present a detailed inter-comparison of our retrievals of total, fine, and coarse AOT, and fine mode effective radius with the correlative AERONET almucantar scan analysis results (Version 2) derived from a CIMEL sun-photometer co-located with two MFRSRs at the SGP's Central Facility.

Keywords: aerosol, sun photometry, mfrsr

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MS003 **Poster presentation** **5011**

Measurement of Aerosol Optical Thickness While PA/AE 2005-2006

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One of the projects realized in the frame of the Polish Arctic/Antartic Expedition 2006-2007 was entitled Measurement of Aerosol Optical Thickness. Measurements were made during the ship cruise from Gdynia (Poland) to Henryk Arctowski Polish Antarctic Station (South Shetlands, West Antarctic), in September and October 2006. There were two phases of the project: in the first one a North-South AOT profile along Atlantic ocean was taken, the second phase was focused on measurements of the optical properties of Antarctic aerosols. Peculiarity of cruise allowed to measure optical properties of aerosols in various climate zones. AOT was measured in the wavelengths of 380, 500, 675, 870 and 1020 nm with the hand held sunphotometer Microtops II. The device proved its usefulness on board due to is small dimensions, internal memory and GPS communication. Optical measurements were accompanied with the meteorological ones: pressure, temperature, wind direction and speed as well as roughness of the sea surface. Data from five channels allowed estimating size of particles according to the Angstrom law. Our records document the influence to of dust particles transported from Shara desert and sea salt from sea spray on AOT. After collection the the data were compared to the information of AOT retrieved from the MODIS satellite sensor and from the NAAPS aerosol prediction system. In the first step MODIS Aerosol Products MOD04_L2 and MYD04_L2 were used to show the difference between satellite algorithms and sunphotometer. In the second step in situ data were compared to AOT values for dust, sulfate, smoke and sea salt from NAAPS. This experiment partially supported by the Polish State Committee for Scientific Research grant number PBZ-KBN-108/P04. Acknowledgments: I would like to thank S. P. Malinowski, T. Stacewicz, K. Markowicz, and M. Witek for help and collaboration during experiment.

Keywords: aerosol optical thickness, sunphotometer, atlantic ocean

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MS003 **Poster presentation** **5012**

Monitoring of Aerosol profiles over New Delhi using Micro Pulse Lidar

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Atmospheric aerosol play an important role in regional meteorology and energy balance of radiation. Specially in mega cities like New Delhi a large amount of aerosols from anthropogenic origins is continuously produced and released in the atmospheric boundary layer. The effect of aerosols on atmospheric energy balance is a key global change problem. Aerosol vertical distribution monitoring can be significantly improved using active remote sensing by Lidar. Micro-pulse lidar proved to be an important state of art tool providing a detailed picture of the vertical structure of boundary layer and elevated dust or tiny aerosol. Aerosols are spatially and temporarily varied in short period. The movement of the pollutants can be tracked or mapped out as a function of time by the help of Lidar which is very important to understand the dynamics of particulate matters. The in-situ measurements of aerosol at ground will not be a true representation of total aerosol and its vertical distribution in the atmosphere, therefore the monitoring of vertical profiles of aerosol is very important and timely which is not possible by conventional methods. In view of the above a micro pulse lidar is being setup at NPL, New Delhi to get vertical profiles of aerosol to study the radiative forcing and characterization of aerosols using depolarization ratio. In the present communication details of the system and some preliminary results will be presented.

Keywords: aerosol, global change, micro pulse lidar

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MS003 **Poster presentation** **5013**

Size distributions of aerosol number concentrations at an urban site New Delhi, India

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Aerosol number size distributions have been measured since November 2004 at NPL, New Delhi using aerosol optical spectrometer. The data presents size-distribution within the particle diameter size range >0.3 to 20.0 mm during the period from November 2004 to December 2006. The daily, monthly and seasonal patterns of the aerosol particle number concentrations have been investigated. Diurnal variation of the particle number concentration showed close correlations with traffic activities, the highest total number concentrations have been observed during traffic peak hours (i.e., 07001000 and 1700-2200 hours). Seasonally, the highest total number concentrations were observed during winter than in summer and monsoon. At NPL, submicron mode (DP <1.0 mm) particles concentration is dominating and is contributing more than 98% for the total number concentration. Particles in the submicron size regime contribute dominantly to visibility degradation and radiative interactions. Interesting features are observed in the behavior of aerosol number-size distribution under intermittent foggy, hazy, and clear-sky conditions prevalent during the above period of study. In all size regimes aerosol concentration exhibited a large distribution in their values, with variabilities being particularly higher on hazy and foggy days. Backward trajectory analysis was also employed to examine the transport process of the air mass in Delhi.

Keywords: aerosols, number concentration, urban site

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MS003 **Poster presentation** **5014**

Investigations of the aerosol load over the Southern Balkan region as an indicator of air quality

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This study describes the atmosphe ric aerosol load encountered over a number of sites from the Southern Balkan region with a relatively well- known air quality factor. Using the aerosol optica l depth, AOD, retrieved from the two Moderate Resolution Imaging Spectroradiometers, MODIS, on board the Terra and Aqua NASA satellites, the aerosol content of numerous sites is investigated under the scope of local pollution sources, inter-regional transport and large scale dust and/or biomas s burning events. The MODIS A OD is validate d over a met ropolis of Nor thern Greece using ground- based Brewer spectrophotometer measurements and co-located AOD and Aerosol I ndex values fr om the Ozone Monitoring Instrument, OMI, on board the Aura satellite. The wide time range conside red permits the discussion of some possible climatological aspects as well.

Keywords: aerosol load, brewer spectrophotometer, satellite modis

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MS003 **Poster presentation** **5015**

Relative contribution of dynamic feedbacks to AIRF

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The extent of aerosol radiative effect depe nds on both the aerosol properties (i.e . ty pes) and cloud properties. At mospheric aerosols (e.g., sulfate, du st, org anic carbon, b lack carbon, s ea salt) can b e changed aerosol induced radiative forcing (AIRF) directly by scattering and absorption of solar radiation, called aerosol optical thickness (AOT) effec t and lo w cloud change induced by the change of dynamic circulation through the effect of aero sol-radiation in teraction can be con tributed AIRF changes, called dynamic feedback effect. We examine how these differences contribute to the impact of aerosols on the surface radiation. In this st udy, the NASA fini te-volume general circulatio n mo del (fvGCM) with Microphysics of clouds in Rel axed Arakawa Schubert Scheme (McRAS) is used to calculate the aero sol induced direct forcing (AIRF) for each aerosol type . Globally, AOT effect and dynamic feedback effect are assessed approximately 57% and 18% i n total aerosols, 13% and 38 % in black car bon, 70% and 26% in dust and 4% and 55% in sulfate, respectively. Also, We showed that increase of 0.1 in AOT can be causing a coolin g of -6.3Wm-2, -15.2Wm-2 , -8.7Wm-2 , and -1.3W m-2 and increase of 1% in low cloud amount can be causing a co oling of -2.0Wm-2, -1.5Wm-2 , -2.0Wm-2 , and -1.7Wm-2 for total aerosol, BC, dust, and sulfate, respectively.

Keywords: airf, aot, cloud

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MS003 **Poster presentation** **5016**

A look-up table method with separating the ground surface process for simulation of satellite-measured radiances

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We developed a new look-up table (LUT) method for fast simulation of radiances measured by satellites with visible and near-infrared channels. This method separates the ground surface process from the radiative transfer process in the atmosphere to reduce the number of parameters for the LUT and to efficiently deal with the radiation with various surface types. By using the radiative transfer code, we independently prepare the LUTs of upward radiances at the top of atmosphere that contains clouds or aerosols without the ground surface reflection, and those of the bidirectional reflectance for ocean and vegetation canopy. The expected measured radiance is synthesized from these LUTs considering the multiple reflection between the atmosphere and the surface. Some calculation examples suggested that this method can simulate well the radiances reflected by clouds and aerosols over the complicated ground surface.

Keywords: satellite observation, radiative transfer, surface process

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MS003 **Poster presentation** **5017**

A nested-grid simulation of cloud microphysical properties with a bin-type cloud resolving model

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In this study, we develo ped a no n-hydrodynamic cloud microphysical model based on the Japa n Meteorological Agen cy Non -Hydrostatic M odel (JM A-NHM) and the cloud microphysical scheme with spectral explicit bin method o f the Hebrew University Model (HUCM), wh ich treats Cloud Condensation Nuclei (CCN) effect on cl ouds. The model can be ne sted in a large dom ain, using interpolation of the dynamical field given by an analysis data to repres ent the realistic atmospheric condition. The nestin g algorithm is also applied to the di stribution of aerosol concentratio n, which is given fro m a glo bal simulation of the Spectral Radiation Transport Mo del for Aerosol Specie s (SPRINTARS) coupled wi th a general circulation model for reproducing the ho rizontal and vertical dis tribution of CCN in the trimmed domain. The simulated results are compared the cloud parameters of the retrie ved data fro m Terra/MODIS s atellite-borne imager. A general agr eement between numerical simulation results and satellite-retrieved results of cloud liquid water and effective particle radius of low le vel clouds for selected days around the East China Sea region. We will also show the comparison with the observation of ice clouds conducted with a ship-board lidar during Mirai cruise.

Keywords: bin model, cloud, ccn

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MS003 **Poster presentation** **5018**

Validation of CERES Polar Night Cloud Detection using Aqua MODIS data with CALIPSO Observations

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The Arctic and Antarctic regions play important roles in the global climate system. Over the past several decades, the climate in polar latitudes has experienced rapid and profound changes. Understanding these changes requires a detailed knowledge of factors that affect the radiative budget such as the distribution of clouds. Accurate detection of clouds over snow and ice surfaces using satellite radiance observations is a crucial first step in determining surface and top-of-atmosphere radiative fluxes. Unfortunately cloud observations at high latitudes from passive satellite senses are difficult during the polar night because the scenes lack information from visible wavelengths and often have poor thermal contrast between clouds and snow/ice surfaces. The successful launch of CALIPSO, as part of the NASA A-Train satellites constellation including Aqua, offers an unprecedented observational data set that provides insight into the occurrence and vertical structure of clouds. This paper presents the distribution of clouds using the CERES nighttime cloud detection algorithmusing Aqua MODIS observations compared with CALIPSO cloud measurements. Preliminary results show generally good agreement between CERES retrieved cloud fraction and cloud heights with CALPSO lidar attenuated backscattering over Antarctica and Arctic regions. Some limitations found in the comparison of optically thick clouds will be discussed.

Keywords: polar night, clouds, detection

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MS003 **Poster presentation** **5019**

Assessing the Aerosol Direct Radiative Forcing of the Canadian GEM Model Against Satellite Measurements

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The represe ntation of the ef fect of aerosols in the Ca nadian Global Enviro nmental Multiscale (GEM) modelhas been revised by usi ng two model-derived monthly aerosol clima tologies: the dataset of the Canadian Cent er for Climate Mode ling and Analysis (CCCMA) and t he d ataset of Tege n at al. (1997) adopted by the European Center for Medium-Range Weather Forecasts. A total of five ae rosol types are considered: sulfate, sea salt and mineral dus t for the CCCMA dataset and additionally black carbon and organic carbon for the Te gen's dat aset. The a erosol optical thick nesses (AOT) from the two climatologies are compared against each other and ag ainst AOT from satellite-derived climatology, such as th at from th e GISS Global Aeroso l Clima tology P roject (GACP). The aerosol radiativ e forcing in th e GEM model is evaluated by using the newly implemen ted narrow-band radiative transfer scheme bas ed on a correlated k-istribution m ethod. The effect of the climatological aerosols is compared to that of the old aerosol and to newly ava ilable satellite measurements from MODIS and CERES, and their impact is examined on the short-to-m edium-range f orecasts. The results demonstrate that t he AOT of t he climatological aerosol has a more realistic distribution rel ative to the ol d aerosol, which has latitudinal dependence and is confined vertically to the boundary layer. Furthermore, the AOT of the climatological aerosol, wh ich is model-de rived, agrees resonably with the AOT fr om the satellite-derived climatology. GEM model simulations demonstrate that the clim atological aerosol prod uces a mode realistic distribution of the aerosol radiative forcing, both at the top of the at mosphere and at th e surface, than the old aerosol . The GEM model aerosol rad iative forcing will be compared to newly available satellite measurements, such as those from MODIS and CERES, and its impact on the short-to-medium-range forecasts will be examined. References: Tegen, I., P. Hollrig, M. Chin, I. Fung, D. Jacob, and J. Penner, Contribution of different aerosol species to the glob al aer osol e xtinction optical thickness: Estimates from model results, J. Geophys. Res., 102, 23,895-23.915, 1997.

Keywords: aerosol, radiative, forcing

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MS003 **Poster presentation** **5020**

Inversion of optical data into microphysical particle data using Markov Chain Monte Carlo approach

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The infere nce of particle microphysical data, such as particle number- o r vo lume-concentration, effective radiu s, refractive in dex etc., from measured optical data is a well-known il l-posed inversion problem. The optical parameter set is connected via a Fredholm integral equation of the first kind with the microphysical parameter set. Various approaches, e.g. least sq uares fitting, based on different methods and constraints have already bee n applied to the solution of this inve rsion problem. Here, for the first time, we propose to tackle the pro blem usin g Bayesian statistics. In the conte xt of Bayesian statistics, one can use probability to quantify uncerta inty about the true value of a physi cal parameter. In order to do so, one needs to summari ze all information about each parameter o utside of the experiment in a probability distribution calle d a prio ri distri bution. Once that is accomplished, one can integrate that information with the information from the experiment using Bayes theorem. The resulting distribution is called posterior distribution. Application of Bayes theorem is usually very c hallenging and one can expec t analytical res ults only in a few cases. In most applications the posterior distribution is obtained appr oximately by simulating dra ws from it. Here we use t he Mar kov Ch ain Mo nte Car lo (MCMC) technique. This is basically a stochastic met hod that explores the unknown posterior distribution, which involves solving repeatedly the Fredholm integral equation for different combination of the physical parameters (ie. we solve the invers e problem by stoch astic solu tions of th e so called forward problem). Bayesian theory offers two great ad vantages in solving these problem s: it integrates information outside of the experiment with information from the experiment in a coherent mathematical context, and pro vides a natural measure o f unc ertainty about the physical parameters.We w ill demonstrate the application of this method to the inversion of ext inction and optical t hickness data in order to derive the accum ulation mode of atmosphe ric particles. Starting po int will be a monomodal logarithmic normal distribution for the particles size distribution. The posterior distributions mode radius, geometric sta ndard deviation and particle concentr ations will be o btained for several different atmospheric measurements using Mie-theory. For simplification the complex refractive index is assumed to be known. However it will be shown that this restriction can be lifted with no loss of generality of our method and an un known re fractive index will co ntribute to the overal l uncertainty of the results. Furthermore an outlook for the application of the method using different (or additional) optical data will be given.

Keywords: inversion, bayesian statistics

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MS003 **Poster presentation** **5021**

An Analysis of Tropical Cirrus from the CALIPSO Satellite Mission

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Tropical cirrus clouds play an important role in the climate system by reducing incoming sunlight from reaching the Earths surface and by absorbing upwelling infrared radiation emitted by the surface and lower atmosphere. The effects of cirrus extend from local to large scales and can affect the global circulation and the large-scale water budget. Understanding the evolution and the effects of cirrus, however, requires a detailed knowledge of several factors including cloud fraction, height and thickness linked to key environmental variables. The successful launch of the CALIPSO satellite on April 28, 2006, and its subsequent insertion into the A-Train satellite constellation, offers a bold new opportunity to examine the distribution and properties of cirrus. The CALIPSO payload includes a two-wavelength polarization-sensitive lidar, a 3-channel infrared imager tailored for cirrus studies and a visible wide field-of-view camera. This paper will present an analysis of the occurrence and structure of tropical cirrus observed by the CALIPSO lidar system during the first year of operation. Comparisons will be made with passive sensor measurements and retrievals (e.g., MODIS) and other satellite data sets including lidar observations from ICESAT and radar observations from CloudSat.

Keywords: cirrus, calipso

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MS003 **Poster presentation** **5022**

Efficient ice crystal growth in the atmosphere prevents an indirect cirrus-aerosol climate feedback

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Understanding the sensitivity of cloud properties to aerosols is essential to credible climate prediction. In warm clouds, increasing aerosol number concentrations (Na) increases cloud droplet concentrations and for a fixed water content, produces brighter clouds that cool the climate (Twomey, 1974). We show that in cold clouds formed by homogeneous freezing, cloud ice particle concentrations (Ni) are sensitive to upper tropospheric Na only when the growth efficiency of small ice crystals is low. We define a dimensionless parameter that controls the dependency of Ni upon Na and that provides a physical basis for variations in the dependency of Ni upon Na as a function of the ice deposition coefficient, vertical velocity, temperature, Na, and aerosol radius. Our parcel modeling results show that Na sensitivity increases dramatically with ice deposition coefficients << 0.1. Na sensitivity also increases as temperature decreases (e.g., much stronger Na sensitivity at typical TTL T=193 K), vertical velocity increases, and aerosol size decreases. Finally, we combine existing observations with modeling to suggest that small ice crystals grow efficiently in the atmosphere at typical cirrus conditions. We therefore conclude that changes in upper tropospheric Na are unlikely to affect the properties of most cirrus formed by homogeneous freezing.

Keywords: cirrus, aerosols, climate feedbacks

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MS003 **Poster presentation** **5023**

Global cloud resolving simulation of aerosol-cloud interaction with NICAM-SPRINTARS coupled model

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In recent years, global cloud resolving simulations have been performed on Earth Simulator with NICAM (Non-hydrostatic Icosahedral Atmospheric Model) model. The simulations were performed for aqua-planet experiment and short-time deterministic experiment with realistic continent. In the present study, we implemented the 3-dimensional aerosol chemical transport model SPRINTARS into a framework of global cloud resolving model NICAM, and performed a global cloud resolving simulation with horizontal resolution of 14km and 7km. In this model, the aerosol transport processes including advection, diffusion, dry and wet deposition, and gravitational settling are calculated in a framework of a global cloud resolving model. The direct and indirect effects of aerosols are incorporated into the model. The indirect effect of aerosol is implemented into the model through a bulk parameterization, which includes an empirical relationship between aerosol and cloud particle numbers, and auto-conversion rate as a function of cloud droplet number as well as cloud water content. The cloud microphysical and optical parameters such as effective particle radius and optical thickness are calculated in the model. The experiment with global cloud resolving model is essentially different from those with conventional GCMs in a point that the aerosol effects are incorporated in to not only stratiform clouds but also convective clouds, which are approximately expressed by cumulus parameterization in GCMs. Simulated results are compared with satellite remote sensing for several important parameters of aerosol and cloud, such as optical thickness of aerosol and cloud, Angstrom Exponent and cloud particle effective radius. The simulated global feature was consistent with satellite observation. It was found that the cloud particle effective radii are simulated to have a detailed feature over equatorial region, similar to the satellite retrieval, which is difficult to be reproduced by conventional GCMs. Some coastal features in effective cloud particle radius are also found to be more realistic than those simulated by GCM. Our model simulation can also be used for comparison with new global cloud observation, i.e. CloudSat data. Simulated vertical profile of cloud water content and effective particle radius will be compared with those obtained from CloudSat data analysis.

Keywords: aerosol cloud interaction, cloud resolving model, aerosol indirect effect

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MS003 **Poster presentation** **5024**

Detecting trends of global solar radiation in the Arctic

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This study is an analysis of the seasonal and interannual solar radiation variability of the Arctic region beginning in 1950 through 1990 from the Environmental Working Group Arctic Climatology Project. This dataset provides more than 40 years of meteorological parameters constructed from the Arctic basin as well as from coastal stations, and synoptic data from ships, buoys, and drifting ice stations. In particular, the monthly mean of the global, direct, and net radiation constructed from land as well as ocean data stations will be used. Other measurements that will be evaluated are the monthly mean cloud coverage based on synoptic surface observations and surface temperatures during the same period. The time series of the radiation budget components and meteorological variables will be presented and linear regression analysis will be applied to characterize their trends. Probable causes of the resulting radiation trends will be discussed with a comparison to current trend analysis of solar radiation in similar climate conditions as well as those reported in global studies.

Keywords: radiation, clouds, aerosols

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MS003 **Poster presentation** **5025**

A Simple Study of Retrieval of Aerosol Optical Depth from All-Sky Images

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Automated all sky imagery system would be a valuable tool in ground-based macro-scale cloud observation. A recent World Meteorological Organization report mentions that the use of all-sky imagery offers the potential to understand and quantify cloud effects more accurately. In China, a type of ASI (All Sky Imager) has been developed by present authors and has collected series of all-sky images since 2004. In our past works, we have mainly made researches on how to get the parameters about cloud from the all-sky images. We found that the aerosol optical depth (AOD) made a critical impact on the decision of cloud pixels, especially for the cities of east China where the aerosol optical depth is bigger than other places mostly. In other words, ASI images contain information about aerosols. In this paper, we investigate a new approach to get the aerosol optical depth information from the all-sky images. First, the relation between AOD and the distribution of blue/red radiative ratio of ASI images was analyzed by numerical model simulations. We find that the radiative ratio value distribution is sensitive to the AOD under different aerosol types and there exits an exponential relations between them. Then, we set up an inversion algorithm for AOD based on the results of model simulation. Using this formula, we compare the AOD retrieved from all-sky images to the values obtained from the AERONET/CIMEL instrument at the same site. Results show that the inversion value is systematic bigger than the AOD provided by the AERONET/CIMEL. This difference may be resulted from the radiative transfer model and atmospheric aerosol profiles. On the other hand, this result indicates that it is possible and feasible to obtain the AOD from the radiative ratio of the all-sky image. In order to improve the retrieved result, the paper established another inversion formula using the CIMEL AOD data and the radiative ratio value of the images. This is a formula with regional character. The comparison results show that this regional formula improved the inversion results of AOD. Based on above investigation, we may establish more continuous AOD series for non overcast sky which is valuable to investigate aerosols direct and indirect effect to climate/radiative interaction.

Keywords: all sky, images, aod

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MS003 **Poster presentation** **5026**

A numerical experiment of the stratocumuls observed during RF02 DYCOMS-I

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A numerical experiment of the stratocumuls observ ed during RF02, DYCOMS-II was pe rformed using a convection resolving model. The observation expe riment DYCOMS-II was performed July, 2001 off the California Coast. The case of research flight 2(RF 02) was selected for the intercomparison case of the GCSS(GEWEX Cloud System Studies) Boundary Layer Cloud Working Gr oup. The model setting is th e same as the intercomparison setting, (http://sky.arc.nasa.gov:6996/ack/gcss9/setup.html). The domain is 6.4 x 6.4 x 1.5 km^3, and the grid interv al is dx=dy=50m, and dz=5 m near the surface and cloud layer top. The cloud layer extends from 40 0m to 800 m in the initial conditions. Because of the surf ace heat flux a nd the cloud top radiat ional cooling, there occur moist co nvections, which brings about the entrainment of the upper layer air, and the deepen ing of th e clou d lay er. However, because of the large-scale subsidence, the develop m ent of the cloud layer is very sl ow. i.e., less than 100m/6hrs, and almost steady state can be at tained. The ex periment was performed for 6 hours. and t he effect of the rainfall on the developmen t of the cloud layer is discus sed. The mod el we used is CReSS (Cloud Resolving Storm Simulator), which was develope d at Nagoya University , and the bulk cloud microphysical scheme is use d. We inco rporated thr ee ki nds of autoconversion sche mes, i.e., Kess ler scheme, Berry sch eme, an d modified Berry sch eme(Richard and Chaum erliac), and we compared the results. Using the Kessler scheme, the conversion fr om cloud to rain is very slo w, the vertica lly integrated liquid water remains large, and there occurs almost no precipitation. When we used the Berry scheme, the conversion from cloud to rain is very fast, and large amount of water becomes rain to fall in the early stage of the simulation. After that, the conversion from cloud to rain is act ive in spite of the few cloud water content, and there occurs continuous precipitation. The convection does not become so active as the other two cases, and the deepening of the cloud layer is th e slowest of th e three cases, because the e ntainment of t he upper layer air is sm all. When we used t he modified Berry scheme, the conversion from cloud to rain is not so large, the vertically integrated liquid water decrease very little, and there occurs a few precip itation, which is the same order as the observational estimate. The results show the very important effects of the autoconversi on schemes in the bul k model on the development of the stratocumulus clouds. We are now us ing a bin model to simulate th e boundary layer clouds, and using the results, we can improve the parameterization schemes in the bulk models.

Keywords: strato cumulus, cloud resolving model, gcss blwg

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MS003 **Poster presentation** **5027**

Climate response to anthropogenic aerosols and CO2-increase in CAM-Oslo

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Equilibrium climate response to anthropogenic aerosols and increased CO2 levels are investigated based on three multi-decadal simulations with the global climate model CAM-Oslo coupled to a slab ocean. The aerosol modul e interacts fully wi th the meteorol ogy and includes a life-cycle sche me for sea-salt, mineral, sulfate, black carbon (BC) and particulate organic matter (PO M), as well as calculations of aerosol optical parameters and cloud conde nsation nuclei (CCN) activation by look-up tables. The joint aerosol direct and indirect ef fect is found to gl obally averaged produce a 1.9 K coolin g and 5.5 % decrease in precipitation, while a 63 % incr ease in CO2 gives a 2.0 K warming and a 3. 8 % increase in precipitation. Regional forcing and response patterns will be discussed. The relatively larg e sensitivity to aerosols is proposed to result from small (possibl y underpredicted) cloud droplet number concentrations in pristine con ditions, t ogether with use o f pres cribed supersaturation s for activation of CCN. Th e climate responses to increased CO2 levels feed back on the spatial and temporal distribution of aerosols, causing modes t reductions in sulfate, BC, POM a nd sea- salt burdens and a sm all increase in dust, globally, but with much larger changes regionally, especially at high latitudes.

Keywords: aerosols, clouds, climate

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MS003 **Poster presentation** **5028**

Aerosol optical depth in the UV range over Belsk, Poland, 1992-2007

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Aerosol optical depth (AOD) data at 320 nm in ferred from the st andarddirect s un total ozone measurements performed by the Brewerspectrophoto meter at Belsk, Poland are pr esented. Beer-Lambert law isused for calculation of AOD. Calibration of the spectro photometer hasbeen performed in situ (by the Langley plot met hod) using the data fr omavailable clear sky half-days that occurred during analyzed period(1992-2007). Cloud screening algorithm allowing for identi fication ofcloudless periods in collected data set is presented. Results ofanalysis of AOD variation at different time scale are presented. MeanAOD at 3 20 nm for 199 2-2007 was eq ual to 0.35, while the maxim um andminimum values were equal respectively to 0.04 and 1.90 (daily means).No significant long term trend has b een observed in the data except during the first three years -probably the effect of Pinatubo eruption in 1991. Analysisof the seasonal variation revealed double (spring an d summer) maximumand single (winte r) minimum of AOD. Several episodes of extremely highva lues of AOD th at occurred during measurem ent period are analyzed.Comparison of measurement results with these obtained from collocatedCIMEL sunphotometer (at 340 nm) showed good agreement between twoinstruments confirming the data quality.

Keywords: aerosols, uv radiation, brewer spectrophotometer

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MS003 **Poster presentation** **5029**

Long term observation of aerosol spectral absorption at an urban site in Seoul, Korea

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Spectral aerosol light absorption is an important parameter for the assessment of the radiation budget of the atmosphere. Using a seven-wavelength Aethalometer and a Beta gauge, Black Carbon (BC) and PM2.5 mass concentrations were measured from May 2006 to Feburuary 2007 at an urban site in Seoul, Korea. Provided that proper numerical corrections are performed, Aethalometer can measure babs over a wide spectral range, 370-950 nm. With increasing filter loading the optical path in the Aethalometer decreases, resulting in under estimation of BC concentration. Empirical correction for this bias requires information on the light scattering behavior of the sampled particles. Another pronounced artifact of integrating-plate type attenuation techniques is due to multiple scattering effects within the filter matrix. Site specific multiple scattering (C(λ)) and filter loading correction factor for Aethalometer have been determined using the results from independent measurement of aerosol optical properties of this site. C(λ) was determined to be 3.6~5.14 in the wavelength range, 370~950 nm. Shadowing factor, f was determined to be 1.12. It was found that the mean PM2.5 mass concentration was 33.428.1, 28.130.9, and 57.135.1 ug/m3 in summer, fall, and winter, respectively while the mean BC concentration was 4.32.6, 4.02.7, and 5.23.2 ug/m3, respectively. From the regression analysis between CO and BC, two distinct regression trends were observed. Regression slope (BC/CO) was determined to be 6.8 ug/m3/ppm during May to October 2006 and 3.7 ug/m3/ppm during November 2006 to February 2007. This result can be used as an indicator for the determination of source origin of CO. Differences in the characteristics of aerosol light absorption have been investigated for different air mass types and haze condition.

Keywords: absorption coefficient, black carbon, seven wavelength aethalometer

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MS003 **Poster presentation** **5030**

Lidar-radar ice microphysics retrieval comparison using CloudSat and CALIPSO data.

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With the launch of CloudSat and CALIPSO it has become possible to derive vertical profiles of microphysical cloud properties globally. These vertical profiles of ice water content (IWC), extinction (a) and effective radii (Reff), will enable a thorough evaluation of the cloud representation in climate models and their embedded parameterization. The extinction can be directly retrieved from the dual wavelength lidar onboard the CALIPSO satellite. This is however only possible for a total optical thickness up to ~4, reducing the retrieval to ice clouds, the top of water clouds and aerosols. From the CloudSat radar (94 GHz) data the IWC can be directly retrieved, however due to the assumptions needed the results are not completely accurate. The combination of lidar and radar gives a more accurate IWC and enables the calculation of Reff without additional assumptions at the same time. In this work three lidar-radar retrieval methods are compared for a number of CloudSat & CALIPSO cases. The cloud cases were chosen to have both lidar and radar signals available as well as clouds where only lidar or radar data was available. Issues which are discussed include, co-location, extinction calculation, multiple scattering and particle habit assumptions.

Keywords: ice clouds, microphysics, active remote sening

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MS003 **Poster presentation** **5031**

Entrainment and mixing in convective clouds: observations in shallow cumuli during the RICO experiment

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CNRMGMEIMNPCA METEO FRANCE

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The liquid water mixing ratio in an adiabatic cell can simply be derived from the temperature and pressure at cloud base, following a wet adiabatic ascent. The actual liquid water mixing ratio is in fact lower than its adiabatic value because of turbulent mixing between the ascending cell and its drier environment. In the homogeneous model, all the droplets that still exist in the diluted cloud volume after a mixing event are exposed to the same sub-saturation. It follows that both droplet concentration and sizes are reduced by further evaporation. On the opposite, in the inhomogeneous model, some droplets are totally evaporated until the mixture reaches saturation, while the remaining droplets keep their initial sizes. Previous in situ observations in convective clouds have shown that droplet spectra sampled in diluted cloud volumes show features intermediate between this two extremes scenarios and that the impact of the entrainment-mixing processes on cloud microphysics is sensitive to the respective values of the droplet response time to evaporation and of the homogenization time scale. The Rain in Cumulus over the Ocean (RICO) field campaign, which took place during the winter 2004-2005 in the trades over the western Atlantic, has provided an extensive data set of measurements on shallow cumuli. Statistics of data collected with the Fast-FSSP droplet spectrometer are examined at different levels from cloud base to cloud top, in order to document the vertical variability of the entrainment-mixing effects on the droplet spectra. It is shown that close to the cloud base, some samples have a measured liquid water mixing ratio close to the adiabatic one and the diluted samples follow the homogeneous model except when the dilution ratio becomes very high, as expected from the time scale analysis. As the altitude above cloud base increases however, most samples have a liquid water mixing ratio significantly lower than the adiabatic one, but the droplet size remains constant, even in the most diluted samples, typical of the inhomogeneous mixing. Theses features will be discussed within the context of vertical velocity, thermodynamical properties; and heterogeneity of the cloud samples as characterized by the droplet spatial distribution. Impact of the spatial resolution of droplet spectra measurements will also be investigated by using the optimal estimator to derive the droplet concentration.

Keywords: microphysics, cumulus, entrainment mixing

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MS003 **Poster presentation** **5032**

Statistical property of ice cloud characteristic in relation to the environment

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Vertical structures of ice cloud characteristics have been studied in locations such as the Tropical Western Pacific by lidar/radar system onboard Research Vessel MIRAI of JAMSTEC (Japanese Maritime Science and Technology Center) for better representation of ice clouds in general circulation models from 2001. Since studies concerning the large variability in the duration time of ice clouds need information on the cloud characteristic and their environment, such relationship was investigated based on cloud microphysics and air motion retrieval by these lidar/radar system for the Tropical Western Pacific cruise case conducted in 2001. Retrieval results for individual clouds showed unique relations among the microphysics and air motion in the vertical, though such dependence of the microphysical properties on cloud dynamical features investigated for the whole period revealed much more variations indicating the need for further classification of these statistical properties. This issue was further accomplished by sorting them by their characteristic background environment according to the cluster analysis of ISCCP tropical dataset [W. Rossow et al., 2005]. Our analysis of cloud characterization showed distinctive features in their ice microphysics and vertical air motion for convectively active and inactive states. Mean profiles of in-cloud air motion for convectively active states usually showed updraft at high altitudes, which tended downward at lower altitudes. One the other hand, average air motion profiles for clouds embedded in one of the convectively inactive states revealed updraft despite the altitude. As a result, mean vertical profiles of ice cloud sedimentation rates estimated from the retrieved air motion and cloud microphysics showed notable features among different weather regimes, e.g., much smaller mass flux was observed for convectively inactive states compared to other active states. Extension of the study will be performed to relate these discrepancies and similarities in the statistical properties of cloud characteristics to the cloud duration time observed for each weather regime. Such study may be helpful to sort out which cloud property representing a particular weather regime have the difficulty of being well represented in climate models.

Keywords: cloud microphysics, airmotion, 95ghz radar

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MS003 **Poster presentation** **5033**

The retrieval of cloud top pressure and effective extinction height using combined observations of MERIS and AATSR

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The present algorithm for the retrieval of cloud top pressure from MERIS observations shows excellent results for optically thick, low clouds. In contrast, the detection of thin, high cirrus clouds is difficult and results in large uncertainties of cloud top pressure because of the large penetration depth into th e clouds. The p roblem is even more complicated in the presence of multi-layer clouds. However, observations from AATSR in the infrared spectral region provide an accurate determination of cloud top pressure for hi gh clouds. A combination of MERIS observations in the oxygen A b and at 761nm a nd AATSR measur ements in the infrared enable s a comple te a nd reliable retr ieval of cloud top pressure. Since clouds are highly abs orbing in the infrared spectral region, th e signal observed by AATSR originates from the emission at the top of t he cloud, whereas MERIS me asures solar ra diation reflected at some level within the cloud, the "effective exti nction height". The co mbination of MERIS and AATSR observations thus enables the determination of the penetration depth of the photons into the cloud. As both instrume nts are mounted on ENVISAT a nd ar e s ynchronously observing the same areas, a combination of measurements is straightforward.

Keywords: cloud top pressure, meris, aatsr

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MS003 **Poster presentation** **5034**

An investigation into aerosol optical properties over East Asia: Combination of aerosol data from 3-D photochemical modeling and satellite/sun photometer network

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Spatial and seasonal distributions of Aerosol Index (AI) from the Total Ozone Mapping Spectrometer (TOMS) and Aerosol Optical Depth (AOD, τ) from the Moderate Resolution Imaging Spectroradiometer (MODIS) were compared with those of model-derived τ and aerosol column loading for four different episodes in East Asia. In order to simulate τ for major types of aerosols in the atmosphere, US EPA Models-3/CMAQ v4.3 model was employed together with the PSU/NCAR MM5 meteorological model and ACE-Asia/TRACE-P official emission inventory for East Asia. Firstly, a comparison study of CMAQ-derived aerosol column loading with TOMS AI was performed, since TOMS AI is a good indicator of UV absorbing particles typically transported through the free troposphere such as black carbon and mineral dust. The model-predicted high aerosol column loading mostly composed of mineral dust during the spring episode concurrently occurred with high TOMS AI over Manchuria and northern part of Korean peninsula where the dust storm had erupted and then transported. Secondly, MODIS-derived τ (tMODIS) was retrieved, using the Bremen Aerosol Retrieval (BAER) algorithm, and CMAQ-derived τ (tCMAQ) was also estimated, using a reconstructed extinction-coefficient based method from the mass concentrations of particulate species. In general, both tMODIS and tCMAQ showed high values around Chinese urban/industrial centers, such as Sichuan Basins (Chengdu/Chongqing), Bohai Bay (Beijing/Tianjin), and Yangzi Delta (Shanghai/Nanjing/Hangzhou) regions and also around agricultural and livestock farming areas. For the four season episodes selected in this study, the CMAQ model generated similar levels of tCMAQ to those of tMODIS throughout the domain with relative differences ranging between -15% (spring episode) and 10% (summer episode). In particular, during the spring episode tCMAQ was under-predicted compared to tMODIS over the areas where a dust storm passed through. This could be due to the fact that the extinction-coefficient calculations employed in this study has a tendency to be more or less insensitive to the coarse-mode dust concentrations. Except for the spring episode the levels of tCMAQ is in general comparable to or slightly higher than those of tMODIS. During the summer episode both high tMODIS and tCMAQ are related to high concentrations of (NH4)2SO4 produced over the Chinese urban/industrial centers. In contrast, during the winter episode high tMODIS and tCMAQ appear to be related to possibly over-predicted NH4NO3 concentrations over Chinese agricultural and livestock farming areas. In future analysis, the accuracy of both tCMAQ and tMODIS will be further evaluated by the comparisons with different types of τ, such as τ estimated from Mie-theory based parametric approximation and τAERONET obtained from Sun photometer network in East Asia like AERONET (or Sky Radiometer networks).

Keywords: aerosol optical depth, 3d chemistry transport model, modis

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MS003 **Poster presentation** **5035**

Aerosol radiative effect on atmospheric thermal dynamics

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Atmospheric aerosols, both natural and anthropogenic, can cause climate change through their direct, indirect and semi-direct effects on the radiative energy budget of the Earth-atmosphere system. The sum of these effects, on a global average, is most likely comparable in magnitude to the radiative forcing of anthropogenic greenhouse gases. Apart from this radiative effect on climate, recent studies show that aerosols can also have an important effect on atmospheric dynamics. Aerosols cool the Earths surface, by scattering radiation to space and by atmospheric absorption, and warm the atmosphere by absorbing solar radiation. Both these effects can significantly modify atmospheric dynamics and the hydrological cycle. Such effects are important to climatic change arising from aerosols. In this study we investigate and quantify a radiative effect of aerosols on the thermal dynamics of the Earth s atmosphere. To accomplish this, we estimate the seasonal direct radiative effect (DRE) of natural plus anthropogenic aerosols on solar radiation under all-sky conditions on a global scale. This is achieved by combining satellite measurements and reanalysis data with a spectral radiative transfer model. The estimates were obtained through detailed spectral model computations which treat separately the ultraviolet (UV), visible and near-infrared radiation. Global distributions of spectral aerosol optical properties were taken from the Global Aerosol Data Set (GADS) whereas data for clouds, water vapour, ozone, carbon dioxide, methane and surface albedo were taken from various satellite and reanalysis datasets (NCEP/NCAR). Global distributions of aerosol optical thickness (AOT) were taken from the Total Ozone Mapping Spectrometer (TOMS) AOT product. Using these aerosol properties and other related variables, climatological (for the 12-year period 1984-1995) monthly mean aerosol DREs were generated at 1x1 latitude-longitude resolution. The aerosol DREs were computed at the top of the atmosphere (TOA, ΔFTOA), within the atmosphere (ΔFatmab) and at the Earths surface (ΔFsurfnet). Subsequently, the magnitude of the aerosol effect on thermal dynamics (AETD) was quantified by the difference AETD = ΔFatmab-ΔFsurfnet. We found that the presence of aerosols has a significant effect on the thermal dynamics of the Earth-atmosphere system. More specifically, by cooling the surface and warming the atmosphere, aerosols act to produce more stable atmospheric conditions by decreasing convective activity. They also reduce evaporation from the surface, and so can have a significant effect on the hydrological cycle by suppressing cloud formation (especially the convective) and associated precipitation. This aerosol redistribution of shortwave radiative energy between the Earths surface and the atmosphere highlights the role of increasing loads of atmospheric particulate matter to climate. The largest effect of aerosols on thermal dynamics is found to occur over deserts and nearby desertification-threatened areas, such as the Sahara and its neighbouring Mediterranean basin.

Keywords: aerosols, climate, atmospheric dynamics

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MS003 **Poster presentation** **5036**

Retrieval of tropical water vapour vertical profiles from wide-band emission spectra acquired by an uncooled FTS spectroradiometer

Dr. Giovanni Bianchini

Bruno Carli, Ugo Cortesi, Samuele Del Bianco, Luca Palchetti

In Earth radiat ion budget experiments, one missing measurement is the spectrally resolved outgoing longwave radiation below 4 00 cm-1. The first wi de-band spectral measurement down to 100 cm -1 performed with a stratospheric balloon, launched in tropical region, near Teresina (Brazil), on June 30th, 2005, is here described. The instrument use d for the measurement is a Fourier transform spectromete r named REFIR -PAD (Radiation Explorer in the Far I nfraRed - Prototype for Application and Development), which operates in the 100-1400 cm-1 sp ectral range with a resolution of 0.5 cm-1 . Despite the op erating spectral range extending to th e far-infrared region, REFIR-PAD does not require any cooled co mponents, th anks to th e use of room temperature pyroelectric detect ors and an optical scheme that c ompensates fo r the instrume nt self-e mission. This work s hows the resul ts of the field campaign focusing on the measurement of the far infrared portion of the atmospheric emitted radiance, and the retrieval of the vertical profiles of w ater vapour and temperature during the flig ht. The vertical resolution of t he retrieval is 2 km in t he upper troposphere - lower str atosphere (UTLS) region, and lower at higher altitudes. The comparison with ECMWF for validation is also shown.

Keywords: water vapour, radiation, far infrared

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MS003 **Poster presentation** **5037**

A new radiative transfer scheme in a NWP model ; GEM meso-strato

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The next major change to th e Canadian gl obal NWP model, GEM, is e xpected in 2008. This project, termed the GEM meso-strato, involves moving the to p of the model to 0.1hPa (from 10 hPa), increasing the number of vertical levels to 80, some new physical parameterizations, namely a new radiative transfer schem e. This new radiative transfer sc heme was developed at CCCma for the GCM4. For its implementation in GEM, many inputs to the radiative transfer scheme were updated. Na mely the ozone climatology, th e aerosol cl imatology, the clo ud optica l prop erties, the part ition of the t otal condensate into liquid and so lid and finally the co nstant trace ga sses were replaced by a 3D climatology. In this presentation, we will describe the new radiative transfer scheme as well as the updated inputs. We will show that the new scheme and inputs reduces the mo del biases in the s urface radiative fluxes which leads to improvements in surface temperature. Using both climate runs and NWP forecast runs , we will discuss the sensitivity of the model results to all the updated inputs.

Keywords: radiation

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MS003 **Poster presentation** **5038**

A simple parameterization for detrainment in shallow cumulus.

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Pier Siebesma

Recently there has been a regained interest in the parameterization for entrainment in cumulus convection. Unfortunately little attention has been paid to the parameterization of the detrainment process although this counterpart of the cloud mixing process is, as we will show, probably even more important for obtaining realistic mass flux profiles in cumulus convection. A new simple but flexible parameterization for the detrainment process in shallow convection is presented. Using LES results it will be shown that the magnitude of the fractional detrainment for shallow convection is decreasing with increasing depth of the cloud layer. Consequently a simple detrainment formulation will be presented that takes this dependency into account by considering the mass flux profile in a non-dimensionalized way. The only free parameter in this detrainment formulation is the percentage of the mass flux at cloud base that is still present half-way the cloud layer. This free parameter turns out to depend on the environmental thermodynamic structure of the cloud layer. Results of this parameterization for a wide range of shallow cumulus convection cases with a single column model will illustrate the strength of this new detrainment parameterization.

Keywords: convection, detrainment

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MS003 **Poster presentation** **5039**

A Case Study of Aircraft Measurements Characterizations of Aerosols over the Beijing Region

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Using optical spectrometer probes mounted on a light aircraft, fine-mode and coarse-mode aerosol size distributionswere recorded within and above the planetary boundary layer in the vicinity of Beijing on 29 April 2005. A regionaltransport and dyn amical model (Weather Research and Forecast coupled with a tracer transport modelWRF-Tracer)and satellite (moderate-resolution imaging spectroradiometerMODIS) data were applied to analyze and interpret theaircraft measurements. The results show that the aerosol pollution in the Beijing region was very hea vy on 29 April 2005.The satellite measured aerosol optical depth (AOD) over this region was exceeded to 2.0 . The aerosol mass concentrationsreached up to 160 mgm 3 in some cases. The analysis sug gests that three impo rtant source regio ns influenced thi s heavyaerosol pollution in th e Beijin g regi on, in cluding: (1) the long-ra nge transport from the Gobi Desert with diameters ranging from 0.5 to 4 mm, (2) the transport from the south of Be ijing area, and (3) the lo cal e missions over Beijing. A st rong vertic algradient of aerosol concentration s in Beijing at Shahe Airport was observed. The fi ne aero sol pa rticles ar e dominatedbelow the planetary boundar y layer (PBL) with number concentrations of 5000 cm 3, diameters of 0.3 mm, and mass concentrations of 144 mg cm 3. However, th e coarse aerosol part icles (dust) are dominated above the PBL with numberconcentrations of 2.5 cm 3, diamet ers of 2.5 mm , and ma ss concentrations of 120 mgm 3. There is an inversion layer at thetop of t he PBL, and t his inversion l ayer acts to suppress mixing between the PBL and overrid ing troposphere and stabil izesdesert dust la yer that is bei ng transported overhead. This study demonstrates that the measurement from the aircrafttogether with the WRF-tracer and MODIS da ta provides good information to understand the origins an d spatialdistribution of aeros ol particles in Beijing. Note that this analysis is based on the measuremen t on 29 April 2005. Thus it isconsidered as an example or a case study.

Keywords: aerosol, aircraft, beijing

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MS003 **Poster presentation** **5040**

Cloud model studies for the simulation of brightness temperatures: improvements and applications to cloud classification from radiosoundings

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Clouds play a key role in the Earths climate system because of their effects on solar and terrestrial radiation, and precipitation. These effects are strictly dependent on cloud vertical structure, such as cloud top and base height, thickness, variability and cloud water content. Therefore, it is important to improve the accuracy of parameterizations that describe atmospheric radiative transfer, water vapor, and clouds. In this work, two cloud models that can be included in the radiative transfer to simulate brightness temperatures from radiosonde data are analyzed. Since radiosondes do not measure cloud water density, models are necessary to estimate cloud liquid and ice density profiles for radiative transfer algorithms that simulate electromagnetic parameters such as atmospheric attenuation and brightness temperatures. Clouds are identified from humidity profiles when the relative humidity exceeds a suitable threshold function (which depends on the type of radiosonde humidity sensor being used). We first evaluate and optimize the capability of the models to detect correctly the presence of clouds, by comparing the cloud base heights identified from the radiosoundings with those provided by a ceilometer. Then, the performances of the different cloud models are analyzed by comparing the simulated brightness temperatures in the absence of scattering with those measured by a dual-channel microwave radiometer. Two cloud models that are currently in use in propagation and remote sensing simulations in the presence of non-precipitating clouds are evaluated: the model proposed by Decker et al. and the model proposed by Salonen and Uppala. Then, a new cloud model is proposed: we both suggest an improvement of the Salonens humidity threshold for detecting the presence of clouds, and a new cloud density function for computing cloud liquid and ice density within a cloud. The performances of the three models are assessed at the Atmospheric Radiation Measurement (ARM) Programs Southern Great Plaints (SGP) site in Oklahoma, USA, by using data from Vaisala RS90 radiosondes, a ceilometer and a dual-channel microwave radiometer at 23.8 and 31.4 GHz (MWR). Finally, the three cloud models will be used to distinguish different types of clouds and to infer inter-annual variations and trends from a long record of radiosonde observations operated by the Royal Netherlands Meteorological Institute (KNMI).Statistics of cloud boundaries (base and top) and layer thickness as a function of height will be presented for each cloud model and monthly and seasonal averages will be performed.A similar investigation will be also carried out by using the radiosonde profiles collected at the station of Pratica di Mare, in Italy, by the Italian Air Force Service, to provide the analysis in a different European area.

Keywords: clouds, radiation, radiosondes

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MS003 **Poster presentation** **5041**

Waste burning under laboratory conditions: a study of aerosol concentrations

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This paper surveys the atmospheric particles size distribution caused by cereal waste burning processes in laboratory combustion experiments. A laser spec trometer was used measuring particles from 0.1 to 10 mm. In order to determine the particle spectrum duri ng the emission and t he diff erences in the burning of two types of cereal waste (oats and barley) a number of controlled burnings were carried out in the laboratory using sampl es co llected during the field campaign i n t he months of September a nd October 2003 in Quintanilla de Onsoa, Spain. The aim was to study the evolution of the particle s released in each process. In each burning experiment the time span was divided into three intervals: (1) from the switching on of the furnace until the time wh en a change was observed in the distribution, (2) from the time of maximum concentration until the time when the number of particles stabilized, and (3) from the time of stabilization until the moment when the concentratio n goes back to the initial le vel. The burning process was very fast and there was a ra pid increase in the number of particles released. The distribution was analy zed at the time when the m aximum numb er of particles per cm-3 wa s reached. The distributions found and their evolution in time have been analyzed to determine variations in the particle size and in the speed of t he coag ulation-condensation processes taking place. The gamma distribution was used to characteri ze the distributions fo und, and the no n-parametric Mann Whitney test w as applied to e stablish any si milarities and differences between the various intervals in the burning of oats and barley. Th e use of a thermobalance enabled us to determine p arameters such as the speed of mass loss during combustion.

Keywords: aerosol size distribution, cereal waste burning, coagulation

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MS003 **Poster presentation** **5042**

Is it possible to retrieve both aerosol and thick cloud properties using a single lidar?

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Pulsed lidars are now widely used to retrieve heights of cloud layers and vertical distributions of aerosol layers. The lidar returned signal is proportional to the amount of light backscattered by atmospheric molecules, aerosols and clouds. To convert measured photon counts to attenuated backscatter profiles, one needs to remove solar background light. However, one person's garbage may be another person's gold. We will demonstrate that lidars can retrieve optical depths of thick clouds using solar background light as a signal, rather than a noise to be subtracted. We will also show that for broken cloud situations, one can retrieve not only the aerosol properties in clear-sky periods using lidar signals, but also the optical depth of thick clouds in cloudy periods using solar background signals. This indicates that, in general, it may be possible to retrieve both aerosol and cloud properties using a single lidar. Thus, lidar observations have great untapped potential to study interactions between clouds and aerosols.

Keywords: lidar, cloud aerosol interaction, remote sensing

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MS003 **Poster presentation** **5043**

The effects of temporal sampling of humidity and cloud fields on the calculated radiation fluxes

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Due to the computational expense, radiation calculations in GCMs and RCMs are often not done at every time step and grid point of the model. For numerical weather prediction the errors arising from the temporal and spatial sampling can be negligible. However, for climate purposes the reduced sampling of variations in water vapour and clouds can affect the model climate adversely and give rise to temperature errors. We have investigated the impact ofchanging the temporal sampling in the European Centre for Medium range Weather Forecast (ECMWF, CY25r3) radiation scheme and in the Rossby Centre Atmospheric (RCA) model radiation scheme. The RCA regional climate model is used for high resolution downscaling of climate scenarios and for simulations of the present climate. The radiation scheme in RCA was originally developed for forecast purposes. The scheme is computationally fast but highly simplified with only one wavelength band for the longwave region and one for the shortwave region and empirical coefficients for most atmospheric gases and for the aerosols impacts. The ECMWF-RRTM longwave spectrum is divided into 16 bands and the ECMWF shortwave spectrum has up to 6 bands. The ECMWF radiation scheme is about 30 times slower than the RCA scheme in single column mode. In the ECMWF model the full radiation calculations are only performed every 3 hours (for a time step of 20 minutes) at every 4th latitudinal point. Interpolations are made in time and space to obtain the fluxes at each grid point and time step. We have run both radiation schemes in single column mode using observed data of humidity and clouds from the Cloudnet project and studied the impact of reduced temporal sampling on the calculated radiation fluxes.

Keywords: radiation, clouds

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MS003 **Poster presentation** **5044**

Aerosol characterisations at the ABC-pyramid high altitude observatory in Himalayas

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The Himalayan-Karakorum range divides two of the most densely populated and very rapidly developing world countries, India and China. The monitoring of atmospheric composition in these areas can play a relevant role in evaluating the background conditions of free troposphere and quantifying the pollution present at high altitudes as well as in studying regional and long range transport phenomena. Due to technical and logistic difficulties to carry out measurements at high altitude in Himalayas, only few continuous observations of atmospheric constituents are available in this area. Thus, a new measurement station in such region represents a unique source of data, able to make up for the lack of this information. For these reasons, in the framework of the Ev-K2-CNR SHARE-Asia and UNEP ABC projects, a remote monitoring station, the ABC-Pyramid Observatory, has been installed near the Ev-K2-CNR Pyramid International Laboratory in the Khumbu valley at 5079 m a.s.l. This monitoring station was projected, realised and tested in Bologna at CNR-ISAC during Autumn 2005. It was designed to be controlled by remote login and to operate for long-term in extremely adverse weather conditions. This station represents an ideal place for studying regional and long-range air mass transport, in relation with natural and human processes. Continuous in-situ measurements of chemical, physical and optical properties of aerosol, surface ozone concentration, as well as non-continuous measurements of halocarbons and other greenhouse gases concentrations are carried out. Moreover, at the ABC-Pyramid site, five-days air-masses circulation forecasts are daily supplied by Lagrangian trajectory model, including suitable forecasts of Stratosphere-Troposphere Exchange (STE) phenomena. First measurements describing the annual behaviours of aerosol, ozone, CFCs, HFCs and HCFCs showed that this high mountain remote area can be affected by local, regional or long range transports of polluted air masses as well as stratospheric intrusion events. In fact, during dry season polluted air masses coming from south Asia (e.g. Nepal, India, Pakistan) contribute to increase the background concentrations of trace gases and aerosol. Few episodes of this type have been found also during wet season. A contribution to background atmospheric compounds was also related with downward transport phenomena of air masses from the stratosphere (STE) or the upper troposphere.

Keywords: aerosol, highaltitude, transport

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MS003 **Poster presentation** **5045**

Radiative transfer simulations within Saharan dust atmospheres compared to measurements from the SAMUM experiment

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Airborne measurements of the radiative flux density and surface albedo have been performed in Saharan dust plumes during the SAMUM experiment 2006 (http://samum.tropos.de/) in South-Eastern Morocco. Simultaneously, aerosol size distributions were measured in the dusty atmospheres. Based on these distributions and the measured surface albedo, the radiative transfer through the dust plumes was computed. The simulated spectral upward and downward radiative flux densities are compared to the in-situ measurements. The results show a satisfactory agreement between the observations and the model simulations using a mean complex refractive index of mineral dust and Mie scattering theory. The radiative transfer model was used to compute shortwave, longwave and total atmospheric radiative effects (AREs) of the measured dust plumes at the top and the bottom of the atmosphere as well as radiative heating rates. The Saharan mineral dust cools the atmosphere over ocean and warms it over the desert surface. Large dust particles show significant warming effects due to absorption of radiation. This presentation is part 2 from SAMUM project group #2, with part 1 being submitted by E. Bierwirth presenting the in-situ radiation measurements performed during SAMUM.

Keywords: dust, radiative, effect

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MS003 **Poster presentation** **5046**

Estimation of fractional sky cover, cloud type and cloud forcing effects at Mario Zucchelli and Concordia stations (75S) from broadband radiation measurements

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Since 1999, during the Antarctic summer, shortwave and longwave radiation fluxes at the surface have been regularly measured at the Italian Mario Zucchelli station (MZS) located on the coast of the Ross Sea in Antarctica (74 43' S, 164 07' E). The four terms of the radiation balance were measured using a CNR-1 Kipp & Zonen radiometer; simultaneously measurements of the diffuse and direct components of the incoming solar radiation were carried out by using a MFR-7 shadowband radiometer. Since the austral summer 2005-2006, at the Italian-French Concordia permanent station located on the East-Antarctic Plateau (75 06' S, 123 24' E, 3233 m a.m.s.l.), measurements of downwelling longwave radiation were performed using a CG4 Kipp&Zonen pyrgeometer. The global, diffuse and direct components of the downwelling shorwave radiation were also carried out using a couple of pyranometers (CM22) and two pyrheliometers (CH1 and NIP). These measurements were performed following the requests of the BSRN network concerning the instruments and the data acquisition procedures. The shortwave data sets at the two stations were examined using the methodology proposed by Long and Ackermann (2000) in order to estimate both cloud effects on downwelling flux and cloud coverage, and to obtain information about inter-annual variability of cloudiness. At Mario Zucchelli, results were compared with synoptic observations regularly performed by the MZS meteorological office during summer. Continuous information about cloud type characteristics were obtained making use of the methodology proposed by Duchon and O'Malley (1999). Comparison with synoptic observations enabled us to adapt their classification to the peculiar conditions of the measurement site. The relative occurrence of all the cloud classes identified by the procedure (Ci, Cu, Ci and Cu, St) ranges from 10% to 20% on a seasonal based average. Clear sky conditions varies between 20% to more than 40%. The influence of cloud amount and type on both shortwave and longwave terms of the radiation balance at surface were also investigated. Making use of the methodology proposed by Durr and Philippona (2005), our analysis were extended to the polar night for the first year of measurement at Concordia using longwave radiation to obtain information on clouds effects and coverage. References Duchon, C.E. and M.S. O'Malley, J. Appl. Meteorol., 38, pp. 132 -141, 1999. Durr B. and R. Philipona, JGR, 109, D05201, doi:10.1029/2003JD004182, 2004. Long, C.N. and T.P. Ackerman, J. Geophys. Res., 105, pp. 15609-15626, 2000. Sutter, M., B. Durr, and R. Philipona, J. Geophys. Res., 109, D17202, doi:10.1029/2004JD004582, 2004.

Keywords: antarctica, radiation, clouds

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MS003 **Poster presentation** **5047**

Relationship between the downwelling longwave radiation at the surface and the GPS derived Precipitable Water at Mario Zucchelli Station, Terra Nova Bay, Antarctica

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The Italian Mario Zucchelli Station (-74 41 5 5.6997 N, 164 06 10.5887 E), situated at Terra Nova Bay, Northern Victo ria Land, is e quipped with a perman ent Global Positi oning System re ceiver (TNB1), continuously observing since 1998. Mario Zucchelli is an Antarctic scientific facility where a large number of scientific observations are carried out, either permanently or seasonally. In particular, an observatory devoted to atmospheric physics is located at Icaro Camp, 2.5 km from the base: it is a Clean Air Facility where several atmospheric measuremen ts are carried out. Since 1999, long-wave radiation measurements have been p erformed and recorded using a Kipp&Zone n CNR-1 net r adiometer. We analyse the GP S data set acq uired over a six year s period spanning 20 00-2005 by the permanent GPS station TNB1 with the aim o f retrieving the Integrate Precipitable Water V apour (IPWV) content. Water vapour radiative effects on the thermal radia tion balance of the atmosphere are of basic importance for the energ y bal ance of the s urface-atmosphere syst em e ven in Antarct ica, where pre cipitable water assumes in general appreciably lower values than ot her areas of our p lanet. Accurate calculations and measurements of the mean longwave radiation reaching the surface at Terra Nova Bay are presented as a function of precipitable wat er to show the relati onship existing betwee n this radiative term and the total atmospheric content of water vapour. GPS-derived IPWV values are compared with radiosonde-derived IPWV values. The radiosounding data were analysed by correcting the temperature data for the errors due to r adiation and heat exchange processes and lag effects, and the ai r relative humidity data for the errors and various dry bias following an accurate procedure recently de veloped.We are presenting the analysis strategies that have b een applied to GPS and radiosonde data sets for computing IPWV, the relati on betw een the measured ra diant-flux de nsity and the GPS-derived IPWV and the comparison with the predicted irradiance derived by a mod el with different profiles of temperature and humidity co mputed fro m radio soundings performed a t Terra Nova Bay during the austral summer season.. GPS and radiosonde derived wa ter vapour contents at Terra Nova Bay show a good agreement over the whole sample period.

Keywords: gps, water vapour, radiation

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MS003 **Poster presentation** **5048**

Convective and stratiform precipitation partition dependence on horizontal resolution

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The precipitation is one of the most importa nt variable generated by the numerical models. The model precipitation is considered to be of two types - stratiform and convective. Different types of precipitation produce distin ct vertical pr ofiles of latent h eat re lease to the atmosphere, however, to estimate the effect of these different profiles of heating it is imp ortant to know accu rately the partition between convective and stratiform precipitation. Models with resolution coarser than 20 km are able to reproduce the cumulus convection with some skill thr ough para meterization schemes. On the o ther hand, models with grid-size resolution small er th an 3 km should solve t he convection explicitly. W ithin the range of these two resolutions hybrid s olutions are suggested, with cumulus conv ection acting together with the explicit form of representation. In the present work, the Eta model was used to simulate a precipitation event associated with the South Atlantic Convergence Zone. This type of system exhibits a large band of cloudiness with embedded convective cells. Th e Eta Model use s the Kain-Fritsch cumulu s parameterization scheme. Clo ud micro physics are treated by Ferrier's s cheme which generated the stratiform precipitation. The convective scheme closure redistributes the mass in the column considering the updraft and downdraft cloud mass flux and the en vironment mass flux until 90% of the initial CAPE (convective available potential energy) is re moved. Simulations with different ho rizontal resolutions, 10, 5 and 1 km, have been carried out. The clo sure based on the removal of the CAPE has been change to include resolution dependence. With this change, the Kain-Fritsch convection scheme acts less with the increase of the resolution. T he re sults sho w that the increase of the r esolution prod uced different patterns of precipitation and change in the ti ming of the event. More intense and localised precipitation was produced when increase of resolution. A substantial increase of the total precipitation was produced by the cloud microphysics scheme in 5 and 1 km resolution.

Keywords: cumulus, cloud, precipitation

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MS003 **Poster presentation** **5049**

Investigation of cirrus cloud formation, maintenance, and dissipation processes by using ARM SGP surface radar-LIDAR observations and NASA GISS SCM simulations

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Three years of ARM ground-based observations, GOES East satellite observations, and NASA GISS Single Column Model (SCM) simulations have been used to study cirrus cloud lifecycle at the DOE Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site (36.6N,-97.49W) during the 1999-2001 period. The DOE ARM 35 GHz cloud radar provides the vertical distribution of clouds and the lidar/ceilometer provides the first cloud base information in a 5-min temporal interval and 90 m vertical resolution. NASA GISS SCM outputs include 35 levels of cloud fraction and cloud microphysical properties in 1-hour temporal resolution and ~ 25 mb vertical resolution. The SCM results are the average of a 2 ox 2.5o grid-box over the ARM SGP site. Numerous cases including isolated, anvil, and synoptically forced high clouds have been used in this study. We will first compare the initial conditions and forcing used by SCM with ARM observations. The SCM simulated cirrus cloud fraction will then be compared with ARM radar-lidar observations. Eventually, we want to investigate the correlations of cloud formation, maintenance, and dissipation processes with temperature, humidity, pressure, and wind profiles. From this study, we want to know during what meteorological conditions the SCM simulations agree well with ARM observations. Events will be classified under their meteorological context, such as ridge crest, warm front, post-cold front, etc., to understand when the GISS SCM misses the majority of cirrus clouds. We also want to investigate whether the missed clouds are due to the SCM used initial conditions and forcing, such as RH being too dry to form clouds, or due to the SCM cirrus cloud parameterizations.

Keywords: cirrus, observation, prediction

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MS003 **Poster presentation** **5050**

Combination of LIDAR plus MODIS radiances to retrieve the vertical profile of aerosol extinction and particle size information

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New lidar instruments are now available to the Earth Sciences Community for the measurement of the vertical distribution of aerosols and clouds from space and aircraft.One example is the Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) space born lidar, which collects profiles of attenuated backscattering coefficients at 0.56 um and 1.06 um, and measures the signal depolarization. Although the CALIPSO measurements alone are not enough to determine unique aerosol physical properties, the A-train provides many opportunities for synergy between different sensors. Here we show results of an algorithm combining LIDAR retrievals and MODIS radiances to select the proper aerosol model and invert optical depths profiles, as well as the vertical distribution of fine and coarse mode aerosols . In addition to the closure between the LIDAR and the MODIS radiances, the depolarization information is used to separate between dust and sea salt aerosols. Results are shown for aircraft retrievals in preparation for applications to the CALIPSO data.

Keywords: aerosols, lidar, retrieval algorithms

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MS003 **Poster presentation** **5051**

Impact of the JULY 2003 Popocatepetl eruptions on the aerosol optical depth in Mexico City.

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Small eruptions have been occurring since December 1994 at Popocatepetl Volcano, 65 km east of highly polluted and populated Mexico City, in centra l Mexico. Intermittent crater dome growth began in 1996 with sub sequent destru ction by explosive even ts and small to moderate gas and ash eruptions which continued up to 2003 and then declined. Ejecta has been sampled and analyzed after each of the eruptions for chemical and textural characteristics. In July 2003Popocatepetl had 3 ash emissions on the 2, 3 and 19, with plumes 3 km high associated with crater dome destruction. Due to climatic conditions in the area, seasonal winds blow ash to the east reaching Mexico City during the s ummer months. The distribution of the ash fall was mapped bu t very fine particles stayed s uspended.Since 1999, NASA's Aerosol Robotic Network (Aeronet) installed a s un photometer in Mexico City in order to measu re the direct solar radiation in different spectral windows. The objective is to calculate the aerosol optical depth (AOD) in the whole atmosp heric column. During 2003, the photometer recorded increasing levels related to the suspended ash. Aerosol optical thickness increased on July 2 (50%), July 3 (150%) and July 19 (100%). We relate the sustained i ncrease from July 3-5 to the pr esence of volcanic aerosols in theMexico City area. From th ese measurements we we re able to calcula te the plume velocity and the residence time of the ash i n the atmosphere in Mexico City . We were also able to es timate concentration of fine particles and their impact on the health of the population.

Keywords: opticaldepth, aerosols, volcanicatmosphericimpact

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MS003 **Poster presentation** **5052**

Impact of surface solar dimming and brightening on global warming

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Speculations o n the impact o f variatio ns in surf ace solar radiation on global warmi ng range fro m concerns that so lar dimming has largely ma sked th e f ull magnitude ofg reenhouse war ming, to claim s that the recent reversal fro m solar dimming to brighteningrather tha n the greenhouse effect was responsible for the observed warming. Todisentangle surface solar and greenhouse influences on global warming, trends in diur naltemperature ra nge are analyzed. The diurnal temperature r anges averaged overglobal lan d su rfaces sh ow, after decades of dec line, a distinct tendency to level o ffsince the mid 1980s. They s uggest that so lar dimming, possibly caused by increasing air pollution, was effective in masking green house warming, but only u p to th e 1980 s,when dimming gradually t ransformed into brightening. The reversal from dimmingto brightenin g m ay be related to more effective air pollution measures and the breakdownof the economy in the former communist countries, leading to cleaner and moretransparent atmospheres. With this tra nsition, the uncovered greenhouse effect startedto reveal its full dimension, as manifested in a rapid temperat ure rise (+0.38C/deca deover land since mid-1980s). Recent surface so lar brightening canno t s upersede the greenhouseeffect as main c ause of global warming, since land temperat ures increased by 0.8Cfrom 1960 to 2000, even though sol ar brightening did not fully o utweigh solar dimmingwithin this pe riod. References:Wild, M., Ohmura A., Makowski, K ., 2007: Impact of global dimming andbrig htening on global warming. Geophys. Res. Lett., 34,L04702. Wild, M., and Co-authors 2005: From dim ming to brig htening: Decadal changes insolar radiation at the Earths surface. Science, 308, 847-850.

Keywords: solar radiation, global warming

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MS003 **Poster presentation** **5053**

Earth radiation budget as simulated in IPCC AR4 GCMs

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Substantial uncertainty still exists regarding the distribution of radiative energy within the global climate system, and its representation in General Circulation Models. Compared to a comprehensive set of surface observations, the majority of the GCMs participating in the latest IPCC forth assessment report (AR4) overestimate the surface insolation, by 6 Wm-2 on average, while the bias is smaller at the TOA. This is in line with an analysis of 20 earlier GCMs participating in the Atmospheric Model Intercomparison Project AMIP II and suggests that the GCM atmospheres are still overly transparent for solar radiation. Based on observational clear-sky climatologies at worldwide distributed anchor sites from the Baseline Surface Radiation Network (BSRN) and the Atmospheric Radiation Measurement Program (ARM) it is shown, that the surface insolation is also overestimated under cloud-free conditions in many GCMs with comparatively low atmospheric clear-sky solar absorption (around 60 Wm-2 in the global mean). This identifies an overly transparent cloud-free atmosphere as a key error source for the long known problem of excessive surface insolation in GCMs. However, there are now several models participating in IPCC-AR4 with higher atmospheric clear-sky absorption (70 Wm-2 and up, globally averaged) and more realistic aerosol treatment, which are in excellent agreement with the observational clear-sky climatologies. This underlines the progress made in radiative transfer modeling as well as in the observation and diagnosis of solar radiation under cloudless atmospheres. A difficult component to model in the longwave radiation budget is the downward longwave flux at the surface. Accordingly, large discrepancies exist in the global means of this component in the GCMs, both under all sky and clear sky conditions. A comparison with available observations from GEBA and BSRN suggests that the IPCC AR4 GCMs tend to underestimate the longwave downward flux. Related References: Wild, M., Ohmura, A., Gilgen, H., Roeckner, E., Giorgetta, M., and Morcrette, J.J., 1998: The disposition of radiative energy in the global climate system: GCM versus observational estimates. Climate Dynamics, 14, 853-869. Wild, M., Ohmura, A., Gilgen, H., Morcrette, J.J., and Slingo, A., 2001: Downward longwave radiation in General Circulation Models. J. Climate, 14, 3227-3239. Wild, M., 2005: Solar radiation budgets in atmospheric model intercomparisons from a surface perspective. Geophys. Res. Lett., 32, L07704, doi:10.1029/2005GL022421. 850. Wild, M., Long, C.N., and Ohmura, A., 2006: Evaluation of clear-sky solar fluxes in GCMs participating in AMIP and IPCC-AR4 from a surface perspective. J. Geophys. Res., 111, D01104, doi:10.1029/2005JD006118. Wild, M., and Roeckner, E., 2006: Radiative fluxes in ECHAM5. J. Climate, 19, 3792-3809.

Keywords: earth radiation budget, gcms

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MS003 **Poster presentation** **5054**

A Flexible Analytical Interface Between the Microphysical and Radiative Properties of Ice Clouds

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Anthony J. Baran, W.P. Arnott, Carl Schmitt

The modified anomalous diffraction approximation, or MADA, is used to predict absorption and extinction in water and ice clouds and can be used in conjunction with parameterizations of the asymmetry parameter, g, to describe the optical properties of ice clouds. In this way optical properties can be described for all combinations of effective diameter (i.e. size distribution) and wavelength relating to ice clouds (i.e. all solar and terrestrial wavelengths out to 100 μm). MADA is analytically formulated in terms of the cloud microphysical properties, namely ice particle and size distribution shape. Ice particle shape is described through power laws relating ice particle mass and projected area to maximum dimension. Any ice crystal shape recipe can be used. Bimodal formulations of the ice particle size distribution (PSD) are easily treated. Analytically calculating the optical properties of 100s of PSD in just a fraction of a second, MADA can serve as an efficient tool for coupling cloud microphysical and radiative properties in an explicit way. Until recently, MADA had undergone only limited testing and the efficiency of the photon tunneling process (which may contribute up to 45% of the absorption at some terrestrial wavelengths) in ice clouds was uncertain since tunneling depends on particle shape. The efficiency of photon tunneling has now been accurately parameterized in terms of ice particle shape, and MADA has been rigorously tested. This study (1) compares extinction efficiencies (Qext) predicted by MADA for a laboratory grown ice cloud against corresponding Qext measurements over the wavelength range 2-14 μm; (2) tests absorption efficiencies (Qabs) and Qext predicted by MADA against those predicted by T-matrix theory and the Finite Difference Time Domain (FDTD) method; and (3) compares MADA with three popular schemes used for predicting the radiative properties of cirrus clouds. MADA errors relative to the Qext measurements were 3.0% on average, while mean MADA errors relative to Qabs from T-matrix, over the wavelength range 2-18 mm (size parameter range 2-22), were 5.9%. The mean error for the single scattering albedo relative to T-matrix calculations was 2.5%. MADA absorption errors relative to FDTD over the wavelength range 3-100 mm were no greater than 15% for six ice particle shapes. Finally, the absorption coefficients predicted by MADA and two other popular parameterizations generally agreed within 5%.

Keywords: interface, microphysical radiative prope, ice clouds

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MS004 **5055 - 5145**

Symposium
Mineral Dust Cycle and its Impact on Clouds and Radiation (ICCP)

Convener : Prof. George Kallos
Co-Convener : Dr. Alcide Di Sarra, Prof. Charlie Zender

This symposium solicits updates and new results in areas of mineral dust research, air quality, cloud and climate implications: 1) Dust sources and processes leading to dust suspension and removal; 2) In-situ measurements of dust physical and chemical properties (size, shape, concentration, vertical distribution, chemical composition, mineralogy); 3) Optical properties of dust particles and their effects on radiation; 4) Remote sensing of dust particles (passive and active remote sensing); 5) Mineral dust effects on aerosols, clouds, and precipitation; 6) Modeling of the dust cycle at meso and global scales; 7) Impacts of dust on air quality, human health, ecosystems and climate; 9) Dust trends from seasonal to paleoclimatic scales

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MS004 **Oral Presentation** **5055**

First systematic observations of Saharan dust over europe during earlinet (2000-2002): statistical analysis and results

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The horizontal and vertical extent of Saharan dust outbreaks over Europe during a 32-months period (May 2000 to December 2002) was studied for the first time, based on more than 90-day observations by a coordinated aerosol lidar network in the frame of the EARLINET project. The dust observations were related to air mass back-trajectory analysis and model calculations from the DREAM dust model, for verification purposes, in conjunction with satellite data analysis (MODIS, TOMS, SeaWiFS). The stations closer to the Sahara region observed much higher (a factor of 5-10) numbers of dust events than the northern European sites. The number of dust observations was mostly pronounced in late spring, summer and early autumn periods, mainly in south and south-eastern European sites, in good accordance with the DREAM model calculations. Multiple aerosol layers of variable thickness (300-8800 m) were observed in the altitude region 1.1-9 km height asl. The mean value of the dust layer typically stayed around 2000-3500 m and in extreme cases reached 6000 m over the European continent. In some cases, traces of dust particles reached heights of 9-10 km, after a 2-5 days transport from the source region. In extreme cases dust aerosols can reach north-western, northern or north-eastern Europe, up to 60oN and 30oE. Aerosol optical depths (AOD), linear depolarization ratios and extinction-to-backscatter ratios (lidar ratios, LR) of aerosols ranged from 0.001 to 0.7 (at 355 nm or 351 nm), 10 to 25 % and 20 to 90 sr, respectively, within the lofted dust plumes. The corresponding mean values of the AOD and LR at the center of the dust layer ranged between 0.1-0.25 and 30-60 sr, respectively. The horizontal and vertical extent of these outbreaks from the DREAM dust model, which is in good accordance with the lidar observations, shows that dust aerosols can reach 7000 m height up to 45oN, mostly during the spring and summer months.

Keywords: mineral dust, lidar, earlinet

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MS004 **Oral Presentation** **5056**

Sub-basin scale dust emissions - geomorphology and landscape controls

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Matthew Baddock, Grant Mctainsh, John Leys

Recent research has concluded that the major global dust source regions are inland drainage basins with annual rainfall <250 mm. Frequently these areas are also characterised by extensive alluvial or playa lake deposits (contemporary and/or ancient) which are assumed to be an important sediment source. However, most inland basins are patchworks of different soils and geomorphological units for example not only including playas, but also dunes, stone pavements and ephemeral channels and each has the potential to yield different quantities and types of dust under certain conditions. This paper uses a combination of meteorological data and satellite image analysis to determine the relative importance of different land types as dust sources at the sub- basin scale. Focusing on central and east Australia (notably the Lake Eyre and Murray- Darling basins), meteorological data are used to characterise individual dust events and split window analysis of MODIS data used to identify the origin of dust plumes. An analysis of the frequency with which different geomorphological units emit dust, the magnitude of events with which these emissions are associated, and variability of emissions from individual units (both spatially and temporally) is presented. The mapped dust plumes can be generated from a single landform type (such as a clay pan) or may comprise dust combined from a range of different sources such as dry river beds and sand dunes. It is noteworthy that superficially similar sites can behave very differently in terms of dust emissions for example, Lake Callabonna is a perennially important dust source in the Lake Eyre Basin whilst dust is rarely observed from the adjacent, larger Lake Frome. The meteorological record is also used to identify times when conditions typical of dust events have been present but no dust emissions have been observed (either on the ground or by satellite). The paper highlights the fact that whilst meteorological observations and satellite imagery are useful tools for identifying and describing dust sources, ground-based field data remain important in order to explain the spatial and temporal variability of dust emissions at the sub-basin scale.

Keywords: dust sources, remotesensing

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MS004 **Oral Presentation** **5057**

Dust-Snow/Ice Interactions: A Glacial Cycle Modulator or Trigger?

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Dust emitted from low- and mid-latitudes deposits on ice and snow atmid- and high-latitudes, where absorbing impurities can trigger andamplify powerful ice-albedo feedbacks. We study the climate effects of dust using a general circulation model that treats previously neglected aerosol and snowpack radiativeand thermodynamic processes and so captures new positive feedbacks.The simulations compare well with observed snow albedo evolution andimpurity concentration. We estimate the total (natural + anthropogenic) dust snowpack-forcingof +0.02 W m-2 warms present global climate 0.03 - 0.07 K. This is much smaller than the present forcing and temperature responseto atmospheric dust, about - 0.6 W m- 2 and - 0.3 K, respectively.These current-climate results are consistent with the commonly heldview that atmospheric dust, on balance, cools climate.However, the climate change efficacy (surface temperature response per unit forcing) of dust aerosol in snow is 3-4 times that of CO2, andnearly ten times that of atmospheric dust. Strong dirty snow forcingefficacies (due to ice albedo feedbacks) have significant implicationsfor dustier climates, such as the Last Glacial Maximum (LGM).Our LGM simulations show that increased snowpack dust concentrationfrom desert and glaciogenic sources may warm equilibrium climate 2 K .This exceeds the LGM climate cooling by atmospheric dust and suggestscausal links between dust-ice interactions and glacial termination s: Gradual cooling and increasing dustiness during glacial phases canlead to a tipping point where dust deposited to snow/ice initiatesglobal atmospheric warming, moistening, and reduced dust emissions.We will describe one mechanism by which Dust-Accelerated Melt mayoccur on fast timescales and help to trigger abrupt climate change.

Keywords: dust, soot, snow

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MS004 **Oral Presentation** **5058**

Modeled dust cycle of the largest desert dust source in the world, the Bodl depression (Chad)

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The Bodl depression, Northern Chad, is tod ay believed to be the single largest source of desert dust in the world, as evidenced by Prospero et al. [2002] and Washington et al. [2003]. An expla nation for that characteristic of the Bodl depression is the presence of a Low Level Jet (LLJ) highlighted by Washington and Todd [2005] in reanalysis data at 925 hPa level ab ove the Bodl depression that blows coincidently with the observed annual and intraseasonal dust tran sported from the de pression. Modeling this LLJ is particularly difficult using global models. For in stance, Kor en and Kau fman [2004] revealed that th e National Centers for Environmental Predictions (NCEP) re analysis under estimates the velocities at 9 25 hPa by a factor of 2 above th e B odl regi on, a resu lt b roadly con firmed from in -situ observation s [Washington et al., 2006; Todd et al ., submitted]. As the frequency of dust emissions is contr olled by the number of times the wind speed excee ds a thresh old and as the dust flux depends on the thir d power of surface wind velocit y, an underesti mation of surface velocity le ads to a large underestimation of dust emissions. We present here a 1-year (2001) detailed climatology of the dust emitted from th e Bodl depression. Our numerical wo rk is do ne us ing the Regional Atm ospheric Mesoscale Modeling System (RAMS, [Cotton et al., 2003]) coupled online with a Dust Production Model (DPM) developed by Marticorena an d Bergametti [1995]. Comparisons are ma de with observa tional data, su ch as I nfrared Dust Differe nce Index (IDDI , [Brooks and Legrand, 2 000]), Total Ozone Monitoring Spectrometer Aerosol Index (TOMS AI, [Herman et al., 1997]) or AErosol RObotic NETwork (AERONET) data, and with reanalysis dat a from the European Centr e for Medium-Range Weathe r Forecasts (E CMWF). A firs t estimate of the annual dust emission budget from the Bodl depression is also given.

Keywords: dust, modeling, climatology

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MS004 **Oral Presentation** **5059**

Don't breathe the air! long-distance atmospheric transport of chemical contaminants with african dust

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African dust is known to transit the Atlantic and impact the Caribbean and Eastern United States. As part of an investigation into the effects of African dust on coral reef organisms and human health, we analyzed African dust air masses for contaminants and compared levels of persistent organic pollutants (POPs) and metals between the source and downwind regions. Air samples from Africa (Mali) were found to contain a greater variety and a higher concentration of pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) than downwind sites in the Caribbean (Trinidad and the U. S. Virgin Islands). To date, nine pesticides, 17 PAHs, and nine PCB congeners have been identified in air samples from the African Sahara/Sahel (Mali) and the Caribbean. One pesticide and four PAHs were detected only in samples from Africa. Of the more than 100 priority pollutant and common-use pesticides screened for in the samples, four pesticides (chlorpyrifos, endosulfan I, hexachlorobenzene, and components of chlordane) were detected in samples from all sites. DDE (a breakdown product of DDT) was identified in Mali, USVI, and Trinidad samples. To date, DDT and chlorinated dioxins and furans have been detected only in samples from Mali. Seven and five PCB congeners were detected in Mali and Caribbean samples, respectively; of those, three congeners were detected in samples from both regions. Similarly, greater numbers of PAHs were detected in Mali than in downwind site samples. Trace-metal concentrations in both regions were similar to crustal composition with slight enrichment of lead in Mali.

Keywords: persistent organic pollutants, african dust, caribbean

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MS004 **Oral Presentation** **5060**

Interannual evolution of North African dust transport over the last decades: an impact of human-induced desertification

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Human-induced soil degradation in Sahel is a major concern for regional climate change. A significant increase in long-range atmospheric dust transport due to human activities would indeed modify the radiative budget and the water cycle over both Africa and the tropical Atlantic. Here we use two independent long-term datasets, i.e., surface concentration measurements at Barbados between 1965 and 2000 and maps of TOMS dust optical thickness between 1979 and 2000, to evidence an increase of a factor of two of background dust loads over the Atlantic since the mid 60s, independently of any climatic phenomenon. Satellite imagery suggests that this trend can be attributed to an intensification of dust emissions in a Sahel region centered on southern Mali. The desertification caused by the doubling of the population in Sahel over the last 40 years likely explains the observed intensification of the Atlantic dust export. Datasets from the follow-up sensors of TOMS and METEOSAT, i.e. OMI/Aura (Ozone Monitoring Instrument) launched in summer 2004 and SEVIRI on METEOSAT-8 (Meteosat Second Generation) launched in 2002 are used to extend this satellite data set to the more recent years (up to 2006). The combination of these two datasets should allow to derive reliable dust optical thickness over both North Africa and northern tropical Atlantic. This 28-year satellite dust record, combined with information on vegetation changes and desertification, will be used to improve our understanding of the impact of human-induced dust on the long-term evolution of North African dust.

Keywords: dust, interannual, sahel

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MS004 **Oral Presentation** **5061**

Compositional trends of mineral ice nuclei: a study at the AIDA chamber

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Mineral dusts are known to be good ice nuclei and ca n therefore affect climate indirectly. Many recent studies have investigated the ice nucleatio n pro perties of mineralogically pure dusts such a s montmorrillonite, kaolinite, alumina and iron oxides. Another approach is to consider a real mineral dust sample and evaluate the composition of t he best ic e nuclei within the lot. Such an approach was performed during a measure ment campaign at the AIDA chamber in Ka rlsruhe, Germany in Novembe r 2005. The AID A chamber consists of a large vessel in which the forma tion of an ice cloud can be simulated. An adiabatic expansion in the ch amber cools the air, induces water vapour supersaturation with respect to ice, and therefore induces the formation of ice crystals. A t ypical experiment consists of injecting a known test aeroso l and inducing ice crys tals d uring the expansion. The properties of the aerosols and resulting ice cr ystals are monitored ov er th e course of the experiment by a wealth of instruments sensitive to the p article size, concentration, shape, water phase and ice crystal shape. The test aerosols consisted here of Arizona Test Dust (ATD), illite and an external mixtu re of ill ite and hematite. Sulphuric acid, ammonium sulphate and organics coatings were sometimes used. For the first time the Particle Aerosol by Laser Mass Spectrometry (PALMS) instr ument was connected to the chamber to investigate the role of the dust composition on ice nucleatio n. Du ring the experiment, ice particles sampled from the AI DA chamber w ere aerodynamically separated from the int erstitial aerosol with a Pumped Counterflow Virtual Impactor (PCVI) and melted. The resulting ice residue was then sent to the PALMS instrument. Particles from 0.2 to 3 micrometers were first aerodynamically sized and then ablated by a p owerful desorp tion/ionization laser (193 nm, 106 W/cm2). The resulting i ons were then analyzed on- line with a time- of-flight mas s spectr ometer which gives a fingerprint of the particle composition. As a result the c omposition of single particles was accessible. External mixture of illite and hematite show ed that hematite nucleates i ce better than illite. Experiments with Ariz ona Test Dust showed that particles with a large silicate negative mass spectrometric signal nucleat ed ice less tha n other particles . No other co mpositional tr ends fo r the major elements of Arizona Test Dust wer e evidenced. The use of a single particle aerosol mass spectrometer for AIDA chamber experiments allows for a better k nowledge of the relevant mine ral dust characteristics with r egard to their ice nucleation properties.

Keywords: aerosol mass spectrometry, mineral dust, ice nucleation

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A numerical study of the heating effect of mineral aerosols on cloud and precipitation

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There have been numerous recent publications showing that mineral dust might be a good absorber for solar radiation in addition to its capability as cloud condensation nuclei (CCN) and ice fo rming nuclei (IFN), and cou ld lead to reduced cloud cover and precip itation in the reg ion it presents. This effect is investigated by using a cloud model with detailed mi crophysics of both warm and ice p hase processes. The model is i nitialized using measured distributions and c oncentration o f mineral dust particles. Our results show t hat when the dust layer with peak concentration appears at the cloud- base height and below 3 km, where the temp erature is war mer than -5oC, evaporation caused b y higher temperature inhibits the development of cloud particles a nd precipitation, and together with ea rly activation of larger cloud droplets on giant cloud condensation nuclei, which accelerates drizzle formation thr ough collision coalescence process, reduces the cloud optical depth and albedo. It is also found that only when the dust layer loca tes at altitudes with temperat ure colder than -5oC, mineral aerosols can act as effective ice nuclei and i ntensify the ice-forming proc esses. Under this condition, t he existence of dust layer can either increase or decrease cloud opt ical depth and alb edo, depending on the con centration and chemical composition of th e absorbing com ponents, or the time the mineral aerosols s uspended in the atmosphere.

Keywords: dust, heating, cloud

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MS004 **Oral Presentation** **5063**

An assessment of the aeronet aerosol size distrituions by comparisons with in-situ measurments at IZAA Global Atmospheric Watch Station: an analisys from clean-air to high saharan dust concentrations conditions

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SERGIO RODRGUEZ 1-2, Emilio Cuevas 2, Ins Toledo 1, Sara Basart 2, Philippe Goloub3 1. University of Huelva, Department of Geology, Hu elva, Spain. 2. Izaa Atmospheric Observatory, Instituto Nacional de Meteorologa, La Marina, 20 , 6 planta, 3 8071, Sant a Cruz de Tene rife, Canary Islands Spain. 3. Laboratoire d'Optique Atmosphrique, Obs ervatoire de Recherche sur les Arosols "PHOTONS / AERONET", Universit des Sciences et technologies de Lille. Ground based remote sensing monitoring of atmospheric aerosols have e xperienced a s ignificant deve lopment during the last years both in the number of parameters determined by these tec hniques and in the worldwide number of sites performing this mo nitoring. These a erosol measurem ents significantly contribute to obtain detailed knowledge of the aerosol pr operties which may co ntribute to improve t he aerosol mo delling and to reduce the uncertainties in the climate forcing a ssessment. Although the remote sensing technique s may provide highly reliable aerosol data, inter-co mparisons with in- situ aerosol me asurements ar e required (among other reasons) for assessing the co nsistency of the inversion algorisms. However, the column-integrated and the in-situ aerosol measurements are not always directly comparable becaus e these may be affected by different processes, for example the presence of aerosols at low altitude (local or regional) mostly affecting the in-situ measurements or aerosol layers at high altitude mostly affecting the column-integrated but not in-situ measurements . O wing to this, data ob tained with these t wo techniques can be properly compared only at some specific locations where the above cited phenomenons are not frequent. One of these sites is the Izaa Atmospheric Observatory which is located above the mixing layer (i.e . in the free troposphere) at 2 367 meter above the sea level in Tenerife (Canary Island s) and is not affected by local or re gional sources of aerosols . At Izaa site we have compared the aerosol volum e tempor al variations and ae rosol volume size distributions obtained by column-integrated measurem ents performed into the AE RONET framework (CIMEL sun photometer instrument) wi th those obtai ned by in-situ aerosol charact erisation techniques (optical particle counter equipment). Time series of the aerosol volume concentrations obtained by the t wo techniques (um3/cm2 and um3/cm3) exhibit highly correlated temporal variations mainly prompted by the concatenation of long range t ransport of air masses fro m North Africa and from the No rth Atlantic mid latitudes, which results in high and low aerosol volume concentrations, respectively. A statistical analysis shows that the aerosol volume si ze distribution obtained with the tw o techniques (um3/cm2 and um3/cm3) exhibits a high correlation in all ranges of the aerosol volume concentration (from low to high concentrations). Under low volume co ncentration co nditions (85th percentile) the aeros ol volume size distribution exhibits a predomin ant 2.5-4.5um mode. Be cause of th is association be tween volume concentrations and coarse mode volume increase, time s eries of the aerosol volume size distributio n mode obtained with the two techniques (c olumn-integrated and in-situ) exhibits correlated temporal variations with frequent incr eases fro m 0. 3um up to 13um. So me mino r differences in the size distributions, such as the contribution (%) of the fine aerosols to the total aerosol load, are attributed to the inherent differences in the measurem ents tec hniques. The results of this study evidence the suitability of the Izaa Global Atmospheric Watch ob servatory for validating aerosol r emote sensing measurements.

Keywords: aerosol size distribution, in situ measurments, column integrated measurments

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Transport of anthropogenic elements on coarse and fine natural mineral particles along the East Mediterranean.

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In IAMAS 2005 we presented the transport and make up of fine (<2.5˜m) and coarse (2.5 to 10 ˜m) particles during dust storm e vents along the east co ast of the Mediterranean Se a. New findings on the association of bioaerosols with dust particles were also shown. This study focuses on the possibility that dust storms minerals are "collecting" anthropogenic particles along their transport pathway to the East Mediterranean. The st udy involves: (1) An intensive sampling campaign t o characterize PM10 p articles during spring 2006, a season known for its h igh occurrence of dust storms. Samples were collected for 21 to 29 da ys with dichotomous samplers i n Tel A viv University. Measure ments included 24 hr samples of fin e an d coarse particles collected on Teflon filters f or gravimetric and element al analysis, fine particles on quartz filters for elemental and organic carbon analysis, and Nuclepore filte r samples for individual parti cle analyses. (2) Application of sca nning electro n micro scopy (SEM) to study individu al particles of selected samples from the abo ve periods, especially during dust sto rm events. (3) Running Hysplit to calculate back trajectories of air masses during the campaign. (4) Mesoscale modeling of dust events measured during the spring 2006 campaign (Alpert P. et al., Geophysics and Planetary Sciences, Tel Aviv University, Israel). A nalyses of samples collected during the spring 2006 campaign showed the presence of alumino-silicate elements in high co ncentrations during thr ee dust storm events. Thes e findings were expected. Often Ca co ncentrations (as calc ite, do lomite) were higher than Si. Those findings were true for both the coarse and fine particle fractions. Sea salt elements were often associated with dust storms events, not necessarily on the same day, but a day later. We had provided in the past evidence (using SEM) on the as sociation of ch lorides with mi neral particles, the result of stormy meteor ological c onditions associated with Saharan and Arabian dust transported to the east Mediterranean. Heavy metals of anthropog enic origin were associated with alumino- silicate minerals. These include V and Ni, particles emitte d from co mbustion of crud e oil in Euro pe and in East Mediterranean, Pb and Zn, S e and As, oil and coal co mbustion sources. The coarse particle fraction could be exp lained by two s tatistical factor s (using principal component anal ysis): mineral elements associated with anthropogenic heavy metals, and sea sa lt. In the fine particle fracti on this association has not been o bserved. Those findings may i ndicate the possible removal of anthropogenic combustion particles by mi nerals. Dust storms may be e fficient in transporting the ant hropogenic constituents with them. The "coating" of minerals with heavy metal particles may have a significant impact on the radiative properties of minerals, and health effect. SEM analyses of individual particles during dust storm events in tel Aviv are currently under way to provide further evidence of the above.

Keywords: minerals, heavy metals, east mediterranean

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MS004 **Oral Presentation** **5065**

Saharan dust transport and its impact on air quality, ecosystems and regional climate

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Air pollution and climate change are key issues worldwide and of course for the Mediterranean Region because of the unique characteristics. The Mediterranean Region is well known for its regional weather and climatic patters that lead in air pollution problems associated with gas phase chemical processes (mainly Ozone formation), gas to particle conversion (aerosol formation) and/or long range transport of naturally-produced PM (mainly Saharan dust and sea salt). The role of each mechanism has been studied extensively at various scales. Despite this fact, significant gap in knowledge still exists on phenomena, processes and impacts associated with the co-existence of air pollutants of various origins and stage of formation. For example, the role of Saharan dust on air quality degradation in urban areas started to be studied only during the last decade and of course the impacts on health are not fully understood. More important is the role of the anthropogenically and naturally-produced aerosols and PM on the fragile water budget of the area. As it has been demonstrated in previous studies, the major transport paths are from North to South for the anthropogenically produced air pollutants and the opposite for the natural ones. The links and feedbacks between Mediterranean air quality and climate are very complicated mainly due to the mixture of pollutants of different origins and ages of the air masses. The implementation of the new EU Air Quality Directive setting legislative measures for reducing the risks associated with the exposure to high PM2.5 concentrations, states exactly the need to control the impacts on human health and the environment. The necessity to control these effects brings the scientific community in front of a new problem; the non-controllable contribution of natural particulate matter to the overall elevated PM concentration. In this work, the main focus will be on the importance of Saharan dust transport, as part of the naturally originated PM, to the air quality of the Region. The effects of such transport on ecosystems and regional climate will be discussed too. The work presented herein has been done with the aid of regional atmospheric modeling systems and measurements. Simulations performed have revealed the multiple effects on the environment caused by high desert dust concentrations: Modification of both short- and long- wave components (effects on atmospheric radiation), modification of the environmental conditions by influencing atmospheric temperature and dynamics (effects on climate), modification of the photolysis rates due to the alteration of UV and visible radiation fluxes (effects on air quality), effects on the water budget due to the increased number of CCN in wet environmental conditions (effects on ecosystems).

Keywords: dust, air quality, climate

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MS004 **Oral Presentation** **5066**

Potential dust emissions from crusted desert soils

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Surface crusts play an important role in dust emissions by increasing the entrainment threshold of a surface and decreasing the number of grains available for transport. Surface crust strength can be characterized by various measurement techniques, which typically provide a measure of the bulk tensile strength which tend to vary considerably depending on the instrument used (i.e. shear box, torvane, penetrometers, and beam balances). Recent research suggests that most available instruments provide strength measurements at vertical and horizontal scales too great to characterize the surface with regard to the effect of abrasion of saltating grains on the top few millimetres of the surface. In the present study, a newly-designed portable field pin penetrometer (1 mm diameter) was used in conjunction with a portable field wind tunnel (0.75 m 1.0 12.0 m open floored working section) to measure dust emissions in relation to crust strength from three crusted desert surfaces. Tests were undertaken on a playa site in Nevada with physical silt-clay crusts and on a sand-rich site in New Mexico with a complex biological-chemical crust. At the Nevada site, tests were undertaken near the centre of the playa with a second set near the margin, which had a somewhat siltier texture than the clay-rich interior location. At all three locations, 14 side-by-side wind tunnel tests were carried out using a sand feed that introduced separately, sand of two different size distributions over a range of shear velocities. Prior to each wind tunnel test, 50 crust strength measurements were made down the edge of the tests plot. Maximum strength values varied considerably at all three sites spanning almost two orders of magnitude. The distributions of the maximum mean strengths for the two playa sites were negatively skewed, with a mean value of 18.2 mPa for the clay-rich playa centre site, and 16.6 mPa for the siltier margin site. In contrast, the sandier New Mexico crust was characterized by a strongly positively skewed distribution of strength with a mean value of 0.98 mPa. These mean strength values are much higher than comparable values presented in the literature for crusted soils. As expected, measured dust emissions were lowest at the sandy New Mexico site (mean 3.01 mg m-2 s-1) and the heavily crusted clay-rich interior playa site (mean mg m-2 s-1). The highest emissions (mean 7.65 mg m-2 s-1) were found at the silt-rich playa margin site indicating the importance of textural characteristics for dust emissions. Similar to other published literature, very poor correlations were found between emission rates and crust strength measured with the pin penetrometer despite the fact that this technique provides a measure of near surface strength at a scale that is close to that associated with the bombardment of a surface by a saltating grains. These results, in conjunction with recent studies suggest that tensile strength, no matter how measured, may not be the appropriate parameter to evaluate the role of crusting on dust emissions.

Keywords: dust emissions, surface crusts, dust sources

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MS004 **Oral Presentation** **5067**

Mineralogy and optical properties of resuspended desert dusts

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This paper presents results on the mineralogical and optical properties of resuspended fine desert dust samples from Africa, China, and the Middle East. Optical properties of mineral dust are needed for the modeling of visibility impairment and radiative transfer as input for global and regional climate models. Globally, the most abundant group of ambient aerosol particles by mass (approximately 50%) consists of silicate and oxide minerals. Wind-blown dust from deserts and anthropogenically disturbed areas comprise one of the highest atmospheric mass loadings of particles on a planetary scale (after sea salt aerosol). Large emissions of mineral dust from Africa and China substantially modify the solar energy input to the earth. Approximately one half of all global dusts originate from the Sahara, making it the most important source region to be investigated. While common filter analysis provides elemental and ion concentrations, optical properties of prime importance in radiative transfer processes and global climate change issues depend on the complex refractive indices of the mineral components, therefore mineral abundances are needed. To model either visibility impairment or radiative effects (including the use of satellite imaging techniques) of entrained dust, its scattering and absorption properties are needed. These properties are a function of the complex refractive index and particle size and shape distribution. The refractive index is not just a function of the readily available elemental composition of the dust, but strongly depends on its mineralogy. The Desert Research Institute (DRI) developed the necessary instrumental capabilities for aerosol sampling as well as mineralogical and real-time optical characterization of dust aerosols. Dust is resuspended in a chamber, passed through PM2.5 size selective impactors, and optical absorption and extinction are quantified by the DRI photoacoustic absorption instrument and the DRI cavity ring down/cavity enhanced detection extinction instrument. Filter samples are simultaneously collected for mineralogical analysis by X-ray diffraction. The resulting XRD patterns are quantitatively analyzed using the Rietveld procedure. This experimental procedure allows for relating aerosol absorption, extinction, and single-scattering albedo to mineralogical composition.

Keywords: mineralogy, optical, xrd

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MS004 **Oral Presentation** **5068**

A new map of Saharan dust emissions based on MSG-IR dust index retrievals with high spatiotemporal resolution

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Mineral dust aerosol from arid and semi-arid regions plays an important role in the climate system by directly and indirectly affecting radiation fluxes and nutrient cycles. A prerequisite for estimates of the influence of dust aerosol on the climate system is the knowledge of the locations of its source areas. So far, locations of dust sources are mostly implied from daily satellite retrievals, or alternatively from reports of dust storm frequencies. Determining dust source areas by such indirect methods is impeded by low temporal resolution and ambiguities of the retrievals. We present a new 1x1 map of monthly dust emission events for the Sahara and Sahel region derived from the Meteosat Second Generation (MSG-1) Satellite infrared (IR) difference dust index. The MSG-1 is a geostationary satellite localized at 0 longitude over the equator. From the Spinning Enhanced Visible and Infra-red Imager (SEVIRI) radiances are available every 15 minutes at 11 different wavelength bands of the electromagnetic spectrum with a resolution of 3x3 km at the sub-satellite point. A dust index is computed based on the difference of the brightness temperatures measured at wavelengths centered at 8.7 m, 10.8 m and 12.0 m. Because of its behavior at IR wavelength, airborne mineral dust is well identifiable in this dust index, especially over land surfaces. Emissions and subsequent transport of individual dust events can be very well observed and followed in these IR composite pictures. Based on visual analysis of all Saharan and Sahelian dust events for a full year (March 2006- February 2007) we derived new observation-based monthly 1x1 maps of locations of mineral dust sources together with frequencies of dust emission events over the African continent northward of 10N . We will compare this new compilation of dust sources to earlier satellite derived dust source area maps, as well as to the spatial distributions of soil surface properties like the aerodynamic surface roughness lengths and geomorphological features as the distribution of topographic depressions, which are commonly used in dust models to compute preferential sources for dust emission.. Furthermore, first results of modeled dust distributions using the new Saharan dust source distribution implemented into the regional dust transport model LM-MUSCAT will be presented.

Keywords: dust source, satellite, model

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MS004 **Oral Presentation** **5069**

Dust mobilization due to density currents in the ATLAS Region observations from the Saharan mineral dust experiment SAMUM 2006

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The Saharan Mineral Dust Experiment (SAMUM) first field campaign took place in southern Morocco between 11 May and 10 June 2006. Ground-based in-situ and remote sensing measurements from Ouarzazate airport (3053N, 654W) and Tinfou (3015N, 537W) provide unique observational data to study the meteorological conditions for dust mobilization in the Atlas region. Usually dust is mobilized by large-scale frontal systems or numerous small-scale dust devils. Here we focus on a little investigated meso-scale mechanism: density currents driven by the evaporation of convective precipitation in mountainous regions. The proposed mechanism includes the following steps: (I) Development of deep convection over the (Anti-) Atlas during the day, (II) shearing-off of cloud tops by upper-level winds, (III) evaporation of precipitation in the dry and hot desert air, (IV) spreading of the cold air driven by density differences to the environment, (V) further acceleration along the topographic gradient, (VI) raising of dust by strong winds at the leading edge and mixing through a deep layer by high turbulence. We will present a detailed case study of a density current that was directly observed by the SAMUM team as a shallow lobe of dust filled air approaching the Tinfou site from the northeast on 31 May 2006. Meteosat imagery reveals intense convection over the Moroccan Atlas and Anti-Atlas chains in the afternoon hours of that day and a quickly southwestward spreading, dusty cold pool with a convex leading edge of several hundreds of kilometres length. Ground-based observations at Tinfou show abrupt changes during the passage of the leading edge of the density current such as (I) an increase in water vapour mixing ratio, (II) a decrease in temperature, (III) an increase in pressure, (IV) an increase in wind speed with a distinct change in direction, (VI) a decrease in visibility from 50 to 3 km and (VII) an increase in aerosol concentration, mainly for particles of 5 m diameter. With the help of additional station data from the network of the IMPETUS project the propagation speed of the front was estimated to be ~20 km/h. Other such events of variable scale and intensity were observed during the SAMUM campaign suggesting a rather frequent occurrence of this phenomenon. These results point to an important role of evaporationally-driven density currents in the Atlas region for the generation of strong and turbulent near-surface winds necessary for dust mobilization. The proposed mechanism is most likely relevant for other mountainous parts of the Sahara like the Ahaggar, Aor Tibesti, and might therefore be a key in understanding dust emissions from northern Africa during summer in general.

Keywords: convection, evaporation, dust emission

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MS004 **Oral Presentation** **5070**

Characterization of mineral dust plume evolution over the Atlantic, by combining MISR dark-water aerosol retrievals and NAAPS transport model predictions

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An understanding of dust property evolution during transport is important for characterizing climate forcing, biochemical processes, and environmental impacts. The diversity of climate model dust deposition results complicates dust radiative impact predictions. The Multi-angle Imaging SpectroRadiometer (MISR), orbiting Earth aboard the NASA Earth Observing Systems Terra satellite, is contributing to the study of global dust characterization by providing, through multi-angular geometry, information about aerosol properties such as optical depth (AOT), single scattering albedo (SSA), angstrom exponent, fraction of coarse to medium-mode aerosols and fraction of spherical to non-spherical particles. We will present a North Africa dust transport study using MISR aerosol observations and data from the Navy Aerosol Analysis and Prediction System (NAAPS). Using NAAPS as a guideline, we selected dust events during the summer of 2000 the timeframe of PRIDE (the Puerto Rico Dust Experiment), and 2001. We analyze MISR Aerosol Optical depth (AOD) and the MISR AOD fraction of non-spherical particles using both MISR standard retrieval products and the aerosol-property sensitive MISR Research Retrieval algorithm, and compare with NAAPS-predicted AOD and AOD dust fraction for the events selected, covering different stages of dust transport. We also compare with coincident AERONET site observations, where available. In addition, we study the evolution of MISR-observed dust properties such as angstrom exponent, size range (small, medium, large) and single scattering albedo (SSA). We constrain our findings with MODIS and AERONET AOD and PRIDE-experiment data. We investigate different dust transport and deposition scenarios and possible long-range dust effects, and discuss the contribution these observations make to our knowledge of African dust impact on environmental processes in the western North Atlantic and southeastern United States. Our goals are (a) improve confidence in the NAAPSs diagnostic and predictive abilities for dust evolution, and (b) further understand the MISR observational data quality and suitability for improving dust aerosol representations in the climate and forecast models.

Keywords: misr, naaps, dust transport

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MS004 **Oral Presentation** **5071**

Long-term measurements of african dust deposition across the State of Florida: how well do models do?

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There is increased interest in the mobilizatio n and at mospheric transport of dust because of its ro le in climate and because it can serve as a source of Fe, a limiting micro-nutrient in many ocean regions. For these reasons many atmospheric chemical transp ort models no w include dust as a co mponent. However, the modeling of dust present s many ch allenges, especially in dealing with deposition processes. There are almost no long-term d ata on du st deposition rates t hat can be use d to constrain models. In this report we present the res ults of a three year program i n which dust deposition was measured in a network of ten stations located throughout the state of Florida, from the Florida Keys to the Pan handle. Previo us studi es have sho wn that Flo rida is stro ngly impacted by Afric an dust e very year, especially during t he months of June through September; in the absence of African dust, mineral aerosol concentrations are extremel y low. In our study rain was coll ected using automated "wet - dry" precipitation c ollectors. The deposition rate s of vari ous el ements that a re dominant in soil particle s (e.g., Al, Fe, Mn) were strongly correlated; their deposition rates showed an extremely strong seasonal cycle with a maximum in the summer which closely ma tched the monthly cycle of dust concentration s that we concurrently measured at our coastal site in Miami. The deposition rates of Al, Fe and Mn at the ten sites were remarkably uniform. Dust concentrations, computed on the basis of the Fe and Al content of the wet deposition , yielde d deposition r ates of roughly 1 - 2 g m-2 y-1. Scavenging ratios were computed for each of the ten deposition sites using dust c oncentrations measured at th e Miami co astal site. While vari able, they tend to fall into a relatively narrow range around a value of se veral hundred. In our report we will present our results and compare them with recent dust model estimates.

Keywords: african dust, deposition

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MS004 **Oral Presentation** **5072**

Transport, Evolution and Entrainment of Asian Dust/Pollution into the

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Various airborne and ship based studies ove r the past several years have allowed us t o measure Asian dust an d po llution aero sol fro m near its so urce to lo cations up to 10, 000km do wnwind where it wa s entrained into the marine boundary layer (MBL). Dust was found to accumulate up to half of the soluble species such as sulfate and nitrate during passage th rough pollution regions in Asia bef ore being lofted into the free troposphere near Japan. At times, transport in the free troposphere encountered regions of subsidence in high pressure r egions that brought these rivers of dust and pollution down to the top of the MBL. S hipboard measure ments and lidar data in dicated both clear ai r entrainment and convective activity, associ ated with the passage of low pressure s ystems, facilitat ed dust tra nsport through the inversion. High temperature volatilizati on of particles in the MBL up to 900C was used to remove most sulfates, nitrates, carbon an d sea- salt to leave only dust sized by an optical particle counter. These shipboard data and concurre nt chemical m easurements r evealed the rel ation between entrainment o f pollution and dust into the MBL associated with passage of high pressure systems. Subsequent passage of low pressure systems also revealed scavenging and re moval of aeros ol through pre cipitation to the ocean surface. This process appears to be a common removal pathway for dust over the Pacific and a mechanism for supplying the ocean surfac e with so luble iron and alu minum to the ocean surfac e. Measurements in the free troposphere and MBL also captured various aspects of these processes. Airborne missio ns flo wn no rth o f Hawaii duri ng the NASA PEM-Tr opics and IMPEX missions characterized the vertical structure of subsidin g dust and pollution. In -flight mapping of the dust/pollution layers and structure using the NASA Langley DIAL LIDAR show a sloping, subsiding Asian air-mass entraining into the marine bo undary layer (MBL). In- situ measurements o f the aero sol size distribution, ch emistry, optica l properties and the incr ease in light scattering as a function of relative humidity [f(RH)] were able to characterize and discriminate between M BL air, FT Asia n dust/pollut ion and an external mixture of the two air- mass ty pes during entrainment. Dusty air-masses were transported from Asia to the Pacific Ocean north of Hawai'i via the free troposphere (FT) and were even evident as a pronounced event in data at the NOAA Mauna Loa Observatory (19.54N, 155.58W, 3,397m alt.). In situ measurements confirmed that regi onal an d global chemical transport models (CTM) successfully predicted several Asian dust/pollution outbreaks and subsidence into the MBL. One episode is put into br oader context using models, satell ite ob servations and data from the Mau na Loa Observatory. We include a discussion of dust-flu x t o the ocean surface due to wet-deposition, a potentially important source of iron to the oligotrophic waters of the North Pacific Subtropical Gyre.

Keywords: dust, entrainment, transport

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MS004 **Oral Presentation** **5073**

Global Influence of Dust Mineralogical Composition on Heterogeneous Ice Nucleation

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Mineral dust is the dominating natural ice nucleating aerosol. Its ice nucleatio n efficiency depends on the mineralogical composit ion. We show the first sens itivity studies with a global climate model and an off-line dust mineralogy, which has been validated against measurements. Results show that in present-day climate, freezing on black carbon compensates th e more or less efficient freezing on mineral dust and model results do not depend on the mineralogi cal c omposition of the dust ice nuclei. F or t he differences between present-day and preind ustrial climate, prescribing a realistic dust m ineralogy gives similar results to assuming all dust has the ice nucleating properties of montmorill onite, which is a very efficient ice nucleus. The glaciation indirect effect of a nthropogenic black carbon, ca lculated with a realistic dust mineralogical composition, is in the order of +0.1 Wm-2, which is only a small offset to the aerosol indirect effect on warm clouds.

Keywords: aerosol cloud interaction, dust mineralogy, heterogenous ice nucleation

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MS004 **Oral Presentation** **5074**

Seasonal behavior of Saharan dust events at the Mediterranean Island of Lampedusa in the period 1999-2005

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Measurements of aerosol properties are carried out at the island of Lam pedusa (35.52 N, 12.63 E), in the So uthern part o f the Ce ntral Mediterra nean, with a multi-filter ro tating sh adowband radiometer (MFRSR), since 1999. Lamped usa experiences long rang e transport of different aerosol types, besides the locally produced marine aerosols: desert dust fr om the Sahar a, po llution from the co ntinent, and, occasionally, biomass burning aerosol. The Saharan dust (SD) outbreaks observed at Lampedusa fro m May to December 1999 and from July 2001 to December 2005 are stud ied using MFRSR data, back-trajectories, and surface wi nds. Daily ave rages of the a erosol optical depth at 500 nm, τ, an d the ngstrm exponent, α, have been calculated in cloud-free in tervals. Five-day back-trajectories ending at Lampedusa at 2000 and 400 0 m a.g.l. altitude are calc ulated by means of the HYbrid Single-Particle Lagrangian Int egrated Trajectory (H YSPLIT) model , in cluding th e vertical win d. We assu me th at airmasses are lo aded with S aharan d ust thro ugh the entrainment in the mixed layer or through the permanence over Sahara for a long fraction of time. We consider that an area is active as a dust source if the surface wind at the source point iden tified by the entrainment condition is larger than 7 m/s. The SD days displa y values of $\alpha+\Delta\alpha\leq1$, with $\Delta\alpha$ equal to the s tandard deviation of the daily α. Out of 911 days with clou d-free intervals, 233 (26%) a re classifie d as SD, and corre spond to epis odes of various duration, from 1 to 13 consecutiv e days, with average values for τ and α of 0.350.01 and 0.300.0 2, respectively. The occurrence of SD events is ma ximum in summer (33%), when also the largest seasonal avera ge of τ (0.40) is measured, and minimum i n winter (7%), when the sm allest seasonal average of α (0.08) is fo und. The highest fr equency of SD episodes occurs in July (47%), followed by May (33%). T he total number of events th roughout the measurement period is 111, about 19 events per year; the average durati on is 2.00.2 d ays, wi th a m aximum length in summer (2.90.5) and a minimum in a utumn-winter (1.60.2). SD days ha ve b een identified from the back-traje ctories also in days lacking of observations, due to either cloudiness or measurement interruptio ns. The frequency o f occurrence of SD days sh ows little ch ange with respect t o the cloud-free periods (24%). The seasonal distribution shows a peak in May (38%), followed by July (37%). The total number of SD events is 256, with an avera ge duration of 2.50.2 days, while th e aver age number of SD episodes per year is 37 . Finally, the MFRSR measurem ents at the solar zenith angle of 60 have been used to der ive the single scattering albedo (SSA) for cases clearly dominated by dust ($\tau\geq0.40$ and $\alpha+\Delta\alpha\leq0.5$). The average SSA for the whole period is 0.770.04 at 415.6 nm and 0.940.04 at 868.7 nm.

Keywords: desert dust, aerosol optical depth, angstrom exponent

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MS004 **Oral Presentation** **5075**

Saharan mineral dust experiment (SAMUM) 2006: vertical profiles of dust particle properties from airborne in situ and LIDAR observations

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The Saharan Mineral Dust Experiment (SAMUM) is a six-year initiative of several German universities and research establishments. Its goal is the characterisation of optical, physical, chemical, and radiative properties of Saharan dust close to a source region and in the outflow regime. The first SAMUM intensive field phase was carried out in May/June 2006 in Southern Morocco near to the Saharan border. The DLR Falcon research aircraft was operating from Casablanca. The DLR Falcon was equipped with an extensive set of aerosol physico-chemical instruments for size, volatility, and absorption measurements, impactor sampling for chemical analyses and with a nadir-looking high spectral resolution lidar (HSRL). In total eight mission flights were conducted from the Atlantic coast across the Atlas mountains to the border of the Saharan desert where the ground sites Ouarzazate and Zagora were located, and from Morocco to Portugal. Three large-scale dust events were probed which extended from southern Morocco to Portugal. Vertical (0 - 10 km) and horizontal (Saharan border to southern Portugal) dust plume structures, aerosol optical depth as well as particle microphysical and optical properties were studied for all cases. The upper boundary of the dust layers was found at altitudes between 4 and 6 km above sea level. The internal structure of the dust layers varied from well mixed to stratified. The optical properties of dust samples were studied by HSRL, a 3-wavelength PSAP and aerosol sizing instruments. Aerosol size information and absorption data were analysed with respect to the Angstrom exponent of the aerosol absoprtion coefficient and the effective diameter. Trajectory data were used for classifying air mass history and dust source regions. A statistical analysis will be presented demonstrating that clusters of the Angstrom exponent can be associated with different dust events. No similar patterns are observed in the effective diameters. Presented results will cover profiles of dust size distributions and dust optical properties. Expected heating rates will be discussed.

Keywords: dust size distribution, optical properties, dust radiative forcing

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MS004 **Oral Presentation** **5076**

Mineral Dust Aerosol Source Characterization and Air Mass Mapping from Space-based Multi-angle Remote Sensing

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Distinguishing non-spherical mineral dust from spherical airborne particles, retrieving column aerosol optical depth and column-effective particle properties even over bright desert surfaces, and determining the heights of discrete aerosol plumes, typically observed near source regions, are among the strengths of the Multi-angle Imaging SpectroRadiometer (MISR), orbiting Earth aboard the NASA Earth Observing Systems Terra satellite. We are using these capabilities to characterize dust aerosol sources, and to map relationships between dust and other aerosol air masses. From the combination of MISR plume elevation, column aerosol optical depth, and meteorological data from other sources, we are piecing together information about plume dynamics and source strength. And with the help of coincident, sub-orbital data collected during the UAE2 field campaign in 2004 and the SAMUM campaign in 2006, we are gaining insight into the way dusty, polluted, and background aerosol air masses mix. This paper will present the latest results of our dust source region and air mass investigations. This work is performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Keywords: non spherical dust, plume dynamics

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MS004 **Oral Presentation** **5077**

The development of a continuous dust / loess stack (0 140 ka) for Central Europe by using the particle analysis and detection system RADIUS on ELSA sediment cores (Eifel, West Germany)

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A comparison of a last interglacial, annually laminated and varve counted maar lake record from the Eifel / West Germany, with a laminated lake sediment record from Northern Germany shows, that high resolution cores can be correlated across central Europe by dust / loess content, if the resolution of grain size data is on the order of decades / centuries. Phases of widespread dust dispersal are the same as the cold events in the Greenland ice and North Atlantic sea surface temperature patterns (Seelos&Sirocko, 2006). The first occurrence of dust in Northern Germany and in the Eifel is during the Late Eemian Aridity Pulse (LEAP, Sirocko et al. 2005) which is called C26 in ocean records. Based on these results we developed a long dust / loess time series for the Eifel region. The complete stack (0-140 ka) is a compilation of four different sediment cores (HL2 dry maar west of Hoher List; De3 Dehner Maar; OW1 Oberwinkler Maar; SM3 Schalkenmehrer Maar). We use the particle analysis module RADIUS (Rapid Particle Analysis of digital Images by ultra-high-resolution scanning of thin sections, Seelos & Sirocko, 2005) to analyse and identify the different sediment structures of all ELSA stack cores. The application allows the detection of climate controlled sedimentation processes like storm events under cool and dry conditions or fine laminated sequences during warm periods and spontaneous events like volcanic eruptions, slumps and turbidites. We will show, that the stack is characterised by a high variability of different dust sequences during the whole period. Especially the transition into cool event C24, 111ka ago, is dominated by a series of single storm events. Otherwise, the loess like sediments of MIS 4 are very homogeneous and unstructured.

Keywords: lgm, dust, grain size

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MS004 **Oral Presentation** **5078**

Trends and inter-annual variations of asian dust aerosols and their trans-pacific transports

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A 44-year climatology of spring Asian dust aerosol emission, column loa ding, deposition, trans-Pacific transport routes and bud gets during 1960 2003 was st udied with NARC M (Northern Aerosol Regional Climate Model) and surface observat ions. La rge inter-annual variatio ns of dust a erosol were observed and simulated. An averaged annual trend of decreasing surface dust concentration or Asian dust storms over the arid and semiarid regions in East Asia was found from 1960 to 1997. However, both modelling and observations suggest an increasing trend since 1998. Climate variation was found to be the majo r factor in regul ating the occur rence and strength of the dust aerosol in the last 44 years and to a les s extent, the dust aerosol was related to the desertification process in Asia.Interannual variability in these Asian dust aerosol properties and their climate connections are analyzed with major climatic indices and records in ground observations. For dust production from most of the source regions, the strongest correlations were with the surface wind sp eed in the source region, t he ar ea (AIAPV) and intensit y (IIAPV) indices of the Asian polar vortex. Dust emission was negatively correlated with precipitation and surface temperatures in spring. The interannual variability of dust loading and deposition showed similar relations with various climate indices. The correlat ion of Asian dust loa ding and depo sition with the Western Pacific (WP) pattern and Atmospheric Circulation Index (ACI) exhibited contrasting meridional and zonal distributions. AIA PV a nd IIAP V were st rongly correlated with the mid-latitude zonal distribution of dust loading an d deposition over the Asian subc ontinent and No rth Pacific. The Pacific/North American pattern (PNA) an d So uthern Oscillati on In dex (S OI) displayed an opposite correlation pattern of dust loading and deposition in the Easter n Pacific, while S OI correlated significantly wi th dust loading ov er Eastern China and Northeast Asia. The Pacific Decadal Oscillati on (PDO) was lin ked to variations of dust aer osol and deposition not only in th e area of Eastern North Pacific and North Americabut also in the Asian dust source regions. The anomalies of transport flux and its divergence as well as dust column loading were al so identified for eight typical El Nio and eight La Nia years. A s hift of the tra ns-Pacific transport pa th to the No rth was found fo r El Nio years, which resulted in less dust storm and dust loading in . In El Nio-year the deserts in and western north close r to the polar cold air regions contributed more dust ae rosol in the troposphere, while in La Nia-year the deserts in central and eastern North Chinafa r from polar cold regions provided more dust aerosol in the troposphere. On the b asis of the variability of Asian dust aerosol budgets, the ratio of inflow to North America to the outflow from Asia was found to be c orrelated negatively with the PNA-index and positively with the WP- index.

Keywords: duststorm, trends, inter annual

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MS004 **Oral Presentation** **5079**

Global Retrieval of Aerosol Properties over Desert and Semi-Desert Regions from SeaWiFS and MODIS

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Mineral aerosols (dust) play an important role in both climate forcing and oceanic productivity throughout the entire year. Due to the relatively short lifetime (a few hours to about a week), the distributions of these airborne dust particles vary extensively in both space and time. Consequently, satellite observations are needed over both source and sink regions for continuous temporal and spatial sampling of dust properties. However, despite their importance, the high spatial resolution satellite measurements of dust near its source have been lacking. In this paper, we will demonstrate the capability of a new satellite algorithm to retrieve aerosol optical thickness and single scattering albedo over bright-reflecting surfaces such as urban areas and deserts. Such retrievals have been difficult to perform using previously available algorithms that use wavelengths from the mid-visible to the near IR because they have trouble separating the aerosol signal from the contribution due to the bright surface reflectance. The new algorithm, called Deep Blue, utilizes blue-wavelength measurements from instruments such as SeaWiFS and MODIS to infer the properties of aerosols, since the surface reflectance over land in the blue part of the spectrum is much lower than for longer wavelength channels. We have validated the satellite retrieved aerosol optical thickness with data from AERONET sunphotometers over desert and semi-desert regions. The comparisons show reasonable agreements between these two. These new satellite products will allow scientists to determine quantitatively the aerosol properties near sources using high spatial resolution measurements from SeaWiFS and MODIS-like instruments.

Keywords: dust, satellite, retrieval

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MS004 **Oral Presentation** **5080**

Observations of Sahara desert dust glaciating clouds at -11C compared to -31C for dust-free similar clouds

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An intense cyclone in the northern Sahara created an intense dust plume that ascended and visibly incorporated into a sloping rising cloud layer that spiraled towards the cyclone center on 22 February 2007. The cloud band was observed to glaciate almost instantaneously as the cloud top rose above the -11C isotherm level, as depicted by two independent microphysical multispectral schemes of the METEOSAT Second Generation (MSG) geostationary satellite, and corroborated by AVHRR and MODIS observations. The glaciation front kept progressing upwind as segments of the cloud band made their sloping ascent. This provided a continuous replication of that observation for every new MSG image (every 15 minutes) during several hours. Higher elevation similar cloud bands above the dust layer glaciated at temperatures ranging between -31C and -35C. Animation of the progress of the glaciation fronts within the clouds will be shown in the presentation. This time sequence of geostationary based measurements of the glaciation temperature of sloping ascending layer clouds provides us with a new way to measure the glaciation temperature of clouds under various aerosol conditions. Lidar measurements of the CALIPSO overpass several hours later supported the visual inferences of the dust being at levels that should have reached the lower clouds that glaciated at -11C, but could not havereached the higher clouds that remained highly supercooled. Nearby convective clouds started to glaciate also at -11C, but the glaciation progressed over a range of several degrees and not as abruptly as in the sloping layer clouds. The cloud drops effective radii just above cloud base were larger and increased faster with height for the convective clouds than for the nearby sloping layer clouds. This suggests that larger dust particles rise with the stronger updrafts that feed the convective clouds. Yet, the onset of glaciation occurred for both cloud types at the same temperature, revealing the ice nucleation temperature of -11C for that desert dust. This is in agreement with previous laboratory measurements for ice nucleation activity of desert dust. TRMM Precipitation Radar measurements over these clouds (not yet analyzed at the time of the submission) will provide us with additional insights to the role of the dust in the formation of precipitation.

Keywords: desert dust, cloud aerosol precipitation

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MS004 **Oral Presentation** **5081**

Observational Constraints on the Global Dust Aerosol Cycle

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In the absenc e of routine t hree-dimensional meas urements of aerosol species and mass fraction, researchers calculate the glob al and regional dust burden using aerosol models. These models calculate the aerosol cycle using a combinatio n of physical and empir ical laws, with the model vali dity evaluated by comparison to observation. Here, we apply gl obal observations to model results submitted to AEROCOM in order to constrain the global burden of dust aerosols. The model dust cycles are compared to gl obal obs ervations of a erosol optical th ickness, surface concentratio n, size de pendence, and deposition. A mean dust bur den is calculated wher e each model is we ighted by its agreement with observations. We also co nsider whether the mo dels can be brought into better agreement with observations by rescaling the emission calculated as a fu nction of wi nd speed, a relation wh ose alternative estimate from first principles is highly uncertain. Finally, we use a single mo del to consider whether emission is the largest source of uncertainty for estimating the global dust burden.

Keywords: dust aerosol, global mass, observational constraint

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

MS004 **Oral Presentation** **5082**

Saharan Dust Longwave Radiative Forcing using GERB and SEVIRI

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The interaction of mineral dust with infrared (IR) radiation in the at mosphere is a n important b ut uncertain fact or influencing the Earths rad iative ba lance. In particular, dust can exe rt a significant longwave radiative fo rcing (LWRF) at the to p of atmosphere (TOA). Mineral dust LWRF stro ngly depends on d ust optical properties, size distribution, optical depth and vertical distrib ution. It is als o very sensitive to surface a nd atmospheri c fields th at a re themselves affected b y t he presence of atmospheric d ust via feedba ck processes. Here we pres ent a method that combine s geostationar y measurements and IR radiative transfer (RT) mode ling to measure dust LWRF and to understand its diurnal cycle dependence. Using the new Geostationary Earth Radiatio n B udget (GERB) experimen t onboard Meteosat Second Generation (MSG) and a dust detectio n based o n the Spinning Enh anced Visible and InfraRed Imager (SEVIRI), we compare the measured broadband (~ 4-100m) Outgoin g Longwave Radiation (OLR) over dust co ntaminated regions to clear-sky RT simu lations to estimate the dust LWRF. Euro pean Centre fo r Medium Range Weather Fo recast (ECMWF) tempera ture, humidity, ozone operational analysis fields and mo nthly me an la nd surf ace e missivity from the Moderat e Resolution Imaging Spectroradiometer (MODIS) are used as input of the MODTRAN 4 RT model. During a very large Saharan dust st orm at the beginning of Mar ch 2004, we estimated an av erage LWRF of 20.3 W.m-2 at 12UTC over a dust front extending acro ss North-West Afr ica. Analysis at different times of day reveals that the dust radiative forcing exhibi ts a strong diurnal cycle. In order to assess the quality of the model used in this approach, we use clear-sky scenes for the month of March 2004 to test the simulated OLR against G ERB measurements and derived an uncertainty of +/-2.9 W.m-2 on the latter LWRF estimate. We also show that this uncertainty on LWRF exhibits a diurnal cycle that is related to the limitations o f the ECMWF mo del to reproduce measured diurn al variations over North Africa. To complement this analysis, we compared radian ce and brightness temperature simulations to measurements made by the SEVIRI instrument in 7 na rrowband IR channels. It is shown that the LWRF of the studied mineral aerosol has a strong spectral dependence and is maximum in the window channel centred at 10.8m. Although the TOA forcing is pred ominant in the 3 SEVIRI windo w channels (8.7m, 10.8m, 12.0m), significant forcing is measur ed in the ozone (9.7m) and CO2 (13.4m) channels and a detectable signal is seen in the 7.3m water vapour channel, consistent with the dryness of the Saharan air and the probably high vertical extent of the dust layer.Performing clear-sky comparisons with SEVIRI narrowband measurements p rovides detaile d informat ion on the causes of the model errors that are responsible for the remaining uncertainty in our measure of the dust LWRF.

Keywords: dust, gerb, longwave

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MS004 **Oral Presentation** **5083**

Long-term simulations (1958-2006) of Saharan dust over the Mediterranean and the Eastern North Atlantic with the DREAM regional dust model

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Airborne mineral dust from worldwide deserts makes a major contribution to the global tropospheric aerosol budget, with dust concentrations being particularly high over arid regions. The Sahara is the worlds most important dust source; it is considered that northern Africa is responsible for more than half of the global mineral dust emissions. Measurements since the 1960s have shown strong daily, seasonal and inter-annual variations of dust concentration over the Atlantic (Prospero, 1999). Moulin et al. (1997) outlined the correlation between the NAO and the dust distribution over North Africa and the Atlantic using satellite data. In this contribution, a 48-year model simulation is used over the period 1958-2006 at 0.3x0.3 resolution (implemented in Mare nostrum Supercomputer) in order to analyze the monthly, seasonal and year-to-year variation of the atmospheric dust load, surface concentration, deposition and the frequency and duration of the events over theMediterranean and the Eastern North Atlantic. For this purpose, the regional dust model DREAM, which has been providing daily dust forecasts over these regions in the last years (now at http://www.bsc.es/projects/earthscience/DREAM/), is implemented. Meteorological fields are initialized every 24 hours and boundary conditions updated every 6 hours with the NCEP/NCAR I global reanalysis (2.5x2.5 resolution). The study also explores links of the simulated dust parameters to the variability of the large-scale circulation covering decades with mostly positive and mostly negative NAO indexes. The possible positive trends of dust in the last years over the Mediterranean, as recently suggested by Antoine and Nobileau (2006), are also studied. The qualitative and/or quantitative validation studies performed so far, using data from lidar stations, sun photometers, satellite and ground level PM levels [e.g. Ansmann et al., 2003, Prez et al., 2006] indicate the good skills of the model concerning both the horizontal and vertical extent of the dust plume in the geographic region of application. In situ measurements of concentrations at the Izaa station (Canary Islands) for the period 1987-1999 and in southern Europe are used for model validation. References Ansmann, A., et al. (2003), Long-range transport of Saharan dust to northern Europe: The 11 16 October 2001 outbreak observed with EARLINET, J. Geophys. Res., 108 (D24), 4783, doi:10.1029/2003JD003757. Antoine D. and D. Nobileau, (2006), Recent increase of Saharan dust transport over the Mediterranean Sea, as revealed from ocean color satellite (SeaWiFS) observations. J. Geophys. Res., 111, D 12214, doi:10.1029/2005JD006795. Moulin, C., Lambert, C.E., Dulac, F., Dayan, U., 1997. Control of atmospheric export of dust from North Africa by the North Atlantic Oscillation. Nature 387, 6916 94. Prez, C., S. Nickovic, J. M. Baldasano, M. Sicard, F. Rocadenbosch and V. E. Cachorro (2006)A long Saharan dust event over the Western Mediterranean: lidar, sun photometer observations and regional dust modeling. Journal of Geophysical Research, 111, D15214, doi:10.1029/2005JD006579. Prospero, J.M., (1999), Long-term measurements of the transport of African mineral dust to the Southeastern United States: implications for regional air quality. J. Geophys. Res. 104, 15.

Keywords: dust, modelling, reanalysis

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MS004 **Oral Presentation** **5084**

Variations of atmospheric dust/aerosol and westerlies circulation over the last 2000 years documented by laminated lake sediments of Lake Sugan in the dust source areas, Arid China

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Northwest arid China was recognized as dust provenance of the North Pacific and the Greenland ice sheet over the geologic times. Qaidam basin at the north margin of the Qinghai-Tibetan Plateau is one of the main dust/aerosol source areas in the arid China. Climatically, it is strongly influenced by the westerly jet stream. Lake Sugan, a hydrological closed lake in the Qaidam Basin with a surface area of and annually laminated varve sediments, is possibly an ideal lake to directly trap the emitted dust/aerosol from source area because it is mainly fed by groundwater or the rivers derived from groundwater at the wet land around the lake. Modern surface samples from the lake catchment, lake sediments, eolian dust trapped in the lake ice cover during winter half year, and airborne sand and dust during dust storms were collected for grain size and SEM analyses. A sediment trap was placed in the lake water for the modern sediments in different seasons. It is found that the lake does record the atmospheric dust. The grain size from lake sediment is consisted of four main components, super-fine fraction (~0.01-0.15 μm), fine fraction (~5-15 μm), coarse fraction (silt) and sand fraction by using the analysis of a well-defined function formula. By comparison with modern surface samples, the super-fine fraction is suggested to document the westerly circulations as that in loess. Fine fraction reflects atmospheric dust loadings in arid central Asia, while coarse fraction (silt) is transported by suspension under dust storm conditions in the region. The sand fraction is transported by saltation or creeping on the lake ice cover during winter half year. The above model is used to document dust and westerlies changes over the past 2000 years based on a lake core with varve chronology in Lake Sugan. Over the past 2000 years, the atmospheric dust loading was higher and unstable with possible strong westerlies ciuculation during the Little Ice Age (LIA). The silt fractions were higher during the Medieval Warm Period (MWP), and fluctuated sharply at other times. This would be resulted from the dry climate condition and the fraction was transported by effective suspension when the lake has shorter term ice cover duration relative to the LIA.

Keywords: atmospheric dust, lake sediments, arid china

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MS004 **Oral Presentation** **5085**

Selective removal of dust particles and its dependence on mineralogy

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During the ASTAR2004 (Arctic Study of Tropospheric Aerosols, clouds and Radiation) campaign, series of aircraft measurements were conducted in the Arctic region in late spring (May-June) 2004. Single particle analyses revealed that irregularly shaped mineral dust outnumbered sea salt particles in the free troposphere (2-7km), most of which exhibited significantly aged features. The air-mass backward trajectory suggested favorable conditions for particle aging such that the air- mass arrived after spending more than few days in the Arctic free troposphere without notable vertical mixing. These aged particles were dominated by silicate minerals. Interestingly, the fraction of silicate particles showing apparent sulfate coatings increased with decreasing altitude. Since the uptake coefficient of SO2 on dust particles is known to be highly dependent on the relative humidity (i.e. the water molecules associated with the dust surface), the observed distribution of coated particles is in agreement with the seasonal increase of the low level cloud activity over the Arctic. It is suggested that the air-mass arriving at the lower altitudes had previously encountered higher humidity conditions. It is worth noting that a significant number of Ca-rich spherical particles were also found in the Arctic free troposphere. X-ray analysis confirmed that these particles often contain Mg along with smaller amounts of Al, Si, and Fe, which are the elements often associated with mineral dust. Recently, increasing number of both laboratory and field studies reported that the carbonate (calcite and dolomite) represents the most reactive fraction among the mineral dust particles, which readily take up acidic gases. In particular, when calcite (CaCO3) particles react with the gaseous HNO3, it is believed to form extremely hygroscopic Ca(NO3)2, which stays in liquid phase even under very dry conditions (near R.H.=10%). Unfortunately, it was not possible to confirm the presence of nitrate in the individual particle due mainly to the technical difficulties in detecting lighter elements. Thus, no definitive conclusion can be made such that the Ca-rich spherical particles were in fact the aged calcite particles. Nevertheless, following indications remain supportive of the possible calcite transformation: 1) Similarities in morphology and elemental composition found in the literature. 2) Absence of intact (i.e. irregular) Ca-rich dust particles. 3) Coexistence of the Ca-rich spherical particles with the silicate particles. If we hypothesize that the collected Ca-rich spherical particles were indeed the aged calcite particles, due to the combination of their large size and the increased hygroscopicity, they may had acted as highly efficient CCN and hence removed selectively from the atmosphere by wet deposition, leaving less reactive and insoluble silicates behind especially in the lower altitudes. This is the likely explanation why the relative abundance of such spherical particles relative to silicate particles decreased sharply with decreasing altitude, and there was almost no such spherical particles found below 2 km. If the hypothesis was right, current result could be considered as an indirect field-evidence which highlights the increasingly distinct roles played by silicate and carbonate fractions of mineral dust in the actual troposphere.

Keywords: mineralogy, single particle analysis, aging process

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MS004 **Oral Presentation** **5086**

Mechanisms of Dust Production from the Bodele, Chad: past and future

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The Bodele De pression, Chad, is one of the planets largest single source s of dust. Deflation from the Bodele could be seen as a simple coincidence of two key prerequisites: strong surface winds and a large source o f suitable sediment. But here we sho w that lo ng term links between to pography, winds, deflation and dust ens ure t he maintenance of th e dus t source such that these t wo apparently coincidental key ingredients are connected by land-atmosphere processes with topography acting as the overall controlling agent. We go on to evaluate the sensitivity of this key global hotspot to future climate change by analyzing winds in the IPCC AR4 simulations.

Keywords: bodele, dust, climatechange

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MS004 **Oral Presentation** **5087**

Potential impacts of mineral dust aerosol on cold cloud formation

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Dust particles ability to scatter and absorb radiation and their potential to interact with water vapor may lead to an important radiative impact on th e climate, b oth directly and i ndirectly. Further, dusts from various regio ns can have di fferent so lubility, hygr oscopicity, chemical and surface properties, and interact with cloud development in a variety of ways that ar e not fu lly understood. We investigated the interaction of several types of dust aerosol, collec ted from the Southwest U.S. and the Saharan region, with water vapor at a wide range of temperature co nditions. Hygroscopic grow th of the particles was determined using a humidifie d tandem diffe rential mobility analyzer at relative humidities (RH) from 5 - 95% and cloud condensation nuclei (CCN) activity wa s measured using a continuous flow CCN co unter at supersatura tions up to 2 %, both at a temperat ure of ~30C. The interaction wi th water at warm temperatures was then compared to ice nucleatio n behavio r, examined us ing a co ntinuous flow diffusion cham ber (CFDC). The CFDC was operated in the temperatur e range of -6 0<T<-20oC to measure the i ce nucleation ability of the dust partic les at RH from ic e saturation to several perce nt above water s aturation. In all experi ments, particles were size selected prior to sampling, yielding a quasi-monodisperse particle stream, gen erally with diameters between 100-400 nm. While most samples showed no hygroscopic gr owth at RH <95%, the particles did serve as CCN at lowe r supersaturations than are pr edicted for insoluble, wetta ble particles. Due to the larger size distribution for dust aerosol than the background aerosol, the potential for the dust particles to serve as giant CCN is important in determining the role of th is aerosol on warm cloud formation. Ice formation behavior of the dust showed little dependence on tem perature between -60 a nd -40oC, nucleating ice on 1% of particles at a similar RH for any temperature, but had a strong dependence on particle size. Initiation of the ice phase was at RH values significantly lower than required for homogeneous freezing of aqueous solution particles; however none of the sam ples showed ice formation at temperatures warmer than ~-30C. The particles which initiated the ice phase at the lowest RH conditions appear to be those with the smallest content of soluble material. This was verified by coating the most IN active dust sample with secondary o rganic co mpounds, which requir ed substa ntial increase in RH for ice phase initiation. The collected ice n ucleation data wa s then used to develop a new parameterization of heterogeneous freezing for use in cloud-resolving models.

Keywords: mineral dust, heterogeneous freezing, cloud microphysics

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The United Arab Emirates Unified Aerosol Experiment: Investigations into the properties of heterogeneous environments

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Frequent dust storms, high pollution levels, and complex flow patterns make the Southwest Asian heterogeneous environment one of the most difficult areas to understand and forecast. But the regions surrounding the Arabian Gulf and Sea are an outstanding natural laboratory as well. For example, the atmospheric flows make Southwest Asia a climatological crossroads for Asia, Europe, and Africa. High modulation between pollution and dust makes it an outstanding Cal/Val site for a number of space and ground based remote sensors as well as mesoscale models. Stratus and convective clouds under a variety of environmental conditions can be studied near-simultaneously. In summer of 2004, the United Arab Emirates Unified Aerosol Experiment (UAE2) was performed by 60 researchers from 15 international organizations with 2 research aircraft and 15 ground sites, including the densest meso-net of AERONET sun photometers ever deployed. In this paper will give an overview of the UAE2 mission, its participants, the general properties of the Southwest Asian atmosphere and discuss future work. We will also emphasize microphysical aspects of regional dust, and note significant differences of Southwest Asian dust to that of other regions of the world.

Keywords: aerosols, radiation, dust

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MS004 **Oral Presentation** **5089**

Iron solubility and redox speciation during dust transport

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In the open ocean, dust deposition undoubtedly provides an important supply of micronutrients to surface ocean waters. Associated with dust particles are several elements of biogeochemical interest such as iron. Via dissolution processes, some of these elements become bioavailable for the biota. During transport away from the dust sources, atmospheric cloud processes of acid cycles, photochemistry and possibly organic complexation coupled to selective losses of coarser mode aerosol particles modify the dust chemical and mineralogical composition and load. Thus, it appears that iron solubility increases with distance from the source. Moreover, it appears that redox speciation of Fe in the atmosphere is critical to understanding the fraction of Fe that will be labile in surface waters after deposition and consequently has implications for the bioavailability of this atmospherically derived Fe. The impact of transport process on the chemical speciation of iron from dust has been study from laboratory experiments on dust collected in source region and over Atlantic Ocean. The size segregation during atmospheric transport also induces a splitting up of aerosol mineral composition in favor to clay content. An extraction procedure was performed on mineral powders usually present in dust and on aerosol sample collection and measurements of Fe(II) and Fe(III) using ferrozine method coupled with preconcentration on C18 phase column. Experiment on clays, feldspaths and (hydr)oxide iron show a greater solubility of iron resulting from clays (~4%) in comparison of the others minerals (

Keywords: fe solubility, redox speciation, mineralogy

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Increasing trend in dust cloud intrusions from the Sahara over Israel

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Israel experiences periodic intrusions of natura l mineral dust clou ds from Afric a. The natur al contribution of aerosols from Dust Events (D E) can increase PM10 to 4000 mg/m3 half-hour average, a hundred times the concentration on clean d ays. Observations and measurements of mineral dust were recorded over the 49 year period 1958/9-20 05/2006 in Te l-Aviv and Jerusalem. Dust was identified b y visibility of les s than 5000 m eter and the p resence of yellow-orange desert du st in rain-water. These comprise 18000 days of obse rvation. From 1995 to 2006 concentrations of aerosols with diameter les s than 10 micron (PM10) were measured by TEOM in Tel-Aviv, by the Isr ael Electric Company and the Ministry for Pr otection of the Environment. The reco rds were analyz ed for statistics su ch as beginni ng, duration and concentration. This dat a ma y help explain the meteorological and ph ysical processes involved in the Dust phenomena. Results : 1) The number of days with DE in Tel-Aviv per year has increased 1958-2006 with a s lope of 2 .3 days per decade, from 18 days in 1962 to 27 days in 2006. Automatic continuous measur ements are av ailable only since 1995. For this period our results are : 2) Duration of DE was 3 to 72 hours, most fell in the range of 3-8 hours. 3) Most DE were observed to begin in Tel-Aviv between 5:00 and 8:00 in t he morning, with the bre aking of the inversion, and ended between 8:00 and 15:00 hou rs. 4) 13%-40% of DE in ea ch year ended in rain. 5) The total duration of DE in Tel-Aviv over a year was 172 to 495 hours, average 328 hours/year. 6) The con tribution of DE caused PM10 values to excee d the Israeli standard of 60 mgr/m3/year in 6 of the 12 years. Using our DE identificati on algorithm we computed the av erage PM10 with and without DE. However, even without the DE contribution PM10 exceeded the le vel recommended by WHO (20 mgr/m3/year) ever y year. PM2.5 values were over the Israeli recommended standard (15 mgr/m3/year) even without DE. 7) The contribution of DE to the an nual P M10 averag e w as 9%-27% . These results may indicate the effect of global or local change, such as des ertification, on dust intrusions. The dust could in turn affect weather and cl imate thro ugh direct (redistribution of heat in the atmo sphere) and indir ect (cloud and precipitation) e ffects. DE statistics are relev ant for transportation eg. th rough visibility, and for publi c health concerns.

Keywords: mineral dust, aerosols, pm10

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MS004 **Oral Presentation** **5091**

Dust and its Role in Tropospheric Chemistry – A View from Model, Laboratory and Field Studies.

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Mineral dust particles can make up over half of the mass loading of atmospheric aerosols. They scatter and absorb solar and terrestrial radiation and alter cloud properties, and thus strongly impact climate. Dust also affects the budgets of important trace gases by providing a surface for heterogeneous reactions to occur upon. Over the last decade our ability to model dust transport has advanced, as has our laboratory understanding of the chemistry of trace gases on mineral surfaces. Many field experiments have also been conducted which have observed dust, along with aerosol composition and size and gas phase chemistry. These studies have pointed out the important role that dust chemistry plays, including providing important reaction surfaces for sulfate production and in controlling the partitioning of semi-volatile components (such as HNO3) throughout large portions of the troposphere. Recent studies also point to the direct uptake of chlorine by dust via heterogeneous reaction with HCl(g). This reaction added significant amounts of chlorine to the dust, with approximately 4-9% of the individual dust particle mass being chloride as a result. Ignoring this process leads to an overestimation of sea salt concentrations from bulk measurements, and an underestimation of the degree of aged sea salt. The uptake of chlorine alters the physical, chemical, and optical properties of dust particles and their overall ability to act as cloud condensation and ice nuclei. The chemistry can also influence the fate of nitrogen- and sulfur-containing gases as the HCl(g) competes with these gases for reaction with alkaline dust particles. Including this heterogeneous process in atmospheric measurements and chemical transport models will improve our ability to predict the atmosphere's composition and radiation budget with greater accuracy. Many uncertainties remain in quantifying the role of dust in tropospheric chemistry. In this paper we discuss these issues in the context of results from field experiments including Ace-Asia, MILAGRO, INTEX B, and PACDEX, and comment on future needs from a modeling perspective.

Keywords: tropospheric chemistry, ace asia milagro, intex b pacdex

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Discussion about

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MS004 **Poster presentation** **5103**

Saharan dust over the Eastern Mediterranean in spring 2006: Model sensitivity

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Saharan mineral dust is one of the main natural air pollutants affecting air quality. 3D-dust distributions, daily predicted by the Tel A viv University Weather Rese arch Center, a re used by the Ministry of Environmental Protection t o d istinguish between na tural and anthropogenic aerosols. This study was aimed at validating dust distributions predicted by dust models, in ord er to better understand the models capabilities for provid ing reliable du st fore casts. This was carrie d ou t by using a quantitative comparison between PM10 measurements of surfac e d ust concentrations and those predicted by models, for the high dust activity season in Israel, from February to June 2006. Two different dust prediction systems were used to perform a sensitivity experiment and to compare the accuracy of the models. The fir st one was t he original DREAM model with four dust p article size classes (0.7, 6.1, 18.0 and 38.0 microns); only the first two class es have a radius less than 10 micro ns and can be used in comparisons a gainst PM10 measurements. Anothe r mod el used was the modified DREAM model (DREAM-8) with a more det ailed set of dust particle size classes with a r adius of betwe en 0.1 a nd ~7 microns (0.15, 0.25, 0.45, 0.78, 1. 3, 2.2, 3 .8, and 7.1 microns), wh ich are mainly responsible for the long-distance dust transport. Quantitative c omparisons between PM10 data an d model-simulated ones showed that t he use of eig ht particle size classe s in d ust modeling, instea d of o nly two classes, improves dust forecasts. The adva ntage o f DREAM-8 compared to the original DREAM is particularl y significant for long-distance dust transport predic tions. During the sp ring 2006, Sa haran du st was transported into the Eastern Mediterranean not only in the typical way for this time of the year (from the Sahara de sert thro ugh Egypt into Israel) , bu t also in an unus ual clo ckwise mo vement fro m the western part of the Sahara desert through Southern Europe into Israel.

Keywords: forecast, dust, pm10

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MS004 **Poster presentation** **5104**

Extra-ordinary dust event over Beijing, China during April 2006: lidar, Sun photometric, satellite observations and model validation

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Strong dust storms originating in western and northwestern China are affecting Beijing, each year during the spring season causing high particulate matter concentrations over the city. Except the naturally occurring dust, local anthropogenic activities are the main additional sources of dust particles in the region. We report on an extraordinary dust event, which occurred over Beijing during April 2006. The dust event was monitored by continuous aerosol lidar (during its intense phase) and Sun photometric (AERONET) observations. Heavy aerosol loading with a notable temporal variation (dust layers from around 3-4 km down to the ground) was revealed by both measurement datasets. Very high aerosol optical thickness (AOT) values ranging from 1 up to 4 (at 440 nm) were measured by the AERONET Sun photometer network and the MODIS Terra/Aqua sensor (at 550 nm), while the corresponding Angstrom exponent (AE) values remained lower than 0.3, even reaching zero or negative values, during the intense phase of the dust event. The aerosol integrated backscatter (IB) obtained by lidar at 532 nm exceeded 0.045 sr-1. Based on air mass trajectory analysis, in conjunction with satellite observations, these high aerosol optical depth values were mainly attributed to dust originating over north-western China desert regions. The aerosol vertical profiles obtained by lidar and the AOT values from the Sun photometer were used for the first time to validate the DREAM dust forecast model data over the Beijing region.

Keywords: china, lidar, dream

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

MS004 **Poster presentation** **5105**

Preliminary Studies on Radiative Properties of Dust Aerosol in North China

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By using the direct solar radia tion data measured by CE-318 sun photometer in Inner Mongolia during the period between June 200 2 and May 200 3, the aerosol optical thickness (AOT) and size distribution were retrieved by extincti on method. The radiative properties including scattering efficiency, single scattering albedo (SSA), extinction coefficient were analyzed. The results show that there is a significant variation of temporal-spacial distributions of AOT. The highest AOT appears in spring wit h the lowest in winter. It shows a significant discrepancy i n differe nt weather co nditions. The aerosol is steady and consistent in the clean weather. The evolution of AOT is relatively steady, while in the dust weather, the AOT increases extremely . T here are four patterns of daily variation of AOT: (1) the AOT is high i n morning and low in evening, about 24 %-29%; (2) th e low AOT is in morn ing and the high one is in evening, about 35 %-36%; (3) the AOT presents a peak at noon, is about 21%-33%; (4) the relatively steady pattern, is about 4 %-14%. The scattering efficiency and exti nction efficiency of dust aerosol both appear a high value whe n radii is 0.1 -1.0μm. The value is about 4. A nd the position of high value is in the direction of bigger ra dii when the channel λi increases. The absorbing efficiency increases with the radii increa ses and approaches 1. The hi ghest SSA is about 0.97 whe n radii is 0 .1μm - 1.0μm. The aerosol extinction parameters are very sensi tive to the imaginary part of complex refractive index. The aerosol size distribution satisfies Junge distribution basically and appears obvious peak values (r=0.3μm, 0.6μm, 1.0μm). However, it s hows a significant discrepanc y in different weather co nditions. Large dust particles and giant dust particles rema rkably increase in dust weather. The aerosol number concentration in dust weather is about one magnitude larger than that of in clean weather. And it is also larger in spring than that in winter but within one magnitude.

Keywords: aerosolopticalthickness, sizedistribution, radiativeproperties

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MS004 **Poster presentation** **5106**

Observation study of dust aerosol physical and optical properties over Helan Mountain area in Northwest of China

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Measurements o f aero sol number co ncentrations, mass co ncentration and o ptical pro perties were performed on April and May f rom 1996 to 1998 at six sites representing sand source in Helan Mountai n area of China, not far from the regions of desertification environment. By analyzing aerosol samplings in dust weather and non-dust weather, it is fo und that the average number concentration and the mass concentration are single- peaked di stribution and the y s howed dist inct lognormal distribution. The average num ber concentration of PM2.5 (particula te matter with aerodynamic diameters less than 2.5μm) in non-dust event is above 90% of the TSP (total suspended particulate) and decreases slightly in dust events. The coarse particles increas ed distin ctly in dust events. In addition, the optical depth change more r emarkable with β(Angstrom turbidity coefficient) in du st events than in background day, which shows a positive correlat ion between them. The optical depth successively increases in background d ay, flo ating dust , blown sand and dust storm. α(Angstrom wavelen gth expo nent) is negative correlation with β.

Keywords: numberconcentration, massconcentration, opticaldepth

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MS004 **Poster presentation** **5107**

Mineral dust in the last deglaciation

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Some details and preliminary results related to mineral dust aerosol from our ongoing modeling study about the transient simulations of the last deglaciation will be presented. The FAMOUS (FAst Met Office/UK Universities Simulator) model used in the simulations has been developed as a fast version of the HadCM3 coupled atmosphere-ocean general circulation model and has a horizontal atmospheric resolution of 5x7.5 degrees and 11 layers vertically. Therefore, it is suitable for experiments that requires multiple ensembles of simulations over thousands of years. It has been found that although they significantly underestimate the wind speed variations in the northern hemisphere middle troposphere associated with the storm tracks, the FAMOUS simulations in the modern climate show the magnitudes and variability of the surface wind speed comparable to HadCM3 simulations and ECMWF reanalysis data. This is an essential feature of a model to properly simulate emissions of dust and sea salt aerosols. In this study, I intend ultimately to evaluate the changes in atmospheric loading and surface deposition of dust due to different processes and the roles of it in the changing climate through different mechanisms such as direct radiative forcing and snow albedo effect. Dust emissions are expected to change due to changes in vegetation cover, ice sheet extent, and exposure of continental shelves due to sea level changes. Its atmospheric loading and distribution of deposition rates will depends on the wind speed and precipitation as well as the distribution of emissions. The simulated deposition rates will be compared with available paleo records such as ice cores, marine sediments, and terrestrial (loess) deposits to validate the model simulations.

Keywords: paleoclimate climate change, fast low resol gcm simulation, changes in dust sources

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MS004 **Poster presentation** **5108**

Chemical differentiation of mineral dusts with single particle aerosol mass spectrometry

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Single particle aerosol mass spectrometers are frequently used to chemically analyze aerosols because they provide composition and thus the particle mixing state. Organic, soot, sea-salt, nitrate and sulphuric acid aerosols have been thoroughly investigated with this technique. Since mineral dusts affect climate, health and biogeochemical cycles, it is important to evaluate the potential of this technique for this type of aerosols. Mineral dusts have traditionally been analyzed using electron microscopy. This technique is single particle sensitive but it requires aerosols to be first collected on filters and then analyzed off-line in a laboratory. Aerosol mass spectrometry, by comparison, allows an in situ, on-line chemical analysis of a larger number of particles. Aerosol particles in this study were analyzed with the Particle Aerosol Laser Mass Spectrometer (PALMS) instrument. Airborne particles from 0.2 to 3 micrometers are focused with an aerodynamic lens into a tight beam. Particles are then aerodynamically sized and ablated by a powerful desorption /ionization laser (193 nm, 106 W/cm2). Resulting ions are analyzed on-line with a time-of-flight mass spectrometer which gives a mass spectrum, fingerprint of the particle composition. Either positive or negative ions can be analyzed at one time. Hematite, goethite, calcium sulphate, calcium carbonate and aluminosilicates such as quartz, illite, kaolinite and montmorrillonite samples were used as models for atmospheric mineral dust particles. Additional samples such as nephelinsyenit, hectorite and wollastonite were used to further explore the ability of PALMS to differentiate mineral dust particles. We show that particles of various elemental compositions, such as iron oxides, calcium dust and aluminosilicates can be unambiguously differentiated in positive ion mode. Moreover, insights to the element speciation and/or mineralogy can be gained for single particles in negative mode. Indeed, the relative occurrence of negative ions (Al,Si)xOyHz allows aluminosilicates to be discriminated according to their mineralogy. Similarly, hematite and goethite can be differentiated based on the relative amount of hydroxyl and iron oxide ions. Finally, the counter species of calcium, such as sulphate or silicon oxide in negative mode and the relative occurrence of its oxide positive ions allows the speciation of calcium materials. Depending on the material, up to 35% of mineralogical pure dry single particles can be identified with a high level of confidence. A low fraction of mass spectra production, due to the nature of the material and the interaction of the laser light with the particles, is compensated by the ability of aerosol mass spectrometers to analyze a larger number of particles in a given time than electron microscopy. This allows a good statistical representation of the sample and a high confidence in the chemical/mineralogical analysis. This makes aerosol mass spectrometers potential field instruments to infer mineralogical composition of mineral dusts.

Keywords: single particle, aerosol mass spectrometry, mineral dust

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MS004 **Poster presentation** **5109**

Using Digital Soil Mapping for prediction of uncertainty of wind erosion

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The Soil thematic strategy has been adopted in September 2006 by the European Commission to improve the protection of the protection of European Soils. Wind erosion is one of the threats outlined in there. Areas of wind erosion have been already outlined in several publications. Traditionally, soil maps have been used, however the uncertainty related to these products, is most often not specified. Data created using digital soil mapping, allows to quantify the uncertainty with for example texture data. We used Wind Force Integrals to approximate the energy, which is available to erode soil surfaces together with forecast data from 2005/2006 created by the European Center for Medium Range Weather Forecast. The impact of texture uncertainty on prediction of wind erosion events on the european scale will be discussed.

Keywords: wind erosion, digital soil mapping

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MS004 **Poster presentation** **5110**

Summertime variability in the aerosol physical properties at izaa free troposphere site: column-integrated versus in-situ measurements of Saharan Dust and North Atlantic free tropospheric aerosols

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Pedro Campos 1, SERGIO R ODRGUEZ 2-1, Emilio Cuevas 1, Philippe Golo ub3 1. Iz aa Atmospheric Observatory, Instituto Nacional de Meteorologa, La Marina, 20, 6 planta, 38071, Santa Cruz de Tenerife, Canary Isla nds Spain. 2. University o f Huelva, Departmen t of Geo logy, Huelva, Spain. 3. Labo ratoire d'Optique Atmosphrique, Observatoire de Recherch e sur l es Arosols "PHOTONS / AERONET", Universit des Sciences et technologies de Lille In this study we present the results of an intercomparison between column-integrated and in- situ aerosol measurements per formed at Iza a Atmospheric Observatory - Global GAW (Global tmospheric Watch) station (28.47N, 16.24W; 236 7m a.s. l.), located above t he mixing layer and representati ve of the Subt ropical North Atlantic free troposphere. The objectives are : 1) to characterize aerosol phy sical properties, and 2) to study the homogeneity of the aerosol physical properties ove r Izaa - free troposphere site by comparing the column-integ rated with the in-situ measurements. The study w as performed in summer (May-September 2003), because the aerosol concentrations reaches high er co ncentrations and ex hibits a higher variability in this period. The column-integrated aerosols m easurements (Aerosol Optical Depth-AOD and the Alfa and Beta ngstrom parameters) were performed with two equipments: an AERONET/PHOTONS Cimel sunphotometer and a Precision Filter Radiometer-P FR (World Ra diation Centre). The in-situ aerosol measurements (mass concentrations of particles le ss than 10um, 2.5um and 1um, i.e. PM10, PM2.5 and PM1, respectively) were performed by an OPC - Optical Particle Counter by converting the aero sol volume to aerosol mass concentrations by experimentally determined conversion factors. The study is divided in two main parts: first an intercomparison between the two c olumn-integrated aerosol datasets was performed. In the second part a detailed time s eries study of the in -situ aerosol c oncentration (PM10, PM2.5 and P M1), column-integrated aerosol load (Beta) and in-situ (PM1/PM10 ratio) and column-integrated fine aerosols fraction (Alfa), was performed. Owing to the lack of local aerosol sources, day-to-day variations of these aerosol parameters were int erpreted in terms of lo ng-range transport by using air-ba ck trajectories , meteorological charts and maps of th e Aerosol-Index of TOMS. In the first part, the study showed tha t the AOD measurements performed with b oth the Ci mel a nd the PRF sunphotometers exhibits a ver y good agreement (r2 between 0.93 a nd 0.97) for all wavelengths, except f or the 870nm channel, which was lower because a signal overestimation detected in by one of the photometers. Moreover, the in-situ aerosol mass a nd volume con centrations exhibited a very good agreement as well. The second part of the study allowed us to understand the ori gin of the high variability in the aerosol c oncentrations i n summer at Izaa. Day- to-day variations in the in- situ PM10, PM2.5 and PM1 aero sol concentrations and the Beta vertically integrated aerosol load exhibited a high correlation. Moreover, the in-situ (PM1/PM10 ratio) and colu mn integrated (Alfa) fine-to-total aerosols fraction exhibited highly correlated day-to-day variations which, in turn, showed a high anti-correlation with the PMx and Beta aerosol concentrations. The analysis of these time series, together t he back trajectories, the mete orological charts and the AI-TOMS, shows that the large variations in these parameters are caused by the c oncatenation of meteorological scenarios prompting Southeastern ai rflows bringing high amo unts o f co arse Sahara n mineral dust with strong NW subsiding a irflows inducing very lo w aero sol co ncentrations with a predominant fine size. The concatenation of these events induces frequent increases from <10 to >125 ug/m3 in PM10 concentrations and from ≤0.01 to >0.4 in Beta, and decreases from 0.45 down to 0.15

in the PM1/PM10 ratio and from 1.5 down to <0.1 in Alfa fro m clean air and Sahara n dust events, respectively.

Keywords: izana tenerife, saharan dust, free troposphere

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MS004 **Poster presentation** **5111**

Beautiful seasonal cycles of atmospheric dust and tritium obtained from Mount Wrangell Ice Core, Alaska, in the North Pacific Region and comparison with statistical backward trajectory analysis

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The North Pacific region is known to various climatic phenomena such as the Pacific Decadal Oscillation (PDO), the El Nio-Southern Oscillation (ENSO), and the Arctic Oscillation (AO), significantly impacting on the ocean and the atmosphere. Moreover, material circulation is also very active in this region such as spring dust outbreaks due to cyclonic activities in the desert and arid region in East Asia and summer forest fire occurrences in Siberia and Alaska. Understanding the complex connections among the climatic phenomena and the material circulation in the North Pacific region, seasonal ice core data set is necessary. The 50-m ice core was drilled at the summit of Mount Wrangell in 2003, where is located near the coast of Alaska (62N, 144W, and 4100 m a.s.l.). We analyzed dust particle number concentration, tritium concentration and delta-D in the core. The ice core covered the atmospheric information from 1992 to 2002. Here, we show the beautiful seasonal cycles of atmospheric dust and tritium as a result of seasonal dating. The ice core data were divided into five distinct seasons (early spring; late spring; summer; fall; winter). Those mainly had maxima in early spring and late spring, respectively. For further understanding of the causes on those variations, we should know the origins of the seasonal dust and tritium. Hence, we investigated their air mass origins by the calculation of everyday 10-day backward trajectory analysis from January 1992 to December 2002 with 3-D wind data of the European Center for Medium-Range Weather Forecast (ECMWF). In early spring, the air mass from East Asia increased and it also explained dust increases in the ice core in springtime, although the air contribution in winter increased too. In late spring, the air mass from the stratosphere increased (Monthly mean tropopause height pressures of the International Satellite Cloud Climatology Project (ISCCP) D2 data were used with trajectory analysis), and it also corresponded to the stratospheric tritium increase in the ice core in this season. The air masses from Alaskan and Canadian inlands in the boundary layer and free troposphere increased in summer, suggesting aerosol contributions due to forest fire from those areas. The air masses in the interior of North America did not contribute to Mount Wrangell so much. Seasonal data set of ice core is important for the detailed discussions on seasonal climate variations in the periods when there were no meteorological data. Connecting detailed meteorological analyses with ice core ones in the past several decades, then we can go back to the distant past with bringing those discussions. Our preliminary study for it would finally lead to obtain important perspective for the mechanism of seasonal climate changes and material circulations in the distant past.

Keywords: dust, ice core, backward trajectory

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MS004 **Poster presentation** **5112**

Dust mineralogy and elemental composition of red rains North-eastern Spain in (1983-2002)

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Major wet African events have been sampled at a rural locality in the Montseny massif (4146N, 221E, Barcelona, Spain) from 1983 to toda y. The minerals det ected were (by order of ab undance): illite, quartz, smectite, palygorskite , kaolonite , calcite, feldspars and dolomite . Elements analysed were: Al, Fe, Ca, Mg, K, P, Ti, Na, S, Cu, Ni, Zn, Pb, Ba, Mn, Cr and 210Pb. In North-eastern Spain, African dust is delivered by w et deposition under two main meteorolog ical scenarios: (1) an Atlantic de pression (AD) which usually is respo nsible fo r the entrainment o f dust f rom the West ern Sahara, a nd (2) a Nort h African depression (NAD) which transports dust from the Tunisian area. Also, high pressures over North Africa (NAH-H) which are responsible for dry intrus ions o ver the who le Iberian Peni nsula, can be combined with local convective orographic storms to produce red rains. Here we use back trajectories , satellite images and model results to relate t he dust mineralogy and elemental composition with source areas in North Africa. Stepwise regression has show n that quartz and kaolinite are the minerals most contributing to the dust amount, with a sharp distin ction depending on the source areas and length of transport. Quartz, calci te and dol omite were higher in shorter trajectories, while smectite and kaolinite were enriched in longer displacements. The elemental composition varied accordingly.

Keywords: chemical composition, mineralogy, north africa

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MS004 **Poster presentation** **5113**

Impacts of desert dust on photochemical processes

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Photochemical processes are affected by the presence of increased particle concentrations in the atmosphere in various ways. One is the alteration of UV and visible radiation fluxes because particles absorb and scatter the incoming solar radiation. Photochemical reactions are then affected by the modification of the j-values (photolysis rates). Another effect is the uptake of gas molecules into the particles surface that can lead to reduced gas concentration and when that gas takes part in a photochemical reaction, the result is a shift of the budget of the photochemical products. In this work the main focus will be on the quantitative and qualitative effects that desert dust has on photochemical processes, especially on ozone, sulfur dioxide, particulate sulfate and particulate nitrate concentrations. For this purpose, advanced atmospheric and photochemical models are implemented with the aid of air pollutant measurements from stations in the region. The models used are the RAMS atmospheric model, the SKIRON/Eta atmospheric modeling system with the implementation of the dust module and the CAMx photochemical model. New model development will be presented referring to new aerosol formation in the air quality model. Results from the simulations have shown reasonable agreement with the available measurements and have also revealed the contribution of desert dust particles to the photochemical processes in the Mediterranean Region by lowering ozone levels and increasing particulate sulfate, depending on the atmospheric conditions.

Keywords: dust, air quality, photochemistry

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MS004 **Poster presentation** **5114**

Effect of weak crust on saltation mass flux after small precipitation event during JADE IOP

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To demonstrate the impacts of soil water content and related crusting on saltation flux, erosion threshold, and particle size, we measured soil water contents and saltation process at a fallow-wheat-field in Australia during one month: JADE IOP1. Small precipitation event occurred on 12 March 2006. The soil water content was measured using oven dry method and the result shows that soil water content slightly increased from dry and no crust condition to weak crust condition during a strong wind event after precipitation. The measurements suggest that saltation mass flux q at no crust condition was higher than that at weak curst condition. Further discussion would be necessary to understand how the size dependency on saltation mass flux.

Keywords: dust, wind erosion, soilwater

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MS004 **Poster presentation** **5115**

Multi-size Saltation Process from fallow-wheat-field in Australia during JADE IOP.

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As the first intensive observation on Japan Australia Dust Experiment (JADE), which was launched from April 2005 as a three years project, we conducted a filed experiment at a fallow-wheat-field in the Lower Murray Darling Catchments in Australia. The project aims to gain a better understanding of wind erosion processes, including multi-size saltation, multi-size dust emission, and meteorological/soil-physical conditions that control wind erosion. Observation was made for monitoring multi-size saltation process using sand particle counter (SPC), which monitors saltation particle ranging from 40 micron meters to 600 micron meters for every second. A portable wind tunnel was also used to calibrate SPC with orthodox instruments such as Sensit. Wind erosion events were monitored at the site almost everyday during IOP, from 23 Feb. to 13 March, 2006. The threshold friction velocity of saltation is estimated to be 0.35 m/s and no clear particle size dependency on threshold friction velocity can be found. The normalized size spectrums of multi-size saltation indicate that saltation flux, q, has clear size-height relation that is q=q(d, z).

Keywords: dust, saltation, wind erosion

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MS004 **Poster presentation** **5116**

Regional modelling of Saharan dust as part of the SAMUM project: Characterisation of dust events in May 2006 using the model LM-MUSCAT

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Due to its significant contribution to the global atmospheric aerosol mass, airborne mineral dust, mostly from arid and semi-arid areas, is expected to impact the Earths climate by direct and indirect effects. Since there are considerable uncertainties in the optical parameters and the variability of the spatio-temporal distribution of mineral dust, the understanding of magnitude and sign of the dust radiative forcing is still poor (IPCC, 2001). The project SAharan Mineral dUst experiMent (SAMUM) aims at investigating the radiative properties of Saharan dust. The SAMUM I field campaign took place in Morocco during May and June 2006. The experiments comprised surface and airborne measurements determining the optical, physico-chemical, and morphological properties of Saharan dust near the source region. Within this framework a new regional model system was developed for simulations of emissions, transport, deposition, and radiative effects of Saharan desert aerosol. It is based on the Lokal Modell (LM), which is the operational weather prediction model of the German Weather Service (DWD), the MUltiScale Chemistry Aerosol Transport model (MUSCAT), and a dust emission scheme. The meteorological model LM is modified to enable interaction of the computed dust load with the solar and thermal radiation and consequently with the model dynamics. The model will provide additional information for the evaluation of the field experiment results, help to extrapolate the findings to larger regions, and allow estimation of radiative effects and feedbacks on atmospheric dynamic and the hydrological cycle. Here, first model results for the SAMUM I field period are presented for May 2006. The modelled dust load is evaluated with the measurements from the field campaign, satellite data, lidar profiles from the European Aerosol Research Lidar Network (EARLINET), and sunphotometer measurements at Aerosol Robotic Network (AERONET) stations.

Keywords: mineral dust, transport modelling, dust radiative effects

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MS004 **Poster presentation** **5117**

Size distribution, mineralogical and chemical composition of Saharan mineral dust at Tinfou, Morocco

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The Saharan Mineral Dust Experiment (SAMUM) is dedicated to the understanding o f the radiati ve effects of mineral dust. A joint field campaig n focusing on the source-near investigation of Saharan dust was carried ou t in southern Morocco. Gr oundbased me asurements were performed near Tinfou and at the Ouarz azate airport; airborne measure ments we re c arried out onb oard a Falcon and a Partenvia aircraft. Together with Satellite observations, these measurements ranged fro m May 1 3th to June 7th, 2006. This pre sentation discusses results fr om gro undbased measurements at the Tinfou station. Th e aerosol particle number size distribution was meas ured with a co mbined scannin g mobility particles sizer/aerodynamic particle sizer system in the sub-mi cron range starting at 20 nm particle diameter and with a nozzle impactor/free-wing impactor system followed by automated optical mi croscopy in the super-micron r ange up to 500 m. Samples were collec ted with a miniature impactor sys tem on carbon coated substrates and carbon foils; additionally, filter samples were collected, of which the aerosol mass concentration was determined. The size-re solved part icle aspect rati o and chemical composit ion is determined by means of electron-microscopical single particle analysis. The mineralogical composition of the filter samp les is determined by x-ray diffraction. Additi onal inform ation o n single pa rticles will be collected by transmission electron microscopy. Various atmospheric conditions were encountered during the measurement period: For clear atmospheric conditions, mass concentrations of approximately 100 g m-3 for total, 80 g m-3 fo r "PM10" and 30 g m-3 for the "PM2.5" were found. During moderate dust storms, conce ntrations of u p to 300.000 g m-3, 3000 g m-3 and 1000 g m-3, res pectively, wer e measurered. I n the size dist ribution measurements, variations due to local and regional mineral dust emissions wer e observed for particles with d > 300 nm. Signatures of anthropogenic influence were detected in th e submicron range. The largest variat ions in concentration were found in the range d > 100 m, which can account for up to 95 % of total aerosol mass under high dust concentrations. The bulk mineralogical composit ion was found t o be dominated by m ajor compounds like quartz, calcite, feldspars (plagioclase and K-spars), and cla y minerals (ill ite/muscovite, k aoline, and +/ - chlor ite) and minor co mpounds like hematite. In co ntrast to fo rmer measurements at Te nerife (Spain), elevate d concentrations of calcite and other calcium- bearing pa rticles were found. First hints on particle sulfat e coatings were found.

Keywords: saharan mineral dust, aerosol chemical composition, aerosol microphysics

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MS004 **Poster presentation** **5118**

Saharan mineral dust experiment (SAMUM) 2006: vertical characterization of mineral dust from LIDAR and sun photometer observations in Morocco

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The Saharan Mineral Dust Experiment is a six- year initiative of several German institutes with the goal of characterizing optical, physical , chemica l, and radiativ e properties of Sahara n dus t at the s ource region and in the outflow re gime. The data set may serve as ground truth data to validate satellit e aerosol retrieval schemes and atmospheric transport models. Information on dust properties will support the CALIPSO (Cloud-Aerosol Lidar and Infrared Path finder Satellite Observation) mission. In th is contribution we discuss results on optical and microphysical dust properties obtained with three ground-based Raman lidar systems. The systems measured during the first intensive field phase of SAMUM which was carried out in May/June 2006 in the south of Morocco. A ll thr ee systems were stationed at Ouarzazate (30.93 N, 6.9 W). A high-spectral-resolution lidar aboard on e research aircraft, operated by the German Aerospace Agency (DLR), sounded the du st plumes from the western coastline of Morocco to the field site at Ouar zazate to a second field site at Za gora (30.15 N, 5.37 W), the latter being the place of intensive gro und-based in-situ observations. It is for the first tim e that vertically resolved dust properties wer e investigated with aerosol lidar sy stems stationed in one of the source regions of Saharan mineral dust. Altogether, the lidar systems pr ovide information on part icle volume extinction coefficients and particle extinc tion-to-backscatter (lidar) r atios at 355 a nd 532 nm wavelength, and particle backscatter coefficients at several wavelengths b etween 355 a nd 1064 nm. The four lidar systems provide linear depolarization ratios of dust at four measurement wavelengths between 355 and 1064 nm. In addition, sun photometer ob servations were carried out at Ouarzaz ate. One of the instruments be longs to the A erosol Rob otic Network. Dust plu mes were o bserved on 25 out of th e 28 measurement days. The plumes reached t op heights of up to 6 km ab ove sea level. Optical depth at 500 nm wavelength was as high as 0.9. Daily co lumn-mean Angstrm exponents avera ged between 0-0.4 in the wavelength range from 380-1640 nm. Preliminary analysis shows particle depolarization ratios around 30% a t visible wavelengths, which is larger than what is usually o bserved during lo ng-range dust transport events to Ce ntral Europe. In the first ha lf of the SAMUM field phas e a long-rang e transport event carried dust from Northwest Africa to West and Central E urope, and Italy and Greece. Raman lidar stations of the European Aerosol Resear ch Lidar Network observed the plume during that transport event. This work is supported by the Deutsche Forschungsgemeinschaft DFG.

Keywords: dust, lidar, sunphotometer

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MS004 **Poster presentation** **5119**

Changes in the flux of Saharan dust to the Eastern Mediterranean.

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Recent studies have increasingly recognised the importance of aeolian dust within the climate system. The available marine and terrestrial records from the Last Glacial Maximum (LGM, 21 ky BP) imply that the increase in atmospheric dust loading was not spatially uniform. No detailed long-term dust record exists for the Eastern Mediterranean (EM) despite its proximal position under the Saharan dust (SD) plume to Europe and western Asia. The detrital sediment in the Eastern Levantine basin of the EM are derived principally, but not entirely, from two sources: the River Nile with its Blue and White Nile tributaries - and SD. These sources are characterised by distinct 87Sr/86Sr isotopic ratios (Blue Nile (BN) ~ 0.705, White Nile (WN) ~ 0.710 and SD ~ 0.720). Preliminary 87Sr/86Sr isotopic data on detrital sediment collected from under the Nile plume (marine core 9509) show a close inverse relationship between the Nile signal, controlled by changes in the African monsoon, and the EM climate signal for most, but not all, of the period considered. The EM record is based on oxygen isotope measurements on the planktonic foraminifera from these cores and the speleothem records from the adjacent Soreq caves. In this study a ca. 21 ky SD record in the EM has been developed based on a well-characterised marine core situated S.E. of Cyprus (marine core 9501). Previous results have shown that at present the detrital sediment is approximately 50% SD and 50% NP. This core is well dated both by radiocarbon and through correlation with U/Th dated continental speleothem records. Through use of Sr isotope analysis and subtraction of the Nile signal of core 9509 from core 9501 we construct a semi-quantitative Saharan dust flux curve for the Levantine basin for the past ca. 21 ky. The results show a decrease in dust flux during the African Humid period 5-9 ky BP compared to both the Holocene and prior to 12 ky BP.

Keywords: dust, east mediterranean, sahara

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MS004 **Poster presentation** **5120**

Seasonal evolution of the vertical profile of desert dust in the central Mediterranean

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The Mediterranean basin is influenced by the presence in the atmosphere of different types of aerosol. The University of Rome "La Sapienza", in collaboration with the Ente per le Nuove Tecnologie lEnergia e lAmbiente (ENEA), has installed a lidar system with the aim of studying tropospheric aerosols, at the Station for Climatic Observation on the island of Lampedusa (35.5N, 12.6E), in the central Mediterranean. Beside lidar, other instruments (among them Sun photometers, broadband radiometers, spectrometers) are operational at the site. Several measurement campaigns, and dedicated regular observations have been carried out since 1999. Measurements collected during day time, to allow comparison with solar radiation data, are used in this study. Over 250 days of cloud-free measurements, distributed throughout the year, are included in the dataset. Saharan dust events are identified by combining observational data and airmass backward trajectories. The transport of Saharan dust toward the central Mediterranean shows a marked seasonal behavior, with a maximum frequency in summer. The daily profiles have been separated in two classes, the first one including trajectories that overpass Africa, and the sesond one trajectories that do not overpass Africa. The monthly average profiles for the first class display the following characteristics: the vertical aerosol extent peaks in April and May, with values of the backscatter ratio at 532 nm, R, of 1.2 at 7 km, and is minimum in January-February, with aerosol up to approximately 2.5 km; above the boundary layer, the largest values of R (>3) occurs in July. Occasionally, between April and July, dust particles were detected above 8 km. The vertically integrated backscattering peaks in July. The backscatter-to-extinction ratio is derived from the combination of lidar and Sun photometer measurements. Its value for the desert dust is about 40 sr-1. The dust amount in the free troposphere is highly enhanced when strong convection occurs over Sahara. When airmasses do not overpass Sahara the aerosol loading is lower both in altitude and amount throughout the year. The seasonal cycle of non dust particles is much smaller than for dust aerosol. Specific cases of dust transport will be discussed.

Keywords: aerosol, dust, lidar

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MS004 **Poster presentation** **5121**

Seasonality of dust emission potential at the Salton Sea in California, U.S.A.

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The Salton Sea was formed accidentally when a dike failed during the diversion of the Colorado River in the early 20th Century. Over the next 100 years, this lake has remained full, in part due to agricultural discharge and minor river inflows. Althou gh it has continually increased in salinity, it remains a n important wetland for migratory birds. Beca use of a mandated redistirbution of water re sources in the state of Calfiornia, the inflows to the lake are slated to decrease substantially over the n ext 75 years or so. Owing to its shallow de pth, this decr ease in water inflows w ill r esult in large amounts of so il sediment becoming exposed. There exists a significant potential for this exposed sediment to become a large local or regional dust source during windy co nditions. To examine the potential for the Salton Sea for becoming a large dust source in the Mojave deser t, a series of long-term m easurement a nd monitoring effo rts have beg un. In t his p aper, we present the res ults of the first two years of measurement of the dust e mission potent ial at the Salton Sea. Using a novel devic e called the P I-SWERL (Portabl In- Situ Win d ERo sion Lab) , the po tential for windblown dust emission from expose d shoreline was examined at si xteen sites around the lake in Fall of 2005 a nd Winter and Spring of 2006. Similar in o peration to a wind tunnel, the PI-SWERL provides the ada vantage of portability and ea se of use, allo wing a large num ber o f measure ments to be completed in a short period of time. Results indicated a pr onounced seasonal effect, where the potential for dust emissions was much higher in winter co mpared to fall and spring. Our wo rking hypo thesis is that salts, precipitat ed as the wat er retreats, can s erve to either stablizie or destabilize the s oil surface with respect to wind erodibilit y. Measurements of dust emission potential will be pr esented and a preliminary assessment of the role of salts and seasonality will be discussed.

Keywords: pi swerl, eolian, pm10

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MS004 **Poster presentation** **5122**

Investigation on the impact of dust aerosol on solar radiation

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Atmospheric mineral-dust loading is one of the largest uncertainties in global climate- change modeling and is known to have an important impact on the radiation budget and atmospheric instability. During number of dust storm events occurred in the western Indian region (i.e., on 9-11th April, 2006, 27-29th April, 2006, 1 3rd May, 2006 and 6-9th May, 2006) covered by the Thar Desert spreading substantially across the downwind direction. The present study deals with the effects of dust events on aerosol parameters over tropical urban region of Hyderabad, India using a combination of ground-based monitoring and satellite data. Changes in Aerosol Optical Depth (AOD), columnar water vapor, UV erythemal (UVery), ground reaching total global flux and Particulate Matter (PM) loading were analysed using ground-based measurements. Analysis of satellite data sets from TOMS-OMI, MODIS, NOAA-AVHRR and IRS-P4 OCM showed intensity and spread of dust storm over Indian region. Aerosol optical depth data derived from satellite sensors showed good correlation with ground measurements. Decrease in ground reaching solar irradiance in different spectral bands was observed during the dust storm periods.

Keywords: desert dust, aerosol index, solar radiation

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MS004 **Poster presentation** **5123**

Study of the saharan dust impact on PM10 levels combining punctual and LIDAR techniques

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The Saharan dust transport phenomenon strongly affects the European regions and in particular the Italian peninsula, above all during spring and summer. Although dust particles are long-range transported from North Africa mainly above the planetary boundary layer (PBL), subsidence and sedimentation can transport dust to lower atmospheric heights. As a consequence, mineral dust can influence the particles mass concentration measured at ground level becoming the major naturals sources of particulate matter as satellite observation, modelling and groundbase measurements have shown. Starting from the climatology of Saharan dust intrusions over Potenza, based on 3 years of Raman lidar measurements performed in the framework of EARLINET (European Aerosol Research LIdar NETwork), the impact of Saharan dust on PM concentrations has been investigated. The PM10 concentrations, measured at CNR-IMAA during the considered period by means of a low-volume (16,7 lmin-1 flow rate) gravimetric sampler, show, in some cases, values exceeding the threshold limit established by European Directive (50mg/Nm3). These exceedances are measured during Saharan Dust advection, as monitored with the CNR-IMAA lidar system for tropospheric aerosol study. The CNR-IMAA lidar system is based on a Nd:YAG laser source equipped with crystals for second (532 nm) and third (355 nm) harmonic generation. This system allows measurements of aerosol backscatter coefficient vertical profiles at two wavelengths (l=355nm and l=532nm) and the independent measurement in the UV of aerosol extinction. This allows to obtain profiles of the lidar ratio (i.e. extinction/backscatter ratio), that does not depend on the aerosol amount and it is related only to aerosol type. A qualitative comparison has been carried out between the PM values and the backscatter Angstrm exponent, obtained from the backscatter profiles at 2 wavelengths, that is generally used as qualitative indicator of aerosol particle size. Particular cases of Saharan Dust episodes have been analysed starting by lidar vertical profiles; analytical 96- hours back-trajectories, provided by the German Weather Service, have been used to identify incoming air masses and aerosol origin. The comparison between lidar and PM10 data and the analysis of several case studies show that the PM10 daily average value depends on the Saharan dust events occurrence and particularly on the aerosol load and is related to the optical depth measured below the PBL. It is also correlated with the aerosol size and type, feeling the effects of possible Saharan dust intrusions in the PBL and of possible aerosols modifications because of air mass enrichment with different particles. Finally, in coincidence with aerosol transport episodes from African regions, a lower anthropogenic contribution to the PM10 concentration is observed.

Keywords: lidar, pm10, saharan dust

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MS004 **Poster presentation** **5124**

Synoptic aspects of dust emission and transport during the saharan mineral dust experiment SAMUM 2006

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Understanding the mechanisms of dust emission and transport on various temporal and spatial scales is an important pre-requisite for a successful modelling of the dust cycle and its impac ts on radiation, atmospheric chemistry and many other processes. Many source regions for Aeolian dust, in particular in the worlds lar gest source, t he Sa hara, ar e locate d in sparsely inhab ited areas with no or few observations. Therefore the ground-based in-situ and remote sensing measurements that were taken at the southern Moroccan locations Ouarz azate airport (3053N, 654W) and Ti nfou (3015N, 537W) as part of the Saharan Mineral Dust Experiment (SAMUM) first field campaign (11 May to 10 June 2006) provide valuable infor mation from a near-source environmen t. Measurements o f aerosol optic al thickness at both sites reveal large day-to-day variability, but also several phases of persistently enhanced dustiness, one of which occurred toward s the end of the campaign from 0207 June 2 006. Throughout this period LIDAR measur ements at Ouarzazate during the even ing hours show a d ust layer with a clear upper-boundary and a depth of between 3.9 and 4.7 km. Radiosonde ascents from the same location show an inversion at the top of the almost dry-adiabatic dust layer on most of these days. Both measurements suggest that turbulent mixing during the day creates a relatively homogeneous deep boundary layer. In order to identify the source regions for the dust, two-day backward trajectories were calculated from al l available gridp oints in the E CMWF operational analys is from within the entire layer (ground to ~550 hPa). On all da ys most dusty trajectories originate in northern and central Algeria in the vicinity of the Sahara Atlas and the Great Western Erg. Standard weather charts s how that between 31 May and 01 June a weak upper-level disturbance moves from the Moroccan High Atlas into northern Algeria. At the surface a low-pressure syste m forms and causes stro ng westerly o r southwesterly winds in the central Algerian Saha ra and some localized dust stor ms. These winds advect hot desert air towar ds northeastern Algeria, whi ch s upports the negative pressure tendencies. When the upper-level for cing ceases on 01 June, relatively cool air from t he Mediterranean Sea penetrates into the no rthern Algerian lowlands causing 24- hour temperature dro ps of 13K and pressure rises o f up 16 hPa . This pressur e surge is accompanied by st rong, hi ghly ageostrophic winds that mobi lize large amounts of dust as documented by station reports and satellite imagery. This dust is then advected into the SAMUM st udy region over th e following days. T o the best of ou r knowledge this mechanism of win d generation and dust mobilization in the central Algerian lowlands has not yet been described in the literature and thus is a genuine finding of the SAMUM project.

Keywords: pressure surge, trajectories, central algeria

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MS004 **Poster presentation** **5125**

Influence of african dust outbreaks on levels and composition of particulate matter in an urban background in Barcelona, Spain

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African air masses loaded with dust reach the Iberian Peninsula, usually increasing PM levels. The daily limit value of 50 g PM10/m3 of the EU air quality directive (1999/30/EC) and an arbitrary daily value (DV) of 35 g PM2.5/m3 recorded during African dust outbreak episodes are frequently exceeded.The interpretation of the variability of PM levels recorded at urban background sites can help to identify external and local contributions for the implementation of plans for the improvement of air quality. To this end, a comparison of data from a regional and an urban background site is necessary to identify the external mineral contribution. The identification of African dust outbreak episodes is carried out to assess their influence on the levels and composition of particulate matter. The PM monitoring sites selected for this study are an urban background station under the influence of the emissions of road traffic from one of the largest avenues at the western edge of Barcelona, and a regional background PM monitoring site in Montseny Natural Park (at a distance of 40 km to the north-west of Barcelona). The levels and chemical speciation of PM10, PM2.5 and PM1 were measured during 2002 to 2006, with special interest on mineral matter. Furthermore, PM10 and PM2.5 1999-2001 data from other urban background sites in Barcelona were also used to support interpretations.For the period 1999-2006, the mean PM levels for days with African dust outbreaks reached 43-61, 27-36 and 14-27 g/m3 for PM10, PM2.5 and PM1 respectively, and for the remaining days 37-47, 20-27 and 12-21 g/m3. The annual increase due to the African dust influence is 0.6-2.3, 0.5-1.8 and 0.1-0.6 g/m3. The contribution of African dust to PM levels depends on the frequency and intensity of African dust episodes in a year, from 31 (2005) to 85 (2003), with a mean value of 59 days. During this period, 16 (2000) to 45% (2003) of the total annual daily exceedances for PM10 and 13 (2000) to 65% (2003) for PM2.5 were recorded during days with African dust influence. Finally, the mineral contribution to PM10 levels at an urban background station can be decomposed into an urban background fraction (70%) and a regional background fraction (30%). The regional crustal load can be decomposed as the regional soil re-suspension (21%) and the African dust contribution (9%).

Keywords: african dust outbreaks, mineral matter, exceedances of daily limit

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MS004 **Poster presentation** **5126**

Impact of african dust in the air quality of an urban site in the Canary Islands (Spain)

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Sonia Castillo, Andrs Alastuey, Xavier Querol, Miguel Escudero, Omaira Garca, Pedro Miguel Romero, Emilio Cuevas, Juan Pedro Daz, Francisco J. Expsito, Anna Vila

Owing to their location in the Atlantic Ocean, close to the north-western African coast, ambient air particulate matter (PM) levels in the Canary Islands is strongly influenced by two natural PM sources, African dust outbreaks and sea spray, which have an important impact on the air quality of the Canaries.In order to quantify these natural PM contributions, a complete characterization of PM (levels, grain size distribution, chemistry and source contribution) was performed at an urban background station (Santa Cruz de Tenerife, SCO, Tenerife Island, 28 28 21 N, 16 14 51 W; at sea level) using data from February 2002 to November 2003. To this end, PM10, PM2.5 and PM1 were continuously monitored using a GRIMM 110 7 monitor and 24h filters of TSP (total suspended particles) and PM2.5 (particles with aerodynamic diameter <2.5 m) were periodically collected. The mean annual levels recorded at SCO were 112 and 17 g/m3 of TSP and PM2.5 respectively. During the African dust outbreaks, the mean PM levels were 183 gTSP/m3 and 27 g PM2.5/m3, whereas for the remaining events the mean PM levels were 73 gTSP/m3 and 14 g PM2.5/m3. Therefore, the African dust annual mean contribution was estimated in 39 gTSP/m3 and 3 gPM2.5/m3. Crustal load (Al2O3, CO32-, SiO2, Ca, K, Mg, Fe, P and Ti) and sea spray (Na, Cl and ssSO42-) were the major contributors to TSP accounting for 33 and 17% of the TSP mass, respectively. These contributions considerably decreased for PM2.5 (14 and 8%) due to the coarser size distribution of these PM components. Levels of OM+EC (organic matter + elemental carbon) accounted for 28% of PM2.5 and 14% of TSP, showing a marked coarse size distribution (PM2.5/TSP=0.3). Finally, the secondary inorganic aerosols (SIA) accounted for 20% of PM2.5 and 11% of TSP and were characterized by an unusual coarse size distribution when compared with results obtained in continental Europe and North America. Thus, sulphate and ammonium shows an intermediate grain size (PM2.5/TSP 0.4 and 0.5, respectively), whereas nitrate shows a coarse distribution with a PM2.5/TSP ratio of 0.1. These coarse grain size distributions of nssSO42- and NO3- are partially attributed to the interactions between the anthropogenic gaseous precursors and/or fine particles with coarser natural particles (African mineral dust and marine aerosols).Receptor modelling techniques allowed the identification of 3 PM sources for both TSP and PM2.5: 1) the crustal source defined by the association of Al, Fe, Mg, Ca, Ti, Mn, K, Rb, Sr and La, mainly related with the African dust outbreaks; 2) a local anthropogenic source related with the industrial (refinery) and road traffic emissions in Santa Cruz, defined by the association of SO42-, NH4+, Ni, V, Pb,NO3-, OM+EC and P; 3) the marine source defined by Na, Cl, Mg, and ssSO42-.

Keywords: african dust outbreaks, secondary particles, marine aerosols

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MS004 **Poster presentation** **5127**

Geochemical speciation of aeolian dust particles from the Sahara-Sahel Deserts

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Sonia Castillo, Xavier Querol, Andrs Alastuey, Teresa Moreno, Emilio Cuevas, Ludger Herrmann, Mohammed Mounkalia

The Sahara-Sahel deserts in North Africa represent the largest aeolian dust source in the world. The vast amount of mineral particles transported from this area into the Atlantic Ocean, America and Europe is likely to have a considerable influence on global and local climate, ecosystems and human health. For these reasons it is important to know their geochemical and mineralogical composition, as the African dust air masses may have different sources of particles emission, with mineralogical differences depending for example on the dominant geology of the emission area. Previous studies have identified different source areas by means of chemical (major elements) and mineralogical profiles. To contribute to these studies, a preliminary geochemical (major and trace elements) and mineralogical characterisation has been performed on soil samples obtained from 4 areas within the Sahara-Sahel region. The selected areas were: the Chad Basin (Bodl depression and proximity to Chad Lake), Southwest Niger, South of Algeria and Western Sahara. The most significant major element chemical variation between the different sources is shown in the content of CaO, MgO, Al2O3 and SiO2. The Western Sahara area presents the highest concentrations of CaO (12-17% of the total mass) and MgO (3%), and the lowest in Al2O3 (5-7%) and SiO2 (46-57%). The area shows the higher contents of Al2O3 (14-15%), Na2O (2 %) and K2O (2%). Finally the and areas have elevated contents in Al2O3 (12%) and SiO2 (63-70%). Regarding trace elements, the most significantly differences are found in the high concentrations of Li, Co, Rb, Ba, La, Ce, Hf, Pb and Th registered in the area in comparison with the rest of areas. The differences in the mineralogical composition obtained from the different areas are consistent with the geochemical data and geological setting, with the higher content of carbonates (calcite principally) for example being related to calcareous bedrock in the Western Sahara area. Similarly, the samples from the area present the highest proportion of phyllosilicates (mainly kaolinite and illite) and mafic igneous minerals such as pargasite, and preserve the geochemical signature of the local hard rock geology. Only the Chad Basin sample has shown the significant presence of gypsum, given the evaporitic nature of many of the sediments in this area. The grain size distribution reflects species such as quartz, albite and pargasite occurring mainly in the coarser grains, whereas calcite, paligorskite and kaolinite occur in finer grain sizes. During African dust outbreaks the mineral particles are generally emitted from different sources which are normally mixed during transport. It is still unclear for how long dust populations can retain a recognisable geological signature and, if so, whether such subtle compositional differences could influence physical interaction with the atmosphere over the ocean.

Keywords: sahara sahel deserts, soil geochemistry

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MS004 **Poster presentation** **5128**

Impact of african dust outbreaks on the dry and wet deposition in the eastern of Spain and the Canary Islands

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Areas close to North Africa, such us the Iberian Peninsula and the Canary Islands, are subject to an important influence of dust contribution which adds to the nutrient fluxes from other sources. Most studies that quantify the African dust deposition have only measured the soluble fraction. Here, we compare the fluxes, both in the soluble and insoluble fractions for the wet and dry deposition sampled at two sites located at different distances relative to North Africa. One sampling site was in the Northeasthern corner of the Iberian Peninsula (at 40 Km NNE from Barcelona) in the Montseny Mountains (41 46'N, 2 21'E; 700 masl). The sampling site was in a rural area with an annual mean precipitation of 800-1000 l/m2 and an annual mean temperature from 10 to 14C. The other site was in Santa Cruz de Tenerife (Canary Islands, 28 28'N, 16 14'W; 52 masl) with an annual mean precipitation around 200 l/m2 and an annual mean temperature of 21C. The deposition fluxes depend on the concentration of suspended particulate matter (SPM) in the atmosphere. Thus in the Canary Islands, where the SPM levels were high due to the elevated frequency of African dust outbreaks and the high sea spray contribution, the total annual deposition (soluble and insoluble fraction) was up to 28 g/m2/yr, whereas in the Montseny Mountains it was around 24 g/m2/yr. The local climatology, and particularly precipitation, usually has a notable influence on the distribution of deposition between the wet and dry modes. Because precipitation in Montseny was about 5 times greater than in Tenerife, one would expect greater wet deposition fluxes in Montseny. However, total wet deposition amounted to 15g/m2/yr and 12 g/m2 /yr in Montseny and Tenerife respectively. The relatively high wet fluxes registered at Tenerife were accounted for by the high sea spray contribution at this coastal site (50% of wet deposition was composed by the marine ions Na+ and Cl-). By contrast, annual dry deposition was higher in the Canary Islands than in Montseny by a factor of 2, with 16.4 g/m2/yr registered in Tenerife against 8.6 g/m2/ in Montseny. This is the result of the high influence of African dust outbreaks at these islands close to North Africa. Due to the proximity with the African continent and the quasi-permanent dry meteorological conditions in the Canary Islands, the vast amount of mineral dust particles transported from Sahara and Sahel deserts into the Atlantic Ocean generate elevated dry deposition fluxes of mineral dust to the surface.

Keywords: wet dry deposition, soluble fraction, insoluble fraction

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MS004 **Poster presentation** **5129**

Properties and Environmental Impact of Saharan Dust Layers Over Rome (Italy): Observations and Model Results

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We discuss lo ng-term obser vations and modelling of Saharan dust advection events over the city of Rome, , in th e period 2003 -2006. Sahara n dust events were either detected by lidar (laser radar) observations carried o ut at CNR- ISAC Rome o r fo recasted by the D REAM mo del running at th e Barcelona Supercomputing Center. Both techniques allow for an altitude-resolved description of the dust layers. Comparisons between the re sults of the two appr oaches will be discussed. Lidar and model-determined days of Saharan advections can be also employed to evaluate the impact of these events on the local PM10 record. Results for the year 2001 will be presented.

Keywords: saharandust, lidar, modelling

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MS004 **Poster presentation** **5130**

Characterization of saharan dust particles over Portugal during DARPO

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The experime nt DARPO (f unded by EUFAR) was performed in May 2 006. It aimed at determinin g properties of desert dust particles transpor ted over long distances from Africa to Portugal. Variou s ground-based as well as airborne particle measuring inst ruments were used in order to investigate optical and m icrophysical p article parameter.On 26-29 May 2006 a strong desert dust outbreak occurred. The aircraft Falcon flew inside and ab ove the aerosol plume from Casablanca, Morocco to vora, Po rtugal and to Cabo da Ro ca, Po rtugal during the morning ho urs o n 27th May. Gro und-based radiation measurements showed that desert dust partic les arrived first in higher altitude at vora, likel y at the 700 h Pa level, about noon on 26th May. Abou t 18 h ours later ground-based in situ instruments (Nephelometer, TEOM, APS) co uld also o bserve mine ral A frican particles. A mean mas s diameter of about 3 um was determined and the mass scattering efficiency of about 1 m2/g could be observed.Lidar measurements onboard the aircraft showed the pa rticle plume was ho rizontally as vertically inhomogeneous. In principal a three laye r struct ure could be observed with the highest aerosol concentrations below 1.8 km and an elevated layer extending between 3 and 4 km. The transition layer between 1.8 and 3 km ex hibited lower particle conce ntrations.The in-situ particle size distributi on between 4 nm and 100 um diameter derived from several particle counting devices onboard the aircraft can be approximated with 4 lognormal distributions. The accumulation mode (mean diameter = 0.6 um) and coarse mode (mean diameter =1.2 um) do not change with height. Ad ditional a large coarse mode with a mode d iameter of 6.5 um could be observed. Investigations of aerosol volati lity showed that a significant part of particles were lost in the accumulation mode. This loss can be attributed to a volati le coating of aero sols.The aerosol opt ical thickness varied between 0.3 and 0.45 during the day 27 May . However comparison of the height-integrated extinctioncoefficient derived from lidar and aerosol optical thickness derived from sun photometer at t he time of the overpass of t he aircraftshowed excellent agreement within 0.01 at both ground-based sites.

Keywords: mineral dust, long range transport, aerosol properties

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MS004 **Poster presentation** **5131**

Characterization of saharan dust optical properties with a multi-wavelenght Raman Lidar

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A Raman/elastic lidar for tropospheric aerosol study is operational at CNR-IMAA (4036N, 1544 E, 760 m above sea lev el) since May 2000 in the fr amework of EARLINET (European Aerosol Research LId ar NETwork), the first lidar network for tropospheric aerosol study on continental scale. Since August 2005, this system provides aerosol backscatte r coe fficient profiles at 1 064 nm, and independen t measurements of aerosol extinction and backscatter coefficient profiles at 355 and 532 nm. In this way, lidar ratio (i.e. extinction to backscatter ratio) profiles at 355 and 532 nm are also obtained. In addition, the detection of components of backscattered light po larized perpendicular and parallel t o the direction of the linearly polarized tran smitted laser beam at 532 nm allows the measureme nts of the aerosol depolarization ratio vertical profiles. While depola rization ratio measurements give information abou t shape and ori entation of ae rosolic particle s and lid ar rat io measureme nts are import ant for aerosol characterization, high quality multi-wavelength measurements (3 ba ckscatter + 2 exti nction) can be essential for the determination of microph ysical aero sol properties (ref ractive index, single-scatterin g albedo and effective particles radii). Fo llowing the EARLINET mea surements sc hedule, three measurements per week are systematically perf ormed since May 200 0. Further measurements ar e performed in order to investigate particular events, like dust intrusions, volcanic eruptions and forest fires. Particular attention is devoted within EARLINET to Saharan dust intrusions in the European region: an alerting system was established in order to coordinate measurements and monitoring the distribution of dust particles an d their optical properties over Europe. At ou r station, because of th e short distance between our s ite and the Sahara desert, about 1 day o f Sa haran dus t intrusio n eve ry 10 da ys is observed. Dust particles are observed betwe en 1.8 and 9 km above the sea level and the optical depth of the dust lay er is on averag e 0.13 reaching a maximum value of 0.68. The large number of observed dust cases allows a climatological analysis of Sahar an dust intrusions in terms o f optical properties as well as the id entification of some peculiar cases for whi ch a more det ailed analysis is carried out . ACKNOWLEDGMENTS The fi nancial suppo rt o f this wo rk by the Euro pean Co mmission under gra nt RICA-025991 is gratefully acknowledged.

Keywords: dust, multi wavelength lidar

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MS004 **Poster presentation** **5132**

Impacts of wind velocity on sand and dust deposition during dust storm as inferred from a series of observations in the northeastern Qinghai-Tibetan Plateau, China

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Fahu Chen

The monthly sand and dust deposition flux and modern dust storms were monitored in the northern Qaidam Basin of the Qinghai-Tibetan Plateau. The monthly sand and dust flux varied between 0.57 and 18.12 mg cm2 month1 from June 2003 to April 2005, and was well correlated with the monthly extreme wind velocity (Vextr) (r2 = 0.60, n = 23). Sand and dust was mainly deposited in spring and early summer in the study area. The weight of settled sand and dust collected during dust storms exhibited a positive correlation with the mean 10-min wind velocity (r2 = 0.60, n = 16) during the dust storms. For the typical dust storms, the weight and flux of settled sand and dust will linearly increase with the increasing wind strength and fluctuation amplitude of wind velocities. The coarse fraction (>63 m) also increases with them, in contrast, the fine-grained fraction (<63 m) decreases. It is plausible to assume that most of the fine-grained dust particles are lifted and transported far from the region under dust storm conditions, especially under the stronger and more variable wind conditions. The results demonstrate that the wind regime (strength and variability) is a key control on the sand and dust deposition during dust storm; dust can be emitted from the Qaidam Basin as one of dust source areas in China.

Keywords: dust storm, 10 min wind velocity, sand and dust deposition

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MS004 **Poster presentation** **5133**

Application of PIXE-PIGE and SEM-EDX methods to the geochemical characterization of micrometric ice dust and continental sediments.

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The geochemical characterization (major, trace an d REE elements) of ice dust, mineral particles deposited over the Antarctic ice sheet, is basic for th e assessment of the actual polar dust sources, and therefore the present day and past atmospheric pathwa ys, by comparison with material collected at the dust source. B ecause of the effect of che mical we athering o n sediments geo chemistry at the dust source, the climatic and environmental con ditions ex perienced by source areas in different climatic regimes can al so be inferred by investigations on ice dust. The PIXE (Par ticle Induced X-ray Analysis) technique has proven to be a reliable tool for majo r and minor elements investigation of polar ice dust samples. This multi-elemental technique, based on energy dispersive X-ray spectrometry, was applied to the direct measurement on fi lters of the insoluble du st fraction (after sa mple melting and without any other pre-treatment), with analytical detecti on limits less than 1 ppb. By means of the combined use of PIXE and PIGE (Particle Indu ced Gamma-ray Emissio n), particular attention was paid here to improve the accuracy of the quantitati ve determination of light ele ments (mainly Na, Mg, but also Al and Si) i n different sized materials. R esults of measuremen ts per formed on size-selected Cer tified Mineral Standards (sampled as bulk size up to 50 µm - and size selected < 5 µm), together with the first results obtained on the finer fr action (<5 µm) of PSA (Potential Source Area) s amples, are here presented. Combined PIXE-PIGE measurements permitted us to evaluate the effective thickness of the different samples and hence to est imate (acc ording t o the given mineral co mpositions and densities fo r each standard an alysed) the attenuation correction coeffi cients for the lighte r elements (N a, Mg, Si, K). Moreover, size-selected Certif ied materials were also analysed with a SE M-EDX system in order to te st the possibility t o characterize single <5mm mineral particles with mineralogy and chemical composition similar to that expected to find in A ntarctic ic e samples. This appro ach, with the paleo-climati c information derived from the geoche mical (isotopic, major and trace el ements) analysi s on polar dus t being compared with that obtained from continental proxy records, will help in understanding source-related environmental changes and Earths climate system dynamics.

Keywords: geochemistry, antarctic dust, x ray analyses

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MS004 **Poster presentation** **5134**

Geochemical and mineralogical characterisation of selected Saharan dust events collected in aerosol sampled at Lampedusa Island.

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Mineral aerosol contributes to about 45% of the global atmospheric aerosol load. In particular, Saharan desert annually injects into the troposphere three billion metric tons of mineral aerosols. These windswept aerosols from African continent are responsible for a variety of climate (affecting the radiative budget of Earths atmosphere), health (transport of pollutants on Earth's surface), and environmental (providing nutrients to sea surface water and continents) effects on both global and regional scales. Aiming to study the chemical composition in the mineral dust aerosol and how Saharan aerosols affect the regional atmosphere, a sampling campaign was carried out at the Station for Climate Observations located on a 45 m high plateau on the North-Eastern coast of Lampedusa (35 N, 12.6 E). The sampling was performed from June 2004 to January 2006 on a daily basis using an EN 12341 (2.3 m3 h-1) sampler, with PM10, PM2.5 and PM1.0 pre-selected cut-off heads. The particulate was collected on Teflon filters (Pall, 47 mm diameter, 2 µm nominal porosity). PM10, PM2.5, PM1.0 masses were obtained by weighing with a microbalance (5 decimal digits) the Teflon filters before and after exposure, using a certified protocol. Each Teflon filter was divided in three parts: a quarter was extracted in ultrapure water and analyzed for main and trace ions (Na+, NH4+, K+, Mg2+, Ca2+, F-, Cl-, NO3-, SO42-, methanesulphonate - MSA, acetate, formate, glycolate, oxalate) and another quart was extracted in suprapure HNO3 in ultrapure water at pH = 1.5 for metal determination (soluble fraction at pH = 1.5). All primary aerosol species (e.g. Na+, Mg2+, Cl-, Ca2+) are mainly distributed in PM10 fraction, showing concentrations about one order of magnitude higher than those found in the finer fractions (PM2.5 and PM1.0). In the PM10 Ca2+ profile, some sharp spikes represent high atmospheric concentration of dust from Sahara, as demonstrated by air masses backward trajectories. These Saharan dust events were characterised by elemental analysis (PIXE), and since PIXE analysis is a non-destructive technique, by SEM-EDX analysis on the same half filter. The combined use of PIXE and SEM-EDX allows the geochemical characterization of the total mass of sampled material and the mineralogical characterization of single mineral particles. The link between the mineralogical composition of Saharan dust transported at Lampedusa Island and several potential source areas was investigated. In fact, by combining chemical data with backward trajectory analysis it is possible to study the mineralogical signature as a function of both source latitude and longitude. This result is of primary interest in improving the knowledge of present day atmospheric circulation and paleoclimatic record based on continental dust in ocean sediments and ice core, and for dust radiative impact modelling, since dust mineralogical characteristics directly affect its optical properties.

Keywords: saharan dust events, lampedusa island, geochemistry mineralogy

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MS004 **Poster presentation** **5135**

Geological influences on the chemistry of inhalable desert dusts from central and southern Australia

Dr. Teresa Moreno
Erath Sciences Institute IAMAS

Dust particles fine enough to be inhaled (PM10: particulate matter

Keywords: mineralogy, geochemistry, pm10

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MS004 **Poster presentation** **5136**

Aging of mineral dust: comparative studies over desert and downwind regions in East Asia based on balloon and aircraft measurements

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It is becom ing more evident that the mineral dust pa rticles provide react ion surfaces to various acidic gases (e.g. SOx, NOx, HNO3) , thus partitioning part iculate sulfate and nitrate into larger size ranges and modify dust hygroscopicity. This may have sign ificant co nsequences o n the atmo spheric radiative balance an d hydrological cycle. Current study aims at providing ins ights into the mineral dust modification by comparing individual particle composition and morphology found in the free troposphere over the dust source (Dunhu ang inland Chi na, 4000N, 9430E) and downwind regions (Wakasa Bay central Japan, 3600N, 13530 E). Collection of aerosol particles over Dunhuang took place on 24 Marc h 2003, with a s eries of cascade impactors (flow 1L /min, 50%cutoff d = 0.2um) onboard a free flying balloon. Co llodion (Nitr ocellulose) film wi th Ni support was chosen as a sampling medium. The trajectory of the balloon was tracked by GPS and the s uccessive retrieval of the im pactors provided particles fro m 3-9km altitude range. Fo ur a ircraft-borne measurements were co nducted o ver Wakasa Bay on 14 and 17 December 2002, and 28 and 29 May 2003. Particles in the 2-6km altitude range were collected using the same cascade impactors. Particles collected over both regions were later analyzed on individual basis using Scanni ng Electron Micros cope (SEM; Hitachi S-30 00N) equipped with Energy Dispersive X-ray spectrometer (EDX; Horiba EMAX- 500). Nitron reagent fil m method was employed to aid the detection of nitrate. In the free troposphere over both the source and downwind region, mineral dust was found predominant among the larger particles (d>1um). Over the source region, only a minor fraction of dust particles were found to contain Sulfur. On the other hand, it was evident that more dust particles in the downwind region contained Sulfur in larger frequency and amount, most probably due to the heterogeneous uptake of SO2. It is suggested that carbonate (Calcite and Dolomite) particles collect Sulfur faster, while Quartz being the slowe st among major mineral types. Electron micrographs showed apparent coatings of sulfate around some of the Sulf ur containing particles in the do wnwind region. If we simply group dust part icles into silicate (Q uartz, Feldspar, Clay) and carbon ate (Calcite and Dolomite), it became more evident that such sulfate coating is more typical form of modification among silicate particle s. Meanwhile, transf ormation into spherical droplets was more typical for carbonate particles. There are increasing reports that carbonat e par ticles turn into droplets after reacting with HNO3 to form extremely hy groscopic Ca(NO3)2. In deed, such droplet s were m ore abundant when larger fraction of particles contained nitrate. Interestingly, fraction of particles containing Sulfur seemed to inversely correlate with that co ntaining nitrate. This might be an ind ication that the formation of either species might be acting as an inhibitor of th e other, suggesting the future needs of the re action kinetic studies measuring up take co efficient no t o nly for a single gas species, but in multiple gas to particle regime.

Keywords: mineralogy, single particle analysis, aging process

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MS004 **Poster presentation** **5137**

Physical and optical properties of dust particles during the saharan mineral dust experiment (SAMUM)

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During the SAMUM field campaign, physical and optica l aerosol proper ties were measured in order to investigate optical properties of mineral dust aeroso l. In-situ measurements were performed at a field station near Zagora in Southe rn Morocco from May 17 to June 7, 2006. Particle number size distributions were measured using a combi ned DMPS/APS system. Hygroscopic growth factors and the number fraction of hydrophobic particles f or subm icron and supermicr on particles were determine d using a HTDM A and a H- DMA-APS system. The optical characterization was done using an integratin g nephelometer for measuring the particle scatteri ng and backsc attering coefficients at three wavelengths. Absorption coe fficients were determined usi ng a MAAP a nd a PSAP at 5 30 nm a nd 63 7 nm, respectively. Additionally, a spectral abs orption spectrometer covered the wavelengt h range from 250 to 800 nm with an optical resolu tion of 25 nm. A class ification of the aerosol was done separating cases of high dust (HD) and low dust (LD) conditio ns. Time perio ds with lo w concentration in the d ust mode (mode diameter ~600 nm) were classified as LD and periods with high concentration were classified as H D. For both classes the mea sured numb er size distributions were us ed to calculate the scattering and absorption c oefficient using Mie th eory. The effective complex refractive index wa s inferred by minimizing the d ifference between meas ured and calculated scattering and absorption coefficients. For HD aerosol a n effective refractive index of 1.53-i0.002 (at 530 nm) and 1.53-i0.00004 (at 637 nm) was derived. The single average scattering albedo was determined to 0.95 and 0.98 for the wavelengths 530 and 630 nm, respectively. The average number fraction (dp= 350 nm) of hydrophobic particles for HD aerosol is up to 86%. The effectiv e refractive index for LD aerosol is 1.57-i0.0043 (at 530 nm) and 1.53-i0.00014 (at 637 nm). The single scatteri ng albedo is lower compared to HD aerosol. The lowest values were 0.88 for both wavelengths. For the LD case, the number fraction of hydrophobic particles (dp= 350 nm) is lower than 50%. The spec tral absorption shows for both cases similar absorption spectrum. The average ng stroem coefficients calculated fo r the wavelength range from 300 to 800 nm are 1.8 and 2.1 for LD and HD aerosol, respectively. The absorption spectra for both aerosol types show a significant increase of absorp tion for wavelengths below 550 nm. This feature is more pronounced for th e high dust aerosol what is an indication for a h igher volume fraction of ir on oxides (Hematite, Goethite) in the dust cases. Our Results will be compared with the mineralogical composition determined by x-ray diffraction and transmission electron microscopy.

Keywords: dust, scattering, absorption

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MS004 **Poster presentation** **5138**

Forecasting of saharan dust contribution to PM10 concentrations in Southern Europe

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Operational air quality (AQ) forecasts are being provided in several European regions by means of an air quality Decision Support Sys tem. PM10 surface conc entrations are am ong the simulated variables. Southern Euro pe is frequently affected by Saharan dust intrusion during the who le year with different space and se asonal patterns. Hence the importance of modeling the dust cycle in order to predict the Saharan aero sol co ntribution with go od accuracy . AQ methodology passes through t wo main steps: emission inventory and air quality modeling and fo recasting. T he emi ssion in ventory is performed according to C orinair meth odology, th e at mospheric circulation is predicted by the Fifth- Generation NCAR / Penn State Meso scale Mo del (MM5) and finally the transport a nd deposition is driven by the California Photochemical Grid Model (CALGRID). To better assess PM10 concentrations, mineral dus t emission flux has been modeled and assimilated into the DSS. The algorithm to determine surface dust flux is based on the Dust Entrainment an d Deposit i on model (DEAD), suitably modified to allow its implementation into the DSS. The dust algorithm uses MM5 forecasted wi nd fields, friction velocity, soil moisture, and estimated pr ecipitation as input. Fina lly, dust transport and deposition is driven by CALGRID. In t his work we present the fir st result s of the implement ation of the d ust algorithm. Currently, the system is run ning using t hree nested domains with increasingly grid resolution (54 km, 6km and 2km) and providing 72 hour forecasts. The first results show that the introduction of the DEAD model emission algorithm clearly improves the fore cast. This is an important achievement for the decision makers, since it allows to distinguish between exceedances of natural and anthropic origin.

Keywords: air quality forecast, decision support system, saharan dust

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MS004 **Poster presentation** **5139**

Dust - Climate Interactions in a Coupled Atmosphere-Ocean GCM

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The effects of radiative forcing of climate due to mineral dust aerosol in a coupled ocean - atmosphere GCM are investigated, as are the feedbacks of climate on dust concentrations.The GCM used for the study is a version of the new HadGEM2-AO GCM, which includes a mineral dust scheme based on that designed for the HadAM3 model, but with a modified emission parametrisation. A pair of multidecadal climate simulations have been run: in one of these dust radiative effects were allowed to impact on the climate, in the other the dust was treated as a passive tracer. Dust fields, forcings and climate variables in the two runs are examined, and results will be presented showing the modelled dust radiative forcing of climate and the mechanisms whereby the changes in climate feed back on the dust fields.

Keywords: dust modelling, climate, feedbacks

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MS004 **Poster presentation** **5140**

The impact of changing atmospheric conditions on the variability of summer dust concentration at Barbados: a back-trajectory analysis

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Large quantities of mineral dust are transported every summer from the North African deserts across the Atlantic Ocean to the Caribbean. Since 1965 atmospheric dust concentrations have been measured continuously at Barbados. The measurements from Barbados provide one of the longest continuous records of modern transatlantic dust transport even dating back to the pre-satellite era. The record shows a high variability on day-to-day, seasonal and interannual timescales. Three processes have the potential to affect dust concentrations at Barbados: a) changes in the quantities of dust emitted at the source regions in North Africa, b) changes in transport pathways and transport speed across the Atlantic Ocean, and c) changes in precipitation rates during transport which leads to scavenging of the suspended dust (wet deposition). Here we use a trajectory model to calculate trajectories backwards in time released from Barbados between 1980 and 1992 in order to study the impact of these three processes on the variability dust concentrations and to quantify their respective importance. The statistical analysis of the back-trajectories shows significant differences in the circulation pattern over the Atlantic Ocean during high and low dust concentration days in summer. Also, the impact of changes in emission rates at the sources in North Africa and precipitation during transport affect dust concentrations. The results highlight the importance of changes in the atmosphere conditions on the atmospheric transport of mineral dust and help to understand the observed variability in the Barbados dust record.

Keywords: sahara, barbados, variability

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MS004 **Poster presentation** **5141**

Impact of Desert Dust Radiative Forcing on Sahel Precipitation

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The role of direct radiative forcing of desert dust aerosol in the change from wet to dry climate observed in the African Sahel region in the last half of the twentieth century is investigated using simulations with an atmospheric general circulation model. The model simulations are conducted either forced by the observed sea surface temperature (SST) or coupled with the interactive SST using the Slab Ocean Model (SOM). The simulation model uses dust that is less absorbing in the solar wavelengths and has larger particle sizes than other simulation studies. As a result, simulations show less shortwave absorption within the atmosphere and larger longwave radiative forcing by dust. Simulations using SOM show reduced precipitation over the intertropical convergence zone (ITCZ) including the Sahel region and increased precipitation south of the ITCZ when dust radiative forcing is included. In SST-forced simulations, on the other hand, significant precipitation changes are restricted to over North Africa. These changes are considered to be due to the cooling of global tropical oceans as well as the cooling of the troposphere over North Africa in response to dust radiative forcing. The model simulation of dust cannot capture the magnitude of the observed increase of desert dust when allowing dust to respond to changes in simulated climate, even including changes in vegetation, similar to previous studies. If the model is forced to capture observed changes in desert dust, the direct radiative forcing by the increase of North African dust can explain up to 30% of the observed precipitation reduction in the Sahel between wet and dry periods. A large part of this effect comes through atmospheric forcing of dust, and dust forcing on the Atlantic Ocean SST appears to have a smaller impact. The changes in the North and South Atlantic SSTs may account for up to 50% of the Sahel precipitation reduction. Vegetation loss in the Sahel region may explain about 10% of the observed drying, but this effect is statistically insignificant because of the small number of years in the simulation. Greenhouse gas warming seems to have an impact to increase Sahel precipitation that is opposite to the observed change. Although the estimated values of impacts are likely to be model dependent, analyses suggest the importance of direct radiative forcing of dust and feedbacks in modulating Sahel precipitation.

Keywords: dust climate interactions, online gcm simulations, north africa

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MS004 **Poster presentation** **5142**

Operational High-resolution Dust Storm Forecasting For Southwest Asia

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Real-time dust forecasting using US Navys Coupled Ocean-Atmospheric Mesoscale Prediction System (COAMPS) with an inline dust aerosol model is being conducted by US Fleet Numerical Meteorology and Oceanography Center. Daily forecasts of dust concentration, visibility and optical depth are produced out to 72 hrs on nested grids of 9, 27 and 81 km with two-way nest interaction. A high-resolution dust source database has been developed to support the dust forecasting in this region. Dependence of dust prediction on source resolution is studied in an storm by using different databases to prove the importance of accurate representation of fine source points and streaks. Parallel dust forecasts of single-bin and multi-bin modeling are performed in simulating a severe storm over the Arabian Peninsula to compare the similarities and differences between forecast products and provide evidence for the choice of the optimal number of bins in operations. The model performance is evaluated for a special period of the Iraq War in the spring of 2003 using ground weather reports, visibility observations, and enhanced satellite retrievals. The verification shows COAMPS predicted the arrival and retreat of major dust events within 2 hours, the intensity of storms (reduction in visibility) with an error of less than one kilometer, and the spatial distribution of dust fronts and plumes being consistent with observations. An extensive statistical analysis of dust-related visibility is conducted to examine the model bias, RMS and relative errors, as well as forecast rates and threat score. Overall COAMPS predicted more than 85% of the observed dust and non-dust weather events in the war period.

Keywords: dust, operational, forecasting

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MS004 **Poster presentation** **5143**

A simple method for directional and vertical distribution assessment of airborne coarse particulate matter

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Maria Cabello, Javier Mateo

Directional assessment is a c omplement to particulate co ncentration measures. The knowledge of the direction from which dust is coming provides useful information to identify local sources; it combines the existence of specific dust sources and the wind directions at the study site.First results are presented on the use of an inexpensive and simple passive system for directional dust measurement. Dust is collected on a 7cm hig h transparent adhesive film fixed co mpletely around a vertically mo unted cylinder. Following exposure, the samples are scanned and images are saved as BMP files on a computer for later image analysis. Previous uses of sticky pads includ e dus t quantification by percentag e reduction i n reflectance (Beaman & Kingsbury, 1981) and by the proportion of p ixels that have been duste d (Farnfield & Birch, 1997). We calculate dust levels from the scanned images by recording the position and size (from the are a of the two-dimensi onal projection) of individual coarse particles (greater tha n 20 microns); as a complement we also record the presence or absence of dust for each pixel as done by Farnfield & Birch. The colour of the particles is retain ed as well.We used vertical arrays of samplers to estimate the vertical distribut ion of horizont al pa rticle flux. Collectors were mounted on masts at six heights: 0.05, 0.16, 0.27, 0.3 8, 0.55 and 1. 05 m above t he ground, thus sampling a combination of saltation and suspension.Mea surements of directional and vertical part iculate distributions have been performed at several sites in semi-arid SE Spain. The study sites are affected by airborne soil particulate emissions prod uced by (a) wind flow across fields with different vegetal coverage, (b) vehicular traffic on dusted pav ed roads near extractive industries , and (c) emissions from aggregate storage piles. Differences on the vertical pr ofiles accord ing to surface coverage (see Raupach et al., 2001) and the involved dust sources are found. This work was su pported by the Ministerio de Educacio n y Ciencia under the CGL2004-04419/CLI (RESUSPE NSE) project. Be aman, A.L. & Kingsbury, R. W.S.M. (1981). Clean Air, 11, 77-81.Farnfield, R.A. & Bir ch, W.J. (1997). Clean Air, 27, 73-76.Raupach, M.R.; Woods , N.; Dorr, G.; Leys, J.F.; Cleugh, H.A. (2001). Atmospheric Environment, 35, 3373-3383.

Keywords: coarse, windblown dust

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MS004 **Poster presentation** **5144**

Influence of the air mass origin over the aerosol size distribution: a study in SE Spain

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A k-means cluster analysis of 96 hour trajectories arriving in 38.3N, 0.7W at 3000, 1500 and 500m for the 7-year period 2000-2006 has been performed to identify the main flows arriving in SE Spain. The dependence of PM10, PM2.5 and TOMS AI values on the air mass origin is statistically significant as already shown by the authors for shorter time periods. Here we focus on the influence over the particulate size distribution.Back-trajectories at 12UTC were computed with the HYSPLIT v. 4 with the FNL meteorological data. Hourly latitude and longitude were used as input variables in the clustering procedure. We have considered some modifications to the procedures followed in the literature (Dorling et al., 1992; Mattis, 2001) to retain the appropriate number of clusters and to deal with the dependence of the final results on the seed centroids used to initialise the method; in some cases those procedures are far from achieving the smallest total RMSD (i.e. the sum of the Root Mean Square Deviation of every cluster).The 96h back-trajectories at 3000, 1500 and 500m are found to be clustered into 6, 5 and 6 groups, respectively.Aerosol size distributions measured every ten minutes from January to May 2006 with a GRIMM 190 aerosol spectrometer have been analysed. Measured size distributions range from 0.25 to greater-than-32 microns diameter in 31 size channels. The study site, Agost, is a village of 4000 inhabitants located 18 km from the Mediterranean coast, where main activities include brick manufacturing and grape cultivation. Application of principal components analysis to the normalized aerosol size channels, using varimax rotation, reduced the 31 variables to four factors accounting for the 93.8% of the variance. The factor loadings indicate that the factors correspond to four particulate size intervals. We considered one representative particle size interval for each factor: 0.30-0.35, 0.8-1.0, 6.5-7.5 and 30.0-32.0 microns.The variation of the particle concentration on these size channels according to the different clusters is significant as shown by the Kruskal-Wallis and the Mann-Whitney tests. That variation can be linked to specific aerosol contributions of local, regional and long range origins. Atmospheric parameters like precipitation, mixing heigh and surface wind speed are also discriminated by the clustering results and affect particulate load as well.Other features of the time series contribute to the results. As an example, the auto correlation function of the selected four size channels shows a stronger one-week periodicity (anthropogenic) the smaller the particle size; for the 30 microns size there is no such periodicity. This work was supported by the Ministerio de Educacion y Ciencia under the CGL2004-04419/CLI (RESUSPENSE) project. Dorling, S. R., Davies, T. D. & Pierce, C. E. (1992). Atmos. Environ., 26a, 2575-2581. Mattis, I. (2001). http://lidarb.dkrz.de/earlinet/scirep1.pdf

Keywords: size distribution, trajectory, long range

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MS004 **Poster presentation** **5145**

Saharan dust vertical extinction over the Atlantic during 2005-2006 summer outbreaks

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rea de Investigacin e Instrumentacin Atmosfric

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Saharan outbreaks are com mon events in which large amounts of dus t are lifted from the desert a nd transported fa r fro m the so urces, co vering extended ar eas in layers up to 6- 7 km in height, an d affecting the r adiative transfer balance. Under thes e conditions backscatttered UV solar spectrum is perturbed both by absorption and scattering, pote ntially interfering satellite oz one instrumentation operating in nadir viewing geometry. To explore this pos sibility, a field experiment was designed to characterize the aerosol layer in terms of vertic al extensio n and extinction based o n airbo rne instrumentation aro und the Canary Archipelag o (Gimar, 28.31N, 16.41W) where ground-based s un photometers a nd backscattering lidars are in operat ion. I n addition, the Izaa Observat ory host high quality ozone instrumentation operating in different sp ectral ranges: Brewer (UV), DOAS (Visible), FTIR (IR) than can be compared with co-llocated satellite to search for differences. The campaign was carried during two large outbreaks (AOD = 0.7/1) in July 2005 a nd July 2006 i n the frame of the TROMPE TA project. We focus in this presentation in the aircraft aerosol concentration measurements by the Passive Cavity Aerosol Spectrometer (PCASP) in 1 5 channels from 0.1 to 3 micron s from wh ich size distribu tion and vertical extinction were inferred. Profi les sh ow a coarse mode dominati ng (dp>=2 microns) i n dA/dlog(D), a well defined top of the layer close to 6 km and quite uniform vertical distribution in the free troposphere, except in the first profile in which a heavily loaded narrow layer modify the temperature profile by an incr ease of 0.4 C below the maximum. The integrated extinctions, computed from an empirical fu nction of the aerosol vol ume, is found to be in excellent agreement with AOD from the CIMEL-AERONET data at the nearby station of Sta. Cruz.

Keywords: saharan dust, size distribution, aerosol extinction

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MS005 **5146 - 5167**

Symposium
Biological Ice Nucleators in the Atmosphere at the Crossroads of Physics and Biology (IAMAS/ICCP)

Convener : Dr. Gabor Vali
Co-Convener : Dr. Cindy Morris

Biogenic ice nuclei are among the most active of the known ice nucleators, yet their contribution to atmospheric processes has not been clarified. However, techniques of detection improve, understanding of biological sources is growing, and observations and modelling of clouds identify the role of early ice nucleation in the formation of precipitation and in determining other cloud characteristics. Experts from the atmospheric and biological sciences will review knowledge and assess evidence about the nature, distribution and role of biogenic ice nuclei in the atmosphere, and discuss the future research directions

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MS005 **Oral Presentation** **5146**

Diversity of bacteria producing pigmented colonies in aerosol, snow and soil samples from remote glaciated areas (Antarctica, Alps, Andes)

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R. J. Delmas, J.-R. Petit, J. Komarek, R. Amils, J. Elster

Five different cultures of pigmented bacterial colonies were obtained by incubation of samples retrieved from high elevation snow collected in the Alps (Mt. Blank area) and the Andes (at the summit Nevado Illimani, Bolivia), from Antarctic aerosol (French station Dumont dUrville) and soil (King George Island, South Shetlands), in mineral medium (B G 11). Molecular analysis of more than 200 16S rRNA gene clones showed that all the cultured cells belong to the Bacteria domain. The phylogenetic analysis of the sequences showed close relationship with -, - and -Proteobacteria, Actinobacteria and Bacteroidetes. The Andes snow culture exhibited the highest level of diversity, with sequences with high similarity with Afipia, Agrobacterium, Brevundimonas, Limnobacter, Hydrogenophaga, Pseudonocardia, Microbacterium spp. and an uncultured Bacteroidetes. The composition of two of the Alps sampling sites differs. At Col du Midi, sequences related to Bradyrhizobium, Afipia, Agrobacterium, Limnobacter, Hydrogenophaga, Pseudomonas and an uncultured Bacteroidetes spp. were found, while at Col du Dome; only Bradyrhizobium, Zooglea, Dietzia spp. were detected. In the Antarctic, aerosol sequences with high homology with Bradyrhizobium, Brevundimonas, Limnobacter, Hydrogenophaga, Pseudonocardia and Brachybacterium spp. were found. The Antarctic soil showed the lowest level of diversity, only one sequence out of fifty clones analyzed showed high homology with Brevundimonas spp.

Keywords: pigmented bacteria, antarctica alps andes, 16s rrna gene

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MS005 **Oral Presentation** **5147**

Laboratory studies of the ice nucleating ability of pollen and model simulations of the effects of biological aerosol particles on cloud microphysics

Dr. Karoline Diehl
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Martin Simmel, Sabine Wurzler, Nadine Von Blohn, Subir Kumar Mitra

Literature studies reveal th at biological aerosol parti cles are most likely involved in cl oud and precipitation p rocesses. Leaf litter, fungi, l ichen, bacteria, and marine plankton act a s ice nuclei at temperatures not far below 0C, i.e. at definitely hi gher temperatures than other atmospheric ice nuclei such as mineral dust and soot. This was also demonstrated for a number of pollen species showing that the ice nucleating ability of po llen is not restricted to single pollen types. These laboratory experiments were undertaken at the facilities of the M ainz vert ical wind tunnel where single droplets are freely floated at their terminal velocity. By different ex perimental techniques im mersion and c ontact freezing of su per-cooled droplets were in vestigated. T he resu lts s how that dro plets co ntaining po llen fro ze at temperatures up to 9 C (immersion mode), and drops colliding with pollen froze at temperatures up to 5 C (con tact mode). It was further observed that pollen types released earlier in the year show a higher ice nucleation efficiency which implies that an expl anation for their ice nucleating ability might be a biological freezing tolerance: extra-cellular freezing protects the interior of the cells. The results confirm the potential importance of biolog ical aero sol part icles in cloud and pr ecipitation pro cesses in their ability to act as ice nuclei at r elatively warm temperatures. To estimate the possible effects of bio logical particles on cl oud microph ysics model sim ulations were performed using an air parc el model with a detailed sectional description of the cloud microphysics. Ice formation proceeded by d rop freezing in immersion and contact mode s. The descriptions of these freezing processes in the cloud model are based on laboratory results and allow to investigat e the dependence of freezing on the type of ice nuclei. Sensitivity studies were performed for variou s types of ice nuclei to show their effects on ice formation and, thus, o n the vertical clo ud dynamics . The ice nuclei were bacteria, lic hen, leaf litter, pollen, and, for comparisons, montmorill onite, kao linite, a nd soot. T he fraction s of active ice n uclei during the mo del simulations were 1% for the biolog ical p articles, 20% f or mineral dust, and 10% for soot; these v alues are bas ed on field m easurements of th e proporti oning of atmo spheric aeroso l particles. Although the amount of biological particles as active ice nuclei w as much lower than the ones of min eral du st an d soot, th e effects on ic e formation and vertical clou d dynamics were in the same order of mag nitude. This indicates the importance of biol ogical pa rticles for cl oud microph ysical processes, and hence, they should not be neglected against mineral dust and soot.

Keywords: biological ice nuclei, pollen, cloud model

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MS005 **Oral Presentation** **5148**

High-resolution ice nucleation spectra of sea-ice bacteria: Implications for cloud formation and life in frozen environments

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Karen Junge

Even though studies of Arctic ice forming particles (IFN) suggest that a bacterial or viral source derived from open lea ds could be im portant for cloud format ion i n the Arctic, the ice nucleation potential for polar marine psychrophiles or viruses has not been examined under conditions closely resembling those in the atmosphere. Here, we examined the ice nucle ation activity (INA) of several sea- ice bacteria l isolates that were representat ives for most of the kn own groups of Arctic and Antarctic s ea-ice bacteria and a polar C olwellia lysoge n phage virus. High-res olution ice nucleatio n spectra were o btained fo r solutions co ntaining bacterial cells o r virus part icles using a free-fall freezing tube technique to determine th e fraction of f rozen droplets at a particular droplet temperature by measuring the depolarized light scattering intensity from the drople ts in free- fall. Our tests revealed t hat all sea- ice isolates and t he virus nucle ated ice at te mperatures ve ry clo se to th e ho mogeneous nucleatio n temperature fo r the nucleatio n medium (e.g. F (T) defined as the tempe rature at which 50% of the droplets were frozen) for artificial seawater; 42.2 0.2C). Even though strains derived from other sources might prove important for ice nucleation pr ocesses in polar clouds, results so far indic ate that mari ne psychro-active bacteria and viruses are not important for heterogeneous ice nucleation processes in sea ice or polar clouds.

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MS005 **Oral Presentation** **5149**

Supercooling In Over-wintering Pine Beetle Larvae

Mr. Ryan Schnell
IAMAS

Pine beetle larvae cause over $1 Billion in forest loss each year in the United States and Canada. The larvae survive over winter to temperature of -25C beneath the tree bark by supercooling. The amount of supercooling exhibited by the larvae is seasonally dependent and is greatest in the coldest northern hemisphere winter months (January and February). We tested the ability of pine beetle larvae to withstand supercooling stress by subjecting recently harvested tree sections to different below freezing temperatures and then determining the mortality rate of the larvae. For February trees, larvae survived to beyond -15C, but were killed 100% by -25C. It is suggested that it might be possible kill all of the larvae in a living tree by subjecting the tree to a cold stress.

Keywords: supercooling, larvae, pine beetles

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MS005 **Oral Presentation** **5150**

Detecting ice nucleating bacteria in environmental samples using PCR of the gene conferring ice nucleation activity

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Plant Health and Environment Inst. Nat'l de la Recherche Agronomique - Franc

Caroline Guilbaud, Helen Ahern, Hlne Dominguez, Catherine Glaux, Bruce Moffett, Tom Hill

Fewer than 10 species of bac teria are known to be ic e nucleation-active. Furthermore, this property is conferred by a single gene a nd the overall gene se quence is rather well conserved among the 5 or 6 variants of the gene whose s equences have been reported. Nevertheless, there have been no methods reported for detecting ice nucleation-activ e bacter ia in environmental samples via PCR (Polymerase Chain Reaction for amplification of the nucleic acid sequence) that take into account t he full range of known variability of the bacterial gene. We have designed sets of primer s for PCR based on reported sequences of the core and C-terminal regions of th e inaW, inaY and inaZ, inaK and inaV alleles an d sequences of s trains from our cult ure collect ions. The sensi tivity and specificity of these primers were determined in PCR conducted on about 100 pure cultures of ice nucleatio n active (and some inactive) strains of Pseudomonas syringae, P. viridiflava, P. fluo rescens, P. putida, Panteoa agglomerans and Xanthomonas campestris collected from plants, rain, snow, clouds, aquatic habitats, frogs and insects in North America n, Eu rope, Ch ina an d An tarctica. T he sensitivity of these primers wa s tested with environmental samples (rain, sno w, aquatic habitats) fro m which previo us iso lations revealed t he presence of ice nucleation acti ve bacteria, and in environmental samples (r ain, snow, aerosol samples) seeded with t he test strains from our collection. Th is tool will be use d to detect a nd quantify ic e nucleation acti ve bacteria in environmental sample s and can be a means of co llecting corr oborative evidence of the role of these bacteria in atmospheric processes.

Keywords: ice nucleation gene, pcr

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MS005 **Oral Presentation** **5151**

Genetic analysis and diversity of primary biogenic aerosol particles

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Janine Nowoisky, Melanie Klose, Ralf Conrad, Meinrat O. Andreae, Ulrich Poeschl

This study explores the applicability of molecular genetic methods for the characterization of primary biogenic aerosol (PBA) particles in the atmosphere. Samples of fine particulate matter (PM2.5) and total suspended particulates (TSP) have been collected on different types of filter materials at German sampling locations. From filter aliquots loaded with about one milligram of air particulate matter, DNA could be extracted and genetic sequences could be determined for bacteria, fungi, plants and animals. Molecular techniques (e.g., DNA sequencing, T-RFLP) were used to determine the identity of biological organisms, and to estimate diversities and relative abundances of microorganisms. Investigations of blank and background samples showed that filter materials have to be decontaminated prior to use, and that the sampling and handling procedures have to be carefully controlled to avoid artifacts in the genetic analyses. Mass fractions of DNA in PM2.5 were found to be around ~0.05 % in all sampled locations. The average concentration of DNA determined for urban air was on the order of ~7 ng m-3, indicating that human adults may inhale about one microgram of DNA per day (corresponding to ~105 haploid human genomes). Most of the bacterial sequences found in PM2.5 were from Proteobacteria and some from Actinobacteria and Firmicutes. The fungal sequences were characteristic for Ascomycota and Basidiomycotas, which are known to actively discharge spores into the atmosphere. The plant sequences could be attributed to green plants and moss spores, while animal DNA was found only for one unicellular eukaryote (protist). Over 80% of the 53 bacterial sequences could be matched with about 40% of the 19 T-RF peaks (58 to 494 base pair length) found in the investigated PM2.5 samples. The results demonstrate that the T-RFLP analysis covered more of the bacterial diversity than the sequence analysis. Shannon-Weaver indices calculated from both sequence and T-RFLP data indicate that the bacterial diversity differs among sampling locations

Keywords: dna, t rflp, microorganisms

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MS005 **Oral Presentation** **5152**

Evidence for biological ice nucleating particles in snowfall

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Biological ice nucleating particles (BINPs) have been reported in rain and at altitudes of several kilometers. Due to the relatively warm temperatures at which they can function as freeze catalysts, BINPs in the atmosphere may impact meteorological processes and induce precipitation. We examined 10 snowfall events at four locations in the vicinity of Bozeman, Montana USA during the 2005-06 winter season (from October to April) and seven snowfall events at 5 locations in the French Alpes, Pyrenees and southern France from December 2005 to March 2006. The temperature of detectable ice nuclei activity for the majority (60%) of the samples was greater than or equal to -5 C, based on immersion freezing tests from -2 to -9C. Successive treatment of melted snow with lysozyme (i.e. to lyse bacterial cells) led to reductions in the frequency of nuclei at the warmest temperatures detected, and heat treatment (i.e., to denature proteins) of the samples greatly reduced or completely eliminated all detectable nuclei at - 9 C. This ice nucleation activity of apparent biological origin was as prevalent in samples collected during the peak of winter as it was during the early and late portion of the season. Deciduous plants are thought the sources of BINPs (e.g. Pseudomonas syringae); however, ice nucleation activity was also documented in snow samples collected in the Antarctic (Mc Murdo Station) and Arctic (Wheaton Glacier, Yukon), suggesting long distance air transport of biological ice nuclei to remote sites and maintenance of the ice nucleating activity during transport. Multiple regression analysis of biogeochemical data (major ions, organic carbon, particles, and cell concentrations) collected from the 6 month Montana record provided a model that can predict the total microbial cell concentration in the snowfall based on the NH4+, Ca2+, and total organic carbon concentration. Our results imply that BINPs are ubiquitous in the atmosphere and that for some geographic locations, the concentration of airborne biological particles is related to the snow chemistry.

Keywords: snow, atmosphere, biological ice nucleation

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MS005 **Oral Presentation** **5153**

Cloud Modeling with an Empirical Parametrisation of Heterogeneous Ice Nucleation for Multiple Aerosol Species: Role of Biogenic Particles

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Analyses of the residual material in ice crystals have revealed that most of them are formed on ice nuclei of dust and carbonaceous aerosol. A significant fraction of these carbonaceous insoluble aerosols appear to have a biogenic source from such things as bacteria, pollen fragments, and decayed vegetative matter. Recent advances in measurement techniques have revealed very high concentrations of bacteria in the free troposphere (e.g. up to 100-1000 L-1). Such bacteria had previously eluded detection because they are mostly rendered non-culturable by atmospheric conditions. Many laboratory studies have shown that a commonly occurring species of bacteria (Pseudomonas syringae) that grows on plant surfaces can have ice-nucleating properties. Its strains have been observed to display a spectrum of varying nucleability. Climate change has the potential to modify the temperature-dependent sources of such biogenic ice nuclei. Consequently, there may be a contribution to the aerosol/ice-cloud interaction in climate change from this temperature-dependence, possibly forming a climate feedback. To address this issue, an empirical parametrisation of heterogeneous ice nucleation is proposed for application in cloud and large-scale atmospheric models. It represents dependences on predicted mass concentrations for multiple chemical species of ice nucleus (IN) aerosols, including biogenic aerosols, in addition to dust and black carbon. The biogenic IN particles are assumed to be ice-nucleation active (INA) bacteria. The scheme includes condensation-, immersion- and contact-freezing modes, in addition to vapour deposition, as mechanisms for heterogeneous nucleation. As an input, it requires prediction by the model of the supersaturation at the convective scale. The scheme is presented and its validation with independent observational data is shown. Sensitivity studies show the impact that such biogenic aerosols can have on cloud properties for a realistic range of scenarios of emission of bacteria.

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MS005 **Oral Presentation** **5154**

Characterization of snowborne taxa and bioaerosols in several Arctic and sub-Arctic sites

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There is a limited understanding, and a growing inte rest, in comprehending the impact of bioorganic matter in chemistry and physics of the atmosphere. Concurrent field a nd experimental studies and of snow (semi)vo latile organ ic c ompounds (V OC), sn ow-embedded microbes an d bioaerosols at several urban, suburban/remote mountainous, and Arctic sites were performed during 2004 a nd 2006. We will present our data on number density and nature of identified bioaerosols, chemical characterization and variability of wide range of V OC, the impact of taxa on snow microphysics, as well as photobiochemical experiments at snow-air interface. We will d iscuss the potential impact of our results on the chemistry of the air- snow interface, with implications in air- snow exchange rate. We will also discuss potential uncertainties and some key future work in studies related to climate change.

Keywords: bioaerosols, snow, arctic

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MS005 **Oral Presentation** **5155**

Isolation of ice-nucleation acive microrganisms from cloud water

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Airborne micro-organisms have long been considered as particles simply transported by the atmospheric circulation that can subsequently colonize or invade new environments. In this context, their importance is mostly related to ecological and socio-economical issues (bio-terrorism, health, etc). However, the structure and function of microbial communities in clouds remain largely unknown. Atmospheric water represents, in some respects, an extreme aquatic environment characterized by low temperatures, relatively low pH and complex mixtures of organic and inorganic compounds. However, bacteria, fungi, yeast and protozoa not only survive in such media but some of them could also multiply and potentially modify the physical and chemical properties of clouds This is due mainly to their hygroscopic and ice nucleation properties that could affect the initial process of droplet and crystal formation. Secondly, micro-organisms can be considered as biocatalysts thereby transforming organic and in organic compounds in cloud water (Amato et al. 2005). In this study, the structure of the microbial population present in atmospheric water samples from clouds at the Puy de Dme (altitude 1465 m, Massif Central, France) is described (Amato et al. 2007). The total microflora was quantified by epifluorescence microscopy; ATP concentration was measured by an enzymatic method and culturable aerobic micro-organisms were isolated. Bacteria were identified by 16S rDNA sequencing and fungi by morphological criteria. Most of the isolated culturable micro-organisms, including 90 bacterial strains and more than 40 fungi and yeasts, are described here for the first time in atmospheric water. Many bacterial strains have characteristics indicating that they are adapted to the extreme conditions found in cloud water: (1) most of them are psychrotolerant, as shown by their good growth at 15C, or even for some of them at 5C which is the average temperature in troposphere clouds at the Puy de Dme; (2) they generally have pigments (or are at least spore- forming), which are well-known to protect against cold and light exposure; (3) some bacterial strains are closely related to polar ones. Twelve of these strains of fungi and bacteria, including Pseudomonas, Panteoa, Verticullum, Botrytis and Fusarium species, were tested for their ice nucleation activity by immersion freezing using the droplet freezing method. One bacterial strain of Pseudomonas synringae and one fungal strain of Fusarium avenaceum showed very high activities (ice-forming nuclei temperatures of -6C and -3C respectively). In conclusion the presence of ice nucleation active microorganisms in cloud water suggests that microorganisms could play an active role in controlling the physical properties of atmospheric waters. P. AMATO, M. MENAGER, M. SANCELME, P. LAJ, G. MAILHOT, A.-M. DELORT. Atmosph. Environ., 2005, 39, 4143-4153. P. AMATO, M. PARAZOLS, M. SANCELME, P. LAJ, G. MAILHOT, A.-M. DELORT FEMS Microbiol. Ecol., 2007, 59, 242-254.

Keywords: microorganisms, cloud water, ice nucleation

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MS005 **Oral Presentation** **5156**

New cloud chamber studies on the ice nucleation efficiency of airborne bacteria

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The ice nucleation activity (INA) of bact erial species is known since several decades and was investigated in many laborat ory studies. Some stud ies also addressed the role of INA bacteria on the formation of clouds and in p articular the in itiation of precipitation through the ice p hase in clouds at temperatures below 0C. This is important because ba cteria are among t he aerosol par ticles to initiat e ice formation at the warmes t temperatures. However, the detailed microphysical processes in such clouds are far from complet e or satisfactory u nderstanding. Recently, new interest emerged on the assessment of sources, distribution , characterisation, and impacts of atmospheric bacteria and othe r biological particles directly emitted to the atmosphe re. We have used the AIDA (Aerosol Interaction and Dynamics in t he Atmo sphere) clo ud simulatio n chamber o f Fo rschungszentrum Karl sruhe fo r new experiments on the ice nucleation efficiency of several Pseudomonas syringae species in the aerosol and droplet phase at temperatures between 0 and -15C. Suspensions of cultured cells in water were directly sprayed into the large aerosol chamber (84 m3 volume) at temperatures between -2 and -10C. Resulting aerosol size distrib utions measured with a scanning mo bility instrument and an aerodynam ic particle spectr ometer showe d two distinct particle mode s, a narrow, almost mono-disperse peak o f intact cells with aerodynamic diameters of about 0. 8 m and a poly-disperse mode of smaller particle s with diameters between about 10 and 500 nm composed of residual particles from evaporating droplets. The contribution will briefly su mmarize the experimental methods and discuss results about the numbe r fraction of INA cells immersed in supercooled droplets.

Keywords: bacteria, icenucleation, aida

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MS005 **Oral Presentation** **5157**

Biogenic Ice Nuclei Studies Proposed for the BEACHON Project

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Alex Guenther

Key to improving the predicta bility of earth system be havior over the time scale of months to a decade is an improved understa nding of the coupling between wat er, energy a nd biogeochemical cycles in a multi-scale modeling framework. Credible predictions at these time scales require coordinated modeling, observations and process studies that explicitly a ddress the coupled water, energy and biogeochemical cycles at multiple temporal and spatial scal es. This capability is particul arly important for semi-arid landscapes where biogeoche mical cycles are limited by water and nut rients and are threatened b y drying associated with climate chan ge. Water-limited landscapes cover half of the earths land surfac e and include some of the f astest growing population centers. Trace gas es and aerosols emitted by a water-limited b iosphere are key points of interaction between the atmosphere and biosphere. A new project, called BEACHON (Bio-hydro-atm osphere in teractions of Energy, Aerosols, Carbon, H2O, Organics & Nitrogen) has recently b een initiated to study th ese interacting cycles. A key element of this study will be the linkage bet ween biogenic ice nucle i and the water and carbon cycles. Both laborator y and field studies are propos ed to address this link age. At the conference, progress to date will b e reported, including plans for a long term field study.

Keywords: biogenic, ice, nuclei

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

MS005 **Oral Presentation** **5158**

The ability of leaf litter debris to initiate ice phase formation in the atmosphere

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Sonia M. Kreidenweis, Paul J. Demott, Alex Guenther, Ray Fall

Biological sources are an important contribution to the overall global aerosol burden and can be the main source of aerosols in the absence of human activities. Recently, studies are providing quantitative understanding of the contribution of biogenic particles to the total aerosol loading, both in terms of particle number and particle mass. Although ice nuclei (IN) particles typically represent less than 1 in 106 of atmospheric aerosol particles, IN are crucial in initiating ice formation at temperatures warmer than -40C, where homogeneous ice nucleation cannot occur. Sources of IN include dust particulates, metal oxides from metal works, combustion products, and it has been suggested that ice nucleation active (INA) bacteria contribute importantly to ice formation in the atmosphere. Studies have suggested that bacterial and other biological IN are particularly efficient at initiating ice formation at warmer temperatures, the most effective being capable of ice formation at -2 to -5. INA bacteria tightly adhere to the leaf surface but leaf litter is a significant source of IN. Accurately representing the role of bacteria in ice formation is particularly important in modeling studies of regions where anthropogenic contributions are expected to be minimal, such as the Amazonia region. While in most previous experimental studies on the role of bacteria to initiate ice formation, the bacteria are studied in liquid suspensions, or on the surface of a filter or other surface exposed to cold temperatures at ice supersaturated relative humidity (RH) conditions, in this study we are using the Colorado State University Continuous Flow Diffusion Chamber (CFDC) to examine the ability of the particles to initiate the ice phase as an dry- dispersed aerosol. Leaf litter debris from plant types expected to contain high numbers of IN, such as tea plants, is mixed with bronze beads contained within a fluidized bed. As the mixture fluidizes the bronze beads serve to agitate the leaf litter and remove the bacteria and other biological material from the leaf surface, while being too heavy to escape the bed. Thus, only the biological material is aerosolized. Since the leaf litter is not suspended in water, the potential for the biological particles to be contaminated with small amounts of impurities in the water is eliminated. Particles larger than ~1 μm are removed using an impactor to yield a polydisperse, submicron distribution of biological material. The CFDC then exposes the particles to temperatures between ~-5 to -40C and RH from ice supersaturation to several percent above water saturation. Ice nucleation results will be presented as a function of temperature and required RH for ice formation.

Keywords: biological ice nuclei, heterogeneous freezing, cloud microphysics

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MS005 **Oral Presentation** **5159**

The discovery of biological ice nuclei: early successes, missteps and some remaining questions

Dr. Russ Schnell
IAMAS

In the mid-1960s Gabor Vali refined the drop freezin g method of detectin g freezing nucl ei that allowed for quick and unequivocal detection of active ice nuclei, and their activity spectrum, over a wide temperature range. His early work suggested that the more fertile a soil, the more ice nuclei active at -5 to -6 C it contained. But it took a year of research beyond that to real ize the active i ce nuclei were coming from th e organic component of the soil, an d another 6 mo nths to determine that well decay ed leaves were the probable source of the ice nuclei. These nuclei were named leaf derived nuclei (LDN). In an attempt to follow what was thought would be a slow chemical release of the ice nuclei from green leaves as they decayed, to our great surprise ice nucle i active at -1.5 C were produced in the moist leaf slurry. I n an as y et un explained action, the author put t hese sample s in to froz en storage an d n ever thought to test them again for some living entity. It was one year later that a repeat of the earlier leaf decay experiment led to the identification of living P. syrin gae bacteria as producing active ice nuclei. These nuclei were named bacteria derived nuclei (B DN). In retrospect, what could have been a tw o year project, took four. That was 30+ years ago. Yet today, the process of how the BDN become LDN (assuming they do) is still unclear. Also unknown to this day is the true role of BDN and LDN in atmospheric ice nucleatio n pro cesses even tho ugh it is believed they are important. How then to address some of these unknowns? It would seem th at one could trace a genetic marker for the ice nucleus pro tein pro duced b y B DN fro m its fo rmation in the co at o f the bacteria thro ugh to its appearance in LDN, and by extension look for that marker in the atmosphere and in ice nucleatio n sites in young ice crystals collected within clouds.

Keywords: nuclei, bigenic, freezing

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MS005 **Oral Presentation** **5160**

Fluorescent pseudomonads in Scottish cloud and rain water: diversity, ice nucleation activity and biosurfactant production

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Bacteria are abundant in the atmosphere. Yet we know little about the diversity of the species present in cloud and rain water, and whether they possess ice nucleating and cloud condensing abilities. Cloud and rain samples were collected from two coastal mountains in the Outer Hebrides, NW Scotland. Community composition was determined using a combination of amplified 16S ribosomal DNA restriction analysis and sequencing. 256 clones yielded 100 operational taxonomic units of which half were related to bacteria from terrestrial psychrophilic environments. Cloud samples were dominated by a mixture of fluorescent Pseudomonas spp., some of which have been reported to be ice nucleators. However, the IN gene was not detected in any of 80 cloud and rain isolates using both the polymerase chain reaction (PCR) and freezing point. (To test for presence of the gene directly, we are currently using real-time PCR to measure the abundance of actively expressed and total IN genes in further cloud samples obtained from southern Scotland.) Interestingly, 55% of the Hebridean isolates displayed significant biosurfactant activity when analyzed using the drop collapse technique. Surfactants have been found to be very important in lowering atmospheric critical supersaturations required for the activation of aerosols into cloud condensation nuclei (CCN). They also influence cloud droplet size and increase cloud lifetime and albedo. Some bacteria are known to act as CCN and so it is conceivable that these fluorescent pseudomonads are using surfactants to facilitate their activation from aerosols into CCN. This would allow water scavenging, countering desiccation, and assist in their widespread dispersal.

Keywords: biosurfactants, ice nucleation, pcr

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MS005 **Oral Presentation** **5161**

Atmospheric ice nuclei concentrations and characteristics: constraining the role of biological ice nuclei

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Ice initiation in clouds warmer than -35C is presently known to occur only through the action of special particles acting as ice nuclei. Atmospheric measurements of ice nuclei concentrations, physical and chemical characteristics made over the past 15 years demonstrate the apparent nature of this special population and provide some apparent constraints on the contributions of ice nuclei from biological sources. Measured concentrations of ice nuclei are usually below 0.1 cm-3 at any temperature below 0C except in special circumstances, including strong dust transport events. Ice nuclei concentrations measured in the free troposphere with a continuous flow diffusion chamber instrument do not follow an exponential increase with decreasing temperature, but rather increase only modestly at lower temperatures. The strongest decrease in ice nuclei concentrations occurs for aerosols processed warmer than about - 15C. This result and the known nature of biological ice nuclei to express activity in the temperature regime between 0 and -10C indicates the potential special realm of biological ice nuclei.Investigations of the compositions of the residual particles from freshly nucleated ice crystals by transmission electron microscopy and more recently using single particle mass spectrometry support that the largest source type of ice nuclei are mineral dust particles. Contributions to ice nuclei from carbonaceous aerosol particles vary from just a few percent to as much as 33% at temperatures below ˜10C. The source of these carbon-containing particles is not known. Few are recognizable morphologically as bacterial cells, although this could be influenced by present sampling procedures that have restricted measurements to aerosols below 1 micron. Nevertheless, the typical larger ice crystal residual nuclei are predominately mineral dust particles. It is possible that the smaller carbon particles detected as apparent ice nuclei have a source from biological aerosol fragments, but this remains to be confirmed. It is particularly important to advance investigations of the types of particles that are active at the warmest sub-cooled temperatures where the influence of the nuclei on the subsequent ice phase evolution of clouds may be strongest.

Keywords: ice nuclei, aerosols, clouds

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

MS005 **Oral Presentation** **5162**

How to enumerate airborne microorganisms?

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Bacterial enumeration of environmental samples may in some cases be a difficult tas k. Typically, in seawater and soil samples less than 1% of assumed alive bacteria are easily cultured on agar plates. It is difficult to s ee any reason why airborne bacteria should be more easily cultured. The question then arrives: how to enumerate airborne bacteria? We collected air samples using a XMX-CV collector (Dycor) as well as rain samples. The samples we re then analys ed using different methods to enumerate bacterial concentrations: Flow cytometry (FCM), Quantitative PCR (Q-PCR), Epi-fluorescense microscopy (EFM) and agar plating. In general FCM and Q-PCR yielded results in the same order of magnitude. In air samples it was difficult to discriminate between bacteria and background noise using EFM as t he bacterial concentration in general was low compared to other environmental samples. Around 1% of the bacteria counted by FCM and and Q-PCR grew on agar plates. The next question then arrives: Are these bacteria alive? We incubated rain samples with radioactive leucine in order to measure bacterial activity. The cell-specific bacterial activity was sho wn to be comparable with t ypical sea wat er samples. In general airborne/rainborne bacteria may be enumer ated using FCM, Q-PCR and in some cases EFM. Updated results will be presented.

Keywords: bacteria, enumeration

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

MS005 **Oral Presentation** **5163**

Is there a role for ice nucleation activity in bacterial dissemination?

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C.E. Morris, D. G. Georgakopoulos

Our scientific understanding of microbes started with species deions, and then additional discoveries were added in a sequential manner. In the case of Pseudomonas syringae, it was first differentiated from similar bacteria because of its ability to cause plant disease. In the 1920's-1940's the plant host range and symptoms were described, with several hundred "species" being described, each "species" denoting the capacity to cause disease to a different plant host. In the 1960's a series of six biochemical and behavioral tests were used to differentiate Pseudomonas syringae as a group from other plant disease causing pseudomonads. In the early 70's some 200 physiological tests on hundreds of strains representing dozens of bacterial "species" resulted in a numerical taxonomy that holds today with minor adjustments, even in light of molecular phylogenetics. The discovery of ice nucleation, its effect on plant frost injury and its unique structural protein occurred in the 1970's and 1980's. In the last 20 years the complete genomic sequence of several strains has been reported. There appear to be genetic "islands" of associated genes associated with a specific function – for example, the "pathogenicity island" which includes genes for hypersensitivity (secretion systems) and toxins. The genes for ice nucleation associated activities, for epiphytic/saprophytic growth appear to be independent and separate genetically from pathogenicity genes. Their involvement may be more associated with dissemination (how these bacteria get around). Our own focus has been on whether or not bacterial ice nucleation activities of P. syringae might facilitate their long distance transport, and whether or not the presence of this bacterium in clouds, rain and snow is just a set of spurious observations, or, in fact, is a very real unique and essential aspect of their survival. In an attempt to avoid our natural pathocentric tendencies – given that P. syringae was first described as a plant pathogen - we note that some P. syringae are associated with algae and insects and they may even have an airborne ecological niche as well.

Keywords: pseudomonas syringae, dissemination

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MS005 **Poster presentation** **5164**

Modeling studying the role of bacteria on ice nucleation processes

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Certain bacteria have been recognized as efficient ice nuclei at temperatures above -10 C. Inhabiting plants, soils and ocean surfaces, these ice-nucleating bacteria were found in almost all climate regions, even in the polar-regions. These ice-nucleating bacteria are readily disseminated into the atmosphere and have been observed in clouds and hailstones; bacteria thus should play a more important role than any other ice nuclei in ice formation of clouds at temperatures above -10C. High concentration of ice crystals exceeding background ice nuclei were often observed in the warm-based cumulus clouds, which were caused mainly through collisions of graupels with cloud droplets (riming process). The formation of graupels is responsible for ice multiplication process under suitable conditions. The initiation of graupels highly depends on the initiation process of ice crystals at relative warm temperatures (growing stage of cumulus clouds). Thus, we hypothesize the ice-nucleating bacteria plays a key role in graupel formation and the subsequent ice multiplication process. A 1.5-D non-hydrostatic cumulus cloud model with bin-resolved microphysics was developed to investigate the interaction between aerosols and clouds. The ice nucleation process by bacteria was simulated and the relationship between this process and graupel formation was determined. On one important aspect of the global aerosol indirect effect, this finding will improve estimation accuracy of radiation budget of the Earth with the aerosol-climate model.

Keywords: bacteria, ice nucleation, modelling

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

MS005 **Poster presentation** **5165**

Contribution of fungi to primary biogenic aerosols in the atmosphere: active discharge of spores, carbohydrates, and inorganic ions by Asco and Basidiomycota

Mr. Wolfgang Elbert

Philip E. Taylor, Ulrich Poeschl

Spores and related chemical compounds from actively spore-discharging Ascomycota (AAM) and actively spore-discharging Basidiomyc ota (ABM) are primary biogen ic compon ents of air particu late matter (characteristic size range: 1- 10 m, characteristic bo undary layer co ncentrations: ~10^3-10^4 m^-3). Measurement results and bud get calculations based on investigations in Amazonia (Balbina, Brazil, July 2001) indicate that the forcible discharge of fungal spores may account for a large pr oportion of coarse air particulate matter in tropi cal rainforest region s during the wet season (0.7-2.3 g m^-3). For th e particle diameter range of 1-10 m, the estimated proportions are ~ 25 % during day-time, ~ 45 % at night, and ~35 % on average. For the sugar alcohol, mannitol, the budget calculations indicate that it is suitable for u se as a molecular tracer f or active ly discharged basidi ospores (ABS), and that t he literature-derived emission ratio of about 5 pg per ABS may be taken as a representative average. ABM emissions may acco unt for most of the atmo spheric abund ance of mannitol (10-68 ng m^-3), and can explain the observed diurnal cycle (higher abundance at night). ABM emissions of hexose carbohydrates might also account for a signi ficant proportion of glucose and fructose in air particulate matter (7-49 ng m^-3), but the literature-derived ratios ar e not co nsistent with the o bserved diurnal cycle (lowe r abundance at night). AAM e missions appear to acco unt for a large p roportion of potassiu m in ai r particulate matter over tropical rainforest regions during the wet season (17-43 ng m^-3), and they can also explain the observed diurnal cycle (higher abun dance at night). The results of our investigations and budget calculations for tropical rainforest aero sols are co nsistent with measurements performed at other locations. Based on the average ab undance of ma nnitol in particula te matter, which is co nsistent with the above emission ratio and the observed ab undance of ABS (~10^3-10^4 m^-3), we have also calculated a value of ~ 17 Tg yr^-1 as a first estimate for the global aver age emission rate of ABS over land surfaces. Comparisons with estimated rates of emis sion an d form ation of other major types of organic aerosol (~ 47 Tg yr^-1 of anthropogenic primary organic aerosol; 12-70 Tg yr^-1 of secondary organic aerosol) indicate that emissions fr om acti vely spo re-discharging fungi sho uld be taken into account as a significant source of organic aerosol. Their effects might be particularly important in tropical regions, where both physicochemical processes in the atmosphere and biological activity at the Earth's surface are particularly intense, and where the abundance of fungal spores and related chemical compounds are typically higher than in extratropical regions.

Keywords: fungal spores, primary organic aerosol, emission rate estimate

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

MS005 **Poster presentation** **5166**

Biological characterization of atmospheric aerosol particles

Mrs. Janine Nowoisky

Cimbal Julia, Klose Melanie, Conrad Ralf, Andreae Meinrat O., Pschl Ulrich

Aerosol particles are of central importance for atmospheric chemistry and physics, climate and public health. A significant fraction of the atmospheric particles are of biological origin, e.g. bacteria, bacterial and fungal spores, pollen, plant and animal fragments, etc. So far, however, the abundance, diversity, sources, properties and effects of biological particles in the atmosphere have not been well characterized. The use of molecular genetic methods resolves many limitations of traditional detection methods for the analysis of biological aerosol particles. In this study, air filter samples were collected with a High Volume Sampler separating fine and coarse particles (aerodynamic cut-off diameter 2.5m) over a period of one year 2006/2007 in Mainz, Germany. The samples were analyzed for the presence of fungal, plant, bacterial and archaeal DNA. All PCR products were cloned and several clones sequenced. The sequences were blasted in the National Center for Biotechnology Information databank to find the closest match and determine the taxonomy of the organisms from which the DNA had originated. Fungal DNA was detected on coarse and fine particle filters. Preliminary results show high taxonomic diversity for the 161 fungal sequences obtained from coarse particle samples. The sequences were characteristic for different groups of Ascomycota and Basidiomycota, which are known to actively discharge spores into the atmosphere. Ten genera within the phylum Basidiomycota were found. Eight of them belong to the class Homobasidiomycetes and some of them include species which can act as plant pathogens or human allergens (e.g. Stereum). Few sequences belong to the genus Itersonilia within in the class of the Heterobasidiomycetes. Among them are typical plant pathogens. Further the allergenic genus Sporobolomyces was detected from the Basiodiomycota class Urediniomycetes. The sequences within the Ascomycota belong to the genera Cladosporium (an important allergen) and Epicoccum (a soil and litter fungus and allergen) as well as to some other genera which include plant pathogen species (e.g. Stemphylium). The plant sequences could be attributed to green plants, within the families Betulaceae (e.g. birch), Poaceae (e.g. barley), Plantagiaceae (e.g. plantain), Urticaceae (e.g. nettle), Taxaceae (e.g. yew), Cupressaceae (e.g. fir) and moss spores within the Bryophyta moss superclasses. Bacterial sequences could be attributed to Proteobacteria, Actinobacteria and Bacteroidetes, which are known to be widespread in the atmosphere. Archaeal DNA could also be detected on the coarse particle filters and the first sequence analysis points to high similarity with Archaea and Crenarchaeota environmental sample sequences. Besides Pro- and Eukaryotes, Archaea represent the third domain of life and are potentially the most abundant organism group on Earth. They are bacteria-like microorganisms which are mostly found under extreme environmental conditions and have the capability of living in almost all kinds of environments, including different kinds of soil, ocean water and sediments.

Keywords: bioaerosol, dna, fungi

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MS005 **Poster presentation** **5167**

Snowborne taxa characterization and Impact on Ice nucleation

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Roya Mortazavi, Parisa Ariya

Little is kn own abou t sn ow-atmosphere chemical interactions, despite t heir potential implications in climate change [Domin and Shepson, 2002]. Snow sa mples were taken at several sit es of an urban setting of Montreal, Canada d uring winter 2005 and 2006. We will present our results on the identified bacteria and f ungi micro organisms, and their abunda nce. We have also perfo rmed complementary microphysics experiments on their importance as ice nuclei. We will discuss potential importance of our results and existing uncertainties on snow-atmosphere interactions.

Keywords: ice nucleators, snow, bioaerosols

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MS006 **5168 - 5196**

Symposium
Ice Microphysics: Theory and Measurement (ICCP) merged with MW001

Convener : Dr. Paul Field, Dr. Alexei Korolev, Dr. George Isaac

Results of experimental and theoretical studies of ice initiation and its following transformation in clouds are expected on topics including: observation of first ice formation and secondary ice production, concentration of small ice particles, metamorphosis of ice particle shapes in clouds, mechanisms of growth of ice particles by deposition, aggregation and riming, laboratory and theoretical studies of ice growth, effect of dynamics and radiation on ice formation, ice nuclei measurements, of homogeneous and heterogeneous ice nucleation, parameterization of ice concentration in numerical models, explanation of ice particle size distribution, instrumentation for in-situ measurements, remote sensing of cloud ice particles, validation and accuracy of ice measurements

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MS006 **Oral Presentation** **5168**

The Chemical Composition of Ice Nuclei in Ice and Mixed Phase Clouds

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Stphane Gallavardin, Hanna Herich, Livia Keller, Paul Demott, Daniel Murphy, Ulrike Lohmann

The 2001 IPCC report notes that one of the largest uncertainties in our current understanding of climate change can be attributed to a poor understanding of the complex relationship between aerosol particles and clouds. It is generally understood how changes in aerosols (e.g., number density, size distribution, and chemical composition) can impact cloud properties (e.g., lifetime, optical depth, and glaciation) but specific cause and effect links are almo st co mpletely lacking. A number o f recent advances in instrumentation have allo wed us to tackle this pro blem i n a new way. Inertial separation techniques, such as co unterflow virtual impaction, are now much better understood and this allows for the efficient separation of clou d elements. Single particle mass spectrometers, first successfully implemented in the 1990s, now pe rmit the deter mination of th e chemical composition of the particles which formed these cloud elements in situ and i n real time. Using th ese tec hniques we have been able to study those aerosols which nucleate ice in several cloud types. Studies conducted from 2001 through 2005 at Storm Peak Laboratory and from aboard a NASA WB-57F aircraft studied cir rus clo ud fo rmation. Studies conducted during 2005 and 2006 at the high Alpine research sta tion Jungfraujoch permitted investigation of ice nucleation within mixed-phas e clouds. The composition of the ice nuclei was dominated by mineral dust with lesser contribution s of other insoluble species. These results are important in any attempt to mode l the ice and mixed-phase cloud syst ems which are known to be important to our understanding of climate as well as the initiation of precipitation.

Keywords: ice, nuclei, composition

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MS006 **Oral Presentation** **5169**

Studies towards the understanding of ice microphysics in mixed-phase clouds

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Tempei Hashino, Gregory J. Tripoli, Edwin W. Eloranta

The correct parameterization of ice microphysics in mixed-phase cloud situations remains a formidable challenge. Work being completed at the University of Wisconsin Madison aims to better our understanding of these complex systems in order to better simulate their presence in both cloud-resolving and global scale models. Observationally, algorithms designed using data from the University of Wisconsin Arctic High Spectral Resolution Lidar (AHSRL), in combination with a NOAA Millimeter Cloud Radar (MMCR) continually retrieve cloud properties such as phase, particle effective size, number density, cloud base height, cloud thickness and water content. To date, this combination has provided over a year of observations from a high-latitude location. This information, along with data from a ground based radiometer, interferometer, radiosonde launches, and other aerosol and microphysical probes combine to form a climatological dataset of parameters having to do with the existence of boundary layer mixed-phase clouds. This dataset is utilized as a source of information as well as a source of validation for simulations of mixed-phase cloud scenarios. A numerical study is being completed using the University of Wisconsin Non-Hydrostatic Modeling System (UW-NMS), along with its new microphysical module, the Advanced Microphysical Prediction System (AMPS). The Spectral Habitat Ice Prediction System (SHIPS) handles the ice microphysics in AMPS, predicting quantities such as a-axis length, c-axis length, dendritic axis length, irregular polycrystal length, bullet rossette length, circumscribed volume, soluble aerosol mass, insoluble aerosol mass, mass produced by riming process, mass produced by melting, mass produced by vapor deposition. These quantities allow for the formation and growth of any type of ice particle. Using this unique framework, this study is aiming to understand the frequently observed longevity of the unstable mixed-phase situation, and the proper handling of ice initiation and growth in this environment. Results from simulations as well as examples of observations will be presented and discussed.

Keywords: mixed phase, microphysics, remote sensing

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MS006 **Oral Presentation** **5170**

The ice growth equation solution by utilizing truncated ice spectra

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The mechanis m of ice growth is considered theore tically in bulk m icrophysics scheme. The most important equation within this scheme is the integrand form of stochastic collection equation. The exact solution of this equation that involves general hypergeometric functions is not applied yet in praxis due to computation al expense. We therefore pr opose the new treatment of collection equation by utilizin g the truncated spectra within observed boundaries instead of conventional approach involving interacting particles with diameters between zero and infini ty. We introduce both the approximate solution involving the incomplete gamma func tions and the exact solution that differs from previous one for a term with convergent power series. The charac teristics of new solutions are testing through comparisons b etween approximate an d exact soluti ons for new and conv entional approach as well as between exact solutions of both treatments. We analyze most in teractions invol ving in model microphysics. Two kin ds of i nteractions are an alyzed separately: fast-falling particles with slow-falling collected ones and slow-falling partic le with fast-falling collected ones . General conclusion that follows from differen t comparison s is th at th e u se of solu tions w ith the new approach is better in almost all cases analyzed. Such treatment leads to sm aller difference between the approximate and exact solution for rain/snow, graupel/snow and graupel/rain interactio ns. We pr opose the exact solution w ith truncated spectra fo r rain/graupel interactio n beca use the former exact solution take s considerably lower values. For hail/snow interact ion the exact solution consists only on incomplete gamma functions in contrast with conventional a pproach. For sn ow/rain in teraction th e n ew and former solution differ slightly from each other

Keywords: ice growth, stochastic equation, truncated spectrum

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MS006 **Oral Presentation** **5171**

Microphysics of wave and cirrus clouds

Dr. Brad Baker

Highlights of recent publications (Baker and Lawson 2006, Lawson et al. 2006) on microphysics of wave and cirrus clouds are presented. Wave cloud results include: A presentation of both the complexity and the potential simplicity of wave clouds and the concept of using wave clouds as natural laboratories. A large data set (17 wave cloud missions) is segregated according to the observed number of cycles of condensation and glaciation within the same cloud. Well-behaved wave clouds exhibit only one such cycle and may be considered natural laboratories for the study of cloud microphysical processes. This is evidenced by the replication of earlier results on the onset of riming of columnar crystals (Ono 1969), if and only if data from well-behaved clouds are considered. Other results of Ono (1969) on the maximum width of columnar ice are contradicted. New results for the onset of riming of rosette crystals and for the onset of side plane growth are derived from the same data set. Examples of copious ice production coincident with the evaporation of the super cooled liquid have been reported in earlier wave cloud studies (Cooper 1995, Field et al. 2001, Heymsfield and Miloshevich 1993). This mysterious observation is well documented and nearly ubiquitous, in this new larger data set. Thus, the phenomenon is observationally well established. However only speculative explanations exist, making the study of wave clouds a priority of cloud physics research. Resolution of this mystery may go a long way toward s understanding the general problem of ice in the atmosphere. Cirrus cloud results include: The similarity of cirrus cloud microphysics to wave cloud microphysics but on larger temporal and spatial scales; the existence of high concentrations of small ice crystals; the application of a large (15000 Km) in situ cirrus data set to global climate model parameterizations. References Baker, B. A., and R. P. Lawson, 2006: In situ observations of the microphysical properties of wave, cirrus and anvil clouds. Part 1: Wave Clouds. J. Atmos. Sci. 63, 3160318 5. Cooper, W. A., 1995: Ice formations in wave clouds: Observed enhancement during evaporation. Preprints: AMS Conf. On Cloud Physics, January 1995, 147-152. Field, P. R., R. J. Cotton, K. Noone, P. Glantz, P. H. Kaye, E. Hirst, R. S. Greenaway, C. Jost, R. Gabried, T. Reiner, M. Andreae, C. P. R. Saunders, A. Archer, T. Choularton, M. Smith, B. Brooks, C. Hoell, B. Bandy, D. Johnson, and A. Heymsfield, 2001: Ice nucleation in orographic wave clouds: Measurements made during INTACC. Q. J. R. Meteorol. Soc., 129, 19031927. Heymsfield, A. J., and L. M. Miloshevich, 1993: Homogeneous ice nucleation and supercooled liquid water in orographic wave clouds. J. Atmos. Sci., 50, 2335-2353. Lawson, R. P., B. A. Baker, B. Pilson and Q. Mo, 2006: In situ observations of the microphysical properties of wave, cirrus and anvil clouds. Part 2: Cirrus Clouds. J. of Atmos. Sci., 63, 3186-3203. Ono, A., 1969: The shape and riming properties of ice crystals in natural clouds. J. Atmos. Sci, 26, 138-147.

Keywords: wave cloud, riming onset, ice in clouds

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MS006 **Oral Presentation** **5172**

Polycrystal Formation through the Freezing Nucleation Processes

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This study provides a theoretical evidence for the formation of polycrystals through the freezing nucleation processes, which is one of the mechanisms proposed in the literature (Pruppacher and Klett, 1997). Recent observations in clouds and laboratory indicate that polycrystals including rosette-shaped crystals are a dominant habit especially in the middle and upper levels (T<-20C). Clouds in this region are known to have large impacts on the energy budget of the earth through radiative forcing. Also, the polycrystals with spatial structure can be important in the precipitation process. The authors have developed a Spectral Habit Ice Prediction System (SHIPS) which explicitly simulates the evolution of ice particles (habits and types) based on their history and ambient conditions in an Eulerian dynamic framework. SHIPS nucleates either monocrystals (hexagonal crystals) or polycrystals (bullet rosettes, side planes and irregular polycrystals) based on the habit frequency data constructed from laboratory experiments conducted by Bailey and Hallet (2004). In addition to microphysical processes, sedimentation and mixing can change the habit frequency that ultimately results at a particular location. Two-dimensional simulations with different combinations of CCN and IN distributions, and freezing nucleation rates were conducted for a winter orographic storm observed during IMPROVE-2 and a stratiform cloud from FIRE ACE. The habit frequency obtained from the simulations will be compared and discussed with available observations of habit frequency.

Keywords: polycrystals, nucleation, habit

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MS006 **Oral Presentation** **5173**

In Situ Microphysical Measurements of Subvisible Cirrus Near the Tropical Tropopause

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IAMAS

Bryan Pilson, Brad Baker, Qixu Mo, Eric Jensen

Subvisible cirrus (SVC) have been shown to have a significant effect on the earths radiation budget, and may play a role in freeze-drying of the tropical stratosphere. In situ microphysical observations of SVC between 8 degrees north latitude and the equator were collected using the NASA WB-57F research aircraft during the Costa Rica - Aura Validation Experiment (CR-AVE) in January 2006. The observations were taken near -85 C (17 to 18 km) and included ice particle size, shape, concentration, ice water content and relative humidity. Instrumentation included a cloud particle imager (CPI), a 2D-S (stereo) probe, a forward and backward scattering probe (CAS), the Harvard Integrated Cavity Output Spectroscopy (ICOS) water vapor probe and aerosol chemistry from the Particle Analysis by Laser Mass Spectrometry (PALMS) instrument. These are the first in situ observations of subvisible cirrus that include a large dataset of digital images of the size and shape of tropical ice particles at -85 C, and the first image of ice particles in SVC since 1973. The data set is markedly different than the data set collected with a replicator in 1973, which suggested that the particles were mostly columnar and trigonal ice, which did not exceed about 50 microns in size. In contrast, the CR-AVE data shows that 84% of the particles are quasi-spherical in shape, and that the particles larger than about 65 microns are plates, with the largest particles having a maximum dimension up to 160 microns. The ice particles are almost always observed in an environment where the ICOS relative humidity w.r.t. ice (RHice) exceeds 120%, and sometimes exceeds 200%, which is where the largest particles are generally observed. Microphysical properties of the SVC clouds averaged over 1,700 km of flight data are presented and discussed. A numerical model that simulates ice particle growth in this environment suggests that the very high RHice (i.e., order 200%) is required to grow 100-micron ice crystals within 500 m of the tropical tropopause, where some of these large crystals are observed. This rekindles a long-standing discrepancy between airborne measurements (such as ICOS) and balloon-borne chilled-mirror measurements, which suggest that RHice is substantially less than the ICOS values. Chemistry measurements onboard the WB-57F show that the aerosols are mainly mixed organics and sulfates. The contributions of high RHice and unusual aerosol chemistry to the growth of these large particles, which are markedly different in size and shape from ice particles observed in SVC in 1973, may require cloud chamber experiments to understand.

Keywords: subvisiblecirrus, tropicaltropopause, microphysics

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MS006 **Oral Presentation** **5174**

Small ice particles: myth or reality?

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J.W. Strapp, G.A. Isaac

During last ten years there has been an ongoing debate about the presence and concentration of small ice particles (5-50um) in ice clouds. Small ice particles have great importance in the understanding of the evolution of ice clouds, formation of mixed phase, and may have a significant impact on radiative transfer in clouds. In-situ observations indicate that the average concentration of small ice particles is a few per cubic centimeter, independent of temperature in the range from -5C to -40C. Confusion has arisen due to the fact that small ice particles are usually observed in all ice clouds, including zones of ice precipitation and ice sublimation, where small ice particles at high concentrations are not expected. Recent studies suggest that small ice particles may result from the shattering of larger ice particles impacting the inlets of aircraft instruments, the fragments of which may bounce into the sample volume of the probes. These studies are balanced by work suggesting that instruments like FSSP are not affected by shattered ice if ice particles are smaller than about 500um. In order to attempt to solve this problem Environment Canada has developed a transmissiometer for measurements of the extinction coefficient of clouds. The probe consists of the transmitter and receiver mounted a few meters apart, and therefore any shattering at the edges of the sample volume are expected to be negligible relative to other instruments with much smaller sample lengths. The transmissiometer was deployed on the NRC Convair 580 and flown during the CloudSat Calipso Validation Program during the winter of 2006/07. The extinction coefficient measured by the transmissiometer was compared to that calculated from size distribution measured by PMS FSSP, OAP-2DC and OAP-2DP. The comparisons of these measurements have permitted some conclusions about the presence of small ice particles. The results of this study will be presented at the Ice Microphysics Session of IUGG Symposium in Perugia,

Keywords: small, ice, measurements

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MS006 **Oral Presentation** **5175**

Aerosol influence on mixed-phase clouds in CAM-Oslo

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A new treatment of cold cloud microphysics has been implemented in the general circulation model CAM-Oslo, an extended version of NCAR CAM 2.0.1. The new treatment takes into account the aerosol influence on ice phase initiation in clouds with temperatures between 0oC and -40oC. Previously, the model supersaturation was simply assumed to be a weighted mean of the supersaturation with respect to water and ice between 0oC and -20oC, the weights being determined by temperature. Similarly, the cloud ice fraction was determined by temperature only within the same temperature-range.Currently, both supersaturation and cloud ice fraction are determined based on a physical reasoning where not only temperature but also the ambient aerosol concentration plays a role.Included in the improved microphysics treatment is also a continuity equation for ice crystal number concentration. Ice crystal sources are heterogeneous and homogeneous freezing processes and ice multiplication. Sink terms are collection processes and precipitation formation, melting and sublimation. The heterogeneous freezing processes are dependent on the ability of the ambient aerosols to act as ice nuclei. Additionally, the processes are dependent on the cloud droplet number concentration and hence the aerosols ability to act as cloud condensation nuclei.Sensitivity simulations based on the new microphysical treatment of cold clouds are presented for both pre industrial and present day aerosol emissions. The effect of anthropogenic aerosols on freezing mechanisms seems to represent a warming of the earth-atmosphere system, counteracting the cooling effect they have through their effect on warm clouds. In our model simulations, this reduction in magnitude of the total aerosol indirect effect amounts to 50-90%.

Keywords: aerosol, freezing, clouds

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MS006 **Oral Presentation** **5176**

Experimental observations of heterogeneous ice nucleation of mineral dust

Mr. Gourihar Kulkarni
Ice Microphysics: Theory and Measurement (ICCP) MS006 IAMAS

Steven Dobbie, Mike Smith, Jim Mcquaid

The role of mineral dust as heterogeneous ice nuclei in ice and mixed phase clouds is not well understood. Uncertainties associated with heterogeneous ice nucleation impacts on the formation and evolution properties of these clouds and can have important implications for the extent and duration of cloud, which ultimately impacts climate. Laboratory investigations are carried out using a newly developed static diffusion chamber to investigate the ice nucleation properties of mineral dust particles, collected from various locations across the Saharan desert (during AMMA campaign) and Spain. The experimental setup is designed in a way that it produces ice supersaturation (SSi) and a linear temperature gradient profile inside the chamber. The unique quality of the chamber is that it allows dust particles mounted on a hydrophobic substrate (which can be raised and lowered) to be exposed to a range of temperature and corresponding SSi values. The advantages of this technique are a reduction in temperature uncertainties and also the same dust particles can be exposed many times to different SSi values. The present study focuses on the role of mineral dust particles as heterogeneous ice nuclei at temperatures between -15 and -30 degree C, and at various humidities below water saturation. The static diffusion chamber is used to determine the onset of nucleation; SSi and temperature values of nucleated ice particles is observed, and the corresponding nucleation rate is determined. The ice formation is observed using a microscope-digital camera. It was found that the onset of nucleation occurs at low SSi values between 103 and 108% for all dust samples. The spatial variation of source regions does not appear to have a significant impact on the onset SSi. At lower temperatures, the onset SSi values are greater than at warmer temperatures. It is also observed that the onset nucleation time and nucleation rate is sensitive to SSi, temperature, and source region.These sensitivities ofice nucleation may be due to surface area and inhomogeneity in chemical composition of the mineral dust particles. Elemental composition and morphological analysis illustrates this inhomogeneity.Implications for stochastic or deterministic nucleation are discussed. Additional studies in quantifying the nucleation onset and rate as a function of temperature for nuclei of different composition and of a wide range of characteristic temperatures are underway and will be discussed.

Keywords: ice nucleation, ice nuclei, mineral dust

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MS006 **Oral Presentation** **5177**

Observations and modelling the heterogeneous freezing mechanism

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Ottmar Moehler, Martin Gallagher, Stephan Benz, Thomas Choularton

Measurements of ice particle formation by the heterogeneous freezing mechanism are presented from 4 experiments at the AIDA facility, FZK GmBH, Karlsruhe - a large aerosol vessel that is capable of being 'under pressured' and is well suited for studying cloud formation. The experiments were conducted in the following mannor; an aerosol population of known composition and size distribution were introduced in to the 84m3 chamber at conditions that were below those required for ice saturation. The temperature was in the range of 0 to -30degC and the total pressure started at 1000 mbar. At the start of the experiments, the air from the chamber was partially evacuated to approximately 700 mbar, which firstly resulted in liquid condensation on the aerosol population to form a cloud of dropletsand then freezing of these droplets, not all the droplets froze, but they rapidly evaporated following freezing due to the Bergeron-Findeisen process. At the end of the experiments, the saturation ratio went to ice saturation. The reasons for this are (1) growth of the ice phase which removes water vapour from the gas phase and (2) warming of the chamber gas, which increases the saturation vapour pressure. The second effect is due to the chamber acting as a large thermal buffer, consequently, the expansion is not adiabatic and cannot be simulated with normal adiabatic assumptions. The resulting cloud of droplets and ice particles were measured with a White light spectrometer probes (WELAS, 0.1<d<40 microns), a Cloud Particle Imager (CPI, 10<d<2000 microns).With these measurementswe were able to identifythe fraction of aerosol particles freezing for the conditions within the chamber. Also, the water vapour and total water contents were measured with a tuneable diode laser and a Fast In-situ Stratospheric Hygrometer (FISH) probe respectively, which enabled us to evaluate the ice saturation ratio and the contribution to water from the ice coated walls of the chamber. A numerical model has been developed at the University of Manchester and was applied to the exactconditions that were measured within the chamber; the model includes the salient microphysical processes important to ice nucleation: there is a detailed descripition of the condensation, deposition and the current theory for the nucleation process. In this contribution we will compare the results from the freezing experimentsto the current theories within the literatureof heterogeneous ice formation via the freezing mechanism. The results have use in improving our understanding of the ice nucleation process for a more accurate assessment of the effects on climate.

Keywords: freezing, aerosol, model

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MS006 **Oral Presentation** **5178**

Ice nucleation efficiency of mineral dust particles coated with sulphuric acid and secondary organic aerosol

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Stefan Benz, Richard Cotton, Dan Cziczo, Karl Froyd, Stephane Gallavardin, Andrew Heymsfield, Carl Schmitt, Johannes Schneider, Joseph Ulanowski, Saskia Walter

Mineral dust particles from various source regions, mainly deserts in Africa and Asia , are considered t o be among t he most efficient heterogeneous ice nu clei in the atmosphere and ther eby af fect the formation and radiative properties of mixed-phase and cirrus clouds. It is among the major challenges in cloud physics to improve the detailed understanding of hetero geneous ice nucleatio n and to develop parameterisations for the representation of heterogeneous ice nucleation in cloud and climate models as a function not only of temperature and humidity but al so of aerosol parameters.Thi s contribution addresses the effect of coating with sulphuric ac id and secondary organic aerosol matter from th e ozonolysis of a-pinene on th e ice n ucleation efficien cy of mineral dust particles. The AIDA (Aerosol Interaction and Dynamics in the Atmo sphere) facility o f Fo rschungszentrum Karlsruh e was used fo r heterogeneous ice nucleatio n studies under simulated cloud co nditions. The ice fo rmation rates o n untreated and coated mineral dust aerosol particles were compared to each other in su bsequent cloud expansion experiments with so-called Ariz ona Test Dust and illite used as reference mineral dust aerosols. Two series of exper iments were c arried out at mixed-phase a nd cirrus cloud temperatures. During the se experiments th e AIDA facility was equipped with a co mprehensive in strumentation fo r aerosol, ice nuclei, and ice particle characterisation which included important contributions from external partners like an aerosol mass spectrometer (AMS) from the Max Planck Institute for Chemistry in Mainz, Germany, the single particle mass spectr ometer PALMS from the NO AA lab in Boulder, Colorad o, currently operated at the E TH in Zurich, Switzerl and, a pumped counterflow virtual impactor for selective ice p article sampling form the NOAA lab in Boulder, Colorado, the small ice d etector (SID-2) from the University of Hertfor dshire and the Met O ffice, UK, and two ice imaging instruments, a cloud particle imager (CPI) and a video imaging particle sampler (VIPS), from NCAR in Boulder, Colorado. The poster will su mmarize the e xperimental methods and gi ve an overview of major results, in particular regarding the effect of coating on heter ogeneous ice nucleation effi ciency in the deposition and immersion mode as a function of temperature and ice supersaturation ratio.

Keywords: aida, ice, mineral

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MS006 **Oral Presentation** **5179**

First results from the GEWEX GCSS WG2 cirrus inter-comparison study of March 9, 2000 ARM IOP at SGP

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Huiyi Yang, Damian Wilson, Gerald Mace, Andy Ross

The GEWEX Cloud Systems Study (GCSS) Working Group 2 focuses on inter-comparisons of cirrus cloud models. On Feb 26, 2007 the new inter-comparison study was announced and distributed. The focus of this new inter-comparison has been to base the study on a well observed case. The observed case selected is March 9, 2000, during the ARM IOP at Southern Great Plains, USA. For this day, we have been able to make use of a wide variety of remotely sensed and in-situ radiosonde and aircraft observations for the study. The last WG2 cirrus inter-comparison highlighted that cirrus models predict widely different values of IWP with time even for a simple case study. The last study noted a variation of an order of magnitude. There has been a need to establish a case study in which a comparison of the models can take place not only between different models, but tested against observations. We have aimed to establish this in the new inter-comparison study. This presentation will summarize the case study and present the findings of the UK Met Office LEM model runs at Leeds, illustrating comparisons with observations. We will also show results from the first analysis of the inter-comparison of models.

Keywords: cirrus, gcss, inter comparison

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MS006 **Oral Presentation** **5180**

Snow size distribution parameterization for midlatitude and tropical ice clouds

Dr. Paul Field
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Andrew Heymsfield, Aaron Bansemer

Many microphysical process rates involving snow are proportional to moments of the snow particle size distribution (PSD) and in this study we propose a moment estimation parameterization applicable to both midlatitude and tropical ice clouds. To this end aircraft snow PSD data were analyzed from tropical anvils (TRMM/KWAJEX, CRYSTAL-FACE) and midlatitude stratiform cloud (FIRE, ARM). Using half of the dataset, we computed moments of the PSDs and generated a parameterization for estimating other PSD moments when the second moment (proportional to the ice water content when particle mass is proportional to size squared) and temperature are known. We subsequently tested the parameterization with the other half of the dataset to facilitate an independent comparison. The parameterization for estimating moments can be applied to midlatitude or tropical clouds without requiring prior knowledge of the regime of interest. Rescaling of the tropical and midlatitude size distributions is presented along with fits to allow the user to recreate realistic PSDs given estimates of ice water content and temperature.

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MS006 **Oral Presentation** **5181**

Laboratory Studies on the Ice Nucleating Ability of Mineral Dust Doped with Traces of Heavy Metals

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Daniel Cziczo, Ulrike Lohmann

Recent studies o n ice nucleatio n have sho wn that mineral dust samples are among the most efficient aerosol particles in activating ice under at mospheric con ditions. There is some evidence from these studies that the ice nucleating efficiency is increased in those particles that are sl ightly enriched in their heavy metal content. In this study we carried ou t experiments with mineral dust sa mples with and without trace amounts of heavy metals added. Th ese particles are t hen brought into the newly constructed Zurich Ice Nucleation Chamber (ZINC) to study their efficiency in forming ice crystals unde r supersaturated conditions. The ZINC instrument is based on the principle of a Continuous Flow Diffusion Chamber, which was first used to study ice nucleation under atmospheric conditions by David Ro gers. Briefly, the instrument consists of two opp osing para llel plates, which are actively cooled to different temperatures. The inner wall s of this chamber are co vered with a thin layer of ice to maintain ice saturation at the correspondi ng wall temperature. Due to the temperature difference, gradients in temperature and water vapour partial pressure lead to a supersaturation with respect to which, to which the aerosols under investigation are exposed. This paper discusses results of experiments done with the aforementioned mineral dust samples where traces of heavy metals were added.

Keywords: ice nucleation, supersaturation, mineral dust

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MS006 **Oral Presentation** **5182**

High Ice Particle Concentrations in Stratiform Layer Clouds

Dr. George Isaac
NA NA IAMAS

Alexi V. Korolev, Ismail Gultepe, Stewart G. Cober, J. Walter Strapp, Faisal S. Boudala, Monika Bailey, John Hallett

Environment Canada has made measurements in stratiform cloud layers for many years. Ice particle concentrations are much higher than can be explained by conventional ice nucleus measurements or by re-circulation of ice from colder temperatures. Ice particle concentration number frequency distributions appear to be the same over a wide temperature range. Ice particle size spectra consistently show larger numbers of particles at smaller sizes, suggesting that small particles are being produced continuously. An interesting case study during profiles made within a freezing rain layer over an airport showed the freezing rain suddenly freezing near the surface at temperatures close to -5oC with the sudden emergence of a high concentration of needles. Ice multiplication was probably occurring during this case. Overall, the evidence suggests that either ice multiplication is occurring in the atmosphere over a wide temperature range, and/or ice nucleation is occurring through mechanisms not well simulated with current ice nucleus counters. Some potential explanations for the existence of these high ice particle concentrations will be discussed.

Keywords: ice, nucleation, clouds

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MS006 **Oral Presentation** **5183**

2. The Definitions of Atmospheric Ice Particles

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This paper proposes a possible frame for a new classification of atmospheric ice particles. The present WMO classification for daily weather observations was established ~60 years ago. It is useless because it concentrates on (nice) pristine ice crystals. The majority out of 10 code numbers is reserved for them. Snow is not even mentioned and, with many other particles, has to be classified as irregular. As a result, not enough categories are available to describe all the observed complexities of other bulkier particles. This Workshop could address the requirement of some basic components of a classification, such as shape, size, density, liquid component and other properties if available. Do we want the observations to be tied to weather situations? It is also suggested that the classification be limited to particles observed at the ground (with photos contributed by participants). Should we consider the frequency of occurrence in the allocation of categories? How could we use such information in scientific papers? This and other additional information could then be pulled together in a discussion document for submission to WMO.

Keywords: ice crystals, snow, graupel hailstones

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MS006 **Oral Presentation** **5184**

Assessing the Concentrations of Small Ice Crystals in Ice Clouds: Combining In Situ and IR Remote Sensing Measurements

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Subhashree Mishra, Bryan Pilson, Qixu Mo

The radiative properties of cirrus clouds rest on the cirrus microphysical properties. A description of cirrus microphysical properties has been elusive due to the many ice crystal shapes, the unpredictable behavior of the ice particle size distribution (PSD), the different dynamics through which cirrus clouds form, and the uncertainty over the concentrations of small ice crystals. While it will take time to meet all these challenges, some progress has been made on each of these points. First, PSD data were obtained from 22 flight missions in mid-latitude cirrus clouds, containing 104 horizontal legs and 15,000 km of in-cloud sampling. The FSSP sampled ice particles from 2-20 μm, the Cloud Particle Imager (CPI) from 20-200 μm, and the 2DC from 200-2000 μm. A new method was developed to accurately describe these continuous spectra in terms of two gamma functions, since ice cloud optical properties may be accurately calculated through gamma functions. This ability to accurately quantify the measured PSD as two gamma functions was the key to developing a PSD parameterization. This new PSD scheme for mid-latitude cirrus can closely reproduce the mean observed PSD and effective diameter (De) for a given temperature interval using only temperature (T) and the ice water content (IWC) as input. Observed PSD for single flight legs for a given T interval generally resemble the predicted PSD, but De has a standard deviation of 45% of the mean De. This De variability is primarily due to variability in the concentration of small (D < 60 μm) ice crystals. Ice particle shape is quantified through the ice particle mass- and projected area-dimensional power laws. A new method makes it possible to extract these power laws from the shape of the PSD and measured IWC or total area for a given temperature interval, where the power laws are representative of the PSD overall. PSD predicted by this PSD parameterization were corrected to account for the potential shattering of larger ice particles at the FSSP inlet, based on the work of Paul Field. This correction had little impact on PSD for T < -30 oC. This PSD scheme was then tested using infrared radiance measurements from the Atmospheric Emitted Radiance Interferometer (AERI), using the ratio of absorption optical depth (AOD) at 8.5 and 11.0 μm. This AOD ratio was also predicted from the PSD using the modified anomalous diffraction approximation (MADA) to calculate optical properties. This AOD ratio is very sensitive to the concentrations of small ice crystals, and if measured and predicted AOD ratios generally agree, this suggests that, to a first approximation, the in situ measurement of small ice crystals was representative of natural cirrus. These comparisons will be presented at the meeting. A similar PSD scheme for continental anvil cirrus is now being developed and undergoing a similar analysis using AERI measurements, and these results will also be presented at the meeting. Due to their ability to approximate leg-averaged PSD, these PSD schemes may be used to generalize PSD measurements for T between -20 and -65 oC. PSD predicted from theory in cloud resolving models (CRM) or GCMs could then be tested against these measurement-based PSD. Alternatively, PSD and corresponding ice particle mass- and area-dimensional relationships given by these parameterizations could be used directly in CRMs and GCMs to describe much of the cirrus microphysics.

Keywords: ice crystals, ice clouds, psd

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

MS006 **Oral Presentation** **5185**

The Impact of Controversial Small Ice Crystals on GCM Simulations

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Philip J. Rasch, Dorothea C. Ivanova, Greg Mcfarquhar, Timo Nousiainen

The concentrations of small crystals in ice clouds having length D < 60 mm remains controversial due to (1) difficulties in measuring these crystal sizes and (2) the inability of existing theory to explain their high concentrations (typically 500-5000 L-1). Various instruments used to measure the size distribution (SD) of these small crystals include the FSSP, the CPI/2DC, the CAPS, the 2DS, and others. It is often not clear what percentage of the small crystal concentration is due to shattering of larger ice particles at the instrument inlet. We have asked the question if these small ice crystals are real, how will they impact the performance of Global Climate Models (GCMs)? To answer this question, the GCM must have a realistic treatment of ice particle shapes, the SD shape (including bimodality), ice particle fall velocities (i.e. SD mass sedimentation rates) and ice cloud radiative properties. The GCM experiment described here was not designed with this question in mind, but the results do provide some insight on what the answer might be. In situ FSSP/2DC measurements indicate that the temperature dependence of the SD in mid-latitude cirrus differs appreciably from that of tropical anvil cirrus clouds. Parameterizations of these measurements have been incorporated into the Community Atmosphere Model (CAM) at NCAR, part of the Community Climate Systems Model (CCSM). Both the tropical and the mid-latitude SD scheme are bimodal, with crystals having D < 100 mm comprising the small mode. The amplitude of the small mode in the mid-latitude SD scheme decreases with decreasing temperature, while the small mode of the tropical SD scheme increases with decreasing temperature. The question evaluated in this study was how does the differing temperature dependence of the small mode in these two SD schemes impact GCM simulations? Another question evaluated was does it matter whether one uses a SD scheme for mid-latitude cirrus or tropical anvil cirrus in GCM simulations of climate? The treatment of ice clouds in the CAM was modified by implementing the following schemes: (1) SD schemes for tropical anvil and mid-latitude cirrus predicted from cloud temperature and ice water content; (2) the fall velocity treatment of Mitchell and Heymsfield (2005) for accurate ice sedimentation rates; (3) the Modified Anomalous Diffraction Approximation (MADA; parameterized for GCM use) for accurate treatment of ice cloud radiative properties. Ice crystal shape recipes representative of the small and large particle SD modes were based on CPI data. Using realistic SD and particle shape information, ice sedimentation rates and the cloud life cycle were better represented, as well as cloud radiative properties. One-year CAM simulations were performed using only the tropical SD scheme and only the mid-latitude SD scheme. In the tropical SD simulation, the albedo and emissivity in the upper regions (T < -50 oC) of anvil cirrus was strongly governed by the small mode crystals. Due to their higher concentrations in anvil cirrus, the small crystals have a strong impact on bulk ice sedimentation rates and hence the ice water path (IWP), cloud lifetime and cloud coverage. These fall velocity related factors, along with the direct differences in SD bimodality, dramatically increase the shortwave (SW) and long wave (LW) TOA cloud forcing in the tropics (up to -26 and +20 W/m2, respectively, for annual zonal mean) relative to simulations using the mid-latitude SD scheme. Moreover, SW and LW heating rates were greater using the tropical SD scheme due to greater IWP and SD projected area, respectively. This resulted in temperatures in the upper tropical troposphere about 3 oC greater than those predicted using the mid-latitude SD scheme. These results suggest that the tropical cold bias predicted by some GCMs in this region may be primarily due to an inadequate treatment of ice microphysics (i.e. small ice crystals and their fall velocities) in tropical anvil clouds. These findings may also provide clues to how aerosol particles affect cirrus radiative properties. Assuming that aerosol particles first affect the small mode of

the SD, mid-latitude cirrus (having a less pronounced small mode) would be most vulnerable to the first indirect aerosol effect. Higher aerosol concentrations would most likely increase the small mode amplitude, resulting in greater heating rates. Recent ECMWF reanalysis and satellite measurements indicate a warming in the upper troposphere in the mid-latitudes but much less in the tropics, contributing to a 200 m increase in tropopause height. This is consistent with the postulated indirect aerosol effect for cirrus.

Keywords: ice crystals, gcm simulations

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MS006 **Poster presentation** **5186**

Vapour density field of a mixed-phase cloud

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In mixed-phase clouds it is possible to describe the cloud phase as a function of the proportion between ice water cont ent and liquid water content. The st ructure of the clou d phase af fects the rate of precipitation formation, climate, and the radiative balance and is very important in numerical modelling, remote sensing, satellite ret rievals and cloud el ectrification. For these reasons mixe d-phase cloud microphysics is considered an important top ic in atmospheric sciences. In some atmospheric conditions liquid water droplets evaporate to keep the air at saturation with respect to liquid water and the sm all ice crystals grow by vapour deposition. Thus, ice gr ows at the expense of liquid water b y the so-called Wegener-Bergeron Fin deisen mech anism. The diffu sional growth or ev aporation of ic e crystals an d water droplets are determined by the vapour densit y field aro und the particles, which in turn may depend o n bo th the co nfiguration o f the neighbouring particles and t he particles pl aced at dista nt regions, which can also mak e a significant contribution to the diffusional vapour field. We solved the diffusion equat ion to calculate the vapo ur density field f or a simple configuration of a mixed- phase cloud. The real problem was simplified by assuming: (a) the system is in steady state, (b) both ice particles and cloud droplets are represented by sphe res which do not change size a nd shape; (b) the positions of th e particles are fixed in space; (d) th e system is isother mal. In this case the diffusio n equation is reduced to Laplaces equatio n. The suitable bo undary co nditions are: (1) vapo ur density takes the ice s aturation value at th e surface of the ice particle and the water saturation value at the surface of t he droplets; (2) vapour de nsity takes t he water saturation value at infinit y. The results obtained allow analysis of the influence on the vapour density field around a crystal in the presence of neighbouring crystals. Also, this model allows us to study the vapo ur density among the cloud droplets and ice particles and to dete rmine the resulting 'amb ient vapour density' among the p articles for the configuration o f a particular mixed- phase clo ud. The ambient vapour density is para meterized as a function of the variables o f the system, namely the number co ncentrations of cloud d roplets and ice crystals.

Keywords: bergeron findeisen, crystals, vapour field

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MS006 **Poster presentation** **5187**

Numerical simulation of frontal mixed clouds (microphysical and optical characteristics) and cloud microstructure effect on satellite signal

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Oleksiy Kryvobok, Boris Dorman

The paper is devoted to numerical simulation of frontal mixed, stratiform clouds including the calculation of microphysical and optical characteristics as well as the satellite signal (cloud reflectance in visible and near-infrared channels of the AVHRR radiometer). The simulation is based on the next models: 1. The realistic microphysical model of a mixed stratiform cloud wiyh 3 forms of ice crystals: needles,plates, columns. The dimension distributions of drops and crystals are calculated. The ice nucleation on sublimation and sorbtion nuclei and metamorphosis of ice partcle shapes are considered in the model. 2. Algorithms of calculation of light scattering characteristics for drops (the Mie theory) and crystals(the geometric optics approximation). 3. The Discrete Ordinate Method for simulation of solar radiative transfer in a not uniform cloud and calculation of the cloud reflectance. We will focus our attention on mixed clouds with maximum liquid water content greater than 0.01 g/kg. The frontal dynamic structure was found to determine the phase composition, the form spectrum of crystals, and the efficiency of precipitation formation. If the cloud top level is under the level of - 35 grad. C isotherm plates prevail in such clouds. If the mentioned level is under the level of - 25 grad. C isotherm the efficiency of precipitation formation is so low that the very great total liquid water content (~1mm) accumulates and the cloud optical thickness (COT) achieves a value more than 100 - 150. The crystal concentration in mixed clouds is under 10 in litre, average radii of of plates are equal 500 - 700 mkm, average dimensions of columns 120 - 300 mkm. The COT of mixed clouds for the wave length 0.55 mkm changes within limits of 30 - 180, The cloud reflectance (CR) is equal 0.7 - 0.9 (for the wave length 0.55 mkm) and 0.05 - 0 .15 (for 3,6 mkm). In the case of sorbtion nuclei mixed clouds during evolution (crystallization) become two-layer in terms of the local optical thickness. The ranges of CR-values for mixed and ice clouds are overlapped. But it has been shown that the COT rations for wave lengths 1. 6 mkm and 0.55 mkm R = [COT(1.6 mkm)/COT(0.55 mkm] satisfy very well such conditions: R >1.04 for water clouds, 1.04>R> 1 for mixed clouds, R =1 for ice clouds. On the other hand effective radii reff for water clouds are under 20 mkm whereas for ice clouds reff are over 100 -200 mkm. So these values of R and reff can be used as criteria for distinguishing cloudiness regions with thick liquid water content layers and regions of highly developed crystallization and precipitation formation.

Keywords: frontal, mixed, clouds

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MS006 **Poster presentation** **5188**

Ice initiation by lightning

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In the proposed acoustic-electrostatic model, it was introduced that drops freeze due to an acoustic shock wave of electrical discharge in the cloud. The glaciation process of supercooled drops due to electrical discharge is assumed to occur in two different ways. The first process is the initiation of ice, frozen drops, as a result of the dynamic stress of the sonic waves generated from the lightning discharge. The second mechanism of the glaciation is contact freezing, freezing caused by collisions between ice particles and water drops. Several numerical simulations have been carried out for a different range of temperatures, liquid water content, averaged drop radius, initial energy density of the lightning channel, values of drop charge, and the size of the charged area. The model results show very fast - almost immediate, freezing of one portion of the supercooled water drop and changes in drop spectra distribution.

Keywords: lightning, glaciation, sonic

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MS006 **Poster presentation** **5189**

Experimental study on immersion freezing in mixed-phase cloud conditions

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The present experiment aims at investigating the ice nucleating abilities in the immersion freezing mode of various insoluble aerosol species. Droplets with immersed aerosol particles are produced by activating dry aerosol p articles at warm temperatures. The ac tivation of m onodisperse aerosol particles and subsequent fre ezing o f the c loud dro plets allo ws for pre cise knowledge of the droplet content and simulates the atmospheric pathway in a mixed-phase cloud from dry aerosol particles to ice crystals in the immersion mode. Activati on of aerosol particles is done with a modified water-based condensation particle counter which activates any kind o f particles due to the very high supersaturati on in its gro wth tube. The experiments o n ice nucleat ing ability in the im mersion mode are therefore not restricted to particles which act as CCN. The droplets with a size of roughly 5 micr ometers are le d in to a c ooling section which cools them to a desired experimental temperature down to approximately -40 C. Droplet freezing is initiated in a par allel-plate c ontinuous flow diffusion chamber (ZIN C Zurich Ice Nucleation Chamber). The conditions of this chamber are set in such a way that droplets are exposed to saturation with respect to water. This prevents evaporatio n which co uld influence the dro plet temperature. A depolarisation detector distinguishes between ice crystals and unfrozen droplets for a given temperature at the end of the chamber. The setup for these experiments will be presented.

Keywords: ice nucleation, immersion freezing, droplet activation

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MS006 **Poster presentation** **5190**

Impact of parameterization scheme of ice crystals formation on cloud microphysics and dynamics

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Boryana Tsenova

Numerical simulations are carried ou t to investigate the e ffect of ice crystals formation mechanism on the dynamics and microphysics of mixed-phase convective clouds. Several different in power convective clouds are simulated by 1-D bulk-water microphysical model. Different types of parameterizations of ice crystals formation are used. The microphysics and dynamics of the simulated cloud cases with primary nucleation without and with t he inclusion of ice mult iplication are compar ed. The results indicate that precipitation starts earlier and at lower levels in mo st of the simulated clouds when multiplication of ice crystals is included. However the simulations show that the impact of ice nucleation parameterization on cloud dynamics and microphysics depends on the power of the simulated clouds.

Keywords: ice crystal formation, numerical model

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MS006 **Poster presentation** **5191**

The effect of dynamics on mixed-phase clouds: theoretical considerations

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Cloud Physics and Severe Weather Research Scientist IAHS

Paul Field

A theoretical framework has been developed describing non-equilibrium formation and maintenance of mixed phase clouds. We consider the necessary and sufficient conditions required to activate liquid water within a pre-existing ice cloud, and thus convert it to mixed phase, for three scenarios: i) uniform ascent, ii) harmonic vertical oscillations, iii) turbulent fluctuations. The general conditions are: 1st Necessary Condition: The vertical velocity of an ice cloud parcel must exceed a threshold velocity to activate liquid water. 2nd Necessary Condition: The activation of liquid water within an ice cloud parcel, below water saturation, requires a vertical ascent above some threshold altitude to bring the vapor pressure of the parcel to water saturation. Only when the first and second conditions are true, these conditions become sufficient for the activation of liquid water in ice clouds. These required conditions for the generation of mixed phase cloud are supported by parcel modeling results and analogous conditions for a harmonic oscillation concerning the amplitude and tangential velocity of the parcel motion are proposed. We do not assume steady-state conditions, but demonstrate that non-equilibrium evolution of cloud parcels can lead to long term steady existence of mixed phase cloud.

Keywords: mixed, phase, clouds

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MS006 **Poster presentation** **5192**

Some peculiarities of freezing of metastable water, influencing cloud ice development

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In the process of development of a water cloud, the freezing of its droplets occurs not at once but is lasting in time owing to increase in probability of freezing of droplets of ordinary water and A-water with their rising. A specific feature of the frontal mechanism of freezing of an individual droplet is that during freezing, this emits molecular vapor carrying the released energy of the phase transition. As a result, a zone of short-living microscale turbulence arises around each freezing droplet. The ice crystal which falls into this zone experiences accelerated growth in convective diffusion mode, in contrast with molecular diffusion one. Such chance for the growth acceleration of individual crystal occurs very rarely on average but more probable the larger it becomes. By this reason, ice crystals grow far not equally and only their little part reach precipitation sizes. With sufficient collective enlargement of crystals, their gravitational sedimentation becomes a source of the irrevocable microscale turbulence, which results in convective diffusion mode of the Bergeron mass exchange. The phase transformation of a cloud is concluded with its avalanche transition into mixed state with A-water as its liquid disperse phase.

Keywords: a water

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MS006 **Poster presentation** **5193**

Simulation of microphysical and optical characteristics of frontal ice clouds with several forms of crystals

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It has been developed the numerical time-dependent model of frontal mixed, stratiform clouds with detailed microphysics description and with 3 forms of ice crystals: needles, plates, columns. The 4 kinetic equations for dimension distributions for drops and crystals are included in the equation system. The ice nucleation on sublimation nuclei and sorbtion ("condensation - freezing") nuclei as well as the metamorphosis of ice particle shapes has been considered. In addition to microphysical characteristics we calculated all optical characteristics of cloud particles: the single scattering albedo, the coefficients of scattering and extinction, the phase functions, the cloud optical thickness (COT). Optical characteristic calculations of drops are based on the Mie theory, of crystals - on the geometric optics approximation. We will give the main attention in this presentation on ice clouds (with the liquid water content under 0,005 g/kg). Most often ice clouds arise when their cloud top height is above the level of 5 km and cloud top temperature is below of - 35 grad C. Columns are the main form in such clouds. The efficiency of precipitation in these cases is very great (the intensity of precipitation formation is equal the thermodynamical condensation rate). These clouds with columns have a not great COT - under 10 - 15. If the nucleation rate (or concentration of active nuclei) increases, a cloud may crystallize in the case of the more lower cloud top height (cloud top temperature T<- 25 grad C). Plates prevail in these clouds and the COT can rise to values of 40 - 45. The crystal concentration in ice clouds is more than 10 per litre, the modal radius of plates is equal 300 - 400 mkm, the modal dimension of columns 100 - 200 mkm. The particular feature of optical properties of ice clouds is as follows: COT does not depend on the radiation wave-length. So this property and high values of effective radius of cloud particles form the informative criteria for distinguishing cloudiness regions with highly developed crystallization and precipitation formation.

Keywords: ice, microphysics

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MS006 **Poster presentation** **5194**

Glaze and rime climatology of the russian polar coast

Dr. Natalia Bezrukova
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Glaze and rime formation on the ground surface or objects due to supercooled rain and fog deposition is one of the phenomena hazardous for surface communication electric wires and poles, water transport, oil-mining platforms, and especially for aviation. Climatology of these phenomena requires more data for different regions. Atmospheric glaze formation in the Arctic is due to cyclonic cold fronts and occlusion fronts in warm seasons and warm fronts in cold seasons. Generally, glaze diameter is observed to be about 5 mm. Its maximum diameter of 76 mm was measured on Uyedineniye Island, the mass being 382 g per meter length of an electric wire. The freezing of supercooled fog water vapor produces considerably thick rime on objects. This paper analyzes a 10-year set of observations (1981-1990) of the frequency of such events for the Russian polar region and mean values for glaze persistence in hours during each month provided by 12 ground polar coastal and island weather stations north of 65N. All the types of freezing precipitation (FP) events were given as WMO Weather Codes 56, 57, 66, 67, 24, and rime due to freezing fog (FF) as WMO Weather Codes 48, 49. The total number of analyzed events is 1023. Weather types coded 48 and 49 (fog deposited rime) prevail on the Russian polar coast, accounting 84% of events. Freezing rain and drizzle are rather seldom 16%. In this region, numerous events with Codes 48, 49 were observed at very low temperatures and higher pressure (>1015 hPa). Below 30C, near 250 events with Code 48 (fog, depositing rime, sky visible) and only several cases with Code 49 (fog, depositing rime, sky invisible) were recorded. Analyzed in this paper is the regularity of space and time distribution of the phenomena for a given territory. Climatic persistence values for glaze events in intermediate seasons (spring and fall) and winter are determined. A correlation between the persistence (per hour/month) and type of air parcels advection is revealed. Seasonal glaze frequency maps are plotted.

Keywords: glaze, rime, climatology

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MS006 **Poster presentation** **5195**

Termiology and interpretation of Glaze and Rime ground observations

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In anal yzing weather observational data one is faced with some inconsistency in terminolo gy, definitions, and interpretation of freezing precip itation pheno mena in different countries. Simila r definitions of weather phenomena by different national schools, when viewed more closely, either prove to be some what inconsistent, or these phenomena ar e interpreted differently or descried, using different char acteristics. Su ch problems would arise when the aut hor analyzed WMO weather phenomena code groups (WMO Doc. No. 306, Ed. 1988) widely applied in aviation, such as rain group, snow group, fog group, driz zle group, using data from the grou nd n etwork of th e former US SR. At negative temperatures in cold seasons, these code gr oups are used to re cord hazardous events such as glaze and rime or other types of solid hydrometeors snow grains, snow groats, ice pellets. For analyzed observational r esults obtained in different countries to be compatible , it is important to c larify the differences between weather phenomena d efinitions and interpretation: which of the phenomena is actually recorded using a certain code and what cha racteristics are primarily as signed to the phenomenon in a given geographic al region. This depends on how hazardous the phenomenon is an d how practically important some of its characteristics are. For example, in the former USSR and presently in Russia, the term freezing rain is primarily interpreted as glaze, i.e . ice crust formed b y precipitating supercooled rain or drizzle, and only secondly as a specific type of rain proper. The characteristics of ice crust such as thickness (diameter), weight p er unit le ngth, ice persistenc e on an object (e.g. electr ic wire) are considered the most important ones for a cold country such as Russia wit h its vast wire networks and lo ngest railways. This interpretation is reflect ed in both observations at weather station s and the way o f handling climato logical data intend ed for Monthly Meteo rological Tables, which include daily reports on freezing rain represented a s persistence of ice deposition on wires. Als o discussed in this paper are other WMO code groups of weather phenomena, their definiti ons and interpretation conventional in Russia.

Keywords: glaze, rime, terminology

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MS006 **Poster presentation** **5196**

Patchiness of cirrus clouds - impact of dynamics and aerosols

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Institute for Atmospheric and Climate Science ETH Zurich IAMAS

Ulrike Lohmann

Cirrus clouds are important modulators of Earth's radiation budget, it is assumed that (thin) cirrus clouds can contribute to a net warming of the Earth-Atmosphere system. Usually, in large scale models cirrus clouds are treated as homogeneous layer clouds. However, even from surface observation the internal structure or "patchiness" of cirrus clouds is obvious, hence these inhomogeneities could lead to additional radiative effects. In recent measurements campaigns the presence of slightly stable or even neutral mixing layers within the ice supersaturated layers was observed (e.g. during CIRRUS II, November 2004). These layers were probably formed by strong wind shear near the jet regions. From first simulations with a cloud resolving model it was observed that latent heat release from growing ice crystals could lead to the formation of small "convective" cells with relatively high vertical velocities (up to 2 m/s). This leads to ice crystal formation by homogeneous nucleation and to discontinuities in the ice crystal number densities within the supersaturated layer of some orders of magnitudes, which represents a sort of patchiness.This effect is investigated in more details in sensitivity studies. The 2D/3D anelastic, non-hydrostatic model EULAG with a recent developed two moment bulk ice microphysics, including nucleation (homogeneous and heterogeneous), diffusion growth/evaporation and sedimentation, is used for idealized 2D studies: An ice supersaturated layer is prescribed at 10-12 km, which is lifted by a synoptic scale vertical velocity (1-10 cm/s). Within the supersaturation layer a "mixing" layer with a thermal stabilty different to the stable environmental profile is prescribed. The stability of this layer ranges between weakly stable over neutral to weakly unstable. The simulations were carried out using high spatial (dx = 10 - 100 m, dz = 10 - 50 m) and temporal (dt ~1s) resolutions. The formation and evolution of "convective" cells and nucleation events within these cells is investigated. Additionally, the effect of aerosols is studied: Using inhomogeneous distributions of heterogeneous ice nuclei we investigate the effect of heterogeneous nucleation of ice crystals on the following homogeneous nucleation event. This leads to various impacts on the dynamics which triggers the patchiness of cirrus clouds.

Keywords: cirrus, dynamics, aerosols

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MS007 **5197 - 5229**

Symposium
Theoretical advances in atmospheric dynamics (ICDM)

Convener : Dr. Eyal Heifetz
Co-Convener : Dr. Nili Harnik

This session will focus on the application of geophysical fluid dynamics theory to the understanding of the atmospheric circulation, with an emphasis on synoptic to large scale atmospheric circulations, both in the troposphere and stratosphere. Contributions are encouraged on a range of topics including wave and cyclone growth and evolution, eddy-mean flow interactions and possible dynamical regimes arising from it, the dynamics of storm tracks and jet streams, the dynamics of the stratospheric polar vortex, and its interaction with the troposphere

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MS007 **Oral Presentation** **5197**

Conditional nonlinear optimal perturbation and its applications

Prof. Mu Mu
LASG, Intstitute of Atmospheric Physics Chinese Academy of Sciences IAMAS

Hui Xu, Guodong Sun

Linear singular Vector (LSV) is one of the useful tools in the stability study and sensitivity analysis in atmospheric dynamics. However, the linear approximation required by the approach of LSV has strong limitations since it ignores the nonlinear processes (such as wave- mean flow interactions). The first author and his colleagues have proposed a new method called CNOP (Conditional Nonlinear Optimal Perturbation), which generalizes LSVs into the fully nonlinear regime. CNOP is the initial perturbation whose nonlinear evolution attains the maximum value of the cost function, which is constructed according to the problems of interests with physical constraint conditions. It can represent the optimal precursor of certain weather or climate event, or stand for the initial error that has largest effect on the uncertainties at the prediction time. In sensitivity and stability analysis of fluid motions, CNOP also describes the most unstable (or most sensitive) mode. In this talk, we present the CNOPs of three models including T21L3 QG model developed by Marshall and Molteni, Zebiak-Cane model for El Nino-Southern Oscillation, and a theoretical grassland ecosystem model by Zeng et al, and compare them with LSVs. It is shown that CNOP can reveal the effect of nonlinearity on the physical problems in which nonlinear process plays an important role. Also CNOPs demonstrate significant physical characteristics that cannot be shown by LSV approach. For example, in T21L3 QG model, LSV does not yield a regime transition related to blocking onset, while CNOP does result in such one, which suggests that the effects of nonlinearity can not be ignored for the regime transitions in the large-scale circulations. In Zebiak-Cane model, CNOPs, rather than LSVs, act as the initial anomaly patterns that evolve into ENSO events most probably, which shows that nonlinearity enhances the evolution of El Nino. And by using the theoretical grassland ecosystem model, we have found that CNOP induces abrupt transitions from grassland (desert) state to desert (grassland) state, but there is no such transitions induced by LSV in some cases. Other applications of CNOP, which includes ensemble forecast and target observations are reviewed too. Prospect and challenge in the future applications of CNOP are also discussed.

Keywords: optimal perturbation, nonlinearity, atmosphere

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MS007 **Oral Presentation** **5198**

Dynamics of Forecast Errors

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M.Didone, M. Sprenger

The dynamics of the difference between the forecast and contemporaneous analysis fields of a particular weather prediction system is examined and interpreted from a PV-perspective. Non-conservation of the PV difference field signifies: isentropic advection of the error across an ambient PV-gradient; misrepresentation of diabatic or frictional processes, and /or error in the analysis field at the verification time. Likewise inversion of a particular feature of the error PV-field can (via attribution) account for error of the primary flow variables in both the in-situ and far-field. Illustrations of the characteristic structure and evolution of the PV difference field are shown and point to inadequate development of the Rossby wave amplitude on the extra-tropical tropopause, and backward trajectories calculated from the dominant regions of PV-error shed further insight on the nature of the "error".

Keywords: forecast error, pv

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MS007 **Oral Presentation** **5199**

Spontaneous inertial gravity wave radiation from a jet stream in a shallow water system on a rotating sphere

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We numerically investigate spontaneous inertial gravity wave radiation from an unsteady jet stream in a shallow water system on a rotating sphere. Recent observational studies reported that inertial gravity waves are spontaneously radiated from strong rotational flows, such as polar night jet, sub-tropical jet, and typhoon. To study these radiation process, we use a simplified experimental setting in a shallow water system. We set a barotropically unstable zonal jet stream initially, and make the jet stream unsteady with zonal forcing. Then spontaneous inertial gravity wave radiation is generated continuously. For the numerical calculation, we use the spectral-like three point combined compact difference (sp-CCD) scheme which has high accuracy as well as the spherical harmonics model, so that we obtain the estimation of gravity wave amplitude with high accuracy. In the present study, we discuss gravity wave radiation for a wide range of Rossby and Froude number space. We also investigate conditions of gravity wave radiation and propagation, which depend on the latitude of the jet stream. Using the analogy with the theory of the aero-acoustic sound wave radiation (Lighthill theory), we specify the region of gravity wave source. All results are discussed in detail by the knowledge of f-plane shallow water system which we used in the previous study. Finally, we will show the recent results of two layer shallow water system.

Keywords: inertial gravity wave, jet streams, shallow water system

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MS007 **Oral Presentation** **5200**

A Diabatically-Dominated Avenue to Moist Baroclinic Cyclogenesis

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Michael T. Montgomery, Huw C. Davies

Since the pioneering study of baroclinic instability by Eady in 1949, a voluminous amount of research has been produced on the topic of mid latitude cyclogenesis. While the dry problem has been well understood for some time, the effects of latent heat release on disturbance evolution remain a point of contention. It has been argued by many that moisture effects merely serve to modify the structure and growth characteristics of a disturbance that is essentially governed by the dry dynamics. More recent results, however, call this conclusion into question. Are there dynamical processes in a moist, baroclinic environment that have no dry counterpart? Idealized model investigations using both a simplified and full physics mesoscale model are used to identify and examine an alternate growth mechanism to that outlined by traditional dry baroclinic instability theory. The ensuing disturbance grows via the constant production of potential vorticity associated with cloud diabatic effects. The bulk of this talk will be spent discussing the general characteristics of this type of diabatically-dominated disturbance and the possible role they may play in the moist baroclinic atmosphere. The latter point will be emphasized via a case-study analysis of a significant cyclogenesis event that resulted in nearly a foot of snowfall in parts of the Northeastern United States.

Keywords: moist cyclogenesis

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MS007 **Oral Presentation** **5201**

Circumglobal teleconnections and wave packets associated with eastern mediterranean precipitation

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Uri Dayan

This investigat ion performs diagnostic analyses with NCEP/NCAR Reanalysis data and daily Israeli precipitation d ata to examine the dyna mical pr ocesses associated with anomalies in eastern Mediterranean (EM) precipitat ion. As in previous st udies, t he positive (negative) phase of the EA/WR teleconnection pattern is found to be closely associ ated with enhanced (reduced) pre cipitation in the EM. Composites of the 300-hPa streamfu nction field show that both phas es of the EA/WR pattern are associated with eastward propagating wave packets th at traverse about three-quarters of the distance across the globe. These wave packets, which ha ve a phase speed that is close to zero, originate in the northeast Pacific and propagate eastward across North America, the North Atlantic, western Europe, the EM, southern Asia, until their eventual dec ay over the no rthwest Pacific. As these wav e packets p ass over western Europe and the EM, the EA/WR pattern is triggered and anomalies in EM precipitation occur. The EA/WR pattern is found to have an e-folding time scale of 4 days, which is determined by the group velocity of the wave packet. Application to interannual time scales suggests that much o f the interannual variability in EM precipitation ari ses from the y ear-to-year variation in the n umber and the phase of thes e circumglobal wave packets . The ti me-averaged spatial structure of t he circumglobal wave packet closely resemb les the first empirica l orth ogonal function of the hemispheric 300-hP a meridional wind field. This suggests that the circumglobal wave packet may be a fundamental pattern of variability which is relevant for the entire Northern Hemisphere.

Keywords: teleconnections, wave packets, precipitation

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MS007 **Oral Presentation** **5202**

Time scale and feedback of zonal mean flow variability

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Seok-Woo Son, Steven Feldstein, John Ten Hoeve

The physical processes which determine the time scale of zonal mean flow variability are examined with an idealized numerical model that has a zonally symmetric lower boundary (Son and Lee, 2005). In the part of the parameter space where the time-mean zonal flow is characterized by a single (double) jet, the dominant form of zonal mean flow variability is the zonal index (poleward propagation), and the time-mean potential vorticity (PV) gradient is found to be strong and sharp (weak and broad). The e-folding time scale of the zonal index is found to be close to 55 days, much longer than the observed 10-day time scale. The e-folding time scale of the poleward propagation is about 40 days. The long e-folding time scales for the zonal index are found to be consistent with an unrealistically strong and persistent eddy-zonal mean flow feedback. A calculation of the refractive index indicates that this strong eddy-zonal mean flow feedback arises because the strong and sharp PV gradient tends to trap the eddies. Additional model runs are performed with an idealized mountain to investigate whether zonal asymmetry can disrupt the eddy feedback. The time scale in these runs is reduced to about 30 days. It is found that the stationary eddies excited by the mountain weaken the time-mean potential vorticity gradient over a broad region, and lead to the formation of critical latitudes on the equatorward side of the jet. As a result, eddies propagate equatorward, and the zonal index events are replaced by shorter time scale poleward propagation. It is these changes to the time-mean flow that disrupt the eddy feedback.

Keywords: zonal mean flow variability, eddyzonal mean feedback, potential vorticity gradient

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MS007 **Oral Presentation** **5203**

A Cascade Type of Global Atmospheric Energy Conversion Diagram Based on Wave-Mean-Flow Interactions

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A three-box cascade type of energy conversion diagram is proposed for the purpose of diagnosing the atmospheric general circulation based on wave-mean flow interactions and Lagrangian-mean meridional circulation. Mass-weighted is entropic zonal means make difference in energy cycle from the four-box diagram by Lorenz (1955). The new scheme does not directly exchange the zonal mean available potential energy PZ with the eddy available potential energy PE but does exchange the zonal mean kinetic energy KZ with PE. Mass weights are able to fully express nongeostrophic wave effects, conservation properties and lower boundary conditions. Wave energy W is defined as the sum of PE and KE in order to gain physical insights into energetics based on the non-acceleration theorem. This leads to a three-box cascade type of energy conversion diagram composed of zonal mean available potential energy, PZ, zonal mean kinetic energy, KZ and wave energy W. The diabatic differential heating produces PZ and it is converted into KZ through the mean-meridional direct circulation C(PZ,KZ). KZ is mainly converted to W through wave-mean flow interactions C(KZ,W) and the rest is dissipated through friction. W is generated not only by the dynamical conversion but also by the diabatic differential heating and it is rapidly dissipated through friction. The energy conversion diagram is characterized by the only two dynamic conversion terms, C(PZ, KZ) and C(KZ,W). A preliminary study is made of the climate in boreal winter and summer using the NCEP/NCAR reanalysis. It is interesting that C(PZ, KZ) equals to C(KZ,W) under the quasigeostrophic balance. In the actual atmosphere, although this relationship almost holds in the extratropics as expected, C(PZ, KZ) is larger than C(KZ,W) in the subtropics, indicating the importance in nongeostrophic effects of the former. About 60 percent of KZ is dynamically converted to W and the rest is dissipated mainly in the subtropics. Note that the energetics is substantially different between the two solstices. Both C(PZ, KZ) and C(KZ,W) are about 30 percent larger in the boreal winter than those in the boreal summer. This is because stationary waves are very active in the boreal winter. Stationary waves as well as baroclinic instability waves considerably contribute to energy conversions in the northern hemispheric winter, while baroclinic instability waves do mainly in the southern hemispheric winter. It is confirmed that the life time of stationary waves are quantitatively estimated to be considerably longer than that of baroclinic instability waves. An important application of the scheme is the diagnosis of global warming. The preliminary result of GCM diagnosis will be briefly presented. References Iwasaki, 2001: Atmospheric energy cycle viewed from wave, mean-flow interaction and Lagrangian mean circulation, J. Atmos. Sci., 58, 3036-3052. Uno and Iwasaki, 2006: A cascade type global energy conversion diagram based on wave-mean-flow interactions. J. Atmos. Sci., 63, 32773295.

Keywords: energetics, isentropic zonal mean, wave mean flow interaction

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MS007 **Oral Presentation** **5204**

Effects of the baroclinic adjustment on the tropopause in the NCEPNCAR reanalysis

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We study the mean tropopause structure from the NCEP-NCAR reanalysis in the framework of baroclinic adjustment theories, focusing on the impact of baroclinic eddies on the mean tropopause height. In order to measure the effects of such perturbations, we introduce an appropriate global index that selects events of high baroclinic activity and allows us to distinguish the phases of growth and decay of baroclinic waves. We then composite the tropopause mean structure before and after baroclinic events, finding that baroclinic disturbances cause the zonally averaged midlatitude winter tropopause height to rise. Our results establish the importance of baroclinic adjustment processes for midlatitude tropopause dynamics.

Keywords: tropopause, baroclinic, mid latitude

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MS007 **Oral Presentation** **5205**

Trapped waves of the Shallow Water Equations in Mid-latitudes

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Andrey Sigalov

A new type of approximate solutions of the Linearized Shallow Water Equations (LSWE) -- trapped waves given by Airy-like functions, is constructed for sufficiently small radius of deformation.In contrast to harmonic Poincare and Rossby waves, these newly found trapped waves vanish fast in the positive half-axis and their zonal phase speed is larger than that of the corresponding harmonic waves. A detailed analysis shows that due to the smaller radius of deformation in the ocean compared to that in the atmosphere the trapped waves are relevant to observations in theocean while harmonic waves typify atmospheric observations, which is consistent with conclusionsderived from recent observations of the westward propagation of Sea Surface Height features in the ocean. Due their rapid vanishing in the positive half-axis, the new waves do not require achannel to limit the nagnitude of the beta-term, which is required in order to justify the linear expansion of the Coriolis parameter.

Keywords: rossby waves, shallow water equations, beta plane

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MS007 **Oral Presentation** **5206**

Multiple jets, beta turbulence, hyperbalance, the Taylor identity and the Phillips effect

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Robustly, jets tend to sharpen themselves w hen disturbed simply because potential vorticity (PV) mixes most readily on the jet flank or flanks. In the limiting case of perfect mixing on both flanks of the jet, and strong inhibition of mixi ng across the jet axis (acting as an 'eddy-transport barrier'), single or multiple jets (PV staircases) are in the 'Rhines-effe ct' o r 'cascade- inhibition' regime in the sense that Rossby-wave elasticity is comparable to Austausch (purely 'turbulent') effects. The r obustness with which PV mixing is associated with jet self- sharpening stems from the robustness of balance and PV inversion. The 'PV Phillips effect', so- called for histor ical reasons, is the tendency for PV mixing to be spatially inhomogeneous, in p art because mixing re duces R ossby-wave el asticity hence makes further mixing easier. This positive feedback is greatly amplified by the further inhibition of mixing by the shear that is an in evitable co nsequence o f P V i nversion. Recent adva nces i n the theo ry of balance an d inversion (hyperbalance equations) will be touched on if time permits.

Keywords: jet self sharpening, jupiters pv staircase, hyperbalance

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MS007 **Oral Presentation** **5207**

The counter-propagating Rossby wave perspective on baroclinic instability and its relevance to the atmosphere

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Paul Berrisford

Baroclinic instability theory describes how waves can grow on a zonally symmetric background state. As the waves attain finite amplitude, the wave fluxes modify the background on which they grow. Changes to the background have a profound influence on the structure of the waves and their fluxes. The two-way interaction between the wave and background is difficult to diagnose because the results depend on the manner in which the background is partitioned from the full flow. The traditional approach is to associate the background state with the Eulerian zonal average. However, then the background and wave both vary rapidly through adiabatic processes. Here we consider defining the background in terms of the modified Lagrangian mean. This state is defined by adiabatically re-arranging the full 3D state so that it becomes zonally symmetric while preserving the mass and circulation enclosed by PV contours within isentropic layers. Mass and vorticity are both re-arranged but they are tightly constrained through PV. The zonal flow obtained by inverting the PV distribution should be consistent with the circulation around each PV contour. In this framework the background can only evolve through non-conservative processes and there is a wave activity conservation law valid at large amplitude. It is shown that the MLM state spins-up following the cyclone mature phase as a result of wave breaking and vortex erosion. The most surprising feature is that the whole system phase speed reduces slightly even though the background zonal flow accelerates. Reasons for this are explored.

Keywords: cyclone, phase speed, nonlinear waves

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MS007 **Oral Presentation** **5208**

Wave-Activity Conservation Laws for the Three-Dimensional Anelastic and Boussinesq Equations with a Plane-Parallel Background Flow

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Dr. Theodore G. Shepherd

Wave-activity conservation laws are key to understanding wave propagation in inhomogeneous environments. Their most general formulation follows from the Hamiltonian structure of fluid dynamics. On the large scales, the Eliassen-Palm wave activity is a well-known example and is central to theoretical analysis. On the mesoscale, while such conservation laws have been worked out in two dimensions (x-z), their application to a plane-parallel background flow in three dimensions fails because of a degeneracy created by the absence of a background potential vorticity gradient. Consideration of a background state depending only on altitude is motivated by the parameterization of unresolved scales in climate models where there is an imposed separation of horizontal length and time scales, but vertical coupling within each column. Here we show how this degeneracy can be overcome and wave-activity conservation laws derived for three-dimensional disturbances. Explicit expressions for pseudoenergy and pseudomomentum in the anelastic and Boussinesq models are derived, and it is shown how the previously derived relations for the two-dimensional anelastic and Boussinesq models can be treated as a limiting case of the three-dimensional problem. The relationship E = c P between pseudoenergy E and pseudomomentum P, where c is the horizontal phase speed, has important applications to gravity-wave parameterization.

Keywords: wave activity conservation, gravity wave propagation

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MS007 **Oral Presentation** **5209**

Dynamics of the NAO and Annular Patterns of Variability

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Edwin P Gerber

We shall discuss atmospheric dynamics of the North Atlantic Oscillation (NAO), the zonal index, and annular patterns of variability (also known as annular modes). The goal of the presentation will to give a unified treatment of these related phenomena, to make explicit how they are connected and how they differ, and to illustrate their dynamics with the aid of an idealized primitive equation model. Specifically, we shall show that the structure of the empirical orthogonal functions (EOFs) of the NAO and annular modes follows, at least in part, from the structure of the baroclinic zone. Given a single baroclinic zone, and concomitantly a single eddy-driven jet, the meridional structure of the EOFs follows from the nature of the jet variability, and if the jet variability is constrained to conserve zonal momentum then the observed structure of the EOF can be explained with a simple model. In the zonal direction, if the baroclinic zone is statistically uniform then so is the first EOF, even though there may be little correlation of any dynamical fields in that direction. If the baroclinic activity is zonally concentrated, then so is the first EOF. Thus, at the lowest or simplest order of description, the NAO is a consequence of the presence of an Atlantic storm track; the strong statement of this would be that the NAO is the variability of the Atlantic storm track. The positive phase of the NAO corresponds to eddy momentum fluxes (themselves a consequence of wave breaking) that push the eddy-driven jet poleward, separating it distinctly from the subtropical jet. The negative phase of the NAO is characterized by an equatorial shift and, sometimes, a weakening of the eddy fluxes and no separation between sub-tropical and eddy-driven jets. Variations in the zonal index (a measure of the zonally averaged zonal flow) also occur as a consequence of such activity, although the changes occurring are not necessarily synchronous at different longitudes, and the presence of annular modes (i.e., the associated patterns of variability) does not necessarily indicate zonally symmetric dynamics. We shall also show that the NAO, is not, however, a consequence of purely local dynamics, for the storm tracks depend for their existence on patterns of topographic and thermal forcing of near hemispheric extent.

Keywords: nao, annular, dynamics

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MS007 **Oral Presentation** **5210**

Energy Spectra from Entropy Principles

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Dr Wim Verkley

The distribution of energy in turbulent systems varies widely, depending upon the nature of the forcing and dissipation and on other factors. A power-law dependence of energy on wavenumber is found in many cases, with the power-index varying with the circumstances. For example, Burgers turbulence exhibits a -2 spectrum, the atmosphere has a -3 spectrum in the synoptic range and fully developed three-dimensional turbulence has the well-known Kolmogorov -5/3 spectrum. In this presentation, we use the principle of maximum entropy under appropriate constraints to derive the energy spectra in a number of cases.

Keywords: energy, spectrum, entropy

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MS007 **Oral Presentation** **5211**

Regions of barotropic regeneration of synoptic-scale eddies in various zonal-like jets.

Dr. Gwendal Rivire

Baroclinic interaction is usually considered as the main mechanism to explain the growth of transient synoptic eddies while barotropic processes are responsible for the decrease of their amplitude. Although synoptic eddies give indeed generally their energy to the mean flow via barotropic processes, our study shows that in specific regions the situation can be the opposite. Our results will first present how to diagnose these particular regions where synoptic eddies barotropically gain energy using ERA40 reanalysis data. The processes involved will be then simulated in a barotropic model on the sphere. A new measure of the constraint exerted by the large-scale horizontal deformation on synoptic eddies is introduced following recent results on perturbation growth in spatially and temporally complex quasigeostrophic flows. This new diagnostic is called effective deformation and is based on the deformation tensor of the large-scale flow. It allows us to indicate regions of the atmosphere where transient eddies can be barotropically regenerated (called hereafter barotropic critical regions). In order to apply this diagnostic to reanalysis data, each atmospheric flow is decomposed into a high- and a low-frequency part by applying a temporal filter with a cut-off of around 10 days. The high-frequency part corresponds to the synoptic signal and the low-frequency one to the weather regime. It is shown that two apparently similar zonal-like weather regimes do not create barotropic critical regions at the same place and can act in a very different way on upper-level high-frequency eddies. The second part of our study consists in analyzing simulations of a barotropic model on the sphere. We initialize the model with the same zonal-like jets as in the reanalysis data. By forcing them to be stationary and by adding to them synoptic-scale perturbations, the same behaviour as in the reanalysis data is recovered for the perturbations. As they evolve close to the barotropic critical regions, they are temporarily barotropically regenerated. Linear and nonlinear simulations will be compared to each other.

Keywords: barotropic, deformation, synoptic scale

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MS007 **Oral Presentation** **5212**

Relating Over-Reflection and Wave Geometry to the Counter Propagating Rossby Wave Perspective: Toward a Deeper Mechanistic Understanding of Shear Instability

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Eyal Heifetz

The two major approaches t o understanding plane pa rallel shearinstability - the Counte r propagating Rossby Wave (CRW) andO ver-Reflection (O -R) appr oaches, illumin ate very differentfund amental aspects. This work examines how such see mingly differentviews can exp lain the same phenomena and why these differences arise,with the overa ll goal of deep ening our und erstandingof shear instability. This is done by rationalizing the O-R theory in terms of CRW thinking,using a generalization of the CRW approach to multiple infinitesi malPV kernels. Firs t the mec hanistics of cross-shear wave propagation andthe exponential decay in an evanescent region are q ualitativelyexplained. Then the cross-shear behavior in di fferent wave geometries(full, partia l and over reflection) are examine d. It is found thatoverreflection is basically a mutual amplificatio n between PV kernels,with the main kernels being at the two side s of the evanescent region,which fo rms on on e sid e of th e criti cal level. T he nondimentionaloverreflection coefficient is obta ined by assuming a b alance betwee nthe mut ual amplification on the two sid es of the eva nescent re gion, andthe rate at which this amplification is carried away. The criticallevel is found to be the only point at which we have a m utualinteraction between two adjacent kernels.We will also examine the sources of energy growth and the role of theOrr mechanism, thought to be central to O-R.

Keywords: over reflection, action at a distance, propagating rossby wave

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MS007 **Oral Presentation** **5213**

A generalized wave kernel approach to plane parallel stratified shear flow.

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Nili Harnik, Orkan Umurhan

The kernel approach to baroclinic and barotropic shear flow andinstability is generalized to stratified plane parallel shear flow,including gravity waves and their related shear instabilities. We present basic gravity wave building blocks which comprise the classical gravity waves in shear flow. We start by describing the waves which arise at adensity jump in terms of two Kernel Gravity Waves (KGWs), which canco-exist with no interaction. The evolution on a generalized densityprofile is then expressed in terms of a mutual interaction of multipleKGWs. The interaction is analogous to the counter propagating Rossbywave kernel (KRW) interaction in the case of baroclinic and barotropicinstability, except that two kernels, rather than one, exist at each level. The results are also extended to include background vorticitygradients, and Rossby waves. We show that when both density andvorticity gradients exist, the kernels become mixed Rossby-gravitywaves, and the formulation reduces to the knownKRWs when buoyancy gradients vanish.

Keywords: gravity wave kernel, stratified shear flow, mixed rossby gravity kernel

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MS007 **Oral Presentation** **5214**

Dynamics of coupled initial condition and model-related errors

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Catherine Nicolis

The atmosphe re and the oceans are complex sy stems driven by highly nonlinear dynamic s. Consequently, models aiming at representin g them need to take into account their inhe rently unstable nature. This natural instability is a ssociated with a rapid growth of erro rs reflecting the uncertainties in the initial conditions and the fact that mode ls are no t perfect representations of reality. In the present work evolution laws are derived for model error, a ccounting for these two sources of uncertainty. Both dynamical and probabilistic aspects of the error ar e take n into acco unt. The work is d eveloped under the assumption of small initial condition and parameter perturbations from the underlying attractor, thus allowing for a linear approach valid for th e short- time r egime. The general ideas are illustrated on representative low-order models of atmospheric dynamics.

Keywords: atmospheric dynamics, chaos, model error

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MS007 **Oral Presentation** **5215**

Balance and Imbalance in Heat Lows

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Roger K. Smith

Heat Lows are an important synoptic feature of dry subtropical regions, where they have a significant effect on the local weather and climate. Previous studies on heat low dynamics in quiescent and simple background flows have focused mostly on the structure and diurnal variation of the low-level cyclonic circulation, which is found to be highly ageostrophic. In this study we describe some idealized numerical model calculations designed to investigate other dynamical features of these systems with special emphasis on the balanced and unbalanced components of the flow. The model employs a new representation of radiative effects. We show that the upper-level anticyclone is a significant part of the overall system and that unlike the lower cyclonic part of the circulation, which has a strong diurnal cycle, it is quasi-stationary. A balance analysis sheds light on the differences in the vertical structure of the balanced flow in the heat low.

Keywords: heat low, balance, diurnal cycle

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MS007 **Oral Presentation** **5216**

Unstable periodic orbits of barotropic atmospheric system

Dr. Andrey Gritsun
IAMAS

Unstable periodic orbits (UPOs) are an important feature of chaotic dissipative systems (i.e. systems having positive Lyapunov exponents and contracting the phase space). For some of chaotic systems like Anosov or Axiom A systems UPOs are dense on the system attractor so that any trajectory of the system can be approximated by UPOs with any given accuracy. As a result all statistical characteristics of such a system can be calculated by set of UPOs. Atmospheric systems are dissipative and chaotic but likely do not have Axiom A property. In this study we try to understand to what extent UPOs of simple atmospheric system approximate its attractor characteristics. The system under consideration is a Galerkin approximation for barotropic vorticity equation on a rotating sphere with T12 truncation. With the help of damped Newton and Gauss-Newton methods we were able to find more than 500 of the system UPOs. It was shown that average state of the system as well as its second order statistical characteristics (variance and leading EOFs) can be calculated by UPOs with very high accuracy. Other system properties like Kaplan-Yorke attractor dimension and number of positive Lyapunov exponents can also be reconstructed using UPOs. These results suggest that UPOs form a skeleton of the system attractor and may be important in understanding atmospheric dynamics

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MS007 **Oral Presentation** **5217**

Effects of surface drag on fronts within baroclinic waves

Dr. Yi Zhang

Theoretical advances in atmospheric dynamics MS007 IAMAS

Using a three- dimensional nonhydrostatic meso scale numerical mo del (MM5), the evo lution and structures of baroclinic waves with and without surface drag in case of dry and moist atmosphere ar e simulated. The re are two different effects of surfac e drag on the low-le vel frontogenesis in the dry atmosphere. O n one hand, t he surface dra g weakens the low-level frontogenesis and less inclined t o develop the ba roclinic wave dur to the sissipation. But o n the o ther hand, the surface dr ag induces a strong ageostroph ic flow, which prolon gs th e lo w-level frontogenesis and fi nally leads to the enhancement of cold fr ont. Compared with the no surface drag case, t he surface dra g increases the frontal slope especially in the boundary layer, where the front is almost vertical to the surface, and then enhances the prefrontal vertical motion. In the mo ist atmo sphere, the influence o f surface drag o n frontal rainband is also obvi ous. The surfac e drag weakens gthe convect ion, and reduces the energy dissipation nea r the s urface when the cold front and rei nforces the prefrontal co nvection, which is beneficial to the maintenance of the rainband in cold sector. Surface dr ag will also influence upper-level frontogenesis through the feedback between low-level cyclogenesis and upper-level tropopause trap. By defining a potential vorticity index(PV I), the relation between the evolution of upper- and lower- frontal systems are illustrated.

Keywords: surface drag, baroclinic wave, frontogenesis

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MS007 **Oral Presentation** **5218**

Empirical master equations for stratospheric climate variables

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Prof Joseph Egger, Prof Martin Dameris, Prof Lesley Gray

Master equations can provide probability density forecasts in a discretized phase space spanned by a few climate variables. The coefficients of an empirical master equation (EME) are estimated from the relative frequencies of transitions observed in time series of the variables. The EME is formally equivalent to an (empirical) first-order Markov chain descrip_tion. The numerical properties of the EME are studied on the basis of data from the three-component Lorenz model with additional white noise forcing. Useful results are obtained by partitioning the phase space into several hundred cells of equal grid size. We find that there exists a threshold length of the time series beyond which the performance of the EME hardly improves. It is even more surprising that the performance deteriorates with reduction of the time step. This is due to an increase in numerical diffusion. The choice of the dimensionality and the selection of the variables are crucial to the quality of the EME. These results provide useful guidelines for an application to time series consisting of standardized and de-seasonalized quantities obtained from the ERA-40 re-analysis and observations. A first EME shows that the Arctic stratosphere at 10 hPa is about 2 K warmer during the easterly phase of the quasi- biennial oscillation (QBO) of stratospheric equatorial zonal wind than during the westerly phase. A second EME including a time series of the solar radio flux at 10.7 cm hints that the relationship between the QBO and the temperature in the Arctic stratosphere is shifted towards warmer or colder states by about 1 K during periods of high or low solar activity, respectively. A third EME shows that northern annular mode (NAM) anomalies tend to propagate from the middle stratosphere into the lower stratosphere and then in the lower troposphere with a timescale of 2 and 4 weeks, respectively.

Keywords: empirical master equation, numerics, stratosphere

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MS007 **Oral Presentation** **5219**

The Behavior of Single and Double ITCZ Regimes for Ocean Temperature Distributions with Poleward Shifted Maxima

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In this paper we investigate how th e poleward shift of sea surface temperature (SST) distributions with different meridio nal curvature influences th e tro pical cir culation. Our results were obtained with an earth-type atmo spheric general circulation mo del (AGCM) in aqua- planet mode and a simplified analytical model of the tropical circulation. We found that the amount of poleward shift of the ITCZ, the rate of precipitation and the asymmetry of the summer and winter Hadley cells are very sensitive to the meridional curvature of the SST distribution. We ca n distinguish two types of atmospheric responses. The first classical type occurs for the poleward shift of SST distributi ons which no n-shifted are connected to a circulation regime with a single ITCZ. In this case moderate poleward shifts of the temperature m aximum lead t o a weakenin g of the total l ower troposph eric convergence and at the same time to a reduction of precipitation wi thin the ITCZ. For larger pole ward shifts the convergence and precipitation will again increase. The se cond type occurs for the poleward shift of SST distributions connected to a twin ITCZ regi me. Here m oderate poleward shifts of the t emperature maximum lead to an intensificati on of convergence and preci pitation within the winter I TCZ, whereas t he ITCZ in t he summer hemisphere becomes less well pr onounced. For larger poleward s hifts we get a transition to a single ITCZ regime. Our inve stigations show that the distance between ITCZ and maximum of the SST temperature is stro ngly curv ature dependent and t hat the double ITCZ regimes can survive even f or SST distribution asymmetric about the equator. The zonally symmetric an alytical model with one or two concentrated convective zones can predict our numerical results and gives a possible simple explanation through the effects of the large scale meridional curvature of the SST distribution.

Keywords: itcz, hadley, circulation

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

MS007 **Oral Presentation** **5220**

Turbulent parameterization influence on high resolution numerical modeling of deep moist convective processes

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Elisabetta Fiori, Franco Siccardi, Luca Molini

Nowadays computer power has grown t o the poin t that very-fine- mesh mesoscale modeling is approaching a new issue: the suitability of subgrid-scale turbulence parameterization used in mesoscale models for op eration in this scale range (O(1 km) or less). In this work, deep moist convective processes in simplified atmos pheric scenarios (e.g. s ingle unsheared cell, supercell, radiative convective equilibrium) are studied by means of high resolution numerical simulations with Lokal Mo del. Particular attention will be paid to dete rmine at what gridsp acing the convection-r esolving soluti ons statistically converge from a turb ulence perspective with respect to fl ow field structure, transport properties and precipitation f orecast. Different mesoscale turbulent closures will be used and their impact on the spatial-temporal structure of convective fields in simplified atmospheric scenarios will be discussed.

Keywords: turbulence, convection, high resolution

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

MS007 **Oral Presentation** **5221**

A first-principles theory for axisymmetric circulation in dry radiative-convective atmospheres

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A central goal of theoretical GFD is to predict major circulation features from first principles, given only external parameters. A successful example is the theory for the axisymmetric component of the global atmospheric circulation, whose currently accepted form was devised in the late 1970's by Schneider, Lindzen, Held and Hou. The theory has become a cornerstone of modern climate dynamics, playing a key role in interpretations of Hadley cell structure in global warming scenarios, paleoclimates and planetary atmospheres. However, it assumes a Boussinesq atmosphere, and the background stratification is externally prescribed, so that the theory cannot really claim to be "first principles". Here, we remove both constraints, presenting an analytical theory for the width and depth of the Hadley cell in a compressible, radiative-convective atmosphere. Radiation is treated using the semi-gray approximation. Convection assumes relaxation towards a dry adiabat. The theory converges to the classical result in the Boussinesq limit. We show that naive application of the classical theory can be misleading in some cases.

Keywords: hadley cell, radiation, convection

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

MS007 **Poster presentation** **5222**

Time scale, power spectra, and bimodality of zonal mean flow variability

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John Ten Hoeve, Steven Feldstein, Seok-Woo Son

This study presents results from probability density function (PDF) and power spectral analyses of the zonally averaged zonal wind from a series of idealized, multi-level, primitive equation model runs. The examination with the PDFs finds that bimodality occurs in the first principal component (PC1) time series if (1) its time scale is very long, (2) it is maintained by a positive zonal mean/eddy feedback, and (3) the background potential vorticity gradient is sharp and large. On the other hand, if all three criteria, which over most of the parameter space are either present or absent, are not satisfied, then bimodality is not found. These results link the occurrence of bimodality to both the properties of the background flow and the type of zonal mean flow variability. For single jet states, the presence of bimodality was found to depend on the height and the number of mountains, whereas for the double jet state no bimodality was observed. The power spectral analyses of the PC1 time series found that when the zonal index (poleward zonal mean flow anomaly propagation) is dominant the corresponding power spectrum more closely resembles that for an AR(1) (AR(2)) process. These results suggest that the zonal index can be better described by a first order ordinary differential (ODE) and the poleward propagation by a second order ODE. These model data are further analyzed to gain insight into the physical processes responsible for the characteristics of the power spectra of the observed Southern Hemisphere zonal mean zonal wind.

Keywords: time scale, power spectra, bimodality

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

MS007 **Poster presentation** **5223**

Mid-Latitude Atmospheric Regimes, Subtropical Jet, and ENSO

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Understanding the atmo spheric lo w-frequency variability is of crucial importance in fields suc h as climate studies, climate change detection, and extended range w eather forecas t. The Northern Hemisphere climate features the planetary waves as a relevant ingredient of the atmospheric variability. Several observations and the oretical arguments seem to support the idea that winter p lanetary waves indicator obey a non- Gaussian statistics a nd may present a multimod al probability density function, thus characterizing the lo w-frequency po rtion o f the climate system. We show th at the uppe r tropospheric jet strength is a critical parameter in determining whether t he planetary waves indicator exhibits a uni- or bim odal be havior, and we determin e the relevant threshold value of t he jet. These results are ob tained by considering the d ata of the N CEP/NCAR and ECMWF reanalyses for t he overlapping period. Our results agree with the nonlinear orographic theory, which explains the statistical non-normality of the low-freq uency variability of the atmosphere and its possible bimodal ity. Moreover, since the intensity of the jet is related to the ENSO phase, these results show a connection between the tropical and the mid-latitude climate. Data comi ng from the 1961-2000 si mulations performed by two very high- resolution glo bal climate mo dels, which ha ve be en previously shown to repr esent very well the overall properties of the Northern Hemisphere mid-latitude winter atmospheric variability, match only partially this picture, thus providing some hint s on models inaccuracy in represe nting large sca le features.

Keywords: regimes, low frequency, bimodality

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MS007 **Poster presentation** **5224**

The dynamics of the North Atlantic oscillation during the summer

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This study examines the dynamical characteristics of the North Atlantic Oscillation (NAO) life cycle for the summer season. The diagnostic techniques, which use NCEP/NCAR Reanalysis data, include composites of 300-hPa streamfunction, a projection analysis with each term in the streamfunction tendency equation, and composites of potential temperature on the 2-PVU potential vorticity surface. For both phases, the NAO life cycles take about two weeks to complete. The NAO anomalies are found to be driven by both high-frequency (period <10 days) and low-frequency (period >10 days) transient eddy vorticity fluxes. The decay of the NAO is accomplished by both low-frequency transient eddy vorticity fluxes and horizontal divergence. The breaking of synoptic-scale waves is found to play a crucial role during the summer NAO life cycle. For the positive NAO phase, the southern centre of action of the dipole arises from anticyclonic wave breaking, and the northern centre of action from trough intensification. For the negative NAO phase, both centres of action develop from cyclonic wave breaking. These characteristics are very similar to those for the NAO life cycle during the winter season, the primary differences being the weaker anomalies, shorter zonal and meridional scales, and the less intense wave breaking of the summer NAO.

Keywords: teleconnections, low frequency variability

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

MS007 **Poster presentation** **5225**

The contribution of the instabilies to vortex disturbances along Convergent Cloud Band

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Keita Iga

In winter over Japan Sea, a striking broad cloud band called Convergent Cloud Band often appears, and meso-scale vortex disturbances generate along it . The vortex disturbances bring severe weathe r phenomena such as gust win d and he avy snow in th e Japan Sea side of the Japan arc hipelago. Many previous studies of the vortex disturbances have been conducted (e.g. Ookubo 1995, Nagata 1993), but the situations of the analysis in these studies permit only one of these instabilities which were expected from observations. Since neither of these analyses treats the basic field which includes both instabilities, disturbances with which scale are dominant has not been discussed. In this study, we investigated the contribution of instabilities to generation and evolution of meso-scale vortex disturbances and dominant vortex disturb ances dependi ng upon the characterist ics of the basic field: the thic kness of frontal transition layer, the potential temperature differenc e on ground and th e stability of atmosphere by calculating the linear stability and time evo lution of a basic field which includes both baroclinic and barotropic instabilities. The li near stability analysis showed that the grow th rates of bot h meso-alpha-scale and mes o-beta-scale u nstable modes are almost same if the transition layer is thick. As the transition layer becomes thin , meso-beta-scale uns table modes becom e dominant, m eanwhile, othe r unstable modes having wave length of about 250km are n ewly generated which have f eatures of both baroclinic and barotropic in stabilities. As stability of at mosphere becomes small, meso-alpha-scale unstable mo des beco me do minant. Next, we calculate time evo lution of the basic field by using no n-hydrostatic nu merical prediction model CReSS (Ts uboki a nd Sakakib ara 2006). In cons equence, whe n the transition l ayer is thick or the stability of atmosphere is small, meso-alpha-scale disturbance having the typical feature of barocli nic instability i s found from anomaly of the pressure. As the stability of atmosphere becomes small, t he disturbance of this ty pe develops relatively fast. When the transition layer is thin and the stability of atmosphere is large, meso-beta-scale vortex disturbances are generated in horizontal shear zo ne of the basic field. The eddy momentum flux ten ds to convert the mean kinetic energy thro ugh the ho rizontal sh ear, and these vortex disturbanc es develop through barotropic instability. In further study, we will investi gate the contribution of heat flux to the development of the vortex disturbances.

Keywords: instability, vortex

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

MS007 **Poster presentation** **5226**

Influence of the increased SST on baroclinic instability wave activities under the aqua planet condition

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Toshiki Iwasaki

Global warmings have been recognized to change dynamical and thermodynamical states of the troposphere mainly through increasing SST. In the extratropics, baroclinic instability wave activities are of great interest under global warmings. Thus, we conduct a series of aqua planet experiments in order to study the influence of the increased SST on baroclinic instability wave activities in the troposphere. First experiment, named "GRA-3 run", is that the control SST is warmed by 3K only in the high latitudes. In the GRA-3 run, midlatitude meridional temperature gradient is decreased in the lower troposphere and the westerlies are suppressed in both the troposphere and stratosphere. Therefore, the eddy kinetic energy is decreased in the entire troposphere. Second experiment, "ALL+3 run", is that the control SST is homogeneously warmed by 3K all over the world. In the ALL+3 run, midlatitude meridional temperature gradient is increased in the upper troposphere and the westerlies are enhanced above the upper troposphere. Despite this, the eddy kinetic energy is generally decreased in the troposphere. These results suggest that the lower-tropospheric baroclinicity is more important for baroclinic instability wave activities in the troposphere.

Keywords: aqua planet, baroclinic wave, global warming

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

MS007 **Poster presentation** **5227**

Moisture Effects on Midlatitude Static Stability in a Hierarchy of Models

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The atmospheric static stability is fundamental to any theory of the general circulation: it determines the buoyancy frequency of dry perturbations in the vertical, the speed of gravity waves, and growth rates and length scales in linear baroclinic instability problems. We examine the determination of the static stability of the midlatitudes in a hierarchy of atmospheric models, focusing in particular on the effect of moisture and latent heat release on the static stability. The simplest model we consider is an idealized moist GCM, which consists of the primitive equations on the sphere, a zonally symmetric aquaplanet lower boundary, and idealized parameterizations of moisture and other physics. We compare a wide range of fixed SST simulations using this model with simulations using a comprehensive atmospheric GCM run over the same boundary conditions. Dry baroclinic adjustment theories for the midlatitude static stability are invalid over the entire parameter range considered in the simplified GCM, and for much of the parameter range considered in the comprehensive GCM. A moist theory similar to that proposed by Juckes, on the other hand, works remarkably well in predicting the midlatitude stability over the entire parameter range for both models. We then examine changes in the static stability in simulations of global warming in the WCRP CMIP3 multi-model dataset. The moist theory of Juckes predicts an increase of dry static stability with increasing temperatures and moisture content. An increase in stability is indeed seen with global warming, in all hemispheres and seasons, but especially in the summer and in the Southern Hemisphere. The moist scaling theories work well in the Southern Hemisphere but fail in the Northern Hemisphere, where enhanced surface warming over land reduces the increase in stability.

Keywords: moisture, static, stability

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

MS007 **Poster presentation** **5228**

Counter-propagating Rossby waves, PV-building blocks, and their interaction

Dr. Hylke De Vries
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There has been a long-standing interest to understand baroclinic instability of perturbations, described by linearized dynamical equations of atmospheric models of various degrees of complexity. Bretherton (1966) showed that the growing and decaying normal mode (GNM and DNM) in the quasi-geostrophic two-layer and Eady model can be understood as a pair of phase-locked and interacting counter-propagating Rossby waves (CRWs). Eversince, studies have been undertaken to systematically generalize Bretherton's CRW-perspective to more complex geometries and models. At present a solid theoretical CRW-framework exists even for linearized primitive equations on the sphere [Methven et. al. (2006)]. Requirements for the CRW-perspective to work are that one is able to identify a background state and the set of GNMs. A pair of CRWs can then be constructed unambiguously.The CRW-perspective comprises an effective, concise description of the linear evolution of initial conditions that can be constructed by arbitrary superpositions of GNM and DNM. Because the GNM and DNM cover only a subspace of all possible perturbations, the question rises to what extent realistic initial conditions project on this subspace. At least since Farrell (1982) it is known that the continuous spectrum (the non-CRW part) is an essential part of the short-time linear evolution if the optimal growth properties of the system are investigated. Since the CRW-perspective allows one to get a physical understanding of the evolution of initial condition described by the GNM and DNM, the aim then is to include the continuous spectrum also in a physically intuitive way. One method of doing that is to view any perturbation as a superposition of PV-building blocks (PVBs). These PVBs have a Dirac delta-function PV-structure at one single level in the vertical (wave-like structure in the horizontal) and zero PV (and boundary potential temperature) everywhere else. In the PVB-view baroclinic instability of perturbations is understood as the interaction of all PVBs (rather than just the two CRWs) with each other.Considering these two views on baroclinic instability, we would like to investigate how they are linked. Obviously, the advantage of the PVB-approach compared to the CRW-perspective is that the continuous spectrum is automatically included. The disadvantage is that we have to take into account all interactions (rather than just the interaction of the CRWs). To more clearly assess the relevance of both views, we will address, among others, the following questions. How effective are PVBs in exciting CRWs and vice versa? How should we partition a given initial condition into a CRW- part and a non-CRW-part? What properties of the system (for instance, growth rates,phase-propagation and structural changes) are modified significantly once we include (or explicitly exclude) different representations of the continuous spectrum?

Keywords: baroclinic instability, pv building blocks, counterpropagating rossbywave

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MS007 **Poster presentation** **5229**

Some aspects of theory the acoustic-gravity waves propagation in the non isothermal atmosphere.

Prof. Olga Savina
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Olga Savina

Theoretical studies of acoustic-gravity wave ex citation and propagation in the non isothermal atmosphere with the winds was carried out. The analyt ical solutions for t he wave characteristics in the model no n isothermal atmo sphere are o btained. So me questio ns o f the stability o f a tmosphere with winds and het erogeneity are investigated. Serio us attention is given to the study o f atmo spheric disturbances at frequencies clo se to Brunt-Vaisala frequency on the basis of the model e xact solutions for the realistic atmosphere models. The orig inal analytical formalism, based at the preliminary an alysis of equation for the polarization rela tionships for acoustic-gr avity waves, was used to corr ect solution of boundary problem for the wa ve fields at lo wer and hig h altitudes. The possibili ty of the transformation of the acoustics- gravity wav es branches ne ar to the region of leakage w as studied. The special r ole of the Lambs wave and oscillations at Bru nt-Vaisala freq uency was examined.The work was partly supported by the Russian Foundation for Basic Research (project No. 05-02-16350).

Keywords: atmosphere, wave, polarization

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MS008 **5230 - 5270**

Symposium
Ensembles and Probabilistic Forecasting (ICDM)

Convener : Dr. Craig Bishop

This symposium invites contributions on all aspects of ensemble and probabilistic forecasting at all lead times and will include the following 5 topics. A) Probabilistic data-assimilation B) Probabilistic short-range forecasting systems C) Probabilistic medium-range forecasting systems D) Probabilistic monthly, seasonal and climate prediction systems E) Applications of probabilistic forecasts

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

MS008 **Oral Presentation** **5230**

The COSMO-LEPS system at ECMWF: present status and future plans

Dr. Andrea Montani
Hydrometeorological service of Emilia-Romagna ARPA-SIM IAMAS

Chiara Marsigli, Tiziana Paccagnella

COSMO-LEPS is the limited-area ensemble prediciton system, developed within the COSMO consortium, to improve upon the predictability of extreme and localised weather events, especially when orographic and mesoscale-related processes play a crucial role. The present status of the COSMO-LEPS system running as a 'time-critical application' at ECMWF will be illustrated and the most recent upgrades (including the increase of the ensemble size and the upgrade of the vertical resolution in the limited-area-model integrations) will be presented. The attention is focussed on the probabilistic prediction in the early and medium-range of surface parameters (e.g. total precipitation, surface winds, positive and negative temperature anomalies...) so as to assess the possibility to issue severe weather alerts on the basis of the COSMO-LEPS products. Particular attention will be also paid to the performance of the system over the Alpine area and a comparison between the operational suite and an experimental suite specifically targeted for the Alps will be illustrated. The spread-skill correlation of the two systems over this region will be analysed for a number of surface variables so as to investigate the reliability of COSMO-LEPS forecasts. Finally, plans for future upgrade of the suite as well as the ongoing international projects related to COSMO-LEPS will be presented.

Keywords: cosmo leps, limited area model, ensemble forecasting

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

MS008 **Oral Presentation** **5231**

The Application of the the Box - Jenkins Methodology for Early Flood Warning in Nigeria

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Department of Agricultural and Environmental Eng Olabisi onabanjo University, Ibogun, Ogun state IAHS

This paper reports on the development of a stochastic model based in the Box - jenkins methodology to forecast River flows. This iterative, powerful but rather complicated modelling proc edure involves identification, estimation and diagnostic check stages. The Autocorrelation {ACF } and Partial Autocorretation {PACF} are demonstrated to be useful indentification tools. Akaike Information Criterion {AIC} is useful for the best model selecti on. When th is methodology was u sed on Niger River flo w, average monthly discharges from 1985 to 2003 were used for the model development, while those from 2004 to 2005 were used for the to test how adequate the model was. The flood years were discovere d. The potentials of this methodology could now aid de cision-makers in their planning ef forts and flood warnings

Keywords: box jenkins methodology, average monthly discharge, niger river flow

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MS008 **Oral Presentation** **5232**

Probabilistic Short-Range Prediction over the Northwest U.S.

Prof. Cliff Mass
Atmospheric Sciences University of Washington IAMAS

This presentation will review the results of an end-to-end high-resolution, real-time ensemble weather prediction system that has been running for over five years over the Pacific Northwest region of the U.S. This system, run at 12-km grid spacing out to 72 h, makes use of both initialization uncertainty (based on the analyses of seven different major operational centers) and physics uncertainty to produce a diverse, mesoscale ensemble. This ensemble of 17 members is bias-corrected and then combined using Bayesian Model Averaging to produce probability density functions that are sharp and well-calibrated. The output from this ensemble system is presented in a series of innovative web pages and applications that attempt to provide maximum accessibility and value for the probablistic information. In addition to this system, a new Ensemble Kalman Filter (EnKF) system has recently been constructed with 90 members at 12-km resolution and is being used as the basis for a new regional assimilation and forecasting system. Initial results from this work will be discussed during this presentation.

Keywords: ensembles, probabilistic, weather

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

MS008 **Oral Presentation** **5233**

Data assimilation through particle filters for small diffusion kernels on branches of prediction

Dr. Paul Krause
Atmospheric Sciences University of Sao Paulo, Brazil

The aim of this work is to establish an efficient algorithm for high dimensional nonlinear filtering problems and provide a physically admissible definition of prediction in agreement with it. A method for parallelizing and reducing the operations count in particle filters is proposed. It summarizes in an efficient way of organizing the set of simulations into branches of prediction, and an efficient way of simulating large branches. This allows defining prediction as a deterministic path continuing the branch with smallest entropy. The simulation of branches of prediction is performed with an approximation of the original equation by a system of equations more amenable to computations. The approximate system provides a non-markovian model (the accumulated system noise modulated by the deterministic dynamical expansion) for the state fluctuation about the deterministic path of a branch of prediction. Its derivation is inspired by a method for model reduction introduced by A. J. Chorin, O. H. Hald and R. Kupferman (Physica D, 166 (2002)).

Keywords: data assimilation, particle filters, entropy

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

MS008 **Oral Presentation** **5234**

A local-ensemble prediction system (L-EPS) for fog and low clouds prediction at paris international airport

Mr. Stevie Roquelaure
mto-france mto-france IAMAS

Roquelaure Stevie, Bergot Thierry

A Local-EPS have been designed for short term prediction (12 hours forecasts) of fog and low clouds at Paris Charles de Gaulle international airport. Under low visibility constraints (visibility<600m and ceiling<60m), airport authorities have to take Low Visibility Procedure to manage and secure air traffic. These prescribed visibility and ceiling thresholds are used as a LVP criterion for the L-EPS. Thus, a ensemble of 54 members have been constructed on the COBEL-ISBA numerical forecast system. Perturbations are generated from initial conditions and mesoscale forcings of 1D model COBEL-ISBA. A Bayesian Model Averaging (BMA) approach is used to calibrate the ensemble for LVP forecasts. This paper, introduces the Local-EPS and his validation by analyzing performances with different scores adapted for probabilistic forecast validation (Brier score, reliability, resolution). This work also show that local and specific use of probabilistic forecasts can be economically advantageous considering a cost/loss approach.

Keywords: local ensemble prediction, bayesian model averaging, validation

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

MS008 **Oral Presentation** **5235**

Applying Probabilistic Forecasts of Physical Systems: Probably not Probability but Probabilistic

Prof. Lenny Smith
Centre for the Analysis of Time Series (CATS) London School of Economics

The application and use of probabilistic forecasts is examined in a variety of physical systems. Applications include the use of ensemble weather forecasts for decision support in the energy industry on a time scale of days to weeks, and the use of ensembles of climate model runs in making infrastructure decisions and policy. The strengths and weaknesses of these forecasts, as well as the rationality of interpreting them as (decision-relevant) probability forecasts, is explored with explicit consideration of the Bayesian Way. While it is argued that predictions must be phrased probabilistically, it is also argued that in the environmental sciences there will be few applications where we can construct probability forecasts that would be used as such. These issues are illustrated by making simple decisions using forecasts of a laboratory physical system where a good, but imperfect, nonlinear model is in hand. Effective alternatives to providing probabilities, some of which are already in industrial use daily, are discussed.

Keywords: probabilistic forecasts, ensembles, nonlinear

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

MS008 **Oral Presentation** **5236**

Impact of using model perturbations in a limited-area ensemble forecasting system for the short-range.

Dr. Chiara Marsigli
IAMAS

Tiziana Paccagnella, Andrea Montani

A strategy to provide high-resolution meteorological ensemble forecasts for the short-range (up to three days) is here presented. The non-hydrostatic limited-area model COSMO (formerly Lokal Modell), run at about 10 km of horizontal resolution, is used to build a 16 member ensemble system, the COSMO-SREPS. Different sources of forecast errors have been considered, to describe the uncertainty affecting the scales of interest in the high-resolution weather forecast at the considered time range. To provide initial and boundary conditions perturbations, a Multi-Analysis Multi-Boundary approach has been adopted: the 10-km COSMO runs are driven by four lower resolution COSMO runs, nested on four different global models (IFS, GME, NCEP, UM) which use independent analyses. Aiming at encompassing also the smaller scale uncertainty, limited-area model perturbations have been applied as well. In particular, the effect of randomly changing (within their range of variability) the values of the parameters included in the schemes for the parameterisation of the sub-grid processes is shown. Results are presented for a 1-month test period in Autumn 2006. The relationship between the ensemble spread and skill is analysed. Furthermore, the role of the different perturbations in determining the spread is assessed, investigating the relative impact of driving-model perturbation and limited-area-model perturbations. Results show that the inclusion of the limited-area model error, although based on a simple technique, allow to increase the spread of the ensemble forecasts to values closer to the error, in terms of surface variables. The impact of the limited-area model perturbations, though less evident globally, can become important at a local scale. Finally, the degree to which members with similar perturbations tend to clusterise and the different behaviour of a model perturbations when applied to members having different initial and boundary conditions are also shown.

Keywords: ensemble, short range, model perturbations

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MS008 **Oral Presentation** **5237**

Application of conditional nonlinear optimal perturbations to ensemble prediction

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Mu Mu

Conditional nonlinear optimal perturbation (CNOP), which is a natural extension of singular vector (SV) into the nonlinear regime, is applied to ensemble prediction study under the perfect model assumption. The comparison is done with two models: a barotropic quasi-geostrophic (QG) model and a T21L3 QG model, which was developed by Marshall and Molteni. SVs and CNOPs have been utilized to generate the initial perturbations for ensemble prediction experiments. The results are compared for forecast lengths of up to 14 days. Its found that the forecast skill of samples in which the first SV is replaced by CNOP is comparatively higher than that composed of only SVs in the medium range (day 6 ~ day 14) for barotropic model. This conclusion is valid under the condition that analysis error is a kind of fast-growing errors regardless of its magnitude, whose nonlinear growth is faster than that of SV in the later part of the forecast. For T21L3 QG model, reliabilities of the above two methods for initialization of ensemble prediction are assessed through Talagrand diagrams and brier score. It further shows that the new ensemble perturbation method has better reliability on the whole.

Keywords: weather, sv, cnop

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MS008 **Oral Presentation** **5238**

Ensemble Data Assimilation with the NCEP GFS

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We will present results of a global ensemble data assimilation (EDA) for ecast system using the NCEP Global Forecast System (GFS) at T62 resolution. This data assimilation system uses a local ensemble transform Kalman filter (ETKF) and has been tested assimilating conventional and satellite observations using January 2004 data. Preliminary results suggest that when only conventional observations are used, the anal yses and fore casts from the EDA is much improved over th at from th e baselin e 3-dimensional variational (3D-Var) analysis. When satel lite data is included, the EDA still outperforms the 3D-Var, but by a lesser amount. Before IUGG, we hope to complete further tests, including the use of a higher-resolution model, the inclusion of more sophisticated model-error parameterizations.

Keywords: ensemble, kalman, filter

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MS008 **Oral Presentation** **5239**

Ensemble forecast calibration using "reforecasts"

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We provide an overview on the calibration of ensemble forecasts using "reforecasts," a data set of prior model forecasts using the same data assimilation and forecast system that is used to produce the operational forecasts. We have a 28-year ensemble reforecast data set with a 1998 version of the NCEP Global Forecast System (GFS). Results show that for calibration of 2-m temperature and precipitation forecasts, this large training data set is especially valuable, producing substantial improvements when compared to calibration using short training data sets. Recently we have also obtained a limited set of reforecasts from ECMWF. We will present results of calibrating this much-better ensemble forecast system at the conference.

Keywords: ensemble, prediction, calibration

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MS008 **Oral Presentation** **5240**

Prediction of Climate Indices Using the First Passage Time

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Climate variability is simply represented by teleconnection patterns such as the Arctic Oscillation (AO), Antarctic Oscillation (AAO), North Atlantic Oscillation (NAO), Pacific/North American Pattern (PNA), and Southern Oscillation (SO) with associated indices. Two approaches can be used to predict the indices: forward and backward methods. The forward method is commonly used to predict the index fluctuation at time t with a given temporal increment . Using this method, it was found that the index (such as for NAO) has the Brownian fluctuations. On the base of the first passage time (FPT) concept, the backward method is introduced in this study to predict the typical time span (t) needed to generate a fluctuation in the index of a given increment . After the five monthly indices (AO, AAO, NAO, PNA, SO) running through the past history, the FPT density functions (inverse Gaussian distribution) are obtained. FPT presents a new way to detect the temporal variability of the climate indices. The basic features for the index prediction are also discussed.

Keywords: firstpassagetime, teleconnection, backwardfokker planckequation

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MS008 **Oral Presentation** **5241**

Forecasting the duration of weather events on the monthly time scale

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Growing interest and application of probabilistic weather forecasts for the medium range offers the opportunity to explore applications out to one month ahead and longer. This paper investigates forecasts of risk related to the duration of periods of adverse weather. An example addressing the risk of periods without precipitation in 2006 in the Mediterranean region will be presented. The risk is derived from 51-member coupled OAGCM monthly forecast ensembles. The method can be applied and evaluated for a range of other weather events, e.g. periods of temperature exceeding thresholds for energy supply planning (degree days), evaporation for irrigation planning, growing season, monsoon onset and many other weather risks. The example product is derived at the Met Office from operational monthly forecasts produced at ECMWF. Initial forecast validation using the case study will be presented.

Keywords: lrf risk duration

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MS008 **Oral Presentation** **5242**

Report of the THORPEX Interest Group on Theoretical Aspects of Ensemble Prediction

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Craig H. Bishop

As part of the activities of the THORPEX Working Group on Predictability and Dynamical Processes, an Interest Group has been set up on Theoretical Aspects of Ensemble Prediction. Several tens of scientists have participated in the discussions of the Interest Group. The discussions have concentrated mostly on the goals that can be achieved by ensemble, or more generally probabilistic prediction, and on how the degree to which those goals are actually achieved can be objectively evaluated. Probabilistic prediction is of a fundamentally different nature from deterministic prediction, in that the object of the prediction (viz. a probability distribution) has no objective existence, and cannot be observed. Two statistical properties that make the quality of a probabilistic prediction system are reliability and resolution. The degree of reliability and resolution of a probabilistic prediction system can in principle be objectively evaluated to any desired accuracy, provided a large enough verification sample is available. Experience shows that the scores that are routinely used for objective evaluation of meteorological ensemble prediction systems saturate at ensemble sizes in the range 30-50. The reason for that fact has not been clearly elucidated. And such sizes are in any case insufficient for prediction of, for instance, variances of probability distributions. Probabilistic prediction is subject to strong limitations, among which the unavoidably (relatively) small size of the verification sample. Precise evaluation of those limitations would be extremely useful for the design of ensemble prediction systems.

Keywords: validation, ensemble size, limitations

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MS008 **Oral Presentation** **5243**

Probabilistic predictions of climate change in Australia using the Reliability Ensemble Average (REA) of AR4 model simulations

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Debra A. Hudson

Reliability ensemble averaging (REA), developed by Giorgi and Mearns, is applied to an ensemble of IPCC AR4 fully-coupled atmosphere-ocean GCM's to produce climate change scenarios for Australia under three SRES emissions scenarios (A2, A1B, B1). The method produces a weighted average of the ensemble of climate change results, taking into account ability to simulate the observed climate and convergence in the predicted climate change. This provides a framework for applying quality criteria to assess the reliability of the REA change and to calculate an uncertainty range. We apply the REA methodology at the scale of a GCM gridbox to provide regional detail in temperature and precipitation changes over Australia in summer and winter. Probabilities of regional climate change can be calculated using the REA method by assuming each models' reliability as an indicator of the likelihood of its' simulation. This procedure is applied over Australia to determine the probabilities of exceeding particular thresholds of temperature and precipitation changes over three regions in Australia: southwest Western Australia, the Murray-Darling-Basin, and tropical Australia. These threshold probabilities provide the basis for the calculation of probability densities. The most interesting feature occurs during the austral winter, where we find substantial differences in the regional warming signal (southwest Western Australia versus tropical Australia) and marked decreases in regional rainfall (southwest Western Australia and the Murray-Darling-Basin). Acknowledgements: This project was supported by the Australian Greenhouse Office (AGO).

Keywords: reliability ensemble average, probabilistic, climate change

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MS008 **Oral Presentation** **5244**

Mogreps: a met office ensemble prediction system for short-range weather forecasting

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The UK Met Office introduced a new quasi-operational short-range ensemble prediction system, MOGREPS, in September 2005, and following successful trials is now planning to make MOGREPS fully operational during 2007. MOGREPS uses a regional model covering the North Atlantic and Europe at 24km resolution, with lateral boundary conditions supplied from a global ensemble with a grid-length of ~90km in mid-latitudes. MOGREPS uses an ETKF (Ensemble Transform Kalman Filter) to provide initial perturbations suitable for short-range use. It is believed to be the first quasi-operational implementation of the ETKF in a full NWP system making use of the full set of observations used in the 4d-VAR system which generates the control analysis. MOGREPS also employs three different stochastic physics schemes to help account for model error. For operational use MOGREPS is supported by a comprehensive web-based display system which allows forecasters real-time access to a wide range of probabilistic forecast products animated in time. Site-specific products are generated through an operational database system allowing statistical post-processing for generation of optimised products for customers.Early results indicate that the ensemble provides skilful probability forecasts for a range of parameters, and in particular has greater skill in the short-range than is available from existing medium-range ensemble prediction systems. This is believed to be due to the use of a higher resolution model and perturbation systems designed for short-range performance. Feedback from operational forecasters has also been extremely positive. Latest verification from MOGREPS will be presented along with initial results of research into an ETKF for the regional ensemble

Keywords: ensemble, short range, etkf

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MS008 **Oral Presentation** **5245**

Dynamical downscaling of ECMWF EPS forecasts applied to cases of severe weather in Croatia

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Dynamical downscaling, using the ALADIN Limited Area Model (LAM), has been applied to the ECMWF Ensemble Prediction System (EPS) forecasts in order to assess its potential impact during cases of severe weather (precipitation and wind) over various parts of . Four synoptic cases are considered, for which both global and regional 51-member ensembles were run. The differences in some basic forecast statistics between the two ensembles have been identified. Such statistics is extended to the clusters derived from both ensembles using the same clustering algorithm. The results indicate that, on average, downscaling may yield differing results between global and regional ensembles and can have an important impact on clustering. Because of such potential dissimilarities between global and regional clusters, a careful consideration must be taken (if and) when choosing the global representative members for dynamical downscaling, currently the operational practice in some meteorological centres. In addition, the differences in the ensemble and cluster analysis, mainly in terms of forecast probabilities, for selected synoptic cases between the two types of models are shown and discussed.

Keywords: downscaling, clustering, probabilities

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MS008 **Oral Presentation** **5246**

Use of linear discriminant methods for calibration of seasonal probability forecasts

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Dr Richard Graham

The linear dis criminant metho d is presented as a tool for calibratin g probability bias in seasonal forecasts, such that the prob abilities provid e an im proved estimate of the likelihood of the predicted event occurring. Results of calibration of the Met Office GloSea model and Multi-model (ECMWF, Meteo-France, Glo Sea) hindcasts pro duced as part o f the DEMETER project will be presented. Results of calibrated Glo Sea model hindcasts combined with SST based statistical predicti ons will also be presented. . When tested using qu intile and tercile hindcasts from the GloSea model, replacing raw ensemble probabilities with discriminant calibrated probabilities improves reliability but reduces forecast resolution as measured by the Relative Operating Characteristic (ROC) diagnostic.. A pragmatic approach that recovers ROC skill whilst retaining the reliability im provements involves generating weighted averages of calibrated and uncalibrated probab ilities and results will be presented Multivariate (MV) discrimanant analysis has also been used to produce calibrated pr obabilities. The predictors are combinations of GCMs or of GCM and SST based statistical predictions. This method is used in prediction of North and East African rainfa ll, NE Brazil rainfall and European winter temperature. The MV probabilities a re not quite as reliable as sing le var iable discriminant fo recasts and can b e disproportionate to predict or skill in certai n case s. Procedures are be ing tested to correct these anomalies by for example significance tests on pred ictors prior to their selection or adapting the discriminant equation to take more account of uncertainty in observations. Ex amples will be presented and discussed.

Keywords: calibration, discriminant, multi variate

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MS008 **Oral Presentation** **5247**

The Prediction of Extratropical Cyclones by the ECMWF Ensemble Prediction System: A Regional Analysis

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A storm-tracking approach to forecast verification has been used to explore the prediction of extratropical cyclones by the European Centre for Medium Range Forecasts (ECMWF) Ensemble Prediction System (EPS). An objective feature tracking method has been used to identify and track the cyclones along the forecast trajectories of the ensemble members. Statistics have been produced to determine the rates at which the positions and intensities of the forecast cyclones diverge from the analysed cyclones with increasing forecast time. The analysis methodology provides an alternative measure of forecast skill to that obtained from conventional RMS and anomaly correlation approaches and gives detailed information about the prediction of extratropical storms. Since these storms are responsible for a vast majority of the weather experienced in the midlatitudes, the method provides a good measure of a forecast systems ability to predict the weather. In the past the ensemble verification statistics, generated from the storm-tracking analysis, have been for entire hemispheres. A regional analysis of the EPS has now been performed to investigate how these statistics vary from one area of the globe to another (e.g. the Atlantic compared with the Pacific). Results concerning the spatial variation of the ensemble mean error, ensemble spread and control forecast error will be presented for various cyclone properties, such as position, intensity, growth and propagation speed. Earlier results have shown some small biases for the cyclones predicted by the ECMWF EPS; in general the cyclones are slightly overpredicted and propagate too slowly. Results will also be presented to show the spatial variation of these biases.

Keywords: extratropical cyclone, ensemble prediction, forecast verification

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MS008 **Oral Presentation** **5248**

Comparison of Ensemble-based Filters for the Stochastic Cessi-Young Equation

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Both estimating the present state of the ocean and forecasting its future evolution have been considered important because the ocean plays a crucial role in climate change. Numerous approaches have been proposed for the state estimation and prediction problems. One approach is using ensemble members that is what so-called particle-based filters such as Sequential Importance Resampling (SIR) method, Ensemble Kalman Filter (EnKF) and Maximum Entropy Filters (MEF). One of Sequential Monte Carlo methods, SIR is a convergent method so that it produces the optimal solution in the limit of ensemble size N. EnKF is an optimal filter to linear models with Gaussian statistics, and practically feasible to large scale nonlinear models. MEFs are newly introduced algorithms. The new approaches are based on the principle of maximum entropy, which determines unknown density subject to constraints such as ensemble moments. This study aims to assess and compare particle-based filtering techniques: SIR, EnKF, and MEF. Their performances are compared by applying to an intermediate ocean circulation model, the stochastic Cessi-Young model. This conceptual model with dimension of 150 is a generalized form of the two dimensional Boussinesq model proposed by Thual and McWilliams. In the model, the random surface salinity flux representing synoptic variability in freshwater sources is attributed to the ocean circulation between thermo-dominated state and salinity-dominated state which are considerable to the present climate state and the ice-aged state, respectively. Moreover, the filtering algorithms above yields the relative entropies which serve as a useful measure of the information gain of the observations and its rate of degradation over time. When observations are available, the quantity of the relative entropy makes a jump whose magnitude is a numerical measure of information gain, and then monotonically decreases back to zero in time. Hence, the relative entropy can be used as utility of ensemble predictability. We show the results of the relative entropies for above filtering methods.

Keywords: ensemble based filters, maximu entropy principle, relative entropy

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MS008 **Oral Presentation** **5249**

A probabilistic forecast approach for (extreme) daily precipitation totals applied to GFS forecasts

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Andreas Hense

We present a probabilistic postprocessor that provides calibrated probability and quantile forecasts of precipitation on the local scale. The forecasts are based on large scale circulation patterns of the 12h forecast from the NCEP High Resolution Global Forecast System. The censored quantile regression is used to estimate selected quantiles of the precipitation amount and the probability of the occurrence of precipitation. The approach accounts for the mixed discrete-continuous character of daily precipitation totals. The forecasts are validated using a new validation score for quantile forecasts, namely the censored quantile verification (CQV) score. The forecast approach is as follows. First, a canonical correlation is employed to correct for systematic deviations in the GFS large scale patterns compared to the NCEP or ERA40 reanalysis. Secondly, the statistical quantile model between the large scale circulation and the local precipitation quantile is derived using NCEP and ERA40 reanalysis data. Then, the statistical quantile model is applied to 12h forecasts provided by the GFS forecast system. The probabilistic forecasts are reliable and the relative gain of the quantile as well as the probability forecasts compared to the climatological forecasts ranges between 20% and 50%. Furthermore, the forecasts are more skilful than a forecast based on the direct precipitation output from the ECMWF forecast system.

Keywords: quantile regression, precipitation, verification

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MS008 **Oral Presentation** **5250**

Climate change ensemble prediction at the Hadley Centre

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An overview of the ensembl e/probabilistic climate change prediction work at the Hadl ey Centre, Met Office will be given. Recent advances includ e; separate coupled model ensembles with perturbations to ocean parame ters and parameters which control the atmospheric sulphur cycle, regional model simulations at 25km resolution, seas onal to decadal predictions initia lised from observations, and work to produce pr obabilistic predictions from perturbed physics and multi-m odel ensembles. Further wor k, currently unde rway, to quantify the uncert ainty fro m terrestrial carbon cycle process es will also be described.

Keywords: climate, ensemble, precition

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MS008 **Oral Presentation** **5251**

Generation and Validation of probabilistic quantitative precipitation forecasts using Breeding and Ensemble Kalman techniques with the global model GME

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Quantitative precipitation f orecasts (QPF) wi th a lead time of synoptic time scales of 3-5 days are intrinsically probabilistic. The only feasible method for predi cting estimates of the underlying probability density fu nction o f precipitatio n amo unt are ensemb le sim ulations. An ensemble forecast systems fo r the global model GME is set up based on the breeding technique. The procedure of ensemble generation is enhanced b y the intro duction of balanced wind- mass disturbances in the initial perturbation generation process. Furthermore the ensemble member initialization is modified to increase the spread of perturbation growth. With an ensem ble f orecasting sy stem available, the covariance matrix of the first guess can be estimate d from the spread of the individual realizations. Essential enhancements of the Ense mble Kalman Filter are achieved by incor porating additional dynamica l information from other sources than observations by the application of the breeding tech nique and the usage of a hybrid 3DVAR/ETKF system which is superior to either a purely ETKF or 3DVAR system. The complete system is validated first by using standard scores from literature on single observations and averages for catchments. Sta ndard scores are extended through a new method from geostatistics t o account for the spatial representativity error. Havi ng set up this syste m new ideas are included in validation and Ensemble Kalman filtering arising from a from a Bayesian view of the statistical problems.

Keywords: ensembles, precipitation, global model

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MS008 **Oral Presentation** **5252**

Probabilistic forecasts of (severe) thunderstorms for the purpose of issuing a weather alarm

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The derivation and verification of logistic regression equations for the (conditional) probability of (severe) thunderstorms in the warm half-year (from mid-April to mid-October) in the Netherlands will be presented. For 12 regions of about 90 km x 80 km each, and for projections out to12 h in advance (with 6-h periods), these equations have been derived using model output statistics (MOS). As a source for the predictands, reprocessed lightning data from the Surveillance et d'Alerte Foudre par Interfromtrie Radiolectrique (SAFIR) network have been used. The potential predictor dataset not only consisted of the combined (postprocessed) output from two numerical weather prediction (NWP) models, as in our previous study, but it also contained an ensemble of advected radar and lightning data for the 0-6 h projections. The NWP model output dataset contained 17 traditional thunderstorm indices, computed from a reforecasting experiment with the High-Resolution Limited-Area Model (HIRLAM), and (postprocessed) output from the European Centre for Medium-Range Weather Forecasts (ECMWF) model. The system was made quasi-operational at the Royal Netherlands Meteorological Institute (KNMI) in 2006. It is expected that the system will help the forecasters to decide whether a weather alarm for severe thunderstorms should be issued.

Keywords: thunderstorms, mos

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MS008 **Oral Presentation** **5253**

Developing multiple approaches for mesoscale ensemble data assimilation and prediction

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Mesoscale (10-2000 km) meteorological pr ocesses differ from synoptic circulatio ns in that mesoscale weather changes rapidly in space and time, which re nders it less predict able. Mesoscale processes ar e influenced b y syno ptic circulatio ns, but largely de termined by regional and local terrain, surface heterogeneity, and associated physical properties. Ph ysical processes such as radiative transfer, cloud and precipitation, boundary layer mixing, play a crucial role in shaping the regional weather and climate. Thus, mesoscale ensemble a nalysis and pre diction systems need to consider the uncertainties induced by various aspects of the modeling system. To addr ess these issues, multiple approach es have been designed to construct the N CAR mesoscale ensemble analysis and pr ediction syste m (MEAPS). The ensemble realizations include perturbations to model initial conditions (IC), lateral boundary conditions (LBC), model p hysical parameterizations (PP), and th e underlying land-surface (LS) prope rties. The IC perturbation consists of perturbing observat ions and data an alysis weighting, and an EnsembleTransform Kalman Filter (ETKF) . The LB C perturbation includes appro aches to deriving LB Cs from different global models , and to adding large- scale phase errors and model error statistic using a 3DVAR schem e. The PP per turbation includes varyin g p arameterization schemes and perturbing the most sensitive and uncertain parameters in some schemes. Finally, the LS perturbations are constructed to consider the uncertainties i n land surface properties (e.g. albedo, vegetation fraction , soil hydraulic properties and others). Additionally, an off-line high-resolution land-surface data assimilation system is used to generate an ensemble of land-soil thermal and moisture state s to facil itate the MEAPS LS perturbation. //// The MEAPS system also includes several data-assimilation schemes that are applicable for mesoscale weather analyses. MEAPS run s in cyclin g-mode at a given time interval, and each cycle contains a data-assimilation period (fr om t he last cycle hour to the c urrent time) a nd short-term forecasts. An "observation-n udging"-based FDDA is activated during e nsemble data analyses cycle s, which assimilates adiverse set o f co nventional an d u nconventional weather o bservations. To en hance the memory of initial condi tion perturbations ge nerated by the E TKF approach and improve the continuity o f the weather ev olution ineach member, a "grid- nudging" scheme is used to nudge the model toward ETKF-perturbed initia l conditions during the first 1- 2 hr fo recasts ofthe ETKF members. Finally, the NCAR/DART (Dat a Assimilation Research Te stbed) ensemble Kalman Filter is employed to produce mesos cale ensemble weather analyses using observations and ensemble forecasts of MEAPS. MEAPS has be en implemented on a 69-node, 272-proces sor Linux cluster. The system is capable of running a 55- member neste d-gridensemble with a fine mesh of 230 by 230 km an d a 3.3 km gr id increment. The system cycles at 6-hr intervals, producing 36-48 h forecasts in eachcycle. The system has been scheduled for operational production in the Spring of 2007. Forecasting and analysis examples and preliminary system evaluation will be presented.

Keywords: mesoscale ensemble forecast, operational, enkf

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MS008 **Oral Presentation** **5254**

Forecast evaluation and proper scores

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An approach to the general evaluation of probabilistic forecasts is presented, which rests entirely on the concept of proper scores. The definition and the implications of propriety are presented in detail. It is shown that proper scores allow for decomposing the overall forecast score into positive definite terms, similar to but more general than the well known decomposition of the Brier Score. A decomposition into sharpness and reliability related terms emerges as a special case. These decompositions require the score to be proper, thereby motivating the use of proper scores intependently of any attempt to encourage 'honesty' among forecasters. Furthermore, it is demonstrated that variability of the forecast system (which can arise for example through variability of parameters of the forecast system) has to be taken into account, which in general leads to a further error term. Since scores give only a general statement of forecast performance, forecasters have developed various tools to investigate forecast quality conditioned on different synoptic situations. One example of such a tool is the reliability diagram. The more detailed information a reliability diagram can give though comes at the price of a higher variability, diminishing the power of the tool. This phenomenon cannot be avoided and therefore has to be properly acknowledged. To this end, it is suggested that consistency bars be added to the reliability diagram, giving the user a hint as to how large variations are to be expected even if the forecast was actually reliable.

Keywords: scores, reliability, sharpness

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MS008 **Oral Presentation** **5255**

Flow dependent inexpensive high resolution ensembles of ocean surface forcings using time deformation

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A time-deformation technique for inexpensively generating high resolution surface forcing ensembles for ocean model ensemble forecasts is developed. The technique is ba sed on the idea that the truth/verification can often be well approximated by a relatively small and smooth shift of the forecast in space and time. It is difficult to predict the s pace-time shifts associated with a pa rticular error, but it is possible to estimate their distribution. Here, we generate random fields of time shifts using a stochastic model that allows the temporal and spatial correlations to be stric tly controlled. The st ochastic m odel also allows the variances of the time shift to be specified as a function of space and time. The extent to which the tim e deformation ensemble can distingu ish oc casions on wh ich the surface forcing error variance is large from occasions where it is small is assessed. The performance of the flow dependent time-deformation surface forcing en semble is compared to that of a non-flow dependent stochastic surface forcing ensemble.

Keywords: ensemble, time deformation, verification

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MS008 **Oral Presentation** **5256**

Model error in probabilistic climate forecasting

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No matter what computing resources we throw at the problem, a forecast of long-term climate change will always be probabilistic, constituting an estimate of the distribution of possible future climates consistent with the information we have available today and some assumptions about the evolution of climate forcings in the future. This is a familiar situation in weather forecasting, where probabilistic forecasts are routine, but with an unfamiliar twist. We can evaluate and improve the performance of a probabilistic weather forecasting system by evaluating its performance over a succession of forecast situations. In a forecast of 50-year climate change, there is only one validation point. We can evaluate our estimate of initial condition uncertainty by investigating the spectrum of model-simulated internal variability, but uncertainty arising from model error, or uncertainty in the simulated response to external forcing,appears to be intractable. Using examples from recent perturbed physics ensemble experiments with simple and complex models, we will argue that the ultimate goalof probabilisticclimate forecasting is, for a particular forecast variable of interest, convergence of the distribution of forecast likelihoods across models and across model-generations, given the same set of climate observations and varying those aspects of the models that are not constrained by data.We will argue for a methodology for probabilistic climate forecasting that will expedite this convergence, while recognisign that this process will take time. Patience is important, since an illusion of convergence could be (and, arguably, is being) created artificiallyby incorporating a strong element of prior opinion in to our forecasts, but such convergence is uninformative, "papering over" problems much like the convergence of simulations of current climate that was achieved by flux adjustment. Once we find that the distribution of forecast responses of a particular climate variable, given the same set of climate observations and scenario of future forcing, is insensitive to our choice of current climate model and (more importantly) ceases to change with successive model generations, then we can claim that the climate modelling problem appears to becomplete for that particular variable. Naturally, there are still matters of degree: convergence may be achieved across the bulk of the forecast distribution, but forecasts may still not have converged in the tails, corresponding to low-probability outcomes that may be particularly sensitive to details of model formulation. In practical terms, assessing whether a forecast distribution has converged requires a succession of perturbed-physics ensemble experiments with a range of climate models in order to compare the resulting distributions of forecast likelihoods. This may require a reassessment of the allocation of resources in climate modelling, from focussing on higher spatial resolution and resolving more processes, to focussing on much larger ensembles. Fortunately, the advent of distributed ("grid") computing means that these large ensembles may be achieved with new computing resources, leaving traditional resources available for more traditional climate modelling activities, such as the pursuit of higher spatial resolution.

Keywords: climate, ensembles, bayesian

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

MS008 **Oral Presentation** **5257**

ECO-RAP, Part 1: A new adaptive error covariance localization tool for 4-dimensional ensemble data assimilation.

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Prescribed, non- adaptive mo deration o r localizatio n functio ns are widely used in ensemble data assimilation (DA) to reduce the amplitude of spurious ensemble correlations. These functions are poorly suited to four-dimensional (4D) DA proble ms beca use true error correl ation functions move with th e flow while non- adaptive lo calization functi ons do no t. A new metho d fo r generati ng lo calization functions that move with the true error correlation functions and that also adapt to the width of the true error correlation function is given. The method us es Ensemble COrrelations Raised to A Power (ECO-RAP). It is based on the discovery that error pr opagation information and error correlation width information retained by powers of raw ense mble correlations can be use d to propagate and adaptively adjust the width o f user-specified correlation functions. The manner i n which powers of raw ensemble correlations can achieve this feat is demonstrated using mathematical analysis an d a gallery of examples. A common test of 4D DA systems is to see if they can accurately estimate a 4D state from a series of observations from a single location. It is shown that 4D DA using raw ensemble Covariances Adaptively Loc alized with ECO-rap (CALECO) passes this test. To highlight the ability of ECO-RAP localization to adapt to cha nges in the width of the tr ue error co rrelation length s cale, a three-dimensional (3D) error syste m was conside red in wh ich such changes occurred and it was shown that ECO-RAP localization was superior to no n-adaptive lo calization. When no such variations in erro r correlation length scale were present, ECO-RAP and non-adaptive localization delivered DA performance of the same quality.

Keywords: ensembles, covariance, localization

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MS008 **Oral Presentation** **5258**

A comparison of pre- and post-model resampling schemes for seasonal streamflow forecasting with Ensemble Streamflow Prediction method

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Adam K. Gobena

This study compared the performance of two K-nearest neighbor (K-NN) resampling schemes for producing ensemble streamflow forecasts using a conceptual hydrologic model. In the first scheme, the weather input data to the hydrologic model (precipitation and temperature) for each day of the forecast year are stochastically generated from historical observations by conditioned resampling from the K-NN. In the second scheme, ensemble members are conditionally resampled from candidate ensemble traces which were generated by assuming that each historical year in the record has an equal likelihood of occurrence in the forecast year. In both schemes, the conditioning vectors for selecting the nearest neighbours comprise large-scale climate information and antecedent station precipitation. The methods were applied to two watersheds located in the headwaters of the South Saskatchewan River basin in the province of Alberta, Canada. Forecasts produced by the two schemes exhibited only marginal differences in terms of overall skill measures such as correlation coefficient, relative root-mean-squared error and ranked probability skill score. However, notable differences were observed between forecasts issued during some months when the relative operating characteristic curve was evaluated for below-normal and above-normal flow categories separately.

Keywords: resampling schemes, streamflow

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

MS008 **Poster presentation** **5259**

Sensitivity study of T2m and precipitation forecasts to soil moisture initial condition using NCEP WRF ensemble system

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George Gayno

NCEP Short-Range Ensemble Forecasting (SREF) system has been running in operation since 2001. It's noticed that ensemble spread particularly in precipitation and near-surface variables such as 2m temperature are underdispersive especially in warm seasons. Early research results suggested that perturbing soil moisture in land surface model (LSM) might increase ensemble spread in summer rainfall forecasts. To test if it's also the case in operational setting, a series of sensitivity tests of precipitation and near-surface variables to soil moisture initial conditions are performed using the NCEP operational WRF ensemble system for both warm and cold season cases. This talk will present the results from those preliminary sensitivity studies including the variation of sensitivity with the structure and size of perturbations as well as with seasons. It's planned to add perturbations to LSM to further increase diversity of the NCEP SREF system although it is a quite challenging task how to design a simple and effective perturbation generating scheme in LSM for an operational mesoscale ensemble system. For NCEP regional ensemble system, you can go to http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html

Keywords: regional ensemble, soil moisture perturbation, near surface fields

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

MS008 **Poster presentation** **5260**

Dealing with the uncertainties related with LAMEPS

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Scientific and computational limitations prevent us from constructing a perfect NWP model of real systems. Small errors in the initial condition, in the boundary conditions, in the model, e.g. physics and dynamics, can grow exponentially and eventually render a forecast useless. For dealing with those uncertainties, in particular, those related with the limited area model, some works have been done at ZAMG. Efforts have been put on combination of initial condition perturbations from global EPS system and LAM EPS system. The method used in the study is the spectral blending for combining the global singular vector perturbation and LAM breeding perturbation. The impact of the uncertainty on the lateral boundary conditions, especially the impact of the inconsistency in the generation of ensemble lateral boundary conditions from global EPS system with the generation of the ensemble initial conditions from the limited area ensemble system itself, has been also investigated. The results will be presented at the conference.

Keywords: lameps

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

MS008 **Poster presentation** **5261**

Ensemble Hindcasts of SST Anomalies in the Tropical Pacific Using an Intermediate Coupled Model

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Jiang Zhu, Rong-Hua Zhang

Ensemble hindcasts of sea surface temperature (SST) anomalies in the tropical Pacific are studied using an intermediate coupled model (ICM), in which an ensemble Kalman filter (EnKF) data assimilation system is implemented to provide the initial ensemble. A linear, first-order Markov stochastic model is adopted to represent model errors. Parameters in the stochastic model are estimated by comparing observation-minus-forecast values over 30 years. Twelve-month, 360 ensemble hindcasts are performed over the period 1975-2004, each with 100 ensemble members. This ensemble technique provides a simple method of extending the standard ICM forecasts to the probabilistic domain. The results show that the prediction skill of the ensemble mean is better than that of one single deterministic forecast using the same ICM. For the probabilistic perspective, those ensemble forecasts have their ensembles following observed SST anomaly variations well.

Keywords: enkf, enso, model error

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

MS008 **Poster presentation** **5262**

An ensemble-based approach to information content analysis and some new applications

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Arthur Y. Hou, Sara Q. Zhang, A. Scott Denning

Ensemble-based data assimilation methods can be li nked with info rmation theo ry and thus pro duce a unified probabilistic approac h to data assimilation and information content analysis of assimilate d observations. We have derived this unified approach employing ideas from Ensemble Transform Kalman Filter (ETKF) and Maximum Likelihood Ensemble Filter (MLEF). Main advantages of this approach include (1) employing flow-dependent, rather then a prescribed, forecast er ror covariance, and (2) defining information matrix in a low-dimensional ensemble subspace. Examples from applications to atmospheric and carbon transport models will be presented and discussed. We wi ll also dis cuss implicati ons o f different data assimilation methods (e.g., variat ional, Kalman filter, an d ensem ble-based data assimilation approaches) on the results of the information content analysis. Some novel applications o f this approach, to define an information-based distance function, will also be discussed.

Keywords: information, dof, distance

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

MS008 **Poster presentation** **5263**

A dynamic localization method for use with targeted observations and ensemble data assimilation

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Dusanka Zupanski

One of the major issues in realistic ensemble data assimilation and prediction is the insufficient rank. A common approach used to deal with the issue of insufficient degrees of freedom is the localization of error covariance, usually accomplished using simple geographical sub-domains in model or observation space defined by an equidistant (circular) radius of influence. Although the impact of increasing the degrees of freedom in this manner is positive, there are potentially adverse effects caused by neglecting the model dynamics in the localization procedure. In other words, the uncertainty of the dynamics does not conform to any regular, prescribed patterns. Typical consequence of applying this approach is an imbalance of the initial conditions, as well as a sub-optimal use of ensembles. Given that the number of ensembles is a limiting factor in realistic applications, it is desirable to improve the utility of available ensembles by introducing a dynamics-friendly localization procedure. We propose a new localization algorithm capable of accounting for the dynamics of the system. The general formulation of the algorithm allows simple adjustment of space and time dimensions. Two components of the new localization algorithm will be discussed in more detail: (i) dynamical correlation structure of the uncertainty matrix, and (ii) neighbor-preserving optimization. The algorithm can be used on a stand-alone basis, in applications to ensemble data assimilation and targeted observations. The algorithm characteristics will be illustrated in several examples ranging from a simple prescribed error covariance structure to a complex error covariance produced by a non-hydrostatic model.

Keywords: dynamic, localization, targeted

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

MS008 **Poster presentation** **5264**

Seasonal prediction of Korea regional climate from preceding large-scale climate indices

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Woo-Seop Lee

In this study, based on multivariate linear regression with an adaptive choice of climate indices as predictors, a seasonal forecast at a lead time of two months was applied to Korea on a monthly basis, and leave-one-out cross validation was applied to obtain forecasting skill at the 1% significance level. The monthly ACC (anomaly correlation coefficient) skill was 0.42-0.65 for temperature and 0.35-0.63 for precipitation. COD (coefficient of determination) was 18-42% for temperature and 14-39% for precipitation. The first coupled SLP pattern related to Korean climate is very similar to the correlation pattern between the preceding climate index and SLP at the target month, indicating that preceding climate indices can be dynamically linked to Korean climate. For example, the AO index at a lead time of four months prior to October is closely related to a circulation anomaly with significant positive correlation over a 5% significance level appears in the region from Siberia to China while strong negative correlation appears around the Kamchatka Peninsula. In fact, the western wing of the Aleutian Low, one of the important pressure systems during the cold season, including October, is extended to the Kamchatka Peninsula, and its variability is also large over the Kamchatka Peninsula. The Siberian High also gradually takes its place over the region of Lake Baikal to China before winter. The strengthening of the Siberian High, especially over the northern Korean Peninsula, may induce cold advection and associated large latent heat flux over the East Sea between Korea and Japan. This pattern provides conditions which supply moisture to the Korean Peninsula.

Keywords: forecast, indices, regression

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

MS008 **Poster presentation** **5265**

The relationship between Lyapunov vectors and singular vectors in a time-periodic baroclinic wave-mean oscillation

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Roger M. Samelson

Lyapunov vectors characterize the asymptotic linear stability of time-dependent deterministic flows and may be defined such that they are norm-independent (and thus non-orthogonal) and invariant under the linearized flow. These Lyapunov vectors are a natural generalization of normal modes for linear disturbances to time-dependent flows and offer insights into the physical mechanisms of disturbance growth and the maintenance of chaos. Singular vectors, in contrast, characterize the transient linear disturbances in a specified inner product over a specified time interval and, as such, complement and are related to Lyapunov vectors. The physical and mathematical interpretation of singular vectors is often problematic due to their dependence on inner product and optimization interval. In order to clarify the interpretations of and relationships between singular vectors and Lyapunov vectors, linear disturbance growth is studied in the context of a nonlinear baroclinic wave-mean oscillation in an intermediate complexity model. The restriction to a time-periodic flow simplifies the computation and interpretation of the Lyapunov vectors, since they reduce to Floquet vectors which may be determined by solving a straightforward eigenvalue problem. The analysis in this study is similar in spirit to those of Trevisan and Pancotti (1998) and Samelson (2001), but in the context of a less dynamically constrained, and therefore more complex, model. It is found that for optimization intervals which are short compared to the baroclinic wave growth time scale, each singular vector projects onto a large number of Lyapunov (Floquet) vectors and the projection varies rapidly with the optimization interval of the singular vector. However, for moderate to long optimization intervals both the most rapidly growing and most rapidly decaying sets of singular vectors rapidly approach constant linear combinations of Lyapunov (Floquet) vectors. The most rapidly decaying singular vectors project onto a small number of rapidly decaying Lyapunov (Floquet) vectors while the leading singular vectors project onto a small number of leading adjoint Lyapunov (Floquet) vectors. This result verifies the common observation that, while singular vectors initially point off the local attractor, they rapidly evolve to become tangent to the local attractor.

Keywords: singular vectors, lyapunov vectors, normal modes

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MS008 **Poster presentation** **5266**

Quantifying Predictability by the Relative Entropy

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Roger M. Samelson, Chris Snyder

The uncertainty and predictability of dynamical systems can be quantified by the relative entropy, which gives a measure of predictive information content based on ensemble distributions. The concept of the relative entropy is explored in primitive-equation simulations of ocean circulation along the Oregon coast. The ensemble members are obtained by perturbing the initial temperature field with either white noise or specified Fourier components, and then advancing the simulations for 60 days with either constant southward wind forcing, or with periodic wind forcing that has a 5-day period and a southward mean. The relative entropy consists of two components, the "signal" and "dispersion" terms, and is computed here under the assumption that temperatures are mutually independent and have Gaussian distributions. The signal term is found to dominate, giving a differentresult than would be obtained using potential predictability, which focuses on the covariance of the ensemble distribution. When the simulation length is increased, the ensemble spread varies in the opposite manner to the dispersion in the relative entropy. This contrasts with results from simple models, for which the dispersion often varies with the ensemble spread. Some of these results depend also on the particular choices made for the definition of the climatological distributions.

Keywords: ensemble predictability, relative entropy, signal dispersion

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

MS008 **Poster presentation** **5267**

A regional scale ensemble prediction system for 10 days - 1 month range

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Mihaela Caian

The mean-range forecast verification (10 days - 1 month) of a regional ensemble (using RegCM+ECMWF models) in which the initial conditions, lateral boundary conditions and regional model's physics were perturbed, is presented. The integration domain is the S-E Europe. The paper has 3 parts: the first part describes the implementation of the system and the ensemble verification methods versus the observational/analysis data; the second part describes the results of the EPS analysis with perturbations in initial conditions and lateral boundary conditions (downscaling of ECMWF 10 perturbed members) for the autumn 2006 - winter 2007 season; the third part presents the study of extreme events during this period for which additional model's physics have been designed.

Keywords: verification, ensemble

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MS008 **Poster presentation** **5268**

Nowcasting with Indistinguishable States

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Kevin Judd, Leonard A Smith

Constructing ensembles of indistinguishabl e states (Judd and Smith, 2001) provides an attractive alternative ap proach to data assi milation in high dime nsion no nlinear systems. Sp ecific cases are presented in detail to reveal that the indistinguishable stat es approa ch systematically outperforms an Ensemble Kal man Filtering(EKF) a pproach in terms o f n owcasting; co nditions under which it may be expected to outperform the plethora of other variants of the Kalman Filter are noted (unsurprisingly, the relevant shortcomings of the KF were first n oted by Kalman (Kalman 1960) himself). In the nonlinear setting, Ensemble Kalman Filterin g (EKF) approaches are hampered by fo undational assumptio ns o f dynamical linearity, while particle filters require vast ensemble sizes to perform well in even moderately high dimensional spaces. To contrast the a pproaches, specifically the statistics of the predictive mass placed within a hyper- sphere about the T rue state are computed as a function of the radius of the hyper-sphere. The improved performance comes at the cost of not being a one-step method, which, on the o ther han d, allo ws an enhanced b alance betw een the extracting information from the dynami c equations and information in the observations themselves. Results are presented in t he 12 and 48-dimensional Lorenz 1996 syst em (Lorenz 1995) as well as illustrated with lower dimensional systems to ease visualization of the state space. K Judd and L. A. Smith, 2001: Indistinguishable sta tes I : perfect model scenario. Physica D, 1 51:125-141 Lorenz, E. N ., 19 95: Predictability: A Problem Partly Solved. Proc. Seminar on Predictability. 1, ECMWF, Reading, Berkshire, UK, 1 -18. Kalman, R. E., 1960: A New Approach to Linear Filtering and Prediction Problems. Trans AMSE Ser D J Basic Eng, 82, 35-45.

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MS008 **Poster presentation** **5269**

Particle filtering for strongly non-linear ecosystem modelling

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Gennady Kivman, Jens Schrter, Manfred Wenzel

We investigate advantages and specific difficulties in implementation of particle filters when assimilating data into stro ngly no n-linear and non-Gaussian sy stems. With respect to the last circumstance, a Sequential Importance Resampling (SIR) filter seems to be of a great advantage since the filter updates probability of the particles (according to their agreement with the assimilated data) and thus, allows one to use the full forecast and data errors statistics. St ill the most challenging thin g in such a filtering is sampling the particles which approximate the conti nuous pro bability density fu nction (pdf) evo lved according to a stochastic dynamical model. We consider different sampling strategies which depend o n our prior knowledge of the system and determine th e filter performance cost and quality. All the experiments have been carried out with an ocean bi ogeochemical model which indeed is an example of a non-Gaussian system

Keywords: particle, filters

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

MS008 **Poster presentation** **5270**

Evaluation of different short-range ensemble forecast methodologies in severe weather events

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Sin Chan Chou

A Short-Range Ensemble Forecast (SREF) system using a mesoscale model with high resolution has been evaluated. The main goal of this study is to evaluate the quality of forecast probabilities (FP) and its skill in capturing the atmospheric uncertainty. Ten severe weather events over the Serra do Mar region, in Southeast Brazil, were chosen. It is a mountainous region located near the coast. Severe weather events were identified when a large preciptation amount occurred in a short period of time, or a large amount of precipitation was accumulated in few days.The severe weather can be caused by the large scale system, the South Atlantic Convergence Zone (SACZ) or by mesoscale forcings such as the topography and the sea breeze. Two SREFs methodologies were tested. The first one considered initial conditions uncertainty (SREF-IC) and the other considered model physics deficiencies (SREF-P). The mesoscale Eta model was used in both SREF, with a 10 km horizontal resolution and 38 vertical levels. The forecast range was 72 hours. The initial and lateral boundary conditions were provided by CPTEC Global Model. The SREF-IC was built from perturbations applied to the Global Model, whereas SREF-P was built from perturbations in Eta Model cumulus and surface layer scheme parameters. FP skill was calculated. The relationship between member spread and model errors was evaluated. The SREF-P results indicated better performance when large scale feature was not the predominant forcing. The five SREF-IC members exhibited smaller spread than the six SREF-P members. The number of members was tested. The performanceof each methodology will be shown.

Keywords: sref, ensemble, forecast

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MS009 **5271 - 5297**

Symposium
Dynamics and Predictability of Severe Weather Events (ICDM)

Convener : Dr. Istvan Szunyogh

This symposium invites papers on all aspects of severe weather events on synoptic scales and smaller, and their predictability. All studies that relate to the global programme THORPEX will be appropriate for this session. This includes dynamical processes and their predictability, observing systems, data assimilation and observing strategies, and societal and economic implications. This session will cover factors affecting the predictability of weather events on one-day to sub-seasonal time scales."

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MS009 **Oral Presentation** **5271**

A Non-hydrostatic Global Model and the Multi-scale Simulation of Sever Storms

Dr. Xindong Peng
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Keiko Takahashi

A coupled global model system, which is named Multi-Scale Simulator for Geo-environment (MSSG), is developed at Earth Simulator Center, Japan Agency for Marine- Earth Science and Technology (JAMSTEC). An overset grid system, namely Yin-Yang, is adopted for both atmospheric and oceanic components, which make it very convenient to switch the model between the global and the regional configuration. It is considered to benefit the simulation of server storms that are greatly controlled by large-scale weather systems. In addition, the so-called multi-moment (M-) grid is installed into the model for the discretization of variables. The M-grid is robust in all spatial scales for geostrophic adjustment, and gives accurate advection when it is used with the CIP scheme. Nesting is available for both atmosphere and ocean. In this presentation, we will show some numerical results with the atmospheric model. Though the MSSG is still on developing, it has been used to simulate Typhoon, rain storms in Baiu front and the evolution of explosive cyclone in winter. The daily global model output of JMA spectral model is used as the initial condition. Two case simulations will be shown in this presentation, include a strong Typhoon case in 2003 and a rain storm at Kyushu in western Japan in concerning with the Baiu front in 2006. The model reproduced the Typhoon track during a several day simulation. The coupled model also shows that the natural response of SST helps to predict better intensity of the Typhoon. In case of simulating the convective rain storms embedded in Baiu front, the robust CIP scheme which is constrained with a positive rational function is proved improve the transport of water substances very much. The modeled precipitation is also improved obviously in the 20-km mesh run. Some detailed analyses of the cases will be presented for the simulation of server storms with fine global non-hydrostatic model.

Keywords: rainstorm, yin yang, non hydrostatics simulation

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

MS009 **Oral Presentation** **5272**

Assessing Predictability with a Local Ensemble Kalman Filter

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David Kuhl, Elizabeth Satterfield

In this paper, the spatio-temporally changing nature of predictability is studied in a reduced-resolution version of the National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS), a state-of-the-art numerical weather prediction model. Uncertain initial conditions (analyses) are obtained by assimilating observations of the atmosphere with the Local Ensemble Kalman Filter (LEKF) data assimilation scheme. This data assimilation scheme provides an ensemble of initial conditions. The ensemble mean defines the initial condition of deterministic model forecasts, while the time-evolved members of the ensemble provide an estimate of the evolving forecast uncertainties. The behavior of the ensemble is explained by using the E-dimension, a spatio-temporally evolving measure of the evenness of the distribution of the variance between the principal components of the ensemble-based forecast error covariance matrix. It is shown that in the extratropics the largest forecast errors occur for the smallest E-dimensions. Since a low value of the E-dimension guarantees that the ensemble can capture a large portion of the forecast error, the larger the forecast error, the more certain that the ensemble can fully capture the forecast error.

Keywords: ensemble, predictability, e dimension

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

MS009 **Oral Presentation** **5273**

The rationale for why climate models should adequately resolve the mesoscale

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A review of the importance of the cyclone-frontal scale system in climate variability and the ability of present climate models to simulate them has been presented. The analysis of three different Climate models, GISS, the NCAR community climate model CCM3 and the GFDL Finite volume AM2 (M90) have been discussed. The intention here was not to determine which one is better but rather to indicate what deficiency may be common to all of them. Evidence shows that the three models tend to be deficient in the generation of cyclone wave activity with the consequences that heat, momentum and moisture may be deficient in the extra-tropical and sub-polar regions. This will affect cloudiness, wind stress and precipitation. Bauer and Del Genio (2005) have shown that the deficiency of moisture and cloudiness over the sub-polar regions was due to the lack of cyclone waves to transport moisture and clouds to these regions. A discussion of complementary work done on clustering of cyclone trajectories by Gaffney et al. (2005) was also presented. Consistent with the present analysis, this study also showed that differences in trajectories between reanalysis and model simulation for each cluster of trajectories was here interpreted to be related to the lack of intense high frequency eddies of the GCM. The previous two studies depend on the surface characteristics based on trajectories of the high frequency eddies. The present analysis on the GFDL-GCM is to tally eulerian and based on the upper level eddy activities (300 mb). However, a similar conclusion has been drawn from the analysis of the band pass frequency of energy and momentum for the GFDL AM2_M90 17 year runs, where it is quite clear that the momentum and energy of the very high frequency is much lower in the model simulation than in the reanalysis. The variance of meridional velocity also shows that the deficiency of the high frequency is in the latitude area where the reanalysis shows it to be positioned in the storm track: the model displaces it south of that. There is also a suggestion that to achieve the correct intensity of the high frequency baroclinic eddies, models should have enough resolution to resolve them, since this intensity depends on the lower level circulation of the frontal circulation system. The mesoscale circulation associated with cyclones could be adequately represented in models with resolution equal or superior to 1/4o resolution. It is clear that to adequately resolve the mesoscale, it is necessary to not only improve the resolution but also to improve the boundary layer and surface fluxes. Clearly, at the present low resolution of climate models, this improvement is probably unattainable. However, if the cloudiness and sea ice over the sub-polar regions are important to the overall climate, this should be an attainable goal because no sophistication in the moist convection or sea-ice model could correct those deficiencies due to the unresolved dynamics.

Keywords: climatemodels, resolution, mesoscale

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

MS009 **Oral Presentation** **5274**

Predicting high-impact weather using medium-range ensemble forecasts

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Helen Watkin

To address the medium- range fo recasting o f high- impact weather, the Met Office is running an experimental global ensemble prediction sys tem. 15-day forecasts are being run twice a day using a n extended version of the Met Office Global and Regi onal Ensemble Prediction System (MOGREPS). The forecast results are contributing to the THORPE XInteractive Grand Global Ensemble (TIGGE), a framework for international collabor ation in the development of ensemble prediction systems. Research is being unde rtaken both t o compare the Met O ffice ensemble with other ensem ble and on the combination of ensemble from different forecast mo dels. A key part of our THORPEX research is the development of a range of products to highlight wh en high- impact wea ther is fo recast. One type o f product is a chart showing the probability, for exampl e, gale-force winds at a particular time. As much of the high-im pact weather i n the UK is a ssociated with synoptic features, we are also developin g feature-based tools. For exa mple, the ens emble foreca st output is aut omatically analysed to identify extra-tropical cyclones and fronts. The fe atures ar e tracked over time t o show how each ensem ble member is pr edicting the f eature to develop, b oth in terms of its t rack and its intensity. Other diagnostics have been develop to highlight persistent peri ods of weath er (e.g. h eat wa ves or spells of wet weather), and to show when changes of large- scale circulation patterns are forecast. These products will be developed further in response to demand from forecasters and other users.

Keywords: high impact weather, ensemble forecasting, cyclones

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MS009 **Oral Presentation** **5275**

Predictability of a large-scale flow conducive to extreme precipitation over western Alps

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MetOps ARPA-SIM

The quality of numerical weather prediction has improved considerably since its beginning, however this remarkable achievement has to be considered true for average conditions. It is known that atmospheric predictability and model errors are highly flow-dependent therefore an increase in skill for average conditions may not imply the same improvements in specific conditions. Moreover the potential value of numerical weather prediction is perceived to be higher in some specific cases, like high-impact weather events. There is therefore a growing need to know the forecasting accuracy of significant weather events, something that cannot be easily inferred through average scores, not least because of the rarity of these events. For these reasons, a study has been carried out to examine the skill of the European Centre for Medium-Range Weather Forecast (ECMWF) global forecasting system in predicting a specific flow configuration that is believed to be associated with extreme precipitation events over the Alpine region. Despite quantitative predictions of extreme precipitations is still challenging, it was found that the large-scale flow conducive to major rain events has better predictive skill than average conditions. This is perhaps surprising since it is a common perception to associate severe weather with low predictability.

Keywords: predictability, extreme precipitation, planetary waves

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MS009 **Oral Presentation** **5276**

Dynamics of Possible Precursors of Severe Events

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THORPEX research is geared to improving NWP predictive skill in the 3-10 range, and concomitantly helping to eliminate forecast busts and improving the reliability and extending the useful forecast range for the prediction of extreme weather events. This presentation is built around the following sequence of premises : - certain identifiable flow features can serve as early precursors of severe weather events - by perturbing either the tropopause-level or surface wave guides in the extratropics, thereby giving the flow an element of transient dynamic memory, and - spawning severe events sometime later and further downstream. Here attention is focussed on three types of potential precursors that are each identifiable as a localized PV anomaly. They correspond to: - vortex-like features in the lowermost polar stratosphere; wave or vortex-like features in the low troposphere induced by cloud-diabatic effects; and filamentary structures in the upper-troposphere located equatorward of the jet stream. Consideration is given the origin and structure, dynamics and impact of these precursors.

Keywords: rossby waves, precursors

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MS009 **Oral Presentation** **5277**

Helicity index of intense atmospheric vortices

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Different terms entering the helicity balance equation for intense atmospheric vortices, such as tropical cyclones and tornadoes, are discussed. It is conjectured that the downward kinematic flux of helicity across the top level of a turbulent boundary layer can serve as a useful index of the strength of the primary circulation in the vortex. Based in this approach, examples are given of case studies of tropical cyclones and tornadoes.

Keywords: helicity, tropical cyclones, tornadoes

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MS009 **Oral Presentation** **5278**

A severe precipitation event over West Africa and the influence of upstream latent heating - sensitivity experiments with the cosmo-model

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Peter Knippertz

In January 2002 parts of tropical western Africa were hit by an extreme and harmful precipitation event in the local dry season. Often anomalies of high potential vorticity (PV) penetrating from the extratropical North Atlantic far to the south accompany such events. The uplift on their eastern flanks and the transport of moisture by the induced circulation deliver favourable conditions for the generation of heavy rainfall. The development of the two successive low latitude PV anomalies involved in the precipitation event in January 2002 was associated with upstream rapid cyclogeneses, the formation of intense warm conveyor belts and abundant latent heat release over the extratropical North Atlantic. It is hypothesized here that the reduction of upper-level PV through the latent heating leads to a substantial amplification of the PV ridge over the North Atlantic and finally also to more intense PV anomalies off the West African coast. In order to quantify the influence of the latent heat release on the development of the PV anomalies and the rainfall itself, a number of sensitivity experiments using the COSMO-Model, the nonhydrostatic limited-area model of the German Weather Service (DWD), have been conducted. The model was run with a horizontal resolution of 0.4?? and 40 vertical levels using ECMWF Integrated Forecasting System analysis fields as initialization and boundary data. In addition to a control run with full physics several runs with suppressed latent heating on the whole or parts of the model domain were considered. A complete dry run was implemented, too. The comparison of the different model runs show in fact that the suppression of latent heating over the extratropical Atlantic weakens the extratropical PV ridges and the equatorward penetrating positive PV anomalies off the West African coast. The rapid cyclogenesis events and the formation of warm conveyor belts over the North Atlantic are also greatly suppressed. Surprisingly the precipitation over West Africa is only slightly reduced if diabatic heating is suppressed in parts of the domain only, despite a weakening of the upper-level PV anomaly. The reasons for this result are currently investigated. One possible factor is a generally higher atmospheric water content in the run with suppressed latent heating resulting from the lacking removal of moisture by tropical convection. Another is related to the equatorward penetration of air warmed by latent heating in the extratropics to the southwest of the first low-latitude PV anomaly in the control run. The associated increase in geopotential height appears to reduce moisture transports into West Africa. This study reveals a complex influence of the extratropical diabatic heating on the development of the severe weather in the Tropics. The examination of similar events over West Africa is envisaged.

Keywords: potential vorticity, trop extratrop interactions, moisture transports

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

MS009 **Oral Presentation** **5279**

Data Assimilation for Extreme Weather Events

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Current data assimilation approaches, including variational and ensemble Kalman filtering, do not properly address the assimilation of severe weather and other extreme weather observations. By definition, the extreme events belong to the tails of a Probability Density Function (PDF), implying that the observations of an extreme event will be rejected or given a negligible weight. Unless an adequate PDF is used, the observation information of an extreme event will not be utilized efficiently. This means that, for example, the extreme precipitation amounts or sudden wind bursts observed during severe weather will have a small chance to be utilized by the data assimilation system. Preliminary development of new data assimilation methodology capable of addressing the non-Gaussian character of the extreme event observation errors will be presented. In the proposed approach the PDF of the errors is formally derived from the assumption about the PDFs of extreme events variables. The general framework of the new data assimilation allows a straightforward extension to other extreme events in weather and climate. In this presentation we will illustrate the new methodology in applications with the multivariate Extreme Value and Pareto distributions, typically used to represent extreme events in geosciences.

Keywords: assimilation, extreme, non gaussian

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MS009 **Oral Presentation** **5280**

A high-impact dry-season rainfall event in tropical west Africa and its dynamical relation to a low-latitude extratropical disturbance

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This study provides a dynamical analysis of a widespread and intense dry-season precipitation event in the tropical Guineo-Sudanian zone of West Africa in January 2004. The abundant rainfall had substantial impacts on the local hydrology and human activities reaching from rotting harvests to improved grazing conditions. The event was accompanied by substantial precipitation in the arid parts of Algeria and Libya, and a major dust storm in the eastern Mediterranean region. Analysis of European Centre for Medium-Range Weather Forecasts (ECMWF) sea-level pressure fields and synoptic station observations reveal that the event is preceded by a several-day-long period of slowly falling pressure over large parts of tropical West Africa north of about 10N, with a rather pronounced pressure drop on 19 January 2004. The pressure fall causes a northward shift and intensification of the weak wintertime heat low, and allows low-level moist southerlies from the Gulf of Guinea to penetrate farther than usual into West Africa. On 20 January daytime heating triggers intense convection that spreads northward, most likely supported by near-surface convective outflow. In order to understand the dynamical reasons for this evolution a special form of the pressure tendency equation is considered that consists of vertical integrals of (1) horizontal advection of virtual temperature, (2) vertical motion times a static stability factor, and (3) a diabatic term. While the dynamical contributions (terms 1 and 2) can be directly calculated from ECMWF analysis data, the third term is estimated from ECMWF operational forecasts. Climatological values show a balance between negative dynamical tendencies, mainly due to subsidence, and radiative cooling. Between 15 and 18 January this balance is disturbed by a weak upper-level low that moves slowly eastward across West Africa. Dynamical pressure tendency anomalies associated with this feature are rather small, but the formation of clouds and the higher moisture content on the eastern side of the disturbance weaken the radiative energy loss and thereby support falling pressure over the region. On 19 January a more intense upper-disturbance penetrates into Algeria and merges with the prior system. This creates a band of negative dynamical pressure tendencies across West Africa that is mainly caused by subsidence in its western part and by warm advection in the east. Together with the enhanced cloudiness this results in the observed pressure drop and finally enables the unusual precipitation event. Examination of operational precipitation forecasts by the ECMWF indicates some skill in predicting this event several days in advance. Most likely the comparably large influence of the usually well-predicted extratropical circulation on the Tropics leads to higher predictability than for ordinary summertime convection.

Keywords: tropical extratr interactions, convection, pressure tendency equation

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MS009 **Oral Presentation** **5281**

The NCEPs WRF NMM and hazardous weather prediction

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The NCEP Nonhydrostatic Mesoscale Model (NMM) has been developed building on NWP experience within the WRF effort. The dynamical core of the model was discretized following the so called mimetic approach first introduced by Arakawa. With this approach important properties of the continuous equations and differential operators are preserved in the discrete system. The conservation of energy and enstrophy improves the accuracy of the models nonlinear dynamics. Despite the complexity of the formulation, the computational efficiency of the model has been significantly higher than the computational efficiency of most nonhydrostatic models. The NMM has been run operationally in NCEP for several years. Since June 2006, the new end-to-end system based on the WRF NMM with 12 km resolution has become the main operational regional forecasting system for North America (NAM). Efforts are under way to implement the NMM operationally as the Hurricane WRF. Finally, commencement of operational runs with 4km resolution in support of the Storm Prediction Center (SPC) operations is planned for the near future. During the first winter in operations, the new regional forecasting system showed noticeable skill in several major winter storms in different parts of the country and in different synoptic conditions. In addition to operational forecasting the model has been tested in many case studies and several validation campaigns. Further evidence has been gathered about the WRF NMM ability to predict tropical storms during the exceptionally active tropical storm season of 2005. For two consecutive years the WRF NMM participated in a carefully controlled springtime experiment in which the model was run at near-cloud resolving horizontal resolution of 4.5 km without parameterized convection. The model demonstrated ability to spin- up severe convective systems on the 24 hour time scale more frequently, and with a stronger signal, than if this were happening only by chance. This indicates that further improvements in deterministic forecasting of severe weather phenomena may be possible with increased resolution.

Keywords: mesoscale, hazardous weather, wrf

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MS009 **Oral Presentation** **5282**

Objective determination of coherent structures, application to Ensemble Forecasting

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Philippe Arbogast, Alain Joly

Synoptic-scale dynamics, and especially mid-latitude cyclones and heavy precipitating events are often driven by upper-level anomalies of potential vorticity. These anomalies appear to have the properties of coherent structures rather than the linear modes that are depicted by existing theories. The sensitivity of extreme events to potential-vorticity structures has been studied extensively in litterature. However, little has been done about the use of the sensitivity to initial coherent structures as a method to generate an ensemble forecast. In a quasigeostrophic model, we show that such an approach leads to better results than a singular-vector ensemble by comparison with a Monte-Carlo. Our purpose is to present a methodology to create a short-range ensemble forecast in an operational context.This method requires a reliable objective determination of the coherent structures at the initial time. Based on the theory of wavelet representation of coherent structures, this extraction will be presented. The questions raised by the generation of the ensemble will be addressed. Then a relevant case study will help to assess the quality of the wavelet extraction, which is used to generate an ensemble. Although the performance of the ensemble cannot be assessed on a single case, its properties in terms of dynamics and dispersion may be compared with other ensembles.

Keywords: potential vorticity, coherent structures, ensemble forecast

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MS009 **Oral Presentation** **5283**

High-resolution numerical forecast of convective precipitation systems: sensitivity analysis to microphysical parameterization using COSMO-MODEL and MM5

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K. De Sanctis, L.Molini, A. Parodi, R. Ferretti, M. Montopoli, F. S. Marzano

Numerical weather forecast of severe weather has received an increa sing attentio n in the hydro - meteorological community. It is well known that the Planetary Boundary Layer (PBL) fluxes are one of the most important mechanisms to trigger convective cells. Therefore, in order to be able to repr oduce these mechanisms a numerical meteorological model ha s to be non-hydrostatic s o that relatively high spatial resolution can be achieved. In this w ork two non hydrostatic models, COSMO-MODEL and MM5, have been used to simulate a co nvective structure o n the Po Valley ( ). The two C-band radars have simultaneously measured a rainfall event on May 20, 2 003 from two different loca tions, S.Pietro Capofiume and Gattatico, revealing strongly localized convective cells. The mesoscale models have been run in the same co nfiguration, with a special a ttention to bo undary co nditions and micro physical parameterizations. Sensitivity tests have been carri ed o ut using several microphysical schemes to the aim of investigating the different hydrometeors production to be compared both the available radar data and hydrometeor classification from dual-polarized weather radar. Finally, further comparison have been performed with pluviometric network and the analysis of the results for this case study will be presented and discussed.

Keywords: high resolution, convection, microphysics

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MS009 **Oral Presentation** **5284**

Observation of Mediterranean severe weather events using the Advanced Microwave Sounding Unit (AMSU)

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Chantal Claud, Jean-Pierre Chaboureau

The Mediterranean basin is an area of frequent cyclonic activity, where both local effects and large scale dynamics hav e significant co ntribution to the ex tent a nd severity of weather events. The high population density makes this region particularly vulnerable to the occurrence of severe weather events, and therefore the importance of satellite information, as in-situ observations are concentrated over land, is clear. Previo us studies have demo nstrated that synoptic-s cale per turbations such as southwar d stratospheric intrusions are often precursors of surface cyclogenesis and occurrence of extreme events. Here we demonstrate the abi lity of AMSU- A and AM SU-B microwave instruments, both onboard NOAA satellites, to detect upper-level intrusions and to lo cate heavily precipitating areas, respe ctively. Results are shown for selected cases studies of severe prec ipitation in the Mediterranean. Such diagnostics are being currently used to perform a climatology of extreme events in the Mediterranean basin, in order to form a typolog y of the precipitating systems based on their frequency, size and position relative to the upper level fe ature. They m ay also be used in real tim e for forecast purposes and assimilation in models.

Keywords: satellite, storms, mediterranean

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MS009 **Oral Presentation** **5285**

A simple model to estimate the forecast value of the Madden-Julian Oscillation

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On intraseasonal time scales, the MaddenJulian oscillation (MJO) is the dominant mode of tropical intraseasonal variability and is most active in the boreal winter. The MJO influences the patterns of precipitation in the global Tropics and in portions of the extratropics including the occurrences of extreme events and the skill of numerical weather forecasts. One of the main goals of THORPEX is the improvement of high-impact weather forecasts. Given the slow evolution of the MJO relative to synoptic fluctuations, the MJO has been increasingly regarded as a potential source to improve the accuracy of weather forecasts in weeks 1 and 2. This paper discusses a simple empirical model to estimate the forecast value of the MJO in the Americas. Probabilistic forecasts of extreme precipitation (i.e. above the 75th percentile) conditioned on the state of the MJO are developed and compared against quiescent phases of the oscillation.

Keywords: madden julian, forecast, value

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MS009 **Oral Presentation** **5286**

Modeling pyro-cumulonimbi and tornadoes spawned by wildfires

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Michael J . Reeder 1, Philip Cunning ham 2 1 Scho ol o f Mathematical Sciences, Mo nash Universit y, Victoria, Australia 2 Departmen t of M eteorology, Florida State University, Florida, USA A s wildfires fires swept through several outer suburbs of the Australian capital, Canberra, on the afternoon of 18 January 2003, a series of large pyro-cumulonimbi developed to the west of Canberra Airport. The complex of pyro-cumulonimbi lasted fo r abo ut 3 ho urs. Each individual cell was a bout 10 km in diameter, and formed near the leading edge of the fire before subsequently propagating eastward (Fromm e t al. 2005). The local weather radar showed that the py ro-cumulonimbi reached heights of 14-15 km, and sooty, black ha il was reported to have fallen from the one of the pyro-cu mulonimbi about 300 km east of Canberra. One of the pyro-cumulonimbi spawned several tornadoes. The aim of the work presented is to use the C anberra wildfires to explore t he dynamics and predictability of pyro-cumu lonimbi and the tornadoes they occasionally spawn. This is achieved through a series of large eddy simulations using the Weather Research and Forecasting (WRF) model configured with a horizontal resolution of 200 m and a vertical resolution of 150 m. The model is initialized with th e upper air sounding on 2300 UTC 17 January 2003 (0900 EST 18 January 2003). A prototype fire is incorp orated into the m odel using the method described by Cunningham et al. (2005). The si mulations capture the main char acteristics of the observed pyrocumulonimbi, including the for mation of a tor nado close to where one was reported.The work addresses: the role pla yed by the heat of co mbustion in the deve lopment of the convection; the importance of the water produced during combustion in deepening the convection; the back-reaction of the convection on the fire; and the dynamics and predictability of pyro-tornadogenesis.Cunningham, P., S. L. Goodrick , M. Y. Huss aini, and R. R. Linn, 2005 . Coherent vortical structures in numerical simulations of bu oyant plu mes from wildlan d fires. Int. J. Wild land Fire, 14, 61-75. Fromm, M., A. Tupper, D. Rosenfeld, R. Ser vranckx and R . McRae, 2006 . Violent py ro- convective storm devastates Australia's capital and pollutes the stratosphere. Geophys. Res. Lett., 33, doi:10.1029/2005GL0251611.

Keywords: pyro cumulonimbus, tornado, wildfire

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MS009 **Oral Presentation** **5287**

Numerical simulations of the European wind storms of December 1999 and December 2004: sensitivity to diabatic effects and preexisting upper-level anomalies.

Dr. Gwendal Rivire

Fabien Crpin, Alain Joly

The explosive growth stage of the first Christmas wind storm of 1999 (Lothar) and that of mid-December 2004 are studied by performing different numerical experiments using the Mto-France operational model (ARPEGE). It is particularly interesting to analyze these two storms together as they had very similar developments; they travelled across the Atlantic Ocean with moderate amplitude south of the upper-level jet and strongly deepened as they crossed it in its exit region. A first set of experiments consists in analyzing diabatic effects. Although moist processes are shown to be essential to explain the formation of the two storms in presence of dissipation (consistently with the work of Wernli et al., 2002 on Lothar), it is shown that adiabatic simulations, where both moist processes and dissipation terms are suppressed, are able to reproduce the track of the two storms as well as their explosive growth stage. This suggests that moist processes compensate the dissipation terms but cannot be involved in the triggering of the explosive growth stage. Another set of experiments consider the possible impact of some local upper-level anomalies. The two surface cyclones have developed without interacting with a coherent upper-level disturbance despite the presence of various upper-level potential vorticity (PV) anomalies of moderate amplitude at different times northwest of their structures. By using PV inversion tools, different simulations were performed by suppressing these local anomalies in the initial conditions. They only lead to a weak attenuation of the surface cyclones amplitude. Our experiments support therefore the idea that the large-scale circulation and the surface low are the two essential ingredients to reproduce the explosive growth stage of the two storms.

Keywords: wind storm, precursors, diabatic

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MS009 **Oral Presentation** **5288**

The Scientific and Societal Motivation for the THORPEX Pacific Asian Regional Campaign (T-PARC)

Dr. David Parsons
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Dr. Pat Harr, Istvan Szunyogh

This invited presentation discusses the planned THORPEX Pacific Asian Regional Campaign (T-PARC). This international effort involves scientists from Europe, North America and Asia. The experiment will take place in 2008 beginning with an intense field phase associated with tropical cyclone and extratropical transition (ET) storms in August and September. A subsequent winter component is planned for November and December. The basic societal motivation is the need to improve prediction and societal response to: i) tropical cyclone and heavy rainfall events in Asia ad ii) the variety of downstream hhigh impact weather events that are triggered over North America and other locations by the interaction of persistent convection and intense cyclogensis events in east Asian and the western North Pacific with the primary Asian wave guides. The talk will present the general approaches to improved understanding of the predictability of these events and improving prediction such:Impact studies of targeting these cyclogensis and convective regions with adaptive use of satellite data, dropsondes, remote sensing aircraft that measure winds with lidar and Doppler lidar and water vapor content with DIAL lidars. These impact studies will investigate different approaches to data assimilation.Use of remote sensing and dropsonde aircraft Investigation of the dynamics of ET events and their impact on the downstream flow through Rossby wave triggering.Investigations of tropical genesis and predictions of typhoon track, intensity and structure with satellite sensing, remote sensing and dropsonde aircraft and driftsonde. The driftsonde is a method of deploying a synoptic style coverage of dropsondes from stratospheric balloons. The tropical genesis studies will examine large-scale vs. local mesoscale triggering of these systems.The impact of high resolution modeling and assimilation strategies on regional and downstream prediction.Basic theoretical studies are intended to accompany these model and observational investigations.

Keywords: thorpex, typhoons, prediction

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MS009 **Oral Presentation** **5289**

Connection between PV coherent structures and convection

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Since pioneer papers by Petterssen it has been demonstrated that the baroclinic development is a major process for mid-latitudes cyclone development with the presence of upper-level coherent structure with strong PV signatures. It also appears that mesoscale convectivesystems may also be driven by upper-level features. However the underlying processes are less known in this case. Among others candidates are the destabilization mechanism of the air mass by the thermal structure usually associated to en upper-level disturbance and moisture convergence enabled by the vertical-velocity signature. Sensitivity studies based on AROME model initialised and forced with boundary conditions provided by different PV distributions thanks to a PV inversion procedure implemented in the frame ARPEGE-IFS will be shown. The nature of the interaction between mesoscale convective system activity and upper-level features will be addressed.

Keywords: convection upper level, dynamics potential vorticity

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MS009 **Poster presentation** **5290**

Direct observations of daytime atmospheric boundary layer depth and a numerical Mesoscale Model

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Masoud Khoshsima, Abasali Aliakbari Bidokhti

The daytime growth of atm ospheric mixed l ayer is impo rtant in time vari ation of air p ollution over big cities. The depth variations o f this layer can be estimated from direct measurements and also from numerical forecast models if the model is pr operly calibrated. The depth of the daytime mixed layer for the city of Zan jan (48.5 N, 3 6.7 E, 1700 m) has been studied using a LIDAR (532nm) system, which works on aerosols scattering of la ser light. The mixed layer depth (zi) for Zanjan city is fo und to be between1 km typically in spring to 3 km in summer for synoptic calm conditio ns. In entrainment zo ne, 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: mesoscale numerical model (mm5, lidar, mixed layer depth

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MS009 **Poster presentation** **5291**

The dynamics of cyclonic systems over Iran using potential vorticity diagnostics: a case study for NOV-DEC 2003

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Ahmadi-Givi Farhang 1, Mohebalhojeh Ali-Reza 1

Potential vorticity (PV) is one of the dynamical parameters which is used in the study of weather system dynamics. It is conserved in the absence of friction and diabatic processes and therefore it can be used as a dynamical tracer in the formation and development of cyclonic systems. In this study we attempt to investigate the dynamic of cyclogenesis over the Middle-East and Iran for the period of Nov-Dec 2003, within the potential vorticity framework. It is aimed to study qualitatively and quantitatively the role of different mechanisms which have been involved in the cyclone development throughout the life cycle of the cyclone. At first, using the NOAA analysis dataset, six hourly geopotential height maps for the period of Nov-Dec 2003 was examined. Only one noticeable cyclogenesis event with clear life cycle was found, beginning at 0000UTC 4 December and ending at 0600UTC 9 December 2003. The results suggest that the main reason that there was only one intense cyclone in the period studied here can be related to the occurrence of two significant blocking systems at the beginning and at the end of this period. As we expect, these blockings act to place stable weather conditions in the east and consequently to inhibit the cyclone development. In the second stage, the Ertel-Rossby PV was calculated every six hours using the NOAA analysis dataset. The data used in the calculation of PV includes the horizontal wind components and potential temperature fields at 20 pressure levels with 50 hPa interval. Then the potential vorticity fields at pressure levels were interpolated to relevant isentropic surfaces, in order to study the contributions of the upper-level, mid-level, and surface PV anomalies in the cyclone development. To support the results, the vertical motions at 700 hPa were also used. In general, three stages of cyclogenesis can be identified in the life cycle of the cyclone studied here. The results show that the upper-level PV anomaly plays the main role in the low-level disturbance development during the incipient stage, without remarkable contributions from the other PV anomalies. In the intensification stage, in addition to the upper-level PV anomaly both the thermal advection and the diabatically generated PV at low levels contribute significantly to the surface cyclogenesis. The results also suggest that there is interaction among the upper-level and low-level PV anomalies at this stage. Finally, the mature stage of cyclogenesis is encountered with the decay and breaking of the PV anomalies.

Keywords: potential vorticity, isentropic surfaces, cyclogensis

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MS009 **Poster presentation** **5292**

Local orography influence on dynamics and predictability of severe convective storm

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Dejan Janc, Vladan VučKović

Complex terrain of Western Serbia with the NW-SE oriented Western Morava valley is an important source of individual severe storms that produce great damages to agriculture. Therefore the investigation of dynamics and predictability of such convective processes is important. Analysis of observations clearly shows that their intensity and duration are due to the fact that the low-level wind is directed along the valley orientation and oppositely to mid-tropospheric NW wind. The sharp low-level directional wind shear lead to formation of a convective storm with two vortices with opposite signs of vertical vorticity. The influence of local orography on storm splitting as well as the intensity of cyclonic and anticyclonic storms is evident. Different behavior of splitted storms is also determined by insolated slope side of the valley that causes faster decrease of anticyclonic storm. Such storm development causes characteristic temporal and spatial precipitation distribution along the valley. All of these peculiarities of convective storms are succesfully simulated by cloud-resolving mesoscale model. Results of simulations are well correlated with observations. This supports further use of such kind of models in investigation of dynamics and predictability of convective storms under influence of complex terrain.

Keywords: complex terrain, vortices, model simulation

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MS009 **Poster presentation** **5293**

Variation of GEM and RUC short-range forecasts accuracy with the urban location: Maniwaki and Buffalo cases

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The accuracy of very short-range forecasts of NWP models is particularly important for severe weather events. In order to assess the relative importance of the data assimilation method for short-range forecasts, the RUC and GEM models were examined. Model first-guess fields derived from RUC archives have the advantage of being analyses rather than forecasts, such is the case for the GEM model. The RUC model analysis includes assimilated data from the automated commercial aircrafts, and as a result the impact of aircraft observations on very short-range forecasts on the RUC model is predictable. Therefore it would be expected that there would be variation in the accuracy of the RUC model forecast with locations because of the different intensities of aircraft observations. The main objective of this investigation is to compare the accuracy of the short-range forecasts of the RUC and GEM models for locations with the low and high aircraft traffic. The Maniwaki and Buffalo locations were chosen as examples. The RMS vector differences of the models (GEM/RUC) forecasts and rawisonde observations of temperature, relative humidity, and wind direction and speed were examined.

Keywords: gem, ruc, forecast

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MS009 **Poster presentation** **5294**

Stability indices and thermodynamic parameters associated with thunderstorms over Kerala during premonsoon SEASON

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Thunderstorms are microscale weather systems fo rmed when the ther modynamic structure of the atmosphere is favorable. There are ma ny empirical methods to assess t he possibility for the formation of thunderstorms. Since inst ability of the a tmosphere plays vital ro le in the co nvective activity, man y instability indices are developed for mid latitude region for assessing the possibility for t he formation of the thunderstorm. Here, an attempt is made to develop a new index combining all available indices used in the mid lati tude regio n. T he parameters , which pl ay vi tal ro le in the thundersto rm fo rmation, are instability, vertical wind shear, and relative h umidity are co mbined to create new thunde rstorm indices specially adjusted to the conditions in Indian regi on. We co nsidered 8 different thun derstorm indices and evaluated their skill s core for near equatorial Ke rala region and modified the ind ices to suit th e region. The conventional instability indices such as Showalter Index, Lifted Index etc. are modified after incorporating t he thermodynamic characteristics of the region. These are combined in an objective manner to create a new thunderstorm index suit able fo r the Kerala, so uthwest peninsular . Thermodynamic parameters are computed for the fo ur statio ns viz: Thiruvananthapuram, Co chin, Mangalore, an d Minicoy using the radioson de data for the recent five consecutive years from 2001-2005. CAPE a nd CINE are used as the indicators fo r convective activity. Th e modified indices are employed to a ssess the convective activity of Kerala regio n. Accordingly a threshold value is identified for each index, to judge the p ossibility of occurrence of thunderstorms. Radiosonde data at 00 UTC and 12 UTC were used fo r the study during the pre-monsoon season (March to May). Since thunderstorms are more freq uent in the afternoon/evening hours, the s tudy is carried out using data at 1200 UTC . CAPE values more than 12 00 J/kg and CINE valu es b elow -100 J/kg are taken as indicator for convective activity. The vario us indices and paramete rs used after modification in this study include Showalter Index, CAPE, CINE, Lifted Index, Total Totals Index, SWEAT Index, Level of Free Convection, Bulk Richardson Number, Boyden Index, and Humidity Index. An em pirical formula was developed for the new index by combining the effect of all the above indices and a threshold value is assigned for the new index. Each of these indices was given a weight age in the empirical formula on the basis of skill score, to predict thundersto rm fo rmation over the Kerala regio n. The newly develo ped index has characteristics of all the above indices. Thes e indi ces are s eparately analyzed for the 00 UTC and 12 UTC during the pre-monsoon periods.

Keywords: thunderstorms, stability indices, new index

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MS009 **Poster presentation** **5295**

Characterization of rainfall C-band radar response and dual-polarized measurement

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L.Molini, R. Ferretti, K. De Sanctis, M. Montopoli, F. S. Marzano

In the last few years, the polarimetric upgrading of weather radars has allowed to improve considerably the accuracy related to the estimation of precipitation rate intensity and to the hydrometeors classification, mainly in deep convective events. Recently, the need to deepen the analyses on such issues has been tackled by means of the development of modelling chains composed by high resolution numerical weather prediction models able to generate atmospheric scenarios with desired characteristics and radar simulation modules feeded with the 3-D output fields of the aforementioned atmospheric models. This work focuses primarily on the evaluation of the effects of different microphysical parameterizations embedded into two atmospheric limited area model (COSMO-MODEL and MM5) on the simulated co-polar and differential reflectivity datasets computed by a radar simulation software (RSM). Since the latter is able to provide C-band polarimetric signatures of different hydrometeors, a second important task is constituted by the intercomparison of both simulated and the available observed reflectivity fields so as to assess the reliability of both models in reproducing deep convective weather conditions with a particular attention on the dynamics of the precipitation processes. Particularly, a severe event occurred over Northern Italy on 20/05/2003 has been simulated through the above mentioned numerical models and results concerning the polarimetric RSM measurements will be presented and discussed.

Keywords: radar, microphysics, convection

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MS009 **Poster presentation** **5296**

The severe weather phenomena related to cyclonic activity in Romania

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The aim of this paper is to analyze the cyclogenetic events and the cyclones evolutions in 2005, year with sever weather phenomena, in Romania. The frequency of the very high precipitation amounts and flood cases was related to an enhanced cyclonic activity. To study the various meteorological conditions related to circulation types over Romania, the daily data set of the sea level pressure and the geopotential height at standard levels, as well as the precipitation amounts were used. In addition, the relative vorticity at different levels and pressure values at the top of the troposphere were analyzed. The both this complex study and back trajectories of the air masses for the periods with sever weather, helped us to emphasize the links and correlations between northern or north-west circulations from high and mid-latitudes, cyclonic activity and very high precipitation amounts and floods.

Keywords: cyclogenetic event, relative vorticity

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MS009 **Poster presentation** **5297**

A simple model of the singular vector spectrum of the Eady basic state

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The leading singular vectors computed from linearised meteorological models have come to be thought of as the perturbations that amplify the most over a finite time interval. Roughly speaking the singular vectors are characterised into two dynamical regimes, which depend upon the optimisation length. For short optimisations, amplification is dominated by the untilting mechanism of Orr. For longer integration lengths interactions between the internal potential vorticity and boundary potential temperature anomalies becomes important1. The implications of the existence of these two regimes on the properties on the singular vector spectrum as a whole are investigated.The nature of the full singular vector spectrum in the short optimisation regime is investigated in the context of a simple Eady-like background shear-flow. The evolution of untilting plane-wavesin a shear flow without upper and lower boundaries is used to infer the expected properties of the singular value spectrum during the untilting regime. From the continuous function defining the evolution of these plane-waves bounds are placed on the maximum finite time amplification/decay. The condition for the orthogonality of the plane-waves at the start and end of the finite integration is used to infer the 'shape' of the singular value curve for differing zonal wavenumbers. In this simple model of short optimisation time singular vectors, it is found that, whilst the maximum amplification rate is independent of zonal scale, the singular value curve drops more rapidly for large zonal scales. The implication of this being that where the amplification is dominated by untilting, the smallest zonal scales must be dominate, since there are a greater number of large singular values associated with the smallest scales.The simple model of the singular vector spectrum is compared to singular vectors calculated numerically from the Eady model with rigid upper and lower boundaries. For short integrations (less than 24h) the untilting model is found to have strong qualitative similarities with the numerical computed singular vectors, particularly for small zonal scales. Over longer time integrations the effect of interactions between the interior potential vorticity and the normal modes become important, and the simple untilting model can no longer explain the characteristics of the maximally amplifying singular vectors. The qualitative features of the less rapidly amplifying singular vectors do however bear a resemblance to those implied by the untilting model.1 Hoskins B. J., R. Buizza, and J. Badger 2000

Keywords: singular vectors, untilting, eady model

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

MS010 **5298 - 5360**

Symposium
Dynamics of Convectively-Coupled Equatorial Waves and the Madden-Julian Oscillation (ICDM)

Convener : Dr. George Kiladis

This symposium invites contributions based on diagnostic, theoretical and modeling studies of convectively-coupled tropical disturbances on synoptic and intraseasonal time scales. The aim of the Symposium is to bring together scientists to exchange their knowledge and experience so as to improve understanding and promote interdisciplinary studies of the dynamics and predictability of equatorial waves. Topics of relevance include: Dynamics of Equatorial Waves, Organized Tropical Convection, Observations of Intraseasonal Variability, Coupled Ocean-Atmosphere Dynamics, Numerical Simulations of Equatorial Waves, Scale Interactions, The Role of the MJO in ENSO Variability, and Tropical-Extratropical Interactions

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

MS010 **Oral Presentation** **5298**

Madden-Julian Oscillation: oscillating or balanced?

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It is often considered that the large-scale tropic al atmosphere is not in any b alanced state but characterized by an ensemb le of equatorial waves. Observationally speaking , various longitudinally-propagating moist convective coherencies a re seen wi th the Madden-Julian wave probably, as the b est known example. These cohe rencies are often inte rpreted as equatori al waves generated under a coupling with moist convective processes. However, a conventional scale analysis (as used for deriving the midlatitude quasi- geostrophy) fail to co nvincingly s upport this view. The present t alk proposes a n alternative possibility that the tropical large-scale is dominated by a bala nced dynamics. The proposed balanced dynamic consists of the two parts. The fi rst and a more domina nt balance is the one betwee n the vertical advection and th e diabatic hea ting in the thermodynamic equation (the thermodynami c balance). An equivalent balance condition may also be posed on the moisture equation. These are well known do minant balances in the tro pical convective obs ervations, and applied to the large-scale dynamic context as a weak- temperature gradient (WTG) approximation by Sobel et al. The second one is the nondivergence condition to the le ading or der, as originally proposed by C harney (1963) . Implications of the proposed balanced dynamics on MJO are extensively discussed.

Keywords: balanced dynamics, equaotiral waves, quasi equilibrium

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MS010 **Oral Presentation** **5299**

MJO Sensitivity to Wind-Induced Surface Flux and Rain Re-evaporation

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Nilesh Araligidad

The sensitivity of the MJO in the NCAR CAM3 with relaxed Arakawa-Schubert convection to wind-evaporation feedback and convective rain re-evaporation is examined. A control simulation in which both wind-evaporation feedback and convective rain re-evaporation are active produces a robust MJO with amplitude comparable to observations. When wind-evaporation feedback and convective rain evaporation are minimized or removed, the amplitude of MJO-like variability in the model collapses. The moist static energy budget is examined to help understand the model sensitivity to rain re-evaporation and wind-evaporation feedback. These budget analyses also suggest that wind evaporation-feedback and convective rain re-evaporation may not be uniquely important for generating MJO variability, and suggest a more generalized approach to understanding why some climate models produce an MJO while others do not. TRMM precipitation, QuikSCAT ocean vector winds, and TAO buoy latent heat fluxes are used to develop observational evidence for the wind-evaporation feedback mechanism that is active in the climate model. These satellite and buoy observations show a significant correlation between wind-induced latent heat flux and MJO precipitation in the west Pacific warm pool, as in the climate model. Partitioning of QuikSCAT-derived wind speed indicates that eddies on timescales of 10 days and shorter contribute significantly to the west Pacific intraseasonal wind speed anomalies that dominate intraseasonal latent heat flux variability.

Keywords: mjo, evaporation, model

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

MS010 **Oral Presentation** **5300**

Multicloud models for convectively coupled tropical waves: Effect of congestus heating

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Multicloud mo del convective parametrizations ba sed on three cloud types (congestus, deep, and stratiform), introduced recently by the authors, where congestus heating and the ind uced low level moisture conv ergence play the major role of low le vel m oistening and preconditioning prior to deep convection, have revealed to be very useful in representing key feature s of organized convection an d convectively coupled waves. Here a new sy stematic version of the multicloud models is developed with separate uppe r and lower troposphere basis function s for the congestus and stratifor m clouds. This formulation allows for asymmetry across the troposphere and has the c onsequence that a fraction of congestus and stratiform precipitation actually reac h th e surface. It also leads nat urally to a ne w convective closure fo r the multiclo ud models enha ncing the congestus heating in order to bette r pinpoint the congestus preconditioning and moisteni ng mechanisms. The models are studied here f or flows above th e equator with out rotati on effects. Fi rstly, the new mo del results co nsist o f the usual synoptic scale convectively co upled moist gr avity wave packets moving at 15-20 m/s but in in addition these packets have pla netary scale envelop es moving in t he opposite direction at about 6 m/s and having ma ny of the self- similar features o f co nvectively c oupled waves, reminiscent of the Madden-Julian oscillation. Secondly, when a warmpool for cing is imposed, dry r egions of r oughly 250 km in extent form 'c onvective barriers" surrounding the warmpool region wh ere on ly con gestus h eating survives. Deep convection a nd moist gravity wave s propagating within the warmpool region are suppressed when they hit the convective b arrier and become dry prop agating first and the second baroclinic gravity waves. Finally, lin ear analysis reveals that, for sufficiently dry mean st ates, in addition to the inherent synoptic scale mo ist gravity waves, the ne w model supports a planetar y (wavenumber 1) standing c ongestus mo de which in a no n-linear simulation preconditions and moistens the environment within its conge stus-active regi on where moist gravity waves evolve and propagate. This results in a Walker-like circulation over a uniform SST background.

Keywords: convective parametrizations, organized convection, convectively coupled waves

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MS010 **Oral Presentation** **5301**

Intraseasonal variations of the Yangtze rainfall and its related atmospheric circulation features during the 1991 summer

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Guoxiong Wu

The intraseasonal variations of the Yangtze rainfall over eastern China and its related atmospheric circulation characteristics during the 1991 summer are examined based on the gauge-observed rainfall and the NCEP/NCAR reanalysis data. The 1991 summer featured the developing phase of a prolonged El Nio episode. Under the El Nio climate background, anomalous seasonal evolution took place in the extratropical East Asian summer monsoon, with devastating floods caused by a series of heavy rain events occurring over the middle and lower Yangtze Basin. Wavelet analysis shows that during the 1991 summer, the active and break sequences of rainfall over the Yangtze Basin are mainly regulated by an oscillatory mode with a period of 1535 days. An investigation of the circulation features suggests that the 15-35-day oscillation is associated with an anomalous low-level cyclone (anticyclone) appearing alternatively over the northern South China Sea (SCS) and the Philippine Sea, and related to a northeastward (southwestward) shift of the western Pacific subtropical anticyclone over the SCS, leading to a lower tropospheric divergence (convergence) over the Yangtze Basin. In the upper troposphere, the 15-35-day oscillation exhibits a dipole anomaly characterized by an anomalous cyclone (anticyclone) over eastern China and an anomalous anticyclone (cyclone) over the northern Tibetan Plateau, resulting in a southwestward shrinking (northeastward extending) of the South Asian anticyclone, and forming a convergence (divergence) over eastern China. Such a coupled anomalous flow pattern between the lower and upper troposphere favors large-scale descending (ascending) motion, and hence reduced (enhanced) rainfall over the Yangtze Basin. Dynamically, the intraseasonal variations in the Yangtze rainfall are mainly determined by the coupling between the low-level relative vorticity and the upper-level divergence. In the middle troposphere, the 15-35-day oscillation of the subtropical high is originated over the central North Pacific north of Hawaii, then propagates westward to the SCS-Philippine Sea, and finally modulates the intraseasonal variations of the Yangtze rainfall.

Keywords: intraseasonal, oscillation, monsoon

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MS010 **Oral Presentation** **5302**

A Multiscale Model of the Madden-Julian Oscillation with Active Convection

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We elaborate upon the multi-scale models of Majda and Klein for the tropical atmosphere and those of Biello and Majda for the Madden-Julian Oscillation to incorporate active moisture, using the multi-cloud models of Khouider and Majda. The asymptotic analysis yields a two time and length scale model wherein embedded waves of synoptic scale activity drive convective organization on the planetary scales through the upscale fluxes of momentum and moisture. The novel multi-scale organization of the latent heat release through deep convection makes for a subtle asymptotic analysis, with the possibility of waves on multiple scales. The Madden-Julian oscillation arises on the planetary scales as an eastward propoagating envelope of synoptic scale convective activity.

Keywords: multiscale, asymptotics, madden julian oscillation

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

MS010 **Oral Presentation** **5303**

The Madden-Julian Oscillation and nonlinear moisture modes

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Many state-of-the-art general circulation models (GCMs) continue to suffer from poor simulations of the Madden-Julian Oscillation (MJO). On the other hand, there is an increasing recognition that a majority of convection parameterizations have only weak sensitivity to free tropospheric environmental humidity, and are unable to reproduce moisture-convection feedback. It is tempting to relate these two common problems of GCMs, as some studies have indicated the link between the two. Using a single-column model and the quasiequilibrium tropical circulation model, this study shows that moisture-convection feedback is essential for a moisture mode previously discovered by other authors, and that the weak temperature gradient approximation is capable of describing its behavior in both linear and nonlinear regimes. Furthermore, it demonstrates that various moist processes, including nonlinear wind-induced surface heat exchange (WISHE) and nonlinear advection, modify a nonlinearly equilibrated moisture mode, which is stationary in the linear regime. The results suggest that slow eastward propagation of the MJO might be due to nonlinear advection of dry air by Rossby gyres.

Keywords: mjo, moisture, wtg

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

MS010 **Oral Presentation** **5304**

Coupled Model Simulations of Boreal Summer Intraseasonal (30-50 day) Variability: Validation and Caution on Use of Metrics

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Hariharasubramanian Annamalai

Boreal summer intraseasonal (30-50 day) variability (BS ISV) over th e Asian mon soon region is more complex than its boreal winter count erpart, the Madden-Julian Oscillation (MJO), since i t also exhibits northward and no rthwestward pro pagating convective components over India and th e west Pacific. Here we anal yze the BSI SV in the CMI P3 and se lect C MIP2+ co upled o cean-atmosphere mo dels. Difficulty remains in simulati ng the life-cycle of the BSISV, including the tilted rainband t hat is associated with the Rossby wave response to the ea stward propagating equatorial convective anomalies (Annamalai a nd Sperber 200 5). The ECHA M4/OPYC clim ate model, which is known to realistical ly represent the boreal winter MJO (Sperber et al. 2005) , gives the most realistic simulation of the BSISV tilted rainband that is predicated on captur ing th e e astward equatorial p ropagation. Th is model also captures the initiation of the BSISV convection over the tropical western Indian Ocean that occurs in the presence of low-level easterly anomalies that are a ssociated with the suppressed phas e of the BSISV to the east, and the transition to lo w-level moisture convergence during the mature phase. The eastward propagation of convection and its relationship to sea-surface temperature, surface fluxes, and low-level moisture convergence is nearly identical to that of the boreal winter MJO. Northward propagation of convective anomalies are also preceded by l ow-level moisture convergence, thou gh only in the vicinity of India. The extent of the northward propagation is related to the easter ly wind shear (Lau and Pe ng 1990, Wang and Xie 1997, A nnamalai and Sperber 2005). In the ECHAM4/OPYC model the simulated easterly shear does not extend as f ar nort h as ob served, co nsistent with a dry bias i n the mo nsoon rainfall climatology. The model also captures the interactive nature of the monsoon system including the link between the enha nced west Pacific rainfall an d the o nset of monsoon break over India. Extreme caution is nee ded when using metrics, su ch as the patt ern co rrelation, fo r assessing the fidelity o f model perform ance, as models with the most phys ically realistic BSI SV do not exhibit the highes t pattern correlations with observations.

Keywords: tropicalvariability, maddenjulianoscillation, airseainteraction

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MS010 **Oral Presentation** **5305**

Predictability of Tropical Cyclogenesis over the western Pacific in 2004

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In 2004 ther e was a record-breaking number of ty phoon landfalls on Japan. Nakazawa(200 6) documented that the MJO ma y play a role on the e vents. In this study we examined if t he JMA weekly ensemble system (9 day forecast, 25 memb ers, breeding method) can capture the MJO signal prier t o the tropical cyclogenesis in 2004. The result shows that in s ome extent the system is capable to predict both the MJO signal and tropical cyclogenesis up to one week or so.

Keywords: predictability, mjo, tropical cyclogenesis

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MS010 **Oral Presentation** **5306**

Convectively coupled equatorial waves simulated by a global nonhydrostatic experiment on an aquaplanet

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This study describes large-scale convective disturbances simulated by a series of aquaplanet experiment with explicit moist physics. The experiment was executed with 7- (3.5-) km mesh size for 40 (10) model days using the Nonhydrostatic ICosahedral Atmospheric Model (NICAM). The results showed the spontaneous organization of tropical convection in cloud systems with zonal size of several thousand kilometers and multi-scale structure similar to the observed super cloud clusters (SCCs). In terms of the coupling between convection and equatorial waves two modes of eastward propagating convective signals were dominant throughout the simulation. The one was tightly coupled to the simulated SCC with typical propagation speed of 17 m/s (SCC mode). This mode resembled the observed convectively coupled Kelvin waves in phase speed and vertical structure. The simulated SCC mode was continuously accompanied with Rossby-wave responses, but with only a slight modification in the well-known properties of the moist Kelvin waves. This supports the idea that the preference of this mode was intrinsic to the atmosphere. Another disturbance was more clearly defined in dynamical structure than in convective signal, and characterized by a combined Kelvin- and Rossby-wave structure with 40,000-km zonal scale (40,000-km mode). The horizontal and vertical structures of the 40,000-km mode were similar to those of the observed Madden-Julian Oscillation (MJO), suggesting that this mode shared some basic mechanisms with the MJO. Moisture buildup leading the deep convective phase was reproduced, mainly due to the frictional convergence in the boundary layer. The typical propagation speed of the simulated 40,000-km mode was 23 m/s, suggesting that the frictional convergence alone was not sufficient to reproduce the slow propagation of the MJO (5 m/s). The effects of sea surface temperature (e.g., zonally uniform with 27 K at maximum in this experiment) and mean flow (e.g., low-level easterly in this experiment) to the propagation speed of the convective disturbance were implied. Moisture flux from sea surface had negative anomalies in the low-level easterly phase of the 40,000-km mode on the equator, suggesting the negative contribution to the moisture buildup leading the deep convective phase. Positive moisture flux anomalies preceding the equatorial deep convective phase were pronounced in the subtropics. The effects of meridional structure and moisture transport were implied. The two modes cooperatively interacted with each other; the SCCs forced the 40,000-km scale dynamical response, and the 40,000-km structure significantly affected the convective activity of the SCCs. In both modes, temperature and vertical motion anomalies were phase-fixed in the upper troposphere, but nearly quadrature in the lower troposphere. In the stratiform phase of the 40,000-km mode vertical second-mode meridional circulation was evident. These suggested the importance of diabatic heating in the upper troposphere to the coupling of convection and the simulated waves.

Keywords: global nonhydrostatic model, convectively coupled waves, aquaplanet

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

MS010 **Oral Presentation** **5307**

The MJO Numerical Simulation: Impacts of Convection Heating Profile and Model Resolution

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Long-term (12 years) integrations are conducted by using the SAMIL which is developed at the LASG in the Institute of Atmospheric Physics (IAP) and the CAM2 in NCAR to study the impacts of convection heating profile and model resolution on the MJO simulation. Two GCMs used in the study have been shown to be better model in numerical simulation experiment. The comparison of simulated MJO in two GCMs with different cumulus parameterization schemes indicates that the largest diabatic heating in the mid-lower troposphere for a simulation, the simulated MJO is more realistic than the others. In a series of numerical experiments, the vertical heating profiles are artificially modified so they peak in, respectively, upper, middle, and lower troposphere. The eastward propagating MJO is produced only when diabatic heating peaks in the middle and lower troposphere. When its peak is in the upper troposphere, the westward synoptic-scale disturbances become dominant. It is suggested that vertical profiles of diabatic heating generated by convective parameterizations is likely to be a critical factor in producing realistic MJO. The SAMIL with identical physical process but three different model resolutions (R15L9, R42L9 and R42L26) all produced the basic features of the MJO as observed, including the time-space spectra, eastward propagation, and strictly speaking, these are no essential differences among these model results. It is indicated that resolution is not essential for simulating the MJO in the GCM, but differences among these model results also suggest that changes in model resolution can modify the simulated MJO remarkably on certain aspects. For instance, although lower horizontal resolution model weakens the high frequency disturbances and makes the structures of the simulated MJO much clearer to a certain extent, improvement in vertical resolution gives a better distribution of time-space spectrum and spatial distribution of MJO precipitation. So improvement of the model resolution is also needed based on improving the cumulus parameterizations scheme.

Keywords: numerical simulation, mjo, numerical model

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MS010 **Oral Presentation** **5308**

Large-scale waves in cloud populations as seen by Cloudsat

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CloudSat's pro filing radar (CPR) sees 2- dimensional cross sectio ns o f clo uds. A contiguo us featu re analysis allows us to define clouds sensibly, yet still drill down to pixel st atistics as needed. Clouds in different phases of larger-scale waves are gathered according to OLR tim e-longitude sections, and the different populations in each wave phase are examined and characterized statistically.

Keywords: cloudsat, mjo

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

MS010 **Oral Presentation** **5309**

Tropical vs. Extratropical Generations of the Madden-Julian Oscillation

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Pallav Ray

The Madden-Julian Oscillaiton (MJO) has conventionally perceived as a phenomenon resulted primarily from coupling between the large-scale circulation and moist deep convection in the tropics. Numerous theories and hypotheses on the MJO have proposed with such circulation-convection coupling as the central mechanism. Global climate model (GCM) simulations of the MJO, however, show stunning incoherence between the circulation and convection, in contract in MJO theories and observations. This raise a question on the MJO mechanism. The possibility of MJO generation by influences from the extratropics has been proposed and discussed in literatures but has not gain much attention from the mainstream research effort. To revisit this possibility, a mesoscale regional model (MM5) was converted into a tropical channel model with its lateral (latitudinal) boundaries at 22N and S. Several case studies were conducted to simulated observed MJO events for three to four months. The NCEP/NCAR reanalysis was used as the initial and lateral boundary conditions. Sensitivities of the simulations to various factors were tested. It is found that the gross features of simulated MJO events are sensitive to neither initial conditions nor sea surface temperature. The decisive factor for whether the model can reproduce the MJO events appears to the lateral boundary conditions. No intraseasonal variability was simulated when a time independent lateral boundary condition was used. When a dry version of the model was used and when moisture effects on diabatic heating were prohibited in the model but a realistic lateral boundary condition was used, the model produced intraseasonal variability that did not propagate eastward. These numerical simulations suggest that the MJO might be initiated by influences from the extratropics but its eastward propagation might depend on deep convection in the tropics.

Keywords: madden julian oscillation, mm5, tropical

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MS010 **Oral Presentation** **5310**

Rapid Transitions in Zonal Wind Around the Tropical Tropopause and their Relation to the Amplified Equatorial Kelvin Waves

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Rapid transitions in the zonal wind (U) around th e tropical trop opause with in several days are investigated by using the global analysis data an d their relation t o th e amplified Ke lvin waves ar e considered. At 100 h Pa, cas es with a rapi d increase in U (TypeU+ events) are concentrated in th e eastern hemis phere, where such cases far outnumber cases that show a rapid decreas e in U (TypeU- events). The difference in t he numb er of the two ty pes of events is greatest duri ng the period November-March in the region 90E --180E. When only considering case s with a large zonal extent and eastward propagation, the dominance of TypeU+ ev ents in the eastern hemisphere is much more distinct. The a symmetry bet ween the two types is only weakly recorded at lower levels. An amplified and nonlinearl y distorted Kelvin wave possibly acco unts for predominance of these TypeU+ events at 100 hPa. The dominance of TypeU+ events is detect ed in the basic ea sterly flow within the uppe r troposphere, which possibly f acilitates the d istortion by enhancing the upward propagation of energy and enabling the high intrinsic speed of the wave. In the distorted Kelvin wave, the latitudinal extent of the westerly signal is much smaller than that of the easterly signal.

Keywords: kelvin wave, equatorial wave

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MS010 **Oral Presentation** **5311**

Satellite Data Analysis of the Madden-Julian Oscillation, Kelvin wave, and the Equatorial Rossby Wave

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The Madden-Julian oscillation (MJO), Kelvin wave, and equatorial Rossby (ER) wave, or collectively intraseasonal oscillations (ISOs), are investigated using a 25-year record of outgoing longwave radiation (OLR) measurements as well as the associated dynamical fields. The ISO modes are detected by applying band-pass filters to the OLR data in the frequency-wavenumber space. An automated wave-tracking algorithm is applied to each ISO mode so that convection centers accompanied with the ISOs are traced in space and time in an objective fashion. The dynamical structure is composited with respect to the identified convection centers of each ISO mode. The Kelvin wave exhibits a low-level wind field resembling the shallow-water solution, while a slight lead of low-level convergence over convection suggests the impact of frictional boundary-layer convergence on Kelvin wave dynamics. A lagged composite analysis reveals that the MJO is accompanied with a Kelvin wave approaching from the west preceding the MJO convective maximum in austral summer. MJO activity then peaks as the Kelvin and ER waves constructively interfere to enhance off-equatorial boundary-layer convergence. The MJO leaves a Kelvin wave emanating to the east once the peak phase is passed. The approaching Kelvin wave prior to the development of MJO convection is absent in boreal summer and fall. The composite ER wave, loosely concentrated around the MJO, is nearly stationary throughout. Individual MJO events are also analyzed using Tropical Rainfall Measuring Mission (TRMM) data to further investigate the possible relationship among different ISO modes.

Keywords: mjo, equatorial waves, satellite observation

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MS010 **Oral Presentation** **5312**

Atmospheric conditions during the MISMO field experiment in the Equatorial Indian Ocean

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In order to investigate the atmospheric and oceanic conditions in the central equatorial Indian Ocean in the fall-winter season, when and where the convections in the MJO are often initiated, Japan Agency for Marine-Earth Science and Technology conducted the intensive observations using the R/V Mirai and the buoy network around (0, 80.5E) as well as the land-based measurements at Maldives Islands. This field experiment is called as MISMO (Mirai Indian Ocean cruise for the Study of the MJO-convection Onset) and was taken place in October - December 2006. Intensive observations using Doppler radar, radiosonde, CTD and others were carried out at the fixed site at (0, 80.5E) from October 28 through November 21, after deploying 12 Argo floats along 80.5E line from 8S to 3N and establishing the buoy array at (1.5N, 80.5E), (0, 79 E), (1.5S, 80.5E), and (0, 82E) with m-TRITON buoys, ATLAS buoys, and sub-surface ADCP moorings. After the stationary observation, onboard atmospheric measurements were continued along the equator from Maldives to the eastern Indian Ocean in early December. Observations were conducted under the positive Indian Ocean Dipole mode event. In spite of that, many deep convections developed over the observational site in late November and then eastward moving of cloud clusters was observed in early December, though they dissipated over the maritime continent region. One significant feature is that westerlies prevailed at the upper troposphere near the tropopause in early to mid-November while there was no dominant wind in the lower troposphere, and then it abruptly changed its direction to easterlies in one day (November 16), and this date corresponded to the time when the convective activity became active. By analyzing the re-analysis and satellite data, this easterly seems to be brought by the westward equatorial wave, suggesting the relationship between the equatorial wave and the convective activity over the central Indian Ocean. Detailed atmospheric vertical structure focusing on this phase change will be presented in addition to the brief overview of the MISMO project.

Keywords: mjo, mismo, indian ocean

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MS010 **Oral Presentation** **5313**

Characteristiscs of the surface and subsurface layers in the equatorial Indian Ocean observed in a positive IOD year

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The Indian Ocean Dipole (IOD) is the most predominant interannual variability in the air-sea coupling system in the Indian Ocean. The Institute of Observational Research for Global Change (IORGC) executed an intensive observation project, Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset (MISMO), during October to December of 2006. We observed the oceanic surface and subsurface layers during an IOD event. In the present paper, we analyze the observed data (e.g., Argo floats, and acoustic Doppler current profiler (ADCP)) during the MISMO period, in order to reveal the variability of the ocean associated with the IOD, focusing on air-sea interaction. The climatological sea-surface temperature (SST) is higher in the eastern part of the equatorial Indian Ocean. However, in 2006, the SST was high in the central Indian Ocean (65-85E). According to the results by the Argo floats, the sea-water temperature near the surface is higher and the isothermal layer is thicker in 2006 compared with the climatological mean. In addition, the salinity was lower by 1 psu near the surface, resulting in a strengthened stratification. Associated with strong westerly wind, an eastward current called the Wyrtki jet is observed near the surface in autumn in normal years. Since the advection from the west is predominant, the T-S diagram in the central Indian Ocean is nearly the same as that in the western Indian Ocean, in the surface and subsurface layers. However, in 2006, the near-surface current was westward corresponding to the easterly wind. The T-S diagram in the central Indian Ocean resembled that in the eastern Indian Ocean near the surface better than that in the western Indian Ocean. According to satellite observations, the zonal gradient of sea-surface height was also reverse. In normal years, the eastward current is observed from the surface to 100 m, and the direction of zonal current is constant above 100m. However, in 2006, the current was eastward beneath the 50 m, while the surface current is westward. It means that the subsurface current was opposite to that near surface. It is revealed that the sea-surface wind, near-surface current, and sea-surface height were inversed in a positive IOD year, although the subsurface current was not changed. The eastward subsurface current seemed to be maintained by the strengthened salinity stratification, which prevented the downward transport of westward momentum. It appears that the low-salinity water near the surface was brought by the advection of low-salinity surface water from the eastern Indian Ocean and the above-normal precipitation over the central Indian Ocean.

Keywords: indian ocean dipole, mjo, air sea interaction

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MS010 **Oral Presentation** **5314**

Air-sea energy fluxes with on-board eddy-covariance system during MISMO

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In the air-se interaction, surface energy fluxes are the direct interaction th orough the ocean surface. They are usually evaluated with the bulk algorithm using the routine meteorological/oceanographic parameters. The accuracy of the fluxes depends on the estimated bulk transfer coefficients. These bulk coefficients are evaluated using the direct eddy-covariance measurements over limited area and conditions. During the MISMO cruise in 2006, present authors experienced the on-board eddy-covariance measurement of surface energy fluxes on R/V MIRAI, JAMSTEC. Air-sea CO2 eddy flux is also available with the flux system, and this should be a very important database for the global warming process. A month long stationary observation continued at the equator, 80E using R/V MIRAI in Nov 2006. During a month, 3-hourly flux runs were carried out steaming up against the wind to minimize the flow distortion and thermal effects of the ship body on the flux system installed at the top of the foremast. Surface radiation fluxes are available with the SOAR system on R/V MIRAI and downwelling shortwave and longwave radiations. Upward radiations were calculated with the albedo(0.055) and blackbody radiation with sea surface temperature. Surafce net radiation were synthesized with the eddy fluxes of sensible and latent heat and lead to net sea surface flux as ocean warming. The latent heat flux can also lead to surface water vapor supply to the atmosphere. The COARE bulk flux algorithm were applied based on the meteorological/ oceanographic parameters from SOAR system and compared with the eddy-covariance results. The eddy heat fluxes can also evaluate the bulk transfer coefficients during the MISMO cruise and they can be useful to evaluate sea surface fluxes over extended areas and times.

Keywords: air sea flux, surface heat budget, mismo

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MS010 **Oral Presentation** **5315**

Convective Inhibition and Dynamics in Convectively Coupled Kelvin Waves

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A linearized, two-dimensional, non-rotating model of the tropical atmosphere is presented here which incorporates the saturation fraction of the troposphere, surface moist entropy fluxes, and the strength of convective inhibition into its convective closure in a simplified fashion. Two types of large-scale unstable modes develop in this model. A slowly propagating "moisture mode" is driven primarily by saturation fraction anomalies and is a candidate mechanism for many tropical disturbances such as easterly waves and monsoon depressions. A convectively coupled "gravity mode" is governed by anomalies in convective inhibition caused by buoyancy variations just above the top of the planetary boundary layer. The model is vertically resolved and no assumptions are made about vertical structure except that the heating profile has the form of the first baroclinic mode. The calculated vertical velocity consists of two sinusoidal components with different vertical wavelengths. One component corresponds to the imposed heating profile while the other one has a shorter wavelength and governs the phase speed of the convectively coupled gravity mode. The gravity modes map onto equatorial Kelvin waves in the earth's atmosphere and the predicted propagation speeds for this mode are close to the observed phase speeds of convectively coupled equatorial Kelvin waves. For reasonable parameter values the growth rate peaks at zonal wavenumbers at which Kelvin waves exhibit the greatest spectral energy. Furthermore, the computed vertical structure, in particular the temperature structure, matches that of observed Kelvin waves.

Keywords: kelvin, dynamics

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MS010 **Oral Presentation** **5316**

Using stable water isotopes to understand the dynamics of tropical disturbance through the MISMO observation

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Naturally occurring isotopes of water, HDO, H218O, has been used as the tracer of the water molecule during its atmospheric hydrological cycle. It is well known that the isotopes in the atmospheric water is intimately linked to the cloud physics, such as formation of precipitation, and evaporation from the condensation phase. Here, we introduce the application of stable isotopes in water to the study of tropical disturbances through the result of MISMO observation program. The isotopic composition of atmospheric moisture and precipitation were observed over the tropical Indian Ocean during the cruise of the research vessel Mirai from October 16 to December 13, 2006. These observations were performed in every 3-6 hour during the IOP. At the same time, to compare the isotope data observed at the Mirai, isotopic composition of precipitation was also observed at the Gan Island, Maldives, which is the windward site of Mirai, and Padan, which is the leeward site, which locates western coast of the island of Sumatra, Indonesia. The observed isotopic features are summarized in bellow. 1)Lowest isotopic value of precipitation occurred in stratiform rain after the tropical disturbances or gust front migrated from west and passed over the observed site. On the other hand, the highest isotope value occurred in isolate convective rain during inactive phase. 2) When the lowest isotopic value of precipitation was observed, the isotopic content of water vapor at near surface also showed the minimum value. It suggests that he moisture that formed precipitation has subsided in the downdraft to the surface. 3) The d-excess value of water vapor that it becomes high as increases of post evaporation from the condensation showed the maximum when stratiform rainfall s occurred. This result supports the above mentioned downdraft. Because the isotopic variability of evaporation from the ocean is small and observation site is far from the continent, these isotopic results show that the isotopes are sensitive to the cloud dynamics. In this presentation, we will discuss the factors controlling isotopic difference between stratiform and convective rain and better understand the feature of dynamics and physics of the tropical disturbance.

Keywords: mismo, isotope, tropicaldisturbance

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MS010 **Oral Presentation** **5317**

Observation of oceanic response to the Madden-Julian Oscillation

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The Madden-Julian Oscillation (MJO) is the dominant mode of intraseasonal variability in the tropical atmosphere, with a typical timescale of 30-90 days. Using newly available observation provided by Argo floats, we show that changes in atmospheric forcing associated with the MJO, i.e. anomalies in surface wind stress, surface heat flux, and precipitation/evaporation, induce changes in the upper ocean structure. Although changes in sea surface temperature (SST) are well documented, this is the first time that a significant effect of the MJO has been documented at depth in the ocean, and in salinity as well as temperature. Temperature and salinity from Argo floats in the Indian and Western Pacific Oceans from 2003 to 2005 inclusive were mapped to a regular weekly-mean grid with one-degree horizontal and five-metre vertical resolution. Composites of SST anomalies during MJO events show the well-known pattern in which SST variability lags surface heat flux by a quarter of a cycle. This signal extends to 50 m. Below that, an MJO-related signal is seen to a depth of 1000 m in the equatorial Pacific that is out of phase with the surface signal, because the thermocline is raised and lowered by propagating waves in response to surface wind stress. Composites of salinity anomalies show complex patterns due to the existence of the surface fresh pool in the western Pacific and the subsurface salinity maximum in the central Pacific. Salinity anomalies at these interfaces vary out of phase of each other when the haloclines are raised or lowered in response to surface wind stress.

Keywords: madden julian oscillation, argo, salinity

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MS010 **Oral Presentation** **5318**

Intraseasonal Oscillations and the Sensitivity of Precipitation to Tropospheric Humidity

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Recent observational and numerical work has shown that precipitation over warm tropical oceans is extremely sensitive to the tropospheric humidity. In particular, the precipitation rate appears to be a steeply increasing function of saturation fraction or column relative humidity, defined as the precipitable water divided by the saturated precipitable water. A convection-resolving numerical model using weak temperature gradient boundary conditions finds that the mean precipitation rate becomes very large for saturation fractions in excess of about 0.87, and passive microwave satellite data analyzed by Bretherton and colleagues show similar results. The steepness of the precipitation-saturation fraction curve determines the time required for the tropospheric humidity to adjust to changes in forcing, such as an increase in the surface latent heat flux. Naive estimates of this adjustment time based on the mean precipitable water and the surface evaporation rate yield adjustment times of 10-30 d. More sophisticated estimates which take into account the fact that small changes in saturation fraction can result in large changes in precipitation rate reduce this to of order 1 d. As Derbyshire et al. and others have shown, many cumulus parameterizations are in sufficiently sensitive in their production of precipitation to the saturation fraction, and therefore exhibit a long moisture adjustment time. In this paper we demonstrate that the sensitivity of a toy convective parameterization to saturation fraction in an equatorial beta plane model plays a key role in determining the time and space scales of tropical convective variability in the model, and in particular those of intraseasonal oscillations. We therefore suspect that the inability of many global atmospheric models to produce realistic Madden-Julian oscillations is a consequence of this particular failing. At least one well-known climate model exhibits such a problem.

Keywords: mjo, convection, precipitation

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MS010 **Oral Presentation** **5319**

Intraseasonal Variations over the Indian Ocean during September-December 2006

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An intensive observation experiment over the Indian Ocean called MISMO (Mirai Indian Ocean cruise for the Study of the MJO-c onvection Onset) was conducted by the Japan Agency for Marine-Earth Scienc e and Technology from late October to early December 2006. Convectively a ctive periods associated with the intraseasonal variations (ISVs) were obs erved four times over the Indian Ocean during September-December 2006. All ISVs except that in October were diagnosed as Madden-Julian Oscillations (MJO) by a wavenumber-frequency spectrum analysis and an MJO in December had the largest amplitude among them. In this study, behaviors of each ISV have been compared by focusing on synoptic-scale disturbances embedded in the ISV, a nd their relation ship with the envir onmental co nditions has bee n examined using satellite and observational data. As for the enviro nmental co nditions, an El Nio has developed ove r the Pacific s ince August. O n the ot her h and, a po sitive Indian Ocean Dipo le (IOD) evolved in late October and decayed in mi d Nove mber. Under the IO D condition, convections were suppressed over the cold pool in the eastern Indian Ocean off the Sumatra. After the IO D event, higher values of sea surface temp erature (SST) and tota l precipitable water (TPW) were f ound over the equatorial Indian Ocean, which is favorable for th e organization of convections. On th e oth er h and, these values in September were not so hig h. During each convectively a ctive period, the Rossby wave disturbances developed over the western Indian Ocean a nd propa gated westward, while new convections generated to the east of them. For the MJO case in October, however, convections over the eastern Indian Ocean did not become organized because of the IOD. It is interesting to note that MJO in September had the second largest amplitude, alth ough the environmental state was not so favorable. In September, near-equatorial SST, especially south of the equator, was relatively hi gher than that in October. This meridionally-extended warm SST is su ggested to facil itate the convectiv e organization centered on the equator and lead to equatorial convective heating, which resulted in the MJO excitation.

Keywords: isv, mismo

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MS010 **Oral Presentation** **5320**

Roles of intraseasonal variability in the development of the 1982-1983 and 1987 El Nino Events

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Intraseasonal variability of the tropical atmos phere modulates the development of rapid changes in the state of the El Nino/Southern Oscillation (ENSO). Ob served data will be applied to demonstrate the dramatic impact of intraseasonal variability on the development of the 1982-1983 an d 1986-1987 El Nino events. Sea level data fr om islands and coasta l sites together with measurements taken from the TOGA-TAO array of moored buoys and outgoing longwave radiation (OLR) data from near polar orbiting satellites show oceanic Kelvin waves forced larg ely by t he Ma dden-Julian Oscillation determined the timing and amplitude of these El Nino events.

Keywords: mjo, el nino, intraseasonal

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MS010 **Oral Presentation** **5321**

Microphysical structures of stratiform clouds observed over the equatorial Indian Ocean

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The eastward propagating 30- 60 days va riability that is called Madden-Julian Oscillation (MJO) is dominant in the Tropics. It is known that the MJO influences the monsoon, El Nio, tropical cyclones, the dipole mode event, etc. An understanding of the pr ecipitation mechanisms in clouds a ccording to th e MJO is importa nt because it relates not only to the upward transportation of water vapor directly, but also to the cloud organization, the vertical heat budge t in clouds. In this study, aiming to clarify the precipitation m echanisms of the clouds according to the MJO disturbance that developed over the Indian Ocean where in situ cloud m icrophysical observation had no t been do ne up to now, we participated in the R/ V Mirai observation cruise MR06-05 (MISMO project), and the vertical distributions of the precipitation particles in the clouds were observed with videosondes.Videosonde is a balloonborne radiosonde which images of precipitation par ticles are acquired by a CCD camera. Videosonde system consists of a CCD camera, a video amplifier, an infrar ed sensor, a transmitter, and a control circuit. It also has a stroboscopic illumination, which gives us t he information of particle size and shape. Im ages of particles are transmitted by the 1680 MHz carrier wave to the receiving system e quipped at th e navigation deck of the R/V Mirai, and the n displa yed and recorded. During the MISMO project, seven videosondes were launched into the stratif orm clou ds that the Doppler radar detected clear bright bands. Particle images transmitted from v ideosondes were ice crystals, graupel, and aggregate s (Snowflakes) near and above the freezing l evel. The shapes of these aggregates were different from aggregations of nearly ro und graupel o bserved in the mar itime stratifor m clouds during TOGA-COAR E (Takahashi et al., 1995) and the R/V Mirai MR04-08 cruise over the western Pacific Ocean (Suzuki et al., 2006). The n umber concentrations of ice crystal and gr aupel were gre ater than that observed in th e maritime stratiform clouds over the western Pacific region. It was found that the stronger ice crystal formation process in the upper level of stratiform clouds was dominant over theIndian Ocean.Moreover, in the latter half of the obse rvation period, the large-scale upper air circulation had b een dramatically changed, a nd the vertical pr ecipitation particle dist ributions were greatl y different bef ore and be hind that. The number concentrations of ice crystal and graupel that had been observed in the latter half was larger than that observed i n the first hal f. Thou gh a detailed further analysis is needed, it wa s suggested that a large-scale circulation might greatly influence such microphysical features in clouds.

Keywords: videosonde, cloud, microphysics

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MS010 **Oral Presentation** **5322**

Diurnal variations in tropical oceanic cumulus convection during the MISMO

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Over the tropical oceans, cumulus convection shows various temporal features, from diurnal to intra-seasonal or seasonal variation. Diurnal cycle is observed in both the convectively active and suppressed phases, and is one of the most dominant elements. Moreover, it is reported that diurnal convective activity plays an important role in preconditioning for the Madden Julian Oscillation (MJO) active phase. Therefore, many investigations have been focused on the diurnal variation in cumulus convection. In the convectively active phase, rainfall reaches a maximum in the midnight to predawn period. In the convectively suppressed phase, on the other hand, maximum rainfall is observed in both the afternoon and predawn periods. This knowledge is all acquired by utilizing in situ observation over the equatorial Pacific warm pool region during the Tropical Ocean Global Atmosphere Coupled Ocean-Atmosphere Response Experiment (TOGA COARE). Therefore, the robustness of the diurnal variation is still unclear. Although passive-sensor observations by satellites provide long-term and wide-coverage cloud data, lower-level clouds are hidden by upper level clouds and it is difficult to examine the low-level features, especially in the convectively active phase. The Tropical Rainfall Measuring Mission (TRMM) satellite provides active-sensor observation data of precipitation systems, and does not have the masking problem. However, TRMM has an under-sampling issue due to a satellite orbital constraint. The Institute of Observational Researchfor Global Change (IORGC) conducted an intensive observation project, Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset (MISMO), in October and November of 2006. This observation data is unique and suitable for the study on cumulus convection over the oceanic regions free from continental influence. Therefore, we investigate the robustness of the diurnal cycle in cumulus convection observed over the Pacific warm pool, making use of MISMO data. Results reveal that (1) shallow precipitation system has two peaks of the activity in the afternoon and late midnight, (2) convective radar-echo area also shows two peaks in the afternoon and late midnight, although the latter peak is still more prominent than the former, (3) stratiform radar-echo area has single peak in the predawn period. These results are consistent with those obtained by previous studies using TOGA COARE data.

Keywords: diurnal, mismo, convection

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MS010 **Oral Presentation** **5323**

Abrupt Seasonal Variation of the ITCZ and the Hadley Circulation

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Using Tropical Rainfall Measuring Mission (TRMM) dail y data, we show that the s easonal migration of the global zonal-mean intertropical convergence zone (ITCZ) is not smooth, but jumps from the winter hemisphere to the summer hemisphere. The period of the abrupt migration is about 10 days. Detailed analyses re veal that the ph enomenon of a brupt se asonal migration of the ITCZ m ainly exists over particular tropical domains, s uch as Indian Ocean, west a nd central Pacific, and So uth America, which gives the rise of the jump of t he global ITCZ. Because the ITCZ constitutes the ascending branch of the Hadley circulation, we also examine whether there exists such an abru pt seasonal v ariation of the Hadley circulatio n. It is fo und th at the stre ngth of the mean meridional mass streamfunction evolve s smoothly w ith time. H owever, the horizonta l scales of the Hadley cells demonstrate abrupt changes, corresponding to the abrupt seasonal migra tion of the global ITCZ. Duri ng the period of the abrupt transition, the width of the winter cell rapidly extends by about 74%, while the width of the summer cell narrows by about 46%. From the point of view of mass transport associated with the Hadley circulation, the solsticial c ell is indeed a dominant cell , whil e the eq uatorially symmetric equinoc tial pattern is ephemeral.

Keywords: itcz, hadley circulation, tropics

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MS010 **Oral Presentation** **5324**

Real-time Extraction of the Madden--Julian Oscillation Using Empirical Mode Decomposition and Forecasting with a VARMA Model

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Barnaby Love, Gareth Janacek

A simple guide to the new technique of empirical mode decomposition (EMD) in a meteorological--climate forecasting context is presented. A single application of EMD to a time series essentially acts as a local high-pass filter. Hence, successive applications can be used to produce a band-pass filter that is highly efficient at extracting a broad-band signal such as the Madden--Julian oscillation (MJO). The basic EMD method is adapted to minimise end effects, such that it is suitable for use in real time. The EMD process is then used to efficiently extract the MJO signal from gridded time series of outgoing longwave radiation (OLR) data. A range of statistical models from the general class of vector autoregressive moving average (VARMA) models was then tested for their suitability in forecasting the MJO signal, as isolated by the EMD. A VARMA (5,1) model was selected and its parameters determined by a maximum likelihood method using 17 years of OLR data from 1980 to 1996. Forecasts were then made on the remaining independent data from 1998 to 2005. These were made in real time, as only data up to the date the forecast was made were used. Forecasts of median skill were accurate at lead times up to 25 days, while those at the upper quartile were accurate beyond 40 days.

Keywords: mjo, statistical, forecast

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MS010 **Oral Presentation** **5325**

Changes in the lifetime and amplitude of the Madden-Julian oscillation associated with ENSO

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The Madden-Julian oscillation (MJO) is analysed using the reanalysis zonal wind and satellite outgoing longwave radiation based indices of Wheeler and Hendon for the 1974-2005 period. The average lifetime of MJO events varies with season, being 36 days for events whose central date occurs in December, and 48 days for September. The lifetime of the MJO in the equinoctical seasons (March to May and October to December) is also dependent on the state of El Nino Southern Oscillation (ENSO). During October-December it is only 32 days under El Nino conditions, increasing to 48 days under La Nina conditions, with similar values in northern spring. This difference is due to faster eastward propagation of the MJO convective anomalies through the Maritime Continent and western Pacific during El Nino, consistent with theoretical arguments concerning equatorial wave speeds.

Keywords: mjo, enso, period

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MS010 **Oral Presentation** **5326**

Barotropic and super-rotating jet formation in the evolution of very short mixed Rossby-gravity waves

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The formation of zonal jets is studied in the context of the evolution of very short mixed Rossby-gravity waves in a zonally periodic equatorial channel. High resolution numerical initial-value simulations show the emergence of a nearly zonally symmetric quasi-steady state with a rich structure in depth and latitude that depends on the parameters of the initial wave. The barotropic component of the long-time quasi-steady state consists of strong westward flow at the equator and short meridional scale extra-equatorial zonal jets alternating in direction with latitude. It is partly explained by a linear theory for the destabilization of the initial wave adapted from that for the destabilization of midlatitude barotropic Rossby waves. A striking feature not easily explained by linear theory is the emergence of low vertical mode eastward jets at the equator, notable as an example of local equatorial "super-rotation" and an exception to Hide's Theorem for steady zonally symmetric flow. An explanation for the super-rotating jets is sought in terms of finite amplitude effects and energy cascades. The effect of the non-traditional Coriolis force terms, due to the northward component of the planetary rotation vector, is also considered, and is observed to lead to a breaking of the vertical mirror symmetry of the final state.

Keywords: equatorial waves, zonal jets, super rotation

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MS010 **Oral Presentation** **5327**

QBO related variation of equatorial gravity wave activity compared to planetary equatorial wave modes in SABER temperature data

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The SABER temperature data set now continuously covers a time period of more than five years. Temperature data are available from the tropopause to the lower thermosphere. This makes SABER temperatures well suited for an investigation of quasi-biennial oscillation (QBO) and semiannual oscillation (SAO) effects in stratospheric and mesospheric waves. Gravity wave activity was derived from four years of residual SABER temperatures and analyzed for variations related to the QBO and SAO. In the equatorial region these data will be compared to the variation of planetary equatorial wave modes such as Kelvin waves or Rossby- gravity waves derived from SABER and ECMWF temperatures for the same period.

Keywords: gravity waves, equatorial waves, stratosphere

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MS010 **Oral Presentation** **5328**

Variability of the Madden-Julian Oscillation during boreal spring and summer

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The El Nino/Southern Oscillation phenomenon is undoubtedly the main mode of interannual variations in the coupled ocean-atmosphere system. Although it is still a matter of debate, important observational evidence supports the idea that stochastic atmospheric forcing associated with air-sea interaction processes can explain the irregularity and changes in the evolution of ENSO episodes.On intraseasonal time scales, the Madden-Julian oscillation (MJO) stands out as the main mode of tropical variability with significant influences on the large-scale circulation and precipitation patterns in the global tropics and in portions of the extratropics. A recent study indicates evidence that high MJO activity in boreal spring and early summer tends to lead El Nino onset in subsequent boreal fall and winter. This study uses reanalysis from NCEP/NCAR and ERA40 to further characterize the variability of the MJO during spring and summer. Particular emphasis is placed on identifying MJO events whose effects in the western Pacific Ocean are unique.

Keywords: madden julian

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MS010 **Oral Presentation** **5329**

Convective Mometum Transport and the MJO

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Our kn owledge of th e effec ts of c onvective momen tum tran sport on th e global circulation of the atmosphere is incomplete, and the MJO is truly a case in p oint. A p ertinent iss ue is the mul ti-scaleorganization of tropical conv ection since o rganized flo ws usua lly exhibit distin ctive mo mentum transport properties. Fu rthermore, orga nized tr ansport is not represented by contemporary parameterizations. Modern prediction mode ls, especial ly s tate-of-the-art global cl oud-system resolvin g models, represent convective organization and momentum transport explicitly yet still incompletely. This is especially true for global models that ap ply super-parameterization (i.e., a procedure wherein cloud-system resolving models are applied in place of co ntemporary convective para meterization). Dynamical models reveal fundame ntal mechanisms of convecti ve organ ization, u p-scale tran sport an d exotic interaction wit h the large-scale circulation such as supe r-rotation. The abov e aspect s of convective momentum transport will be discussed, rationalized, and collated to the extent possible with our present state of knowledge.

Keywords: organized convection, parameterization, cloud system resolving models

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MS010 **Oral Presentation** **5330**

Observation of near sea surface temperature variation during the MISMO intensive observation period

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Yoshimi Kawai, Kunio Yoneyama, Hiroshi Kawamura

The objectives of this study are to understand mechanism of SST and near surface temperature change and also to validate the quality of SST data from surface buoy. The methods of our in-situ measurement are to install temperature sensors around m-TRITON surface buoy (Exp-A), and to measure the near surface temperature and SST from the bow of the ship (Exp-B). In the Exp-A, we used five T107 temperature probes and one CR10X data logger of Campbell Scientific Inc for installing on the surface m-TRITON buoy. A set of instrument consisted of the five temperature probes, which were connected to one data logger. Two sets of instrument, one for 0-82E m-TRITON buoy and the other for the 0-79E m-TRITON, were used. In the Exp-B, we used two ALEC temperature sensors, one ALEC depth sensor, and two HOBO temperature sensors. Those are small and self-recording type, and easily installed along the 4mm-diameter and 3m-length stainless-steel wire using wire clips. The positions of temperature sensor installation on the wire were at 1.5m, 2m, 2.5m and 3m from the top of wire, and that of pressure sensor at 3m from the top. Using boom extending to frontward of ship and specially designed steel bar extending 2-meters towards portside, the sensor system was hanged down to ocean surface using the 10mm-diameter cotton rope. The sensor system was set to measure near surface temperature from sea-surface to 3 meters depth. The system was recovered in every week, and analyzed on board. From the data of Exp-B, the strong diurnal signals were observed in Nov. 2 (306 in Julian day), 3 (307), 7 (311), 8 (312), and 9 (313). The highest temperature was observed in Nov.2 at 0.5m with the maximum higher than 31 degree-C. In these days, strong stratifications were observed only in the upper layer above 1.5 meters, indicating strong solar radiation absorption in upper shallow layer. The observed diurnal temperature stratification is well compared with the outputs from one-dimensional 2nd-order turbulence closure model forced by observed heat and freshwater flux, indicating that SST is forced by surface heat flux and governed by 1-dimensional process. In addition, thick barrier layer is often observed below mixed layer during the intensive period. Using the observational data and performing several model experiments, the role of subsurface salinity structure (Barrier layer effect) to variation of SST and near surface temperature will also be presented.

Keywords: mismo, sst, ocean mixed layer

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

MS010 **Oral Presentation** **5331**

Structure of the Convective Activity Captured by the MISMO-IOP Observation Network

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The MISMO project field campaign was carried out in the autumn of 2006 to investigate Madden-Julian oscillation (MJO) convectively active phase in the Indian Ocean. While the research vessel (R/V) Mirai was principal supersite at (Eq, 80.5E), the atmospheric situations were observed on the islands of along 73E from equator to 7N, to investigate the horizontal special structure of the MJO. The radiosonde were launched at two islands, Gan (0.7S, 73. 2E) and Hu lhule (4.2N, 7 3.5E) f or 2 o r 4 t imes p er d ay. Including the R/V Mirai at (Eq., 80.5E), th e zonal (G an a nd Mirai) and meridional (Ga n and Hulh ule) differences o f the atmo spheric co nditions were o btained. In addition, X-band Doppler r adar was also installed at Ga n and o perated co ntinuously. With C- band Do ppler rada r o n the R/V Mirai, detailed structure of precipitating convections and their zonal differences were also captured. The all radiosonde observation sites captured drastic change of the zonal wind on Nov.16. This date well corresponds to the beginning of the continu ously-appearing widespread radar echoes over equator (at both Gan and Mirai). Toward Nov.16, some key factors could be obse rved. In the beginning of November, the convectively inactive days were observed (Nov.1-4 at Mirai, while Nov.4-5 at Gan) with the dry air above 1-km height. The inactive days were broken by a shower day with the lightning (Nov.6 at Mirai, while Nov.7 at Gan). The widespread conv ection first appeared at No v.8 at Gan and Nov.9 at Mirai, while the co ntinuous westerly layer belo w 3-km height appeared o nly at Gan. Finally on No v.15, the strong zonal convergence appeared between the enhanced westerly at Gan and the enhanced easterly at Mirai. These embedded step-by-step processes (c hange of wind, humid ity and precipit ating clouds) within gradual growth of the convectively active phase suggest the importance of multi-scale processes in the captured convectively active period.

Keywords: mjo, mismo, convection

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MS010 **Oral Presentation** **5332**

Mesoscale structure of eastward-moving precipitation systems during the MISMO field experiment

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The mesoscale structure of e astward-moving precipit ation systems over the Indian Ocean during the convectively active phase of an intraseasonal oscillation (ISO) in the later half period of the MISMO field experiment is studied using Doppler radar data co llected on R/V Mirai and at Gan Island, . These precipitation s ystems were observed within super cloud clusters (SCCs) propagating eastward. Each system was fo rmed in a wind-shift zone where zona l wind changed from easterly to westerly or the speed of westerly increased. The de pth of radar echoes associated with the precipitation systems was shallow (~ 5 km) when they exis ted alone, but incr eased rapidl y when they merged to ot her precipitation s ystem moving westward. The east ward pr opagation speed was 4-11 ms-1, whi ch w as close to the s peed of eastward-m oving SCCs (5-9 ms-1). The lifetime longer than 20 hours wa s observed when R/V Mirai pursuited an e astward-moving systems from 90oE through 95oE. These results suggest that the east ward-moving shallow precipit ating system s are important subsystems that contribute to the maintenance of an eastward-moving SCC in an ISO over the Indian Ocean.

Keywords: mismo, mesoscale, observation

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

MS010 **Oral Presentation** **5333**

Upper Ocean Condition in the Central and Eastern Tropical Indian Ocean during 2006 Indian Ocean Dipole

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Indian Ocean Dipole (IOD) is one of the interannual climate variability in the India n Ocean, associated with the negati ve (positive) SST anomaly in the east ern (western) equatorial region de veloping during boreal summer/autumn seas ons. In 2006, the moderate strength IOD started on A ugust and the anomalous zonal SST gradient con tinued until D ecember. Japan Age ncy for Marine-Earth Science and Technology (JAMSTEC) has been deploying TRITON buoys and ADCP moorings in the eastern equatorial Indian Ocean since November 2000. In addition, an intensive observation, named as Mirai Indian Ocean cruise fo r the Study o f the MJO-convection Onse t (MI SMO), including an array of m-TRITONs an d ADCPs, was conducted during October/November 2006. In the present work, a set of atmospheric and oceanic data from these observations are used to document the evolution of the 2006 IOD. The TRITON buoy at 90E, 1 .5S captured t he first appear ance of the ne gative temperature anomaly at thermocline depth in May 2006. The initiation of the subsurface anomaly, associated with easterly wind anomalies and eastward propagating negative sea surface he ight anomalies on the equator, was about three month earlier than the onset of the dip ole patte rn of SST anomaly in August 2006. The negative anomaly at t he thermocline depth tak es its peak in November-December 2006, with significant intraseasonal signals superimposed. The subsurface negat ive temperature anomaly and southeasterly wind anomalies off the Sumatra coast are also ob served, suggesting t hat a local Ekman upwelling dynamics is one of the imp ortant process es in the eastern pole of the IOD. Further analyses also suggest that zonal wind anomalies in the central equa torial Indian Ocean affect the ea stern subsurface temperature anomaly via e astward propaga ting equato rial upwelling Kelvin waves. The ocean current data also show unusually co nditions in the central to eastern Indian Ocean at the peak phase o f the IOD; there appeared westward surface current confin ed in the shallow s urface mixed layer and strong eastward subsurface flow below the thermocline. The implications of these observational results for the evolution of the 2006 IOD are discussed.

Keywords: mismo, indian ocean dipole, mooring observation

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MS010 **Oral Presentation** **5334**

Convectively Coupled Kelvin Waves in a Simplified Moist General Circulation Model

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We present results concerning the determination of the speed and structure of equatorial Kelvin waves in an idealized moist general circulation model. The model consists of the primitive equations on the sphere, azonally symmetric aquaplanet lower boundary, and various idealized physical parameterizations including gray radiative transfer and a simplified Betts-Miller convection scheme. This simple model framework allows us to study the dependence of Kelvin waves on properties of the convection scheme in a clean manner. A control simulation with the model produces convectively coupled Kelvin waves which are remarkably persistent and dominate the variability within the tropics. These waves propagate with an equivalent depth of approximately 40 m, but have more of a first-baroclinic mode structure than observations. By varying a convection scheme parameter that increases the fraction of large scale versus convective precipitation, we show that the waves increase in strength, propagate more slowly, and move to larger scales. However, when mostly large scale precipitation occurs, the Kelvin wave disappears, and the tropics are dominated by tropical storm-like variability. We relate the decrease in speed to the gross moist stability of the atmosphere, which is reduced with increased large scale precipitation. We additionally present comparisons with full general circulation model simulations, which indicate that similar behavior is present in comprehensive GCM's as well.

Keywords: moisture, tropical, variability

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

MS010 **Oral Presentation** **5335**

Equatorial waves including the Madden-Julian oscillation in TRMM and GPCP rainfall data

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Hye-Yeong Chun

A set of global, daily rainfall products has been investigated in terms of their representation of the equatorial waves. These are the latest Tropical Rainfall Measuring Mission (TRMM) rainfall data retrieved from TRMM satellite only and the Global Precipitation Climatology Project (GPCP) data, which blend satellite data and rain gauge measurements. 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.Computation of continuous statistics shows that both data sets have similar statistical features including mean and regional variations, but they are different in amplitude and at smaller geographical scales. Regionally, average bias is large along the Intertropical convergence zone (ITCZ) regions with intense rainfall bands, whereas both data sets have consistent variations over the subtropics. 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 primary identification of equatorial waves is made by analyzing space-time cross-sections. Although the individual organization and intensity of the convective anomalies in the TRMM and GPCP data sets are highly variable in time and space, the overall features of the wave activity are very coherent. There are climatologically, stationary precipitation maxima over Africa, and the Maritime Continent in the western Pacific. A distinct eastward-propagating feature is most pronounced over the Indian and western Pacific Ocean between 60 and 150E. To separate wave signals from the noisy backgrounds, the classical approach of computing the Hayashi spectra and Wheeler and Kiladiss method are used. Comparisons between two methods are useful to verify the reliability of each method and to reinforce the results from this study. Kelvin, Madden-Julian Oscillation (MJO), and equatorial Rossby waves are found as significant traveling waves in both data sets, but there exists some differences in representing intensity of these waves. Most of the discrepancies between data sets occur in the equatorial Rossby waves and MJO. Cross spectra are also obtained between the GPCP and TRMM data to investigate coherent wave variations within these data sets. In addition, the effect of changing the operating altitude of the TRMM satellite (August, 2001) was investigated by comparison the results from early 4-yr TRMM data with those from late 4-yr data on the spectral domain. Although there exist some differences between data sets, especially rainy regions around the equator, the similarity on the large-scale features between the TRMM and GPCP gives confidence on these data sets and it shows they are good for studying the convectively coupled equatorial waves.

Keywords: mjo, trmm, gpcp

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MS010 **Oral Presentation** **5336**

Interactive relationships among synoptic-scale disturbances, MJO, and large-scale SST variations over the equatorial tropics

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Previous studies have shown that dominant modes of convectively-coupled synoptic-scale disturbances (SSDs) over the equatorial oceans are largely controlled by seasonal, regional, and interannual variations of the sea surface temperature (SST) distributions. On the other hand, sea surface wind forcing is largely determined with the structure and intensity of atmospheric SSDs. In that sense, large-scale SST distributions and SSDs are interactively related over the equatorial oceans. Here, the Madden-Julian Oscillations also play an additional role by modifying the environmental flow patterns for SSDs. In this study, we utilize 25 years of NOAA OLR data and wind data, obtained from the ECMWF Reanalysis (ERA-40) and Japanese 25-year Reanalysis (JRA-25), which are verified with wind data obtained from QuikSCAT and TOGA TAO. We also utilize the intensive observation data obtained from the Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset (MISMO) experiment conducted by JAMSTEC, in order to specifically examine the characteristics of disturbances over theIndian Ocean. The purpose of this study is to analyze relationships among SSDs, MJO, and environmental conditions. One of the focuses here is placed upon the westerly wind bursts (WWBs), accompanying the intensification of SSDs. Frequency of WWBs over the western Pacific showed a significant positive correlation with Nino3.4 SST with a lead of 9 months, while a one-month-lead negative correlation is found for WWBs over theIndian Ocean. It is shown that over the western and central Pacific, a superposition of the westerly phase of MJO to pre-El Nino wind fields provides a favorable condition for an energy conversion from mean to the eddy kinetic energy over the equator, dominantly through the wave accumulation as well as through the shear conversion. Associated development of near-equatorial SSD with a convective enhancement results in a WWB generation. On the other hand, during unfavorable periods, an approach of the MJO westerly phase enhanced shear conversion to the east of the Philippines, which results in intensifying tropical depression (TD) type disturbances frequently observed in this region. Over the Indian Ocean, on the other hand, the effect of superposition of the environmental wind field and MJO westerly winds works in a relatively linear sense. WWBs frequently occur in May and in November, when equatorial strong westerly winds are observed, except for the El Nino years. The MISMO observation period from October to December, 2006 was under the condition of a moderate El Nino. A positive Indian Ocean Dipole was also observed from late October to early November. Utilizing long-term analysis data as well as MISMO data, we discuss the effects of environmental wind fields on SSDs over the Indian Ocean in comparison with those over thePacific Ocean.

Keywords: synoptic scale disturbances, mjo, mismo

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MS010 **Oral Presentation** **5337**

Subseasonal Rainfall Variability during Boreal Spring in the Tropical East Atlantic

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Evident subseasonal rainfall variability is seen in the tropical east Atlantic during boreal spring, corresponding to the first rainfall peak of West African monsoon. In this study, we make efforts to quantify this variability and associated spatial structures and coupled processes by means of various satellite measurements, including the daily rain rate from the TRMM multi-satellite precipitation analysis (TMPA), TRMM Microwave Imager (TMI) sea surface temperature (SST), columnar water vapor and cloud liquid water content, and the QuikSCAT oceanic winds. In addition to the synoptic-scale disturbances, two other modes, a quasi-two-weekly (QTW) and the 30-70-day oscillations appear in surface rainfall data. The QTW signals can also be seen in SST, water vapor, cloud liquid water content, and surface wind fields. However, the 30-70-day oscillation seems weak in SST and surface wind fields. The regional index for this mode during March-July is further defined by averaging filtered rainfall time series in a box in the tropical east Atlantic-West Africa (0-7N, 10W-5E). This index is generally similar to the first Principal Component (PC1) extracted from the EOF analysis of daily rainfall anomalies over a larger domain (10S-30N, 30W-30E). The correlation between this index and the global MJO index peaks (and is well above the confidence level), when the global MJO index leads by about 13 days. This tends to suggest this modes origin from the tropical Pacific. Spatial structure and temporal variations are further explored for these two modes.

Keywords: convection, precipitation, atlantic

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MS010 **Oral Presentation** **5338**

The importance of high-frequency SSTs to the intraseasonal variability of Indian monsoon rainfall

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While the In dian summer mo nsoon exhibits substa ntial interannua l variatio ns, its intraseaso nal variability is of greater magni tude and hence of critical importance for predictability. Thi s intraseasonal variability is co ncentrated in the 30--50 day band and comprises a northward- propagating oscil lation (NPISO) between active and break phas es of e nhanced and red uced precipitation over India , respectively. Recent published literature has emplo yed ge neral circulation models (GC Ms) to sugges t that the NPISO is an intrinsically atmospheric mode, but that atmosphere-ocean coupling is required to achieve realistic intensity an d propagation speed. Specifically, coupled GCMs (CGCMs) outperform atmosphere-only GCMs (AGCMs) due to the CGCMs ability to represent the near-qua drature phase relationship between sea-surface temperatures (SSTs) a nd atmo spheric deep co nvection. Without atmosphere-ocean feedbacks, AGCMs too q uickly initiate convection over warm S ST anomalies. T hese studies have f orced their AG CM simulations with SST s from either previous CGCM integrations or the NCEP (Reynolds) satellite SST pro duct, bo th o f which su bstantially und erestimate intraseaso nal S ST variability in the tropical Indian Ocean. We have forced the Hadley Centre Atmospheric Model (HadAM3) with a new, high-frequency, observed SST dataset from the UK Met Office that shows significantly more variability in the intraseasonal band than the existing NCEP dataset. Two thirty-member ensembles have been conducte d at 1 sp atial resolution: one forced by d aily SSTs a nd the other forced by monthly means. When these ensembl es are compar ed, the en semble with daily SSTs has signi ficantly greater intraseasonal variability in precipitation acros s the monsoon domain , particu larly in th e Bay of Ben gal. Active and bre ak events are easily identified in th e daily SST ensemble, while the ens emble forced by monthly mean SST shows no detectable intraseasonal events. The daily SST ensemble also shows more coherent northward propagation of intraseasonal events than the monthly SST ensem ble. These results indicate that high-frequency SST variability may play a role in forcing intraseasonal variability in monsoon precipitatio n. Daily coupling between the o cean and atmospher e is therefore critical f or the proper simulation of the Indian monsoon.

Keywords: intraseasonal oscillation, indian summer monsoon, atmosphere ocean feedback

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MS010 **Oral Presentation** **5339**

Scientific objectives and preliminary results of the Vasco-Cirene experiment

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Recent observations from Tr opical Rainfall Measuring Missions (TRMM) Microwave Imager (TMI) show SST variations of several degrees at intraseasonal time-scales. These perturbations are especially strong and repro ducible so uth o f th e equato r in the west ern Indian Ocean (5 5E-80E, Eq -15S) during bore al winter. Fo rced o r co upled Ocean mo dels repro duce pa rt of this variability. The amplit ude is however underestimated and the relative role of different physical processes (warm layer formation, Ekman pumping, sub-surface coolin g due to vertical mi xing, s urface fluxes) in these intraseasonal SST perturbations still has to be e stablished.The VASCO-CIRENE field experiment was designe d to measure the impact of the differen t ph ysical processes listed above on SST pertu rbations from diu rnal (warm layer) to intraseasonal time-s cales. This exp eriment aims t o better explai n (i) the mech anisms of the intraseasonal v ariability of th e SST an d (ii) the f eedback of these SST variations on th e atmosphere. During CIRENE (January and February 200 7), physic al oceanography, ai r-sea fluxes and atmospheric measurements were collecte d at a fixed point (8 S-67.5E) and complemented with floats deployed nearby. These measurement s were combined with the Lagrangian balloon measurements of VASCO (Aeroclippers a nd pressurized balloons launched from the Mah Island). Preliminary results from the VASCO and CIRENE measurements will be presented.

Keywords: air sea interaction, field experiment

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

MS010 **Oral Presentation** **5340**

Organization of Mesoscale Convection within Equatorial Waves

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It is well-known that convective disturbances in the tropics occur over a very broad spectrum of scales, ranging from individual cells to planetary scale features such as the Madden-Julian Oscillation (MJO). It is also observed that the larger scale features are composed of smaller scale equatorial waves, so that for example the "envelope" of the MJO is often comprised of Kelvin, westward-inertio gravity, and mixed Rossby gravity waves, and these in turn are comprised of a broad spectrum of mesoscale features not necessarily organized into " waves". This suggests a dominance of both upscale and downscale interactions in the organization of tropical convection. It seems evident that the MJO modulates the occurrence of smaller scale, higher frequency disturbances, but the mechanisms responsible for this modulation are not yet fully understood. While processes such as upscale convective momentum transport have been reasonably well elucidated, the importance of other aspects of the upscale interaction provided by the higher frequency are not obvious, such as those due to heterogeneous fields of diabatic heating on the large scale. Since two different MJOs that behave in similar ways can be composed of an entirely different suite of equatorial waves and mesoscale features, evidently the upscale interactions can be enabled by a wide variety of disturbances. Understanding the precise role of these scale interactions appears to be a crucial step towards the improved simulation of equatorial disturbances in models.A potential aid to the understanding of scale interactions is the fact that there is a certain degree of "scale invariance" in observed gross features of the dynamical structures of organized tropical convection, from the mesoscale on up to the planetary scale structure of the MJO. Convectively coupled disturbances universally exhibit strong vertical tilts in their wind, temperature, moisture, vertical velocity and diabatic heating fields. In general these disturbances display a warm lower troposphere ahead of the wave, with cooling behind, and a warm mid-troposphere within the convective region. Low level moisture and thus CAPE and moist static energy is high ahead of the waves, and drying occurs first at low levels while it is still moist aloft behind the wave. Low level diabatic heating precedes deep convective heating, followed by a signal of upper tropospheric heating over cooling. These dynamical signals are consistent with the observation that the waves show a progression from a dominance of shallow to deep convection, and then stratiform precipitation, regardless of scale or propagation direction. It is a remarkable fact that the temporal and spatial evolution of mesoscale convective complexes, which can be traced back to microphysical arguments, also exists at a certain level on the scale of the MJO. These observations have implications for the simulation of convectively coupled waves. Some General Circulation Models appear to have peaks in their rainfall spectra corresponding to the observed spectra of tropical cloudiness. However, all of the waves identified in models thus far have corresponding equivalent depths that are universally too deep and therefore phase speeds that are too fast. These waves all scale to around the same equivalent depth, a fact which perhaps provides clues to the deficiencies of physical parameterizations involved. Simple modeling and cloud resolving studies are beginning to provide some realistic results, and will no doubt provide useful testbeds for the development of improved parameterizations in next generation GCMs.

Keywords: convection, waves

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

MS010 **Oral Presentation** **5341**

Analysis of convectively coupled Kelvin waves in 15 WCRP CMIP3 models

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Output from 15 global coupled models is analyzed for the existence and structure of convectively coupled Kelvin waves. Waves are isolated using a wavenumber-frequency spectral filtering technique, and composite structures are calculated via linear regression. The resulting 3-dimensional dynamical and thermodynamical wave structures are then compared to observations of convectively coupled Kelvin waves based on satellite and radiosonde data for the 1979-2006 period. Model data are obtained from the World Climate Research Programs (WCRP) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset. Specifically, data from the Climate of the 20th Century Experiment are utilized in this study. Preliminary results suggest that model Kelvin waves typically propagate faster than observed waves. Waves in several models contain fairly realistic horizontal and vertical structures.

Keywords: wave, equatorial, kelvin

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

MS010 **Oral Presentation** **5342**

The Air-Sea Interface during CIRENE: a study of the marine boundary layer during the MJO

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During January and February 2007, the second component of a joint campaign to observe variability associated with MJO was conducted in the western equatorial Indian Ocean. The CIRENE campaign conducted intensive observations at a single point within the area of active convection. Onset, actively convective, and break periods were observed at this point by upper ocean and boundary layer measurements. The variations in the skin temperature, upper ocean temperature, as well as air temperature and relative humidity profiles in the lower boundary layer present a detailed time series of both the diurnal temperature variability and the storage and dissipation of heat over the onset and break periods. As convection begins, the atmosphere is quickly de-coupled from the surface, sometimes with temperature differences as great as 3C. Even light winds measured some distance from the convective centers begin to erode the stratification in the upper-most oceanic layers, eventually "re-setting" the heat balance in the area. This presentation covers initial results from the campaign which will be described in relation to the eastern Indian Ocean data from MISMO and coincident satellite data in another presentation.

Keywords: sst, air sea interaction, mjo

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

MS010 **Oral Presentation** **5343**

Intraseasonal oceanic atlantic Kelvin waves and the atmospheric connection

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Tropical Atlantic intraseasonal variability is inve stigated in the framewor k of the ocea nic waves and based on sate llite measurements and a n OGCM simu lation. The equat orial Kelvin wave propagate s eastward along the equator, reaching the African coast where the wa ve splits and t ravels polewar d trapped along the coast. The Kelvin wave extends as far as 12 degree latitude where it finds the oceanic fronts of the Mauritanian and Benguela upwelling regions, beyond these points wind effects become the SSH predominant factor. At the Guinea Dome and 4S there are sources of Rossby wave that propagate westward as far as the American coast. We have found a mechanism that suggests the ekman pumping ITCZ shift-induced anomalies over the western Atlantic are responsible for a large scale SSH anomalies, which can trigger the equatorial Kelvin waves.

Keywords: tropical atlantic, oceanic waves

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MS010 **Oral Presentation** **5344**

About the MJO, tropical cyclones, the Indian ocean dipole and more: first results from the Cirene cruise.

Dr. Jerome Vialard
LOCEAN IRD

Jean-Philippe Duvel

January and February 2007 were quite unusual in the Indian Ocean. There was a stronger than usual heat content south of the equator in the western Indian ocean due to the 2006 Indian Ocean dipole. The 2006-2007 cyclone season is not finished yet but there have already been 8 tropical cyclones and 3 tropical depressions during October-February 2007. The Cirene cruise allowed collecting oceanic, atmospheric and air-sea fluxes observations during this unusual period. The Cirene cruise was synchronised with the Vasco field experiment. Its main objective was to observe in situ the oceanic evolution during the strong sea surface temperature events associated with convective intraseasonal anomalies during boreal winter between 5S and 10 S in the central Indian Ocean. The Cirene cruise involved collaborations with PMEL (ATLAS and ADCP mooring), WHOI (surface drifters), RSMAS (surface and boundary layer observations) and ODU (ASIP, Air-sea interaction profiler). The Cirene cruise had 2 legs, both starting and returning to Seychelles (8th to 29th, January and 1st to 20th of February). Continuous measurements were collected during the whole cruise (air-sea fluxes, atmospheric boundary layer temperature and humidity, surface temperature and salinity and currents in the upper 200m). Twelve Argo profilers with a specific high temporal resolution sampling strategy were deployed along 67E. An ATLAS mooring with heavy instrumentation and an ADCP mooring were deployed at 67E, 8S for the duration of the cruise and a lighter ATLAS mooring was redeployed at the end of the cruise. Three drifters with high vertical resolution temperature measurements within the mixed layer were also deployed. Finally, the Surot RV made two 12 days long stations during which high resolution data of the upper ocean (CTD casts to 500m or deeper every 20 to 45 minutes) were collected, including some biogeochemical measurements (fluorescence, chlorophyll content, nutrients). The ASIP autonomous profiler was deployed, giving a high resolution sampling of the near surface ocean. Four radiosondes per day were deployed to sample the atmospheric structure evolution. During this talk, preliminary results from the Cirene cruise will be discussed. All the oceanic data show a thermocline much deeper than usual associated with the Indian Ocean dipole (IOD) from October-November 2006. Significant currents at about 30 cm/s down to 600 to 800m were observed and might be the result of the basin scale re-adjustment associated to the IOD. There was no active convection at 67 E during most of the cruise, except at the end of the first leg, associated with Cyclone Dora. A ~ 1C cooling in seven days was observed associated with the strong wind and increased nebulosity during this period and its mechanisms will be discussed. Observations of the diurnal cycle of the upper ocean will also be presented. Finally, the potential impact of the deep thermocline on the cyclone development and response to the convection intraseasonal variability will be discussed.

Keywords: air sea interaction, oceanographic cruise, indian ocean dipole

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

MS010 **Oral Presentation** **5345**

Large vertically propagating Kelvin waves and tropical tropopause variability

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The relationship between local convection, vertically propagating Kelvin waves, and tropical tropopause height variability is examined. This study utilizes both numerical simulations of a global primitive equation model and global observational data sets. Regression analysis with the data shows that convection over the western tropical Pacific is followed by a warming in the upper troposphere (UT) and a cooling in lower stratosphere (LS) over most longitudes, which results in a lifting of the tropical tropopause. The model results reveal that these UT/LS temperature anomalies are closely associated with a vertically propagating Kelvin waves, indicating that these Kelvin waves drive tropical tropopause undulations at intraseasonal time scales. The model simulations further show that regardless of the longitudinal position of the imposed heating, the UT/LS Kelvin wave reaches its maximum amplitude over the western Pacific. This result, together with an analysis based on wave action conservation, is used to contend that the Kelvin wave amplification over the western Pacific should be attributed to the zonal variation of background zonal wind field, rather than to the proximity of the heating. The wave action conservation law is also used to offer an explanation as to why the vertically propagating Kelvin waves play the central role in driving tropical tropopause height undulations. The zonal and vertical modulation of the Kelvin waves by the background flow may help explain the origin of the very cold air over the western tropical Pacific which is known to cause freeze-drying of tropospheric air en route to the stratosphere.

Keywords: kelvin, tropopause, waves

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

MS010 **Oral Presentation** **5346**

Oceanic warm-layers and their link with tropical intraseasonal variability

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The air-sea interaction appears as a potentially important process for the triggering and the evolution of intraseasonal variability (ISV) in the tropics. A warm mixed layer may indeed act to maintain the convective instability through sensible and latent heat release in the atmospheric boundary layer. In this context, the depth of the mixed layer is a basic property that determines the reactivity of the surface temperature and the amount of energy available for the atmosphere. Theoretical studies showed that the ISV amplitude tends to maximize for an optimal mixed layer depth of 20-30 meters. In addition to this basic process, the SST may also be strongly modulated at the diurnal time scale because of the absorption of solar radiation by the upper ocean levels under light surface wind conditions. These diurnal warm-layers may form during the convectively suppressed phase of an intraseasonal event and increase even the diurnal average surface temperature. This is because the nighttimes SST is close to the mixed layer temperature while the noon SST can be increased by up to 5K. This higher SST will modify the air-sea exchanges and the boundary layer instability. These warm-layers disappear as soon as the wind increases in association with a large- scale convective perturbation. Warm-layers organised at large-scale thus increase the amplitude of the intraseasonal SST modulation and may even trigger ISV events. To address the role of warm-layers in ISV, a daily dataset of SST diurnal amplitude in the tropics is produced using COARE 3 Fairall algorithm forced by ERA-40 reanalysis. The results are validated using the global SVP drifter dataset and empiric relations from earlier studies. An important result is that warm layers tend to develop in region where the ISV is strong, confirming their potential role in the ISV amplitude. For moderate to strong warm layers (diurnal amplitude > 1K), the horizontal extension is between 1000 and 4000 km during periods of several days in agreement with the typical size of ISV perturbations. These results finally validate the use of the COARE 3 algorithm forced with surface fluxes at a horizontal scale typical of atmospheric general circulation model. In addition, this method gives an estimate of the warm layer depth and temperature at each physical time scale, making it usable as a parameterization. The implementation of this warm layer parameterization in the LMD GCM is further tested and its impact on the representation of the ISV in the model will be presented.

Keywords: air sea interaction, intraseasonal variability

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

MS010 **Oral Presentation** **5347**

Inertia-gravity waves and stratified turbulence in the upper ocean during Cirne experiment

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Vertical profiles and mooring measurements of temperature, conductivity and currents collected during the Cirne experiment were analyzed with a focus on supra-inertial frequencies. These measurements gave evidence of significant energy radiation from the base of the mixed layer into the stratified ocean as well as strong internal tides. The variability of these waves will be investigated as a function of the atmospheric forcing and upper ocean stratification. The question of the transition from waves to turbulence will then be addressed using high frequency mooring measurements that resolve about two decades in the supra-buoyant frequency range. Direct estimates of turbulent mixing will thus obtained and we hope to develop a fine-scale parameterization from these results.

Keywords: inertiagravitywaves, stratifiedturbulence, parameterization

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

MS010 **Oral Presentation** **5348**

Diurnal Variations in Convective Features and their Role in Atmospheric Moistening during the MISMO

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Diurnal cycle of cumulus convection over the tropical oceans is commonly observed in a variety of data by raingauges, radars, and satellite images. Considerable number of studies were performed and showed that they had maximums both in predawn time and in the afternoon depend on the convective activities of the environment. However, the selection of the maximum time, and the mechanism how the maximum convective activities occur are still under controversial. On the other hand, diurnal variation of cumulus convections plays important roles in modulating environmental atmosphere through radiative and thermodynamic processes. It is also suggested that diurnal variation of convective activity assists preconditioning for the Madden Julian Oscillation (MJO) active phase. The Institute of Observational Research for Global Change (IORGC) conducted an intensive observation experiment, Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset (MISMO), in October and November 2006. In this experiment, high temporal resolution data of cumulus convection were obtained by a radar, radiosonde, and other surface meteorological instruments in two observation sites, R/V Mirai (0, 80 E) and Gan Island in the Republic of Maldives (0.7 S, 73 E). In the later half of the observation period, a MJO passed over the observation sites. Preconditioning was seen in Maldives site before the MJO passing. The radar data in the Maldives site show that diurnal cycles in small sized convective features are significant in the preconditioning period, and diurnal cycles in organized convective features are clear in the active phase of MJO. The observation data suggests that the diurnal variation of small sized convections plays a role in assisting moistening the atmosphere in preconditioning time.

Keywords: mismo, diurnal cycle, cumulus convection

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

MS010 **Oral Presentation** **5349**

Overview of the HARIMAU2006 intensive observation for diurnal to intraseasonal convective variability study over Sumatera Island, Indonesia

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Diurnal cycle of convective activity and its relation to the intraseasonal variation (ISV) over Sumatera Island, Indonesian maritime continent, have been studied since 2000 using TRMM and other satellites, GPS water vapor monitoring, intensive rawinsonde soundings, surface observations, and model simulations (e.g., Wu et al. 2003, Sasaki et al. 2004, Mori et al. 2004, Sakurai et al. 2005, and Shibagaki et al. 2006). In particular, diurnal rainfall peak migrations observed by TRMM PR (Mori et al. 2004) showed a unique feature that a rainfall peak travels eastward (westward) into inland (offshore) region during the daytime (nighttime) from the southwestern coastline of Sumatera Island.Although the sounding data suggested the migrations has specific relation to local circulations, its mechanism has not been shown yet. Shibagaki et al. (2006) found multi-scale convective interactions over western Sumatera using a x-band weather radar, which interactions drive a rainfall peak migration eastward (into inland region) during the daytime. Sakurai et al. (2005) pointed out that the westward (into offshore region) cloud cluster migration are commonly seen though the year, where as those moving eastward occur only in the rainy season. In order to investigate physical multiple mechanisms of diurnal migrating convective systems over western Sumatera, we installed two x-band Doppler radars (XDRs) at the southwestern coastline of Sumatera Island in 2006 as a part of radar-profiler network over Indonesia deployed by the Hydrometeorological ARray for ISVMonsoon Auto-monitoring (HARIMAU) project under the Japan Earth Observation System [EOS] Promotion Plan (JEPP). Although an original objective of HARIMAU/JEPP network is to monitor the hydrological and energy cycles of atmospheric circulation over the maritime continent, we can utilize it for studies on diurnal to intraseasonal variations. We set an intensive observation period (HARIMAU2006) from October 26 to November 27 in 2006. The dual Doppler radar observation captured three dimensional wind and reflectivity structures over the coastline to offshore region continuously, and the wind profiler monitors wind variations beneath the convections. Intensive soundings of 3-6 hours intervals at a coastal meteorological station over Sumatera Island provided fine atmospheric variations which showed well defined diurnal cycles. A network of automatic weather stations with high- sensitive barometer covered the coastal region to monitor local rainfalls, cold surges, and gravity waves. Furthermore, we collaborated with R/V Mirai Indian Ocean cruise for the Study of the MJO-convection Onset (MISMO) which consisted of Doppler radars observations and intensive rawinsonde soundings for the same period over the central Indian Ocean (EQ, 80E) and Maldives (EQ, 73E) as well as those at Sumatera/Indonesia (EQ, 100E) of our study. Although eastward moving active cloud clusters were observed over the Indian Ocean during the period, most clusters were weaken before they reached Sumatera Island. Some active clusters passed over our sites in the beginning and the end of period. Characteristics of diurnal variations were quite different between ISV active and inactive phases, e.g., rainfall amount, echo areas, echo top height, and convective fractions. We also captured several line-shaped storm systems accompanied with strong gust winds near the coastline. Several wooden fishermans houses were broken down by the gust wind on November 19. Furthermore, the radar data was opened for public through the internet not only for research work but also for airline safety, hydroelectric power, agriculture, and other water resource managements. Visit the JEPP-XDR website http://203.88.86.149/mia_xdr/index.html for further information.

Keywords: harimau, mismo, mjo

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MS010 **Oral Presentation** **5350**

Ocean-atmosphere daily coupling estimated from atmospheric radio soundings, surface flux and ocean measurements during the CIRENE campaign

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The western/central part of the Indian Ocean is well recognized as a key region for the genesis/excitation of intraseasonal events in the Tropics such as fluctuations in the Madden-Julian Oscillation (MJO) frequency band. However the physical mechanisms at work in this area, in particular the coupling between the ocean and the atmosphere, are still unclear and remain to be better described. Combining very precise and intensive ocean measurements to surface fluxes estimates and frequent radio-soundings of the atmosphere, the CIRENE oceanographic cruise was an opportunity to precisely investigate the local air-sea interactions associated with large- scale and persistent ocean/atmosphere patterns that were excited during the campaign. Attention is focused here to the observed variability of the vertical atmospheric structures given by radio-soundings during the campaign. More than 50 profiles over a 10 day period or so are analyzed. Preliminary results show three distinct periods. The first one is marked by the impact of Hurricane Dora's tail generating northerly low level winds, drier conditions in both the atmospheric boundary layer and mid-atmosphere leading to a clear inhibition of the convection. While Dora's influence vanished, humidity increased in both lower level and upper level atmosphere. At low elevation, this humidification is related to slackened surface winds and a strong diurnal cycle of Sea surface Temperature and surface fluxes. At high elevation, advection of upper tropospheric wet air masses from the eastern Indian Ocean basin seems to dominate. Convection is still inhibited though due to the simultaneous presence of dry mid-atmospheric layer precluding the full development of convective towers. Cumulus Congestus are progressively replaced by cumulonimbus and moderate showers in the third period of the cruise when the mid-atmosphere dry air progressively dissipates in relation with clear humidity intrusions coming from the South-west over the entire column. The SST diurnal cycle appears to be very week during the latter period which coincides to a very early stage of the MJO-type burst which follows the campaign. This sequence of events will be described in relation with large scale atmospheric dynamics estimated from satellite data and reanalysis/analysis products. A more detailed part will be focused to the diurnal cycle of both the ocean and the atmosphere based on continuous flux and SST/SSS measurements and radio sounding intensive launchs every 3 hours during two days.

Keywords: cirene, ocean atmosphere, coupling

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

MS010 **Oral Presentation** **5351**

On the mechanism of eastward propagation of MJO and super cloud clusters in the Equatorial Region: NICAM analysis and model study

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Madden Julian Oscillation (M JO) and super cloud clusters (SCCs) are in traseasonal variability over the equatorial region and have characteristic features of eastward propagation with the period of 30 -60 days. NICAM (Nonhydrostatic Icosahedral Atmospheric Model) well simulated the eastward propagation of large-scale cloud systems in the aquapla net experiment. In this study, first, using the equatio n of potential temp erature obtained by the NICAM results, diabatic heating and advecti on terms are compared in the active convective regions. It is shown that the diabatic heating term is greater in some heights (roughly 4 7 km) than the advectio n term. This indicates that the atmo spheric instability works in the eastwa rd propagating convective systems. Next, a simple model, in which the moisture is excluded and the diabatic heating term is a n ordinary or positive-only wave-CISK type, is proposed to investigate the eastward propagating featu res in th e large-scale cloud system. Equatorial beta plane and large horizontal diffusion is considered. The vertical profile of diabatic heating obtained by NICAM is used as that of wave-CISK. By using the simple model, the eastward propagating mode is preferentially simulated, although its propa gation speed is faster than that obtained by th e NICAM. This mode has a similar structure to Gill (1980). The selective propagation mode is explained as the combination effect of both amplifying convective modes and damping propagating modes.

Keywords: dynamics of convectively, coupled equatorial waves, madden julian oscillation

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MS010 **Oral Presentation** **5352**

First analysis of the surface energy budget during VASCO-CIRENE

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Previous studies suggest that surface fluxes are one of the main contributors to the SST variations caused by intraseasonal perturbations of the convection in boreal winter, between 5S and 10S in the central Indian Ocean. One of the main objectives of the VASCO-Cirene field experiment is to understand the processes of this variability, and surface flux measurements have thus been identified as a key information. A dedicated instrumented mast was thus installed close to the Surot RV bow during the Cirene cruise. Both classical meteorological sensors (anemometers, temperature, humidity and pressure sensors), and turbulence sensors (a sonic anemometer and a refractometer, coupled with a motion package), as described in Delahaye et al (2001) and Weill et al (2003) were used to estimate the momentum flux, sensible and latent heat fluxes. Downwelling radiation (short and long wave) were measured directly by sensors at the top of the mast. Meteorological sensors, part of the VASCO aero-clipper systems, also provide regional information on the air-sea fluxes around the ship. We will first validate bulk flux estimates from the ship and the aero-clippers. Among the difficulties, the air flow distortion on the ship, which may strongly bias the fluxes when the wind is low (one third of the cruise duration), has to be corrected for, accounting for the wind azimuth with respect to the ship bow. We will then estimate turbulent fluxes using inertial dissipation and eddy correlation methods. Bulk formulae can then be evaluated, taking into account the diurnal cycle (skin / bulk surface temperature difference) and stability conditions. This allows an accurate estimate the net heat budget. During Cirene, the solar heat flux and latent heat flux variability were the main contributors to net heat flux changes. The observations suggest that the phasing between the wind perturbation and convective perturbation is important, as previously suggested by (Duvel and Vialard, 2006). One must indeed have both strong winds (and evaporation) and clouds to make the net heat flux negative (ocean losing heat to the atmosphere).

Keywords: vasco cirene, intraseasonal perturbations, downwelling radiation

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MS010 **Poster presentation** **5353**

Tropics-extratropics relationship: the role of tropical convection in the cold air outbreaks into subtropical South America

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Tercio Ambrizzi

This work indicates how anomalous convection observed in the western Pacific and South Indian Ocean can play a n important role in generating ex tratropical wave patterns which favor the d evelopment of extreme cold events over the southeast of South America (SSA). Numerical simulations using a primitive equation model were carried out and their results were compared with observational data an alysis. From the composite analysis it is noticed the presence of an anomalous heating source in the region of the tropical Pacific Ocean to the northeast of Aust ralia during austra l winters co incident with the maximum occurrence of Gen eralized Frosts (GF) over SSA. This forcing ca n trigger Rossby waves that propagate towards the South American con tinent favo ring the occurrence of these events. Numerical experiments indicate that the extension of the anticyclonic region and the cold air advection over SSA generated when the heat forcing is placed o ver the western Pacific Ocea n are similar to that observe d during GF winters. However , the amplitude s seem to be insufficient to generate the mass field and motion anomalies observed in the composites of GF win ters. When another heat source is placed over the western South Indian Ocean, the expected wave pattern observed during these events is achieved. The results in dicate the existence of a d ouble train of Rossby wave s which propagate along th e subtropical and polar jets, re spectively, whose phases coincide just before they reach South America. This pattern generates a strong polar air advection over the southern cone of the c ontinent with the subsequent de crease in surf ace temperature over la rge areas that cre ate generalize d frosts in the region. This mechanism suggests that tropical and ex tratropical wave interactio n over the South Pacific is important t o generate the appropriate atmospheri c dynamical environment for the o ccurrence of G F in the southern and southeastern regions of South America.

Keywords: tropical convection, wave propagation patterns, frost

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MS010 **Poster presentation** **5354**

A comparison of tropical climate in the CAM and the Super-Paramertized CAM

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Dr David Randall

This study compares data from a pair of model runs, each five years long and using AMIP-style forcing, of the Community Atmospheric Model (CAM) and the same model with an embedded CRM used instead of the traditio nal cloud-scale para meterizations. While the traditio nal C AM data shows little to n o evidence of a 30-60 day oscillation in the tr opics, the Super-Paramerterized CAM exhib its an extremely vigorous signal. Various prop erties and processes within th e two models are compared in an effort to determine which may encourage or suppress the wave.

Keywords: mjo, super parameterized, cam

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MS010 **Poster presentation** **5355**

Characteristics of the MJO in a CSU Multi-scale Modeling Framework simulation

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A new kind of global climate model (GCM), the Multi-scale Modeling Framework (MMF), has recently emerged. MMF-GCM replaces conventional cloud parameterizations with a small-domain cloud-resolving model (CRM; often called in this context a "super-parameterization") embedded into each GCM grid column to explicitly represent clouds and their effects. Recently, the Colorado State University MMF was used to conduct a 19-year AMIP-style simulation using observed monthly mean SSTs and sea ice extent as the lower boundary condition. Results from an investigation of the vertical-temporal structures of MJO-like convective disturbances for this AMIP-style simulation will be presented. These results will be compared to MJO composite structures observed in a previous study based on TRMM and ECMWF 40-year reanalysis data. Additionally, analysis of drying associated with the transition from the convective to suppressed phase of the MJO during the recent Tropical Warm Pool International Cloud Experiment (TWP-ICE) will be shown.

Keywords: mjo, mmf, twp ice

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

MS010 **Poster presentation** **5356**

Hot Event And Diurnal SST Variation In The Equatorial Indo-Pacific Warm Pool

Mrs. Huiling Qin
IAMAS MS010 IAMAS

Hiroshi Kawamura, Yoshimi Kawai, Kentaro Ando

Using advance satellite-derived SST, solar radiation and wind-speed products, we investigate hot events (HEs) associated with very high SST of around 30C. Amplitude of the SST diurnal variation (DSST) is obtained by an empirical formula with the DSSR and the wind speed. The HE is defined as a connected region with SST > the time-dependent SST threshold of about 30C having a minimum areal size greater than 3106 km2 and lasting for a period longer than 10 days. Thirty-one hot events were detected from 1993 to 2003 in and around the equatorial Indo-Pacific warm pool. The HE precursor is increase of an area with SST > the time-dependent SST threshold, and the HE starts when the areal size exceeds the areal threshold. It keeps the very high SST for a while, and then its SST decreases with decrease of the HE area toward its ending phase. The HE area and the high DSST area correspond with each other on time scales of daily and the whole one event period. In the HE period, a clear-sky and low-wind condition becomes the reason of large DSST appearance. Through statistics of the detected 31 HEs, it is indicated that the mean HE period, the mean areal size, and the means of the regional HE-areal averaged SST are 24.2 days, 1.57-107 km2 and 0.25 above the time-dependent SST threshold, respectively. The HE area shifts with season though they stay within/around the SST contour of 28C in the Indo-Pacific oceans. The in situ SST behaviors in HEs have been investigated using drifting buoy and TRITON buoy observations. The large DSST have been shown by the in situ SST. The satellite SST variation reflects skin SST variations which make satellite SST larger/smaller than in situ SST when SST increases/decrease. Using one-dimensional ocean boundary layer model, the mixed layer development during one HE can be well reproduced. It is evident that large solar radiation and low wind speed result in the input of large heat energy into the ocean surface layer of a few meters, and cause large the daily SST variation and the HEs.

Keywords: hot event, diurnal sst variation, ocean boundary layer model

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MS010 **Poster presentation** **5357**

Primary and successive events in the Madden-Julian Oscillation

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Conventional analyses of the Madden--Julian Oscillation (MJO) tend toproduce a re peating cycle of MJO events, such that any particular feature can not be una mbiguously attributed to the curr ent, previous or following event. Here, we take adva ntage of the spor adic nature of the MJO and classify each observed Madden--Julian (MJ) event as either primary, with no imm ediately preceding MJ event, or successive, which does immediately follow a preceding event. Abo ut 40% of MJ events are primary event s. Precursor feat ures o f the primary eve nts c an be un ambiguously attributed to that event. Suppresse d convective anomalies are obs erved to grow and decay in situ over the Indian Ocean, several days prior to the start of a primary MJ event there. An associated mid-tropospheric temperature anomaly then acts to destabilise t he atmosphere, leading to th e genera tion of the active MJ event. Henc e, primary MJ events appear to be thermodynamically triggered by a previous dry period. Other theor ies of the MJO predict that bo undary layer co nvergence and humidity, free tro pospheric humidity, pro pagation o f dynamical stru ctures right a round the eq uator, sea sur face temperat ures, and lateral forcing b y extratropical tr ansients may all be imp ortant in tri ggering an MJ event. Howe ver, although precursor signals from al l of these mec hanisms are di agnosed from reanalysis and satellite observational data in the successive MJ events, they are all abse nt in th e prim ary MJ eve nts. Hence, it appears that thes e precursor signals are actually part of the previous MJO cycle, and do not play a role in the spontaneous generation of the MJO. Additionally , the usual assumption that the MJO starts over the Indian Ocean is tested using t he primary M J events, who se starting lo cation can be unam biguously determined . Although the most frequent starting locati on is th e Indian Ocean (40 % of ev ents), over half of the primary MJ events start elsewhere, from the maritime continent through to the western Pacific.

Keywords: mjo, initiation

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MS010 **Poster presentation** **5358**

Study on Features of Individual Cloud Clusters within the Organized Convection Observed over the Indian Ocean During MISMO

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MISMO (Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset) observation took place inthe equatorial Indian Ocean (IO) from October to December 2006. MISMO consists of three observation sites in Maldives (Male, Gan, Kadhdhoo), buoy network set near 0N 80E, and R/V MIRAI. Using satellite, re-analysis, and MISMO observation data, we are analyzing convective activities over the IO. The purpose of this study is to clarify features of each cloud cluster within the organized convection which wasobserved during MISMO, and to describe the relationship between these features and large scale environmental conditions. We focus especially on vertical wind shear, which is an important factor that affects propagation properties of mesoscale systems (e.g. Miyakawa and Satomura, 2006). According to JCDAS (Japan Meteorological Agency Climate Data Assimilation System) re-analysis data, atmospheric circulation over the IO was at its transition period when the MISMO observation started. Indian summer (westerly) monsoon withdrew in early October, and the Somali (southerly) jet retreated around 15 October. From late October to early November, the IO was in a positive dipole state with high/low SST anomalies and active/suppressed convection in the western/eastern area. Under such condition, in late October, convective activities concentrated at a convergence zone of south-easterly wind at the south of BOB (80-90E), and at the eastern coast of India. In early November, western (60E) part of the IO became the center of convection and convergence. Meanwhile in the east, southwestward propagation of convective cloud clusters originating from diurnal cycles over the Sumatra Islands were frequently observed. The dipole weakened in the last half of November, and the center of the convective area shifted to 75E as the south-easterly and westerly wind blowing into the area intensified, resulting with stronger conversion and convection. In December, the south-easterly wind retreated to the southern hemisphere, and in turn, Asian winter (north-easterly) monsoon reached the south of BOB. They converged near 85E, which became the center of convective activities. The eastward shift of the convective area during late November to mid-December was diagnosed as MJO propagation by Wavenumber-frequency spectrum analysis of BMRC (Bureau of Meteorology Research Centre). The propagation was distinct until it reached the maritime continent (100E). Meanwhile in the lower troposphere, westerly wind was observed, though it is not clear if it corresponds to a westerly burst of MJO. Aware of the conditions described above, we are studying features of each cloud clusters by tracking and by analyzing Doppler radar data, and how environmental condition s affected the features (background conditions will be examined closely using radiosonde and QuickSCAT data). New results from the study will be reported in our presentation as well.

Keywords: mismo, mesoscale, cloud clusters

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MS010 **Poster presentation** **5359**

Lower atmosphere observations over the eastern Indian ocean with a ship-borne L-band lower troposphere radar during MISMO campaign

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LSEET Universite de Toulon et du Var IAMAS

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A wind profiler is one of the most powerful instruments to obtain continuous time series of atmospheric motions. A L-band(1357.5MHz) lower troposphere radar(LTR) has been developed to measure three-dimensional atmospheric turbulences in the lower troposphere by the Radio Science Center for space and atmosphere (RASC), Kyoto University. The LTR consists of 24 x 24 electromagnetic coupling coaxial dipole antenna in 4 m square, and steers beam directions with an active phased array system. We installed the LTR on the MIRAI, which is the oceanographic research vessel by the Japan Agency for Marine-Earth Science and Technology(JAMSTEC), and observed lower atmosphere on the equator of eastern Indian Ocean(0, 80E) from 28th October to 21st December 2006 during MISMO(Mirai Indian Ocean Cruise for the Study of the MJO-convection Onset) campaign. We obtained continuous data of zonal, meridional, and vertical winds with time and range resolutions of 64 s and 150 m up to about 3-5 km altitude. We also installed a three-dimensional angular sensor to detect specific fluctuations of a ship, such as pitch and roll every 0.4 s, and take them into account for off-line analyses. We found that vertical winds showed small variations within 0.3 m/s in a no-rain day, on the other hands, vertical winds kept large upward drafts up to about 1 km altitude before and after a deep convection system passed over MIRAI. A C-band doppler radar is also installed on the MIRAI, which enables us to classify rain clouds into two types, convective rain and stratiform rain. We compared each seven days including no-rain days, we found that vertical winds showed the largest variations in convective rain days, the smallest variations in the stratiform rain days. In the presentation, we will show these wind variations in the lower troposphere and compare with rain systems, horizontal wind and humidity variations obtained by radiosondes, and sea surface temperatures.

Keywords: wind profiler, mjo, mismo

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MS010 **Poster presentation** **5360**

The role of the deep chlorophyll maximum in mixed layer heat budget

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IAPSO

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The mixed layer heat b alance in the weste rn India n Ocean is examined using data c ollected during CIRENE campaign (january 2 007). CIRENE was made in an active convection region, d uring nearly 6 weeks with high resolution t ime sampling. The situation encountered was exception al, as we c ould observe an anomaly of about 4C in the thermocline region in comparison with climatological data, with a much deeper thermocline. This situation may be co rrelated with the Indian dipole variability. The biological heating term, corre sponding either to th e phyto plankton lo cal heating effect, by seawater absorption mo dulation (selfs hading), or t o en trainment resulting of this effect, has been taken in account in the heat budget formulation and is found to be non negligible. Importance of this bio logical term is linked with the presence of a relatively strong Deep Chlorophyll Maximum, developing at thermocline level, around 50m. This DCM has been observed during all the cruise, even after convection events, even if its shape was less sharp in this case due to vertical mixing.

Keywords: fluxes, dcm, indian

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MS011 **5361 - 5386**

Symposium
The Dynamics of Eastern Tropical Oceans and Subtropical Highs (ICDM)

Convener : Prof. Carlos Mechoso
Co-Convener : Prof. Richard Grotjahn

There is considerable current interest in the dynamics of the eastern tropical oceans, particularly with regard to the processes that maintain sea surface temperature, and with dynamics of the subtropical highs, which are often related. The topic is interpreted broadly, and studies that relate to marine stratocumulus clouds, aerosol-stratocumulus interactions, coastal upwelling and ocean eddies, systematic GCM errors in the region, and the interaction between the tropics and mid-latitude will be relevant to this symposium

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MS011 **Oral Presentation** **5361**

Low-Frequency Variability and Remote Forcing of Gap Winds in the Eastern Tropical Pacific Ocean

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Antonio J. Busalacchi, Raghu Murtugudde

The low-frequency variability of gap winds at the Isthmuses of Tehuantepec and Papagayo in the eastern tropical Pacific are investigated using a 17-year wind stress dataset merging the observations of SSM/I and QuickSCAT satellite sensors. A decadal signal is identified in the Tehuantepec gap winds, which is shown to be related to the Atlantic Tripole Pattern. Using linear regression and spectral analysis, it is demonstrated that the low-frequency variability of the Tehuantepec gap winds is remotely forced by the Atlantic basin, while the Papagayo gap winds are primarily governed by El Nino-Southern Oscillation (ENSO). The large-scale flow pattern associated with the positive phase of the Atlantic Tripole Pattern is favorable for steering midlatitude continental systems into the Gulf of Mexico, which prior research has shown to be the local driver of gap winds. The Tehuantepec (Papagayo) gap wind time series can only be reconstructed when the local cross-isthmus pressure difference, and large-scale climate information such as the Atlantic Tripole Pattern (ENSO) are included, suggesting that there is important information in the large-scale flow that is not transmitted directly through the background sea level pressure gradient. Finally, initial results from a tropical Pacific OGCM forced by the wind stress dataset portray a corresponding decadal signal in the Gulf of Tehuantepec, primarily through entrainment-mixing and latent heat flux.

Keywords: gap winds, interannual, decadal

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MS011 **Oral Presentation** **5362**

Dynamics and Seasonality of the Subtropical Anticyclones

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Takafumi Miyasaka

In the eastern portion of each of the five ocean basi ns over the globe, a subtropical high intensifies in summer, driving a cool ocean cu rrent off th e west coast of a continent to the east. The associated along-shore equatorward winds act to maintain cool SSTs underneath by enhancing surface evaporation and coastal upwelling, favoring the formation of marine stratus whose high albedo also a cts to maintain the cool SSTs. Thus the prese nce of a local f eedback system is suggested, but an important issue still unsolved is how the surface anticyclone itse lf is forced and maintained. Although monsoonal convective heating has be en suggested as the possible forcing, we focus o n a pro nounced near-surface thermal contrast obser ved in summer between the relative ly cool eastern ocea n and a heat ed subtropical landmass to t he east. Our model experim ents indicate that it is the shallow cooling/heating couplet associated with this therm al contrast, rather than d eep convective heating, that primarily and directly forces a subtr opical high in summer. Although th e upper-level response is somewhat weaker, the observed three-dimensional structure of the highs is reproduced reasonably well in our model. It is thus hypothesized that a local feedback loop through which each of those highs is forced and maintained can be triggered by increasing insolation over land fr om spring to su mmer a nd th e loop is prolonged into early fall thro ugh its intera ctions with the under lying ocean that maintain cool SST. As actually observed, a wave-activity flux for stationary Rossby waves is distinctively upward and diverging toward downstream in the upper troposphere above those surf ace highs. Therefore, the thermal forcing acting on the highs is also important in the formation of the upper-tropospheric planetary waves in summer. In winter, most of the subtropical highs weaken. It is suggested from data analysis that the high in each of the No rth and So uth Pacific and o ver the No rth Atlant ic (the Azores Hi gh) is formed and maintained mainly as a downstream structure of planetary wave s generated in mid-latitudes, while the Mascarene high in the South Indian Ocean is under the influence of pl anetary waves from the tropics. In addition, the transient eddy forcing is found to effect ively force the Azores and Mascarene highs , the latter of which moves i n winter t o the western portion of the basin in the vici nity of th e storm track c ore. The fact that the core is anchored by the sharp SST gradient across the major oceanic frontal zone around the Antarctic Circumpolar C urrent suggest s that a partic ular kind of air- sea interaction is involved in forcing the wintertime Mascarene high, which is different fro m the co unterpart acting o n the summertime subtropical highs.

Keywords: subtropical highs, land sea thermal contrast, planetary waves

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MS011 **Oral Presentation** **5363**

The VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS)

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VOCALS (VAMOS Ocean-Cloud-Atmosphere-Land Study) is an international CLIVAR program the major goal of which is to develop and promote scientific activities leading to improved understanding, model simulations, and predictions of the SEP coupled ocean-atmosphere-land system, on diurnal to interannual timescales. VOCALS is ultimately driven by a need for improved model simulations of the coupled climate in both the SEP and over the wider tropics/subtropics. In this presentation, it will be shown that the SEP climate is a tightly coupled system involving poorly understood interactions between clouds, aerosols, marine boundary layer (MBL) processes, upper ocean dynamics and thermodynamics, coastal currents and upwelling, large-scale subsidence, and regional diurnal circulations, to the west of the Andes mountain range. We will give a brief overview of the upcoming VOCALS Regional Experiment (VOCALS-REx), an international field campaign that will provide detailed observations of processes central to the SEP climate system. The field program is carefully designed to complement a suite of enhanced long-term observations. Modeling activities, the other major thrust of VOCALS, have provided the context and will directly benefit from the intensive observations in a poorly known region where coupled ocean-atmosphere models exhibit strong biases in sea surface temperature and rainfall. The coordination through VOCALS of observational and modeling efforts will lead to acceleration in the rate at which field data can be used to improve simulations and predictions of the tropical climate variability.

Keywords: vocals, stratocumulus, vamos

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MS011 **Oral Presentation** **5364**

Observational study of subtropical highs

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The five subtropical highs have some differences in their seasonality. Most tend to favor the eastern sides of the subtropical ocean basins, but not always. The North Atlantic high for example, tends to merge with adjacent continental highs over Africa and Iberia. The South Indian Ocean high is often dipolar: have maxima on the east and west sides of the ocean. Most tend to be highest central pressure in summer, but not all. The South Pacific high is strongest during local spring, for example. These differences are worth noting since it is commonly believed that all the highs are strongest in summer. Each high can be viewed as part of the local Hadley cell which on a zonal average is strongest in winter. The talk will illustrate the primary differences and similarities between the five subtropical highs. One purpose of this observational discussion is to clarify how the highs actually evolve over time. A variety of mechanisms have been proposed for their maintenance, both local and remote. Since the Hadley cell can be viewed as being forced in part by tropical convection, several mechanisms invoke tropical or subtropical convection equatorward and east or west of the high. Other mechanisms stress midlatitude forcing and local forcing (such as upwelled cold water reinforcing the high). Another purpose of the observational discussion is to show evidence for or against the various theories proposed for maintaining the highs. The talk will show the climatology for each high. Then we shall show two basic kinds of statistical tests to assess some of the theories proposed to maintain these highs: compositing with bootstrap resampling and 1-point correlations. The focus will be upon the two highs in the Pacific. The South Pacific high has high monthly persistence (though there is much daily variation) and has strong, clear links to remote events: convective activity in Amazonia leads a strengthened high while convective activity over Indonesia lags a strengthened high. Midlatitude frontal cyclones have strong links to the South and North Pacific high, especially the latter. For the North Pacific high strong low-pass filtering is needed to see any signal other than that from frontal cyclones. Contrary to one theory, strengthened North Pacific high leads temperature changes to the east (including over North America) and there is little evidence for a connection to tropical convection. Time permitting we shall also discuss North Atlantic high statistical associations with remote weather.

Keywords: subtropical, highs, sea level pressure

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MS011 **Oral Presentation** **5365**

The coupling between aerosol impacts and the diurnal cycle in marine stratocumuli

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Anthropogenic aerosols have a noticeable impact on cloud radiative properties and their precipitation efficiency, being therefore likely to also significantly perturb the life cycle of boundary layer clouds. It is however not feasible to document such impacts from observations. Indeed, different aerosol types generally correspond to different air masses, hence to different vertical profiles of moisture and stability, and the accuracy of temperature and humidity measurements is not sufficient to decipher aerosol impacts from thermodynamics modulations of the system. These interactions between aerosols and the dynamics of boundary layer cloud systems have therefore been explored with high resolution numerical models, that now include detailed parameterizations of dynamics, radiative transfer, cloud top entrainment, surface fluxes, droplet sedimentation and drizzle precipitation. The results of the simulations are contradictory. Originally, it was expected that a reduced precipitation efficiency would result in an increase of the liquid water path. The most recent simulations however suggest the opposite, because of enhanced entrainment generated turbulence, or enhanced entrainment efficiency. These simulations though were mainly focused on quasi-equilibrium conditions, most often nocturnal. In this study we consider the specific case of a diurnal cycle of a marine stratocumulus, during which aerosol impacts interact with the diurnal variations of the cloud system dynamics. Large Eddy Simulations of a stratocumulus diurnal cycle are produced by assuming either a pristine cloud, or polluted ones with higher cloud condensation nuclei concentrations. These simulations reveal that, when aerosol properties are modified during the night, the liquid water path initially increases in a polluted case. When the sun raises however, the polluted cloud is evaporated more rapidly than the pristine one. During the second night, the polluted cloud, unlike the pristine one, is unable to restore its original liquid water path. Detailed analysis of the simulations show that the non-reversibility of the process is due to both an enhanced entrainment flux and a decoupling of the boundary layer in the polluted case that involves a competition between droplet and drizzle evaporation and short wave heating of the sub-cloud layer. Sensitivity test on the intensity of the subsidence and the large scale advection confirm that the process is robust, though with varying amplitudes of the differences between the pristine and the polluted case. This numerical study demonstrates that the response times of stratocumulus cloud systems to the diurnal cycle and to changes in the aerosol properties are comparable, so that the two processes can be strongly coupled. Differences between the pristine and the polluted case are not only due to different fluxes at the interfaces, but also to different responses times of the boundary layer to the decoupling processes induced by solar heating and droplet evaporation during sedimentation.

Keywords: aerosol, stratocumulus

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MS011 **Oral Presentation** **5366**

The warm bias in the Southeastern Pacific in the NCEP CFS model

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Pingping Xie, Wayne Higgins, Meghan Cronin, Phillip Arkin, Robert Weller, Sarah Levinson

As in many contemporary coupled atmosphere-ocean general circulation models, there exists a sea surface temperature (SST) warm bias in the Southeastern Pacific (SEP) in the National Centers for Environmental Prediction (NCEP) coupled Climate Forecast System (CFS) model. This study examines the formation of this warm bias, its association with the deficiency of model-produced stratus clouds, and its impact on the model's time-mean state and interannual variability. Questions we will address include: (1) Where does the warm bias start, how does it evolve in space, and how quickly does it develop? (2) How does the warm bias relate to the deficiency of model-produced stratus clouds, and what is the contribution of the associated excessive surface radiation fluxes? (3) What is the role of oceanic dynamics in the evolution of the warm bias? (4) What are the impacts of the warm bias on the mean state of the model and on its interannual variability? These questions are addressed based on outputs from a suite of CFS integrations, including: (a) retrospective 9-month seasonal forecasts from realistic atmospheric and oceanic initial conditions from each month of 1981-2004, (b) long-term multi-decade free simulations, (c) experimental free simulations with mean surface radiation errors over the SEP area [30S-0; 90W-68W] corrected, and (d) simulations with the uncoupled oceanic component of the CFS with and without mean surface radiation errors over the SEP area.

Keywords: sst warm bias, stratus clouds, ncep cfs model

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MS011 **Oral Presentation** **5367**

The representation of stratocumulus in global atmospheric models: the role of GCSS

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Boundary layer clouds in general and stratocumulus in particular play a fundamental role in the Earths cloud radiative balance and in the tropical and sub-tropical circulation. In weather and climate prediction models, and in spite of some advances in the development of cloud parameterizations in general, stratocumulus are often not realistically represented. This fact has a profound influence on coupled ocean-atmosphere simulations of the dynamics of the Eastern Pacific. In particular, the distribution of sea surface temperature in these models is profoundly affected by the realism of the stratocumulus parameterizations. During the last decade or so, however, there has been some important progress in the parameterization of the stratocumulus-topped boundary layer. A substantial amount of this research has been performed in the context of the GEWEX Cloud System Study (GCSS) intercomparisons. In this presentation, these recent advances in the parameterization of stratocumulus are described with a focus in the particularly important role of GCSS.

Keywords: stratocumulus, parameterization, gcss

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MS011 **Oral Presentation** **5368**

Impacts of Eurasian Orography on the Subtropical Anticyclone in Different Seasons

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Jun Wang, Xin Liu

The influences of the Eurasian orography on the subtropical circulation in difference seasons are obtained by analyzing the differences between the two experiments with or without Eurasian orography of geopotential height, streamline function, precipitation and temperature. Results show that such influences are seasonal dependant. The features can be classified into winter pattern (November-April), summer pattern (June-September) and transition pattern (May and October), with an equivalent barotropic vertical structure appearing over the high and middle latitudes. For the height difference, the winter pattern is characterized by the north-south and west-east seesaws along 35N and 100E, with high to the west and low to the east in north, and low to the west and high to the east in south. The summer pattern is featured as high in the north and low in the south over Western Pacific, and upper layer positive and lower layer negative over the continent. As to the streamline difference at 850 hPa, the winter type is characterized as cyclonic/anticyclonic circulations over the northern/southern Western Pacific, and a TP dipole pattern over the continent. Whereas the summer patter in the subtropics is featured by a cyclonic circulation surrounding the TP and an anticyclonic circulation over west-Pacific. The orography forced TP dipole pattern enhances the winter cold break from Siberia and forms the spring persistent precipitation over the south of Yangtze River and the pre-monsoon precipitation over South China. The orography forced summer pattern forms the strong difference of precipitation from the Bay of Bengal to the central and eastern TP, enables the rain band to extend northward, and re-distributes the precipitation over Asia.

Keywords: eurasian orography, subtropical high

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MS011 **Oral Presentation** **5369**

How well does the adiabatic approximation apply to the SEP stratocumulus region ?

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David Painemal

The adiabatic approximation provides a powerful means for extending satellite cloud observations. While the adiabatic approximation is generally assumed to apply well to the well -developed stratocumulus regions, it has rarely been examined systematically. The almost-annual buoy-tending cruises to 20S and 85W, within t he south-eastern Pacific str atocumulus region, provide the opportunity for such a comparison. Approximately four months of comparison data from different years and months of year are available. We compare satellite and shipboard observ ations of cl oud top height and use the satellite -derived cloud optical depth to derive a cloud ba se heig ht and cloud depth. Comparisons to the ceilometer-derived cloud base heights for four ship cruises show reasonable agreement and support the use of MODIS data under overcast conditions for studies of this region.

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MS011 **Oral Presentation** **5370**

Eastern tropical SST AND 500 HPA anomalies connected with monthly low and high precipitation over South-Eastern South America

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Gustavo J. Nagy, Carlos M. Martnez, Mario Bidegain

This research aims to identify possible links between anomalies of Sea Surface Temperatures (SST) and 500 hPa geopotential height anomalies over the South Eastern Tropical Oceans (Pacific and Atlantic) and the high and low precipitation occurrence in mid-latitude South-Eastern region of South-America (Uruguay). Upper atmospheric and oceanographic data were extracted from the NOAA/NCAR Reanalysis and NOAA Optimum Interpolation respectively. Ensembles of dry and rainy months were pointed out from 29 rainfall gauges in Uruguay for the period 1981-2000 by means of the quintile rank. The choice of this period is due to both the accuracy of available Optimum Interpolation SST data and the modulation of atmospheric circulation in the Southern hemisphere by late seventies. Composite anomalies of SST and 500 hPa geopotential heights were sketched for these ensembles over both South-Eastern Tropical Atlantic and Pacific. Some conspicuous patterns of anomalies appear, involving the equatorial region around Galapagos Islands and large coastal regions westward Peru and Northern Chile. Most of these observations match with the well-known ENSO Eastern Pacific conditions driving much of the climate variability in South-Eastern South America. In addition, new South-Eastern Tropical Atlantic SST patterns appear for several months, much of the time synchronized with eastern Pacific features. Particularly, there is an apparent flip-flop of SST anomalies involving the eastern Pacific, offshore Southern Angola-Northern Namibia, South West of Cape Town, and far south Cap Agulhas waters. This switch among warmer-than-normal/colder-than-normal patterns matches in every case with high/low monthly precipitation over Uruguay. There is vast literature on correlations and teleconnections related to the Eastern Pacific, but a lack of it in the case of South-Eastern Atlantic. The number of cases for these events is scarce in some monthly subsets for a straightforward statistical analysis whereas a dynamical analysis remains a future task. However, in some cases the SST flip-flop patterns last from the preceding months (one to three months), suggesting a possible wide mode of oscillation.

Keywords: sst anomalies, precipitation, south eastern south america

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MS011 **Oral Presentation** **5371**

Interannual variability of the summertime western North Pacific subtropical high

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The western North Pacific Subtropical High (WNPSH) in summer exhibits significant 2-3 years and 3-5 years oscillations with interdecadal variability. The 2-3-year oscillation is accompanied by anomalous meridional overturning circulation characterized by warm SST anomalies (SSTA) and ascending motion in the maritime continent and anomalous descending motion near the Philippine Sea, and by evolving warm to cold SSTA in the central-eastern Pacific from the preceding winter to the summer. The 3-5-year oscillation is accompanied by anomalous descending motion over the maritime continent and warm SSTA in the central-eastern equatorial Pacific that persists from the preceding winter to the summer; the complementary cooling and descending motion in the western Pacific are related to anomalous east-west circulation associated with ENSO.

Keywords: subtropical high, enso

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MS011 **Oral Presentation** **5372**

Influence of anomalous convective activity on the summertime subtropical anticyclone over the northwestern Pacific: Importance of moist processes and air-sea interaction

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Yosuke Kosaka

The Pacific-Japan (PJ) teleconnection pattern, which influences the summertime subtropical anticyclone over the northwestern Pacific, is associated with anomalous monsoonal convection near the Philippines. 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, 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, the 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 to 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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MS011 **Oral Presentation** **5373**

Aerosol-Cloud-Drizzle Interactions in Marine StratocumulusNatures Way and Mans Way

Dr. Bruce Albrecht
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Well-defined spatial variability in the physical proper ties of marin e stratocumulus clou ds provide clear evidence for t he importance of aero sol-cloud-drizzle inter actions on cl oud structure. A review of pa st and recent in situ and remote sensing observations of ma rine stratocum ulus clouds is used to assess our current understanding of these interactions. The obser vational evidence reviewed will focus on two features o bserved in mari ne strato cumulusship tr acks a nd broken cloud structures e mbedded within ultra clean air masses. Although ship tracks provide strong evidence for the link between increased CCN and more reflective and solid clouds, recent studies indicate the existence of broken, drizzling, and less reflective clouds associated w ith marine ultra clea n air (MUCA) where CCN concentrations fall below 1 0 cm-3. Such areas have been associated wi th Pocket s of Open Cells (POCs) and rift areas in marine stratocumulus as observed fr om satellite an d ship-based remote sensing and probed b y aircraft. Unlike ship tracks, w hich are produced by anthropogenic aerosol forcing, MUCA appear to b e generated a nd maintained naturally by drizzle cleansing. Possible mechanisms for initiating the drizzle process involved in the production of MUCA are discussed a nd the feas ibility of intentionally increasing giant nuclei in marine stratocumulus (via cloud seeding) to study drizzle initiation processes is demonstrated.

Keywords: clouds, aerosols, precipitation

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MS011 **Oral Presentation** **5374**

The impact of ocean mixing on the atmosphere/ocean interactions in the Eastern tropical Pacific

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The strong coupling between the ocean and atmosphere in the eastern tropical Pacific is such that we need to consider the coupled system in studies of the sensitivity of either medium to the details of physical processes. To highlight this point we investigate the role of vertical mixing in the ocean and its impact on both the ocean and atmosphere in the eastern tropical Pacific, in the context of a regional coupled model. A useful diagnostic is the distribution of the diapycnic velocity (the diapycnic component of the overturning circulation) which allows the pathways of transport to be thoroughly examined and highlights the importance of Tropical Instability Waves. Increasing the level of vertical mixing in the ocean component of the model produces substantial changes to the sea surface temperature in the coupled system (a factor of 2 greater than in an ocean-only version of the model). Cooler SSTs produce down-pressure gradient winds along the coast of South America, strengthen easterlies along the equator causing a Bjerknes feedback on the SST anomaly, and weaker precipitation in the ITCZ. The strength of the Equatorial Under Current actually increases as the vertical mixing is increased. An analysis of the heat budget of the upper ocean reveals a complex interplay between changes to the mean currents, the eddy fluxes, and the atmospheric forcing. We also find that changes in the ocean vertical mixing produces changes to the surface temperature over South America, through changes to precipitation patterns. The results show the importance of ocean mixing in the coupled system. Equally importantly they demonstrate the inappropriateness of "tuning" stand alone ocean or atmosphere models by adjusting model parameters.

Keywords: tropics, ocean, mixing

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

MS011 **Oral Presentation** **5375**

Investigation of Stratocumulus Clouds, Drizzle and Boundary Layer Properties in the Subtropical Southeast Pacific

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Bruce A. Albrecht, Pavlos Kollias, Christopher W. Fairall

Marine stratocumulus cloud formation is regarded as one of the most significant regulators of the radiation budget over the eastern subtropical oceans and is closely related to the dynamics of subtropical highs. The subtropical southeast Pacific stratocumulus clouds form one such regime with particular importance and special feedbacks on the regional and global climate, yet largely unexplored in the past. But during the past six years a series of research cruises headed by NOAA ESRL/PSD (former ETL) in this climate sensitive area have provided unprecedented observations of clouds, drizzle and boundary layer structures. The goal of this work is to improve understanding of coupled air- sea processes in subtropical stratocumulus regions and to gather statistics on boundary layer, cloud and drizzle properties to promote the evaluation of models and satellite data products. This study focuses on the comparison of observations from the 2001, 2003 and 2004 EPIC/PACS cruises. The temporal and spatial variability of cloud properties, surface fluxes, and boundary layer profiles is described using a variety of in situ and remote sensing measurements, and the differences between the three years of observations are highlighted. Statistical characteristics of the macrophysical boundary layer and cloud properties are extracted and compared using the 5 to 6-day periods that the research vessels remained stationed at the location of the WHOI ocean reference buoy (20S, 85W) during each cruise. Diurnal forcing and synoptic conditions are considered as factors affecting the observed variability. The relative roles of cloud-top entrainment and drizzle production on the dynamics of stratocumulus are investigated.

Keywords: southeast pacific, stratocumulus, mabl

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

MS011 **Oral Presentation** **5376**

What determines the position and intensity of the South Atlantic anticyclone in austral winter?

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Atmospheric and Oceanic Sciences University of California Los Angeles IAMAS

Ingo Richter, C. Roberto Mechoso, Andrew W. Robertson

The South Atlantic anticyclone is a major feature of the austral winter climatology. An atmospheric general circulation model is used to investigate the dynamics of the anticyclone by means of control simulations and experiments that examine sensitivity to prescribed orography, sea surface temperatures, and soil wetness. The results demonstrate the existence of links between intensity and structure of the wintertime South Atlantic anticyclone and the major summer monsoons in the Northern Hemisphere. This finding carries further the Rodwell-Hoskins summertime paradigm, which relates the subtropical oceanic highs to the monsoonal circulations over the adjacent continents, by providing evidence of the importance of the West African and Indian monsoons for the subtropical wintertime anticyclone over the South Atlantic. The results also confirm the important role of South American and African orography in localizing the South Atlantic anticyclone over the ocean. Other factors, like the regional zonal gradients of sea surface temperatures, are found to have only a minor impact on the anticyclone.

Keywords: anticyclone, monsoon, south atlantic

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MS011 **Oral Presentation** **5377**

Upper ocean processes under stratus cloud decks in the southeast Pacific

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Persistent stratus cloud deck s in the south east Paci fic play an important role in reginal and global climate variability. Given the importance of air- sea coupled processes for formation and maintenance of stratus clouds, understa nding upper ocean processes that control SST in t his regi on is crucial for simulating stra tus clouds and thus predict ing regi nal and global climate. This study investigates interannual var iability of upper ocea n in t he stratus cloud region and its relation with SST variability using ocean general circulation mo del (OGCM) experiments. The OGCM used in this st udy is the Hy brid Coordinate Ocean Model (HYCOM) for the tropical Indo -Pacific basin. The model was fir st forced with daily surface fluxes based on the NCEP reanalysis and satellite-derived surface shortwave and longwave radiation for th e period of 19 79-2004. Gridded surface heat flux estimate s agree well with those base d on WHOI IMET buoy measur ements at 85W, 20S. Als o, the OGCM is a ble to well rep roduce observ ed interannual SST variations in this regi on. Additional m odel experiments were designed to examine th e relative import ance of ocean dyna mics and surface heat fluxes fo r the i nterannual S ST variatio n. T he results indicate that upper ocean dynamics play an important role in controlling the interannual variation of S ST n orth of 20S in th e stratus clou d r egion. T hese r esults of OGC M experimen ts wil l h opefully provide useful info rmation f or upco ming o bservations o f the VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS).

Keywords: upper, ocean, process

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MS011 **Oral Presentation** **5378**

What role does Tropical Atlantic Ocean play in the equatorial atlantic mode?

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Beln Rodrguez-Fonseca, Javier Garca-Serrano

Upwelling variations could be important in the Subtropics SST anomalies, which in turn are associated with Atlantic climate variability over the continents. We are interested in those coupled modes, and the oceanic contribution in the eastern Atlantic SST anomalies formation, persistence and damping, versus the surface fluxes. In particular, we investigate how the SST pattern is generated over the Angola/Benguela upwelling system and how it is developed as equatorial Atlantic mode, and damped later on.

Keywords: equatorial atlantic, upwelling

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MS011 **Oral Presentation** **5379**

Ocean dynamics and thermodynamics at play in the SST seasonal cycle within the Atlantic North Eastern Tropical Upwelling System

Dr. Alban Lazar
IAPSO

Irene Polo, Caroline Serraud

A time-dependent system of contiguous open and coastal ocean upwellings characterizes the North Eastern tropical Atlantic. In comparison with the rest of the basin, the associated shallow mixed layer and thermocline increase the temperature variance; and as importantly, the role of the ocean in controlling the surface temperature, its gradients and the air-sea fluxes. However this system has been relatively overlooked and the understanding of its behaviour requires significant efforts. Here we present recent advances in describing and understanding some ocean dynamics and air-sea interactions at the seasonal scale. Regarding the physics of the upwellings, the effects of local and equatorial winds in forcing are analyzed, using TOPEX-Poseidon and OGCM datasets. In particular the importance of coastally trapped waves of equatorial origin is highlighted along the coast equatorward of about 12N, whereas time-variation of local trades are prevailing offshore, and at the coast further north.The corresponding temporal and spatial SST gradients are potentially important for the air-sea coupling. The marine ITCZ migration and the wind-evaporation SST feedback especially are major coupled phenomena in the region. Both are analysed through a decomposition of the ocean and atmosphere fluxes. It eases the understanding of the migration of the underlying warm zone and the modulations of the meridional SST gradients. Finally the importance of coupled versus forced processes are compared.

Keywords: upwelling, itcz, coupling

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

MS011 **Oral Presentation** **5380**

The large-scale setting for subtropical oceanic anticyclones

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A review will be given of the large-scale atmospheric processes that determine the character of the subtropical anticyclones, particularly in the eastern ocean basins. The role played by monsoon convection and circulations, mid-latitude interaction, radiative cooling, land and oceanic surface processes, and large-scale topography will all be discussed. Use will be made of diagnosis of observations, and the results from simple and more complex atmospheric models.

Keywords: subtropical anticyclones, monsoon, diagnosis

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MS011 **Poster presentation** **5381**

Processes controlling the mean tropical Pacific precipitation pattern

Dr. Ken Takahashi
IAMAS

Numerical experiments suggest that the large-scale distribution of mean precipitation and sea surface temperature in the tropical Pacific can be explained to a large extent by the distribution of the specific humidity of the air brought in contact with the surface by large-scale subsidence associated with subtropical anticyclones. The dryness of the subsiding air keeps the ocean surface cool through evaporation and inhibits deep moist convection. The subsidence is largely forced by orography, most notably the Andes, which have the dominant role in determining the hemisphere in which the ITCZ and SPCZ are located, partly due to their easterly location relative to the Rockies. The positive feedback between low clouds and sea surface temperature is important for the dry subsidence to produce an effect comparable to the observed.

Keywords: subsidence, itcz, spcz

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MS011 **Poster presentation** **5382**

Influence of Anomalous Convective Activity on the Summertime Subtropical Anticyclone over the Northwestern Pacific: Dynamics of the Pacific-Japan Teleconnection Pattern

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The westward extension of the North Pacific summe rtime subtropical anticyclone is known to be influenced by anomalous con vective activity over th e northwestern Pacific. This tele connection pattern, called the Pacific-Japan (PJ) pattern, is one of the dominant anomaly patterns that can affect East Asian summertime climate. Howev er, structure and dynami cs of the PJ pattern have not been studie d comprehensively. In contrast to the picture o f baroclinic in the tropics and barotropic in midlatitudes as has bee n widely accepted, our composite analysis shows that vorticity anomalies of the PJ patter n exhibit zonally-elongated cyclonic and anticyclo nic ano malies aro und the enhanced co nvection center and to its northeast, respectively, in the lo wer troposphere, with an app arent poleward phase tilt with height. Vorticity budget anal ysis indicates the domina nt role of the vorticity advection by the mea n meridional flow and the β effect over the western North Pacific, in the presence of the vertically-sheared mean meridion al flow observ ed with in th e bou ndary region between th e Asian su mmer mon soon and the North Pacific subtropical anticyclone. The associated wave-activity flux is equatorward and poleward in the upper and lower tr oposphere, respectively, indicating that Rossby wave-like po leward energy dispersion oc curs main ly th rough th e cli matological-mean lower-tr opospheric sou therlies over th e western North Pacific. Energy budget analysis based on th e composited anomalies reve als that th e PJ pattern gains energy through b aroclinic conversion associated with westward-til ted anomalies embedded in t he vertically-sheared westerly Asian je t in midlatitudes, as well as through barotropic energy conversion associated with zonally-elongated anomalies embe dded in the exits of the monsoon westerlies and the Trades in the lower troposphere. The se energy conversions, the sum of which is comparable in magnitude w ith the energ y genera tion associated wit h th e an omalous con vective heating, can replenish the total energy associated with t he PJ pattern within a mont h, though thei r 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 v ariability inherent to the me an field over t he summertime western North Pacific, chara cterized by the Asian jet, Asian mo nsoon and No rth Pacific subtro pical anticyclone. Indeed, in a steady, linear, two-level qu asi-geostrophic mo del with an idealized basic flow that includes a subtropical je t as well as a pair of a low- level monsoonal cyclone an d a subtropical anticyclone, a PJ-like respons e emerges in response to pr escribed heating located between the pair, with energy c onversions similar to those obtained for the observed PJ composite. Furthermore, the second least d amped singula r mode for th e same basic f ield shares the fundamental f eatures of the heat-induced response, justifying the characteristics of the PJ pattern as a dry preferred mode.

Keywords: energy conversion, preferred mode, zonally varying mean field

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MS011 **Poster presentation** **5383**

Formation mechanism for isopycnal temperaturesalinity anomalies propagating from the eastern South Pacific to the equatorial region

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Equatorward propagation of temperaturesalinity an omalies on an isopycnal surface , the spicines s anomalies, emanating from the eastern sub tropical South Pacific and their fo rmation mechanism were investigated b ased on a hi ndcast simulation with an eddy-resolving quasi-global ocean general circulation model. Recent studies have revealed th at positive feedback between ocean and atmosphere with land-sea thermal contrast at the eastern bo undary of subtropical ocean basin is important for development of subtropical highs, and t hus the subtropical highs a re enha nced near the e astern boundary of ocean basins. Below the subtropical highs precipitation minus evaporation (P-E) is generally negative with negative maximums equatorward of the maximums of se a level pressur e, and hig h sea surface salinity (SSS) is fo rmed. Indeed, SSS maximums are found in the subtro pics in all of the five large ocean basins to the poleward of the negati ve P-E regions because of poleward surface Ekman transport induced by easterly wind s associated with the subtropical highs. This sugge sts that air-sea interaction with the la nd-sea co ntrast may affect th e climatological salinity distributions at t he sea surface. Because of density-compensating meridion al distributions of te mperature and salinity, the meridional density gradient is w eak at the sea surface to the po leward o f the SSS m aximum in the eastern subtro pical So uth Pa cific. With these mean fields, cool sea surface temperat ure anomalie s (SSTAs) can make an outcrop line of an isopycnal su rface migrate equatorward more than 5 and induce warm and salty anomalies on the isopycnal surface. Subducted warmsalty anomalies propagate to the equatorial region over approximately 5 years and may influence equatorial isopycnal temperaturesalinity anomalies. Although the ass ociated effects are unclear, if these anomalies could furth er induce war m eastern equatorial SSTAs that are po sitively correlated with eastern So uth Pacific SSTAs, opposite sign temperaturesalinity anomalies would be formed in the subtropical Sout h Pacific, and a closed cycle having a decadal timescale might be induced.

Keywords: south pacific, isopycnal temperature anomaly, decadal variability

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MS011 **Poster presentation** **5384**

Observed variability in the subsurface temperatures between near coast and deep sea in the eastern Arabian Sea from XBT observations during the YEAR 2002 to 2007

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As part of the Arabian monsoon experiment around 100 cruises were conducted since May 2002 on a fortnightly basis for XBT observations along with water samples for surface salinity and other metrological parameters. The in-situ observations were analyzed. Along the southwest coast of India the dominant coastal current is the reversing West Indian Coastal Current. Upwelling appears to be strongest off Cochin and the upwelling of cold water is seen together with an increase in salinity. The upwelling intensifies with the southwest monsoon near to coast. The strong temperature gradients in the thermocline region shows strong upward trend and becomes maximum with the advancement of monsoon and shows a decline during the post monsoon season. The depth of 20 deg isotherms, considered as a representation of thermocline is at a depth of 140 meters and the isotherms are almost horizontal; but in June the isotherms in the open ocean rises towards the coast as the coast is approached. The inclination steeps up in July, August and it continues till September. In September the isotherms breaks at the surface near to coast denoting the strong coastal upwelling. The piling up of isotherms marking the strong temperature gradient in the thermocline region gets initiated from the first week of May and gets lifted up with strengthening of monsoon and starts declining in the northeast monsoon. The process is maximum in September. The sub surface temperature difference between the near coast and far sea is specially noted. In pre-monsoon, In May, the temperature difference with depth between deep sea and near coast region shows an increase. During monsoon and in post monsoon this temperature difference shows a strong variability .In June, July and August the difference in temperature shows a reversal just below 100meters. But in post monsoon, in October and November the temperature with depth reverses from the condition prevailed during monsoon and pre-monsoon.

Keywords: thermocline, upwelling

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MS011 **Poster presentation** **5385**

SETP variability and ENSO in coupled GCMs

Dr. Thomas Toniazzo
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The analysis of the ENSO in a perturbed-physics ensemble of the HadCM3 model shows a significant sensitivity of the amplitude of the ENSO to the degree of local variability in the stratocumulus area of the South-Eastern tropical Pacific (SETP). This is confirmed when SST variability in theSETP is artificially suppressed, which results in a great reduction of ENSO activity. SETP anomalies can trigger or reinforce a Bjerknes feedback loop over the Equatorial Pacific, and they often lead NINO3.4 anomalies. Similar relationships are observed in at least some of the IPCC AR4 models. We speculate on the mechanisms that maintain the mean and the variabilty of the SETP climate in this and similar models, and on their relation with the ENSO.

Keywords: enso, east pacific stratocumulus, variability

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MS011 **Poster presentation** **5386**

Modes of SST variability over the Northeastern Subtropical Atlantic: impacts over the North Atlantic

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Javier García Serrano, Irene Polo

The Subtropical North Atlantic (SNA) SST anomalies are evidenced to co-vary with the winter European anomalous precipitation. However, the associated SST patterns show different zonal gradient characteristics. We investigate this different SNA SST behaviour, in one hand, for understanding the different ocean/atmospheric origin, and in the other hand for understanding the different impacts on the North Atlantic Climate variability.

Keywords: tropical atlantic, coastal upwelling

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MS012 **5387 - 5397**

Symposium
Impacts of Biosphere-Atmosphere Interaction on Atmospheric Composition from Synoptic to Annual and Decadal Timescales

Convener : Dr. Parvadha Suntharalingam, Dr. Dylan Jones

Changes in biosphere-atmosphere fluxes of climatic ally important trace gases can impa ct atmospheric composition a nd climate on micro -meteorological to g lobal scales. S uccessful prediction of ch anging atmospheric c omposition and its impact on chem istry and climate will require an improved representation of the proce sses governing biospher e-atmosphere interaction in regional and global models, and an identification of th e critical temporal and spatial pr ocess scales. This symposium will focus on processes responsible for biosphere-atmosphe re exchange of climatic ally si gnificant species (e.g., greenhouse gases and biogenic VOCs). We invi te papers from experimentalists and modelers on atmospheric interaction with bo th land and o cean biospheres, focusing on a range of timescales up to multi-annual, and on regional to global spatial scales

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MS012 **Oral Presentation** **5387**

Sensitivity of Secondary Organic Aerosol Formation to Future Climate and Emissions Changes

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Daven K. Henze, John H. Seinfeld, Larry W. Horowitz, Alex Guenther, Johannes J. Feddema

Recent evidence suggests that secondary organic aerosol (SOA) may dominate the total global aerosol burden. Precursors of SOA include both anthropogenic and biogenic compounds, emissions of which are expected to rise as a consequence of human activities and increasing global temperatures. Climatic conditions also control SOA concentrations via temperature, precipitation and the oxidative capacity of the atmosphere. SOA contributes both to air quality degradation and climate forcing, however their impact relative to other aerosols remains highly uncertain. We investigate here the sensitivity of SOA formation to changes in climate and emissions predicted for the year 2100 according to the IPCC A1B scenario using a coupled global atmosphere-land model. The Community Atmosphere Model (CAM) includes SOA formation from monoterpene oxidation, isoprene photo-oxidation and aromatic photo-oxidation following recent laboratory yields. Biogenic emissions of isoprene and monoterpenes are simulated interactively using the Model of Emissions of Gases and Aerosols (MEGAN) within the Community Land Model (CLM). In addition, we examine the role of future predictions of land use change on biogenic SOA formation.

Keywords: soa, organic aerosol, climate

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MS012 **Oral Presentation** **5388**

Is the Carbonyl Sulfide (COS) seasonal cycle controlled by terrestrial photosynthesis?

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Dan Yakir, Pieter Tans, Steve Montzka

COS is the most abundant su lfur containing atmospheric gas, and thus have important contribution t o stratospheric sulfate particles and to the Ea rth radiation budget and ozo ne chemistry. I n addition, COS is a potential valuable tracer of the terrestrial biosphere, which serve as its main sink, through uptake in leaves and in soils. The major sources of COS are emissions from the oceans, anthropogenic emissions, and biomass burning. Although th e main components of the global COS budget are relatively w ell known, large uncertainties remain regarding the precise fluxes involved. The upta ke of COS in leaves is known to be s trongly co upled to photosynthesis. If the le aves uptake, a nd not the soil,dominates the seasonal cycle of atmospheric COS co ncentration, and interannual variations in this cycle, then COS can be used to tra ce global scale atmosphere t o leav es CO2 flux. Moreover, utilizing COS together with traditional tracers (e.g. [CO2]) will improve the ability to partition net ecos ystem productivity into gross primary productivity (GPP) and ecosystem r espiration (Re), and to explai n past variations in terrestrial carbon storage and predict future ones. In t he current study we explored the most detailed database of COS surface observations available to this date, produced by NOAA-ESRL-GMD. We have focused on the seasonal cycle observed in this database, and compared it to the seasonal cycle in atmospheric CO2 and its delta-18O. In addition, we have compared inter-annual variations in these cycles, to remote-sensing assessment of land plants productivity. T his an alysis indicates a strong linkage between land photosynthesis and atmospheric COS seas onal variat ions, and thus enables us to potentially use the COS as a tracer for the details of the contemporary carbon cycle.

Keywords: terrestrial biosphere, climate change, modis

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MS012 **Oral Presentation** **5389**

Surface Ozone studies at NPL, New Delhi during 1997-2006

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Y. Nazeer Ahammed, Arun Kumar, D.K. Shukla, P.R. Sinha, S. L. Jain

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 hydrocarbons. These ozone precursors are emitted in large quantities due to human activities such as traffic and industry. Ozone in the troposphere plays various important roles like the enhanced production of ozone in the summer can cause photochemical smog. Excessive amounts of ozone near the surface are toxic to ecosystems, animals and man. Ozone is a primary source of hydroxyl radicals, which are the detergents of the troposphere, initiating almost all oxidation processes. Ozone changes in the troposphere have a large impact on the tropospheric composition. The regular information of its concentrations on ground levels is needed for setting ambient air quality objectives and understanding photochemical air pollution in urban areas. In view of the above the regular measurements of surface ozone on round the clock basis are being carried out in NPL since 1997. Seasonal variation in ozone concentrations shows maximum levels in summer and autumn seasons and minimum in monsoon and winter seasons. Diurnal pattern in ozone concentrations shows daytime in situ photochemical build up through out the year. The analysis of data shows that on large number of days the surface ozone values at Delhi exceeds the WHO ambient air quality standard for ozone (hourly average 80 ppb), which is a health hazard and is of serious concern. Number of occurrences of hourly ozone more than 80 ppb was found 83, 39, 113, 158, 112, 111, 173 and 215 during 1997, 1998, 1999, 2001, 2002, 2003, 2004 and 2005, respectively. The surface ozone measurements were also carried out at other locations in the country including at high altitude stations like Leh / Hanle (one of the highest observatory in the world) in campaign mode. The pattern of diurnal variation at Hanle is altogether different from that observed at urban environment like New Delhi. The nighttime increase of surface ozone has been observed under stable boundary layer conditions in nights and also during thunderstorms. Since NW side of the present site is surrounded by agricultural areas (IARI, PUSA Campus), a preliminary evaluation of possible damage to crop yield by O3 has been carried out using exposure plant response index (AOT 40) and found O3 exposures are higher than the critical level of O3 and suggest that the present level of O3 may have impact on reduction in crop yields.

Keywords: troposphere, surface ozone, aot 40

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MS012 **Oral Presentation** **5390**

Use of atmospheric CO2 data for the assessment of carbon-climate interactions in the CSIRO global climate model simulations.

Mrs. Eva Kowalczyk

Rachel Law, Ying-Ping Wang And Bernard Pak

The prediction of future climate change requires knowledge of the evolution of atmospheric CO2 concentrations. This evolution also depends on climate. Therefore global climate models have been developed to include the global carbon cycle to predict both future climate and atmospheric CO2 concentration. In a coupled climate-carbon cycle model, plants can affect climate and CO2 concentrations in the atmosphere while climate affects many processes in the terrestrial biosphere. The CSIRO Atmosphere Biosphere Land Exchange model (CABLE) simulates the interactions between the microclimate, plant physiology and hydrology in a terrestrial ecosystem. CABLE has been coupled to the CSIRO Conformal Cubic Atmospheric Model (C-CAM) to provide the capability to perform global, multi-decadal simulations of the feedback between the terrestrial carbon cycle and climate. Following the protocol of the C4MIP phase 1 experiment, we carried out simulations for the 20th century using prescribed sea surface temperature and either prescribed or simulated CO2. The simulations were assessed using observed atmospheric CO2 concentrations at a number of sites. Modelled atmospheric CO2 was compared with the Mauna Loa annual CO2 growth rate and interannual variability, the north-south annual mean CO2 gradient and seasonal and diurnal cycles of CO2. Various deficiencies were found in the simulations, particularly the need for explicitly representing plant phenology and soil carbon dynamics. Results will be shown from initial simulations that include these new components.

Keywords: model, biosphere atmosphere, carbon climate

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MS012 **Oral Presentation** **5391**

Evaluation of tropospheric chemistry in the NEW UKCA Chemistry-climate model

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Olaf Morgenstern, Guang Zeng, Paul Young, Fiona O'Connor, Colin Johnson, John Pyle

The U.K. Chemistry and Aerosols (UKCA) project aims to provide a comprehensive description of whole-atmosphere gas-phase and aerosol chemistry as a component of the Met Office Unified Model, used here in climate model configuration. We assess the performance of the tropospheric gas-phase chemistry embedded in the UKCA versus available observations for a variety of species. In general the model results agree well with the measurements; we also discuss some remaining problems. In addition, we study the sensitivity of these results to changing isoprene emissions, reflecting possible shifts in the agriculture associated with future large-scale production of biofuels.

Keywords: model validation, tropospheric chemistry, isoprene

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MS012 **Oral Presentation** **5392**

Southern ocean CO2 fluxes, atmospheric CO2, and the tropical land source

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Andrew R. Jacobson, Sara E. Mikaloff-Fletcher, Manuel Gloor, Jorge L. Sarmiento

Spatial and te mporal variations in fluxes of CO2 at the Earths surface l ead to distinct spatiotempora l pattern in the atmospheric CO2 co ncentrations. Sinc e regio nal-scale CO2 fluxes canno t be measured directly, inverse methods ha ve been used widely to infer fluxes from thes e atmospheric CO2 gradients. Such atmo spheric CO2 inversio ns are no toriously und erconstrained, meaning that flux estimates for small region s are n ot in dependent of on e an other. T his permits in formation from one region t o propagate to another, i.e. if one is able to b etter constrain the fluxes in one region, the uncertainty i n the estimates decreases in other regions as well. We show on the b asis of a rece ntly developed atmospheric-ocean joint inve rsion method (Jac obson et al., 2007a,b) how improvements in the estimation and understanding of the pattern and magn itude of the air-se a CO2 fluxes in the Southern Ocean lead to substantially improved esti mates of the magnitude of the tropical land fluxes. In particular, our new estimates of the net air-sea fluxes over the Southern Ocean (south of 44S) indicate a much smaller sink than previously assumed, resulting from a near cancellation between the outgassing of natural CO2 and th e uptake of anthropogenic CO2. At the same time, our estimates suggest a rel atively larger sink for atmospheri c CO2 in the temper ate regions of the Southern Hemisphere (44S-18S), causing a larg e eq uatorward shift o f the main oceanic sinks in the Southern Hemisphere. When this information and its erro r str ucture is com bined with atmospheric CO 2 concentration data through the joint invers ion appr oach, the tro pical an d so uthern hemisphere lan d regions emerge as strong source of carbon to the atmosphere, with a 77% probability that their aggregate source size exceeds 1 Pg C yr?1. This value is of similar magnitude to estimates of fluxes i n the tropics due to land-use change alone, putting into qu estion the ex istence of a large tropi cal CO2 fertilization sink. Systematic errors in the atmosphe ric transport models that we employ to infer the sources and sinks of CO2 at the Earths surface remain a major source of uncertainty for our results. We attempted to incorporate this uncertainty by undertaki ng our inversions using a large suite of models. If our results hold up to further scrutiny, the a bsence of a major CO2 fertilization sink in the tropics would have major implications for the future evolution of the global carbon cycle. References: Jacobson, A. R., et al. (2007a,b), A joint atmosphere-ocea n inversio n for surface fluxes of carbon dioxide. Globa l Biogeochemical Cycles, in press.

Keywords: carbon cycle, air sea co2 fluxes, atmosphere land co2 fluxes

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MS012 **Oral Presentation** **5393**

Interannual variability of biogenic VOC emissions estimated from the MEGAN model and ECMWF analyses

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Alex Guenther, Jenny Stavrakou, Sabine Wallens

Interannual variability in biogenic VOC emissions is expected to result from their direct dependence on environmental conditions (past and current leaf-level temperatures and visible radiation fluxes, also soil moisture) and from the interannual variability in the amount of leaf biomass, as measured by the Leaf Area Index (LAI). The recent availability of a long-term (10 years) dataset of HCHO vertical columns from satellites raises the opportunity to confront bottom-up and top-down estimates of VOC emissions and to assess whether the observed variability in the by-product (HCHO) abundance can be explained using a biogenic emission model in regions where fires are not the dominant source of NMVOCs (cf. Stavrakou et al., One decade of pyrogenic NMVOC emissions deduced from HCHO satellite data, Session JMS003). Here we present a 10-year inventory of biogenic VOC emissions estimated using the MEGAN emission model and the MOHYCAN canopy environment model. The MEGAN model (Guenther et al., ACP, 2006) expresses the dependence of biogenic VOC emissions to environmental conditions, LAI as well as to phenological factors (leaf age). It also provides a high-resolution database of basal emission rates, i.e. the emission rates at standard conditions. MOHYCAN is a multi-layer canopy model calculating the leaf-level temperatures and visible radiation levels in the canopy from meteorological conditions at canopy top (Wallens, 2003). The latter conditions are obtained from 6-hourly ECMWF analyses. The diurnal cycle of meteorological variables at 1 hour resolution is deduced from radiative transfer calculations and from a sinusoidal extrapolation of the 6-hourly temperatures. The MODIS database (2000-2006) is used for LAI. We investigate the contribution of each important driving factor (LAI, radiation, temperature) to the calculated interannual variability of the emissions. We present also the impact of the BVOC emissions on the tropospheric composition using a global CTM (IMAGESv2), and explore the respective influences of vegetation fires and vegetation emissions on the calculated HCHO column variability.

Keywords: voc, biogenic, emission model

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MS012 **Oral Presentation** **5394**

Biogenic Emissions in Coupled Atmospheric Chemistry/Aerosols Model to Regional Climate Model in High Resolution

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Recent studies show considerable effect of atmospheric chemistry and aerosols on climate on regional and local scale. For the purpose of qualifying and quantifying the magnitude of climate forcing due to atmospheric chemistry/aerosols on regional scale, the development of coupling of regional climate model and chemistry/aerosol model has been started recently for dynamical downscaling in the air quality issues on the Department of Meteorology and Environmental Protection, Faculty of Mathematics and Physics, Charles University in Prague. For this coupling, existing regional climate model and chemistry transport model are used. Climate is calculated using model RegCM while chemistry is solved by model CAMx. Meteorological fields generated by RegCM drive CAMx transport a dry/wet deposition. A preprocessor utility was developed on the department for transforming RegCM provided fields to CAMx input fields and format. As the first step, the distribution of pollutants can be simulated for long period in the model couple. There is critical issue of the emission inventories available. Monthly and yearly one way coupled climate/chemistry/aerosol model runs are scheduled in framework of ongoing projects with further studies of on-line impact implementation in regional climate simulations. At this moment, one way coupling on lower resolution is compared with the high resolution simulation at 10 km nested into the lower resolution run to have better boundary conditions both for meteorology and chemistry. Sensitivity of the model couple to the development of land use with emphasis to the possible changes of biogenic emissions and interactions with the other sources of emissions is studied for the EC projects QUANTIFY and CECILIA.

Keywords: chemistry climate modelling, biogenic emission

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MS012 **Oral Presentation** **5395**

The aerosolized biosphere

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The biosphere is a major s ource of atm ospheric ae rosol particles . F iguratively speaking, there are different ways for parts of the biosphere to become airborne: 1) "on pur pose", 2) "by accident", and 3 "by force". By "on purpose" I am referring to the fact that the biosphere releases gaseous aerosol precursors and primary bioge nic aerosol par ticles (P BAP; e.g., sp ores) in an apparently controlled and deliberate manner. Other types of PBAP ar e released more "by accident ", when materi al such as leaf waxes, plant fragments an d bacteria, are suspende d fr om ground or vegetation by atmospheric turbulence. Finally, a large part of the biosphere forcibly b ecomes airb orne wh en vegetation is bu rned by humans action or wildfires. In my presentation, I will compare and contrast the optical, chemical and cloud n ucleating properties of secon dary organic, prima ry biogenic, and biomass-burning aerosols, emphasizing recent observations.

Keywords: aerosol, soa, biogenic

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MS012 **Poster presentation** **5396**

Wavelets in the study of the secondary effects of the Antarctic ozone hole at the Southern Space Observatory: 2003 2005

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Germano Possani, Damaris Kirsch Pinheiro, Nelson Jesus Ferreira

The secondary effects of the Antarctic ozone hole ha ve been a local pert urbation in the ozone content to low latitudes for several years. Wavelet transform is applied for characteriza tion of th is phenomenon at the So uthern Space Obser vatory - SSO/ CRS/INPEMCT (29.44S, 53.82W) at So Martinho da Serra, Brazil, during the years 2 003, 2004 and 200 5. The to tal ozone column data from Spectrophotometer Brewer MKIII# 167 and TOMS are used. The spectropho tometer measures total ozone column on the wavelengths: 306.3, 310.1, 313.5, 316.8 and 320.0 nm, while TOMS measures on: 317.5 and 331.2 nm. The effect occurs between the Julian days 200 and 300 , period of oz one maximum value at the Southern Space Observatory. The years 2 003, 2004 and 2005 presents 2, 3 and 1 eve nt of secondary effects of the Antarctic ozone hole respectively. The wavelets continuous spectrums are analyzed for the three years se parately and s how the influe nce of th e sec ondary effects to low lati tudes with duration about 2.3 days for all years.

Keywords: wavelets, antarctic ozone hole, secondary effects brazil

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MS012 **Poster presentation** **5397**

Integrating satellite observations of atmospheric CO2 and CO to quantify regional carbon fluxes

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Parvadha Suntharalingam, Paul I. Palmer, Ryan Field, Daniel J. Jacob

Satellite measurements of atmospheric CO2 will dramatically enhance the coverage of the existing observational network for CO2. These space-based observations, when combined with measurements of other atmospheric trace gases, have to potential to enhance significantly constraints on terrestrial carbon fluxes. We conduct an inversion analysis to assess the utility of integrating future satellite observations of CO2 with space-based measurements of atmospheric CO to quantify fluxes of carbon on regional scales. Using the GEOS-Chem global chemical transport model, we generate a pseudo dataset of space-based measurements of atmospheric CO2 and CO. We perform a coupled inversion analysis to quantify CO2 and CO fluxes, exploiting the correlations between CO and CO2 in the model. Using two different versions of the GEOS-Chem model, with different meteorological fields, we estimate the model error in the simulation of CO and CO2 and the correlations between the errors in CO and CO2. We show that accounting for the correlations between CO and CO2 in the model transport error enables the inversion to better distinguishing between anthropogenic and biospheric fluxes of CO2 on regional scales.

Keywords: carbon

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MS013 **5398 - 5434**

Symposium
Topographic Effects on Weather and Climate (ICDM)

Convener : Dr. Kenneth Gage

This Symposium invites contributions based on observational, (including diagnostic), theoretical and numerical studies of the effects of the Earth's topography on atmospheric circulation, weather, and climate. Topics of relevance include: boundary layer flow over hills, generation of waves and turbulence by flow over complex terrain, variability of dynamical fields over complex terrain, spatial and temporal distribution of mountain induced rainfall, mesoscale orographic impacts revealed by observations, vortex and cyclogenesis associated with orography and their weather impacts, mechanical and thermal forcing of large-scale orography and their regional and global climate effects

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MS013 **Oral Presentation** **5398**

Numerical simulations of precipitation and temperature over Zagros mountain ranges using RegCM3

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P. Irannejad, I. Soltanzadeh

Numerical experiments using Version 3 of the Regional Climate Model (RegCM3), coupled with the Biosphere-Atmosphere Transfer Scheme (BATS), are performed to study the role of topography and land cover of the Zagros ranges in the simulated mesoscale meteorological features over Iran. The simulation domain covers the area between 34 and 63 degree East and 24 and 44 degree North. The simulation period is the winter 1999. The horizontal resolution is set at 45 km 45 km. The boundary conditions are determined from the (United States) National Center for Environmental Prediction (NCEP) - National Center for Atmospheric Research (NCAR) reanalysis. Three sets of numerical simulations are performed in different conditions, with changing the Zagros topography and land-use. For the first (control) run, the present topography and land-cover, as derived from the GTOPO30_3MIN and GLCC3MIN_BATS data, are used. For the second run, the Zagros ranges are flattened and the surface-level elevation of the grid points in the area is set using a linear interpolation between the grid points on the west and on the east of the ranges. The simulations show that excluding Zagros does not change the regionally averaged precipitation considerably, but changes the precipitation distribution by decreasing it in the west and increasing it in the central and eastern parts of the country. In line with theoretical expectations, the analysis also demonstrates the important role the Zagros topography plays in the formation of vorticity and divergence/convergence fields in the lower levels of the atmosphere. For the third run, the vegetation cover of the Zagros area was replaced with that of the desert. The results show that such a change results in only a minor decrease in the precipitation amount and the temperature of the eastern areas of the domain.

Keywords: zagrostopography, numericalsimulations, regcm3

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MS013 **Oral Presentation** **5399**

Regional effects of an elevated heat source: the Zagros Plateau of Iran

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We propose that a heat-driven circulation from th e Zag ros Plateau h as a significant impact on th e climate of the Middle East Pla in (MEP), especially su mmertime winds, air t emperature, and aridity. This proposal is examined in numerical experiments with a regional climate model. Simulations in which the Zagros Plateau was assigned a highly reflective, snow-like albedo neutralized the heat-driven circulation and produced an extra s ummertime warming of 1- 2°C i n the MEP, m easured relative to a control simulation and to the rec ords of the NCEP /NCAR Rean alysis Product. This effect was largest in mid summer, when heating on the plateau was greatest. Additionally, simulations with high albedo on the Zagros showed reduced sub sidence and e nhanced precipitation in the MEP. These sensitivities are interesting because the Zagr os Plateau lies downwind of the MEP. Anal ysis of model results indicates that the sensitivity of the upwind subsidence region to Z agros albedo can be underst ood as a linea r atmospheric response to plateau heating, communicated upwind by a steady heat-driven circulation that influences the thermodynamic balance of the atmosphere. This regional phenomenon adds to the large-scale subsidence patterns es tablished by t he Hadl ey Circulation and the Asian Monsoon. Observed patterns of ve rtical moti on i n the Middle East, then, are a combined product of Zagros-induce d subsidence and hemispheric scale circulations.

Keywords: middle east, topography, climate

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MS013 **Oral Presentation** **5400**

The relationship between topography and some climate parameters

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Alper Anli, Fazli Ozturk

A two phases research has been planned to determine the spatial variability of climate parameters and the effect of topography on climate parameters in non-homogeneous topography. In first phase, statistical relationships like regression equation, coefficient of determination, coefficient of variation between topographical properties (elevation, slope, aspect etc) and climate parameters will be investigated to determine their interaction. In second phase, kriging and co-kriging geostatistical interpolation techniques will be compared to determine which one is more successful for spatial distribution of climate parameters. Elevation will be used as additional covariates in co-kriging. This study will be conducted in Turkey and six different climate parameters (solar radiation, sunshine duration, temperature, relative humidity, wind speed and rainfall) will be used.

Keywords: climate parameters, spatial interpolation, statistical analyze

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MS013 **Oral Presentation** **5401**

Multi-layered wind structure over Tokyo associated with sea breeze circulation

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In the Tokyo metropolitan area, the extended sea breeze originating from the Pacific Ocean frequently prevails on summer sunny days with weak synoptic wind condition. The sea breeze is, therefore, quite familiar to people living in the metropolitan area. To investigate the characteristics of horizontal and vertical wind fields associated with the sea breeze circulation, we observed the daytime wind fields over Tokyo on summer days, using a ground-based coherent Doppler lidar system developed at the National Institute of Information and Communications Technology (NICT). This study analyzed results of the Doppler lidar measurements performed on August 10, 2006 through meteorological analyses and numerical simulations by use of the advanced research version of Weather Research and Forecasting (WRF) model. Results of the meteorological analyses of data from a fine surface observation network and the numerical simulations with a horizontal grid interval of 5 km showed inland penetration of the southerly sea breeze on the early afternoon of August 10. Satellite images by the Moderate Resolution Imaging Spectroradiometer (MODIS) showed the formation of a cumulus cloud band extending along the sea breeze front. The Doppler lidar detected part of the cloud band and strong updrafts when the sea breeze front passed the observation site. A ceilometer and a wind profiler installed in the lidar observation site also observed the clouds and updrafts, respectively. After the passage of the sea breeze front, vertical wind fields over Tokyo had a sharp multi-layered structure. The multi-layered wind structure was composed of 1) the sea breeze layer at altitudes below 0.8 km above mean sea level (MSL), 2) a layer of weak winds at altitudes of 0.81.2 km MSL, 3) the compensatory return flow layer at altitudes of 1.22 km MSL, and 4) a prevailing synoptic wind at altitudes above 2 km MSL. This wind structure, which was not clearly shown by many previous observations by use of piballs and radiosondes, might influence the movement and development of thunderclouds that frequently appear over Tokyo on summer days.

Keywords: wind, lidar, tokyo

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MS013 **Oral Presentation** **5402**

Upstream topography effects on the South China Sea Summer Monsoon

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Johnny C. L. Chan, Yihui Ding, Keith K.C. Chow

In this study, we investigated the topography effe cts of t he Indochina P eninsula (ICP) and the I ndian subcontinent (IND) on the South China Sea summer monsoon (SCSSM) and the subsequent evolution of East Asian summer monsoon using a regional climate model (RCM). S eries of sensiti vity experiments have been conducted by cha nging the indiv idual and combined terrain height (TH) of I CP and IND int o 0%, 25%, 50%, 75%, 200% and 500% of the original TH, respectiv ely. The results show that the topography change can modify the SCSSM and the subsequent evolution of East Asia summer monsoon. This impact works at not only the immediate su rrounding areas, but also regions far away. Wh en lowered the TH, the precipitation decrease mainly restricts at local regions around BOB when decreasing the terrain hei ght of ICP a nd IND individual ly in Ma y, but expands to the broad remote regions of the South China (SC), the Y angtze River Valley , and th e Ko rean penins ula in J une, with the pro minent decrease also occurring at the south tip of IND. Wh ile Results show that uplift of large-scale orography significantly affects the tropical atmospheric and ocea nic climate, by changing the east-west circulation and altering the evolution of the Asian summer monsoon

Keywords: topography, scs summer monsoon, precipitation

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MS013 **Oral Presentation** **5403**

Reflection of global climatic changes on teritory of Bosnia and Herzegovina

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In purpose of ascertain ing correlation wi th global climates changes, we have studied: average an nual temperatures, absolute annual maximum a nd mini mum t emperatures, annual sum of rainfalls and drought in dex. Correlati on wi th global ten dency of climat e h as been shown as foll ow: - We n otice increase of average tempera ture about 0.7oC in th e past 100 years - We notice a r apid increase of absolute minimum temperature in co mpare with va lues of abso lute maximum temperatures. - Annual sum of rainfalls show mild trend of increase - We no tice increase of drought using De Martone index; ref. 1 Bosnia and Herzegovin a stands at t he junction of three main climatic zones, the Mediterranean, mountain and the moderate continental. Periodically, air breaks through mountain barriers to the north and south, bringing dramatically contrasting weather patterns. That is why it was s o interesting to research how global climate changes affecting climate on BiH territory. In last ten years major variability of weather was noticed: quick changes between warm and cold, dry and rainy weathe r etc. It reflects on whole living world, especially on human health. It is recorded in records: absolute minimum and maximum, and quantity of precipitatio n. Esp ecially caused of global warming in the last ten years we were observing different per iods duration of colds and warm waves and precipitatio n variability too . However, rese arches with monthly and dec ade values hadn't give adeq uate results, because extremly warm and extremely cold p eriods are of short dura tion. So, we desid ed to do our researches by pentade's valu es (periods of five days) and compare it with adeq uate values in respective order 1961-1990 year. This metod was enough se nsitive to indica te existence of very warm an d very cold sho rt periods, as also their consecutive fast exchanges, which have the opposite effect on humans health. We encountered about hundred records in different parameters in last ten years.

Keywords: warm, cold, short periods

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MS013 **Oral Presentation** **5404**

A study on urban heat island over greater Tehran area

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Ahmad Asgari, Abdolah Sedaghatkerdar

Cities can be very hot during the summer. On warm summer days, the air in city can be hotter than its surrounding areas. This phenomenon is called the Urban Heat Island. What causes this to happen? Heat islands form as vegetation is replaced by asphalt and concrete roads, buildings, and other structures necessary to accommodate growing populations. These surfaces absorb rather than reflect the suns heat, causing surface temperatures and overall ambient temperatures to rise. The displacement of trees and shrubs eliminates the natural cooling effects of shading and evapotranspiration. A natural cooling process in which water transpires from a leafs surface and evaporates into the atmosphere, reducing ambient temperature. We are concerned about heat islands, because they increase ground-level ozone pollution. It is a harmful pollutant and the main constituent of smog. Heat islands increase energy use, mostly due to a greater demand for air conditioning. In this research, we used the mean monthly temperatures at 03, 09, and 15 UTC in our defined period. These are obtained from meteorological stations over Greater Tehran area. The results show that, heat islands are formed in downtown of the city in the morning and are shifted to its northeast part.

Keywords: evapotranspiration, smog, heat island

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MS013 **Oral Presentation** **5405**

Influence of topographical features and orientation of watershed to dynamics of snow accumulation in mountains

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As is known, mountain systems are sources of freshwater and regulators of river flow (RF). Inflow regime of rivers (glacier-snow, snow-glacier, snow-rain etc.) depends on snow accumulations intensity (SAI) in river basin (RB) and determines dynamics of RF's seasonal distribution. In turn, SAI in mountains strongly varies from topographical features of RB (average height, arrangement concerning a direction of air carry etc.). At the same time, many cases are observed, when inside of RB the strong variation of SAI takes place with other things being equal. Analysis the snow covering's maps in mountain Kyzylcha RB (Tashkent province, Uzbekistan) have shown that under-windy mountain slopes have always much more snow in comparison with slopes, which "meets a wind". One of the main reasons of it is an aerodynamic of RB or its orientation concerning the basic air direction. In particular, at presence of the snow air flow (snowfall) there is an additional snows loss, and the most favorable conditions are observed for snow carry. For account of snow volume, which is transferred to other watershed party, one of the empirical formulas was chosen. In this formula the snow volume transferred through watershed (Ms) is function of the wind speed (Ws), which is equal or more than certain meaning (5 m/s), and time (t), during which the snow loss was observed (at the given wind speed - 5 m/s and more): Ms = f (Ws, t). Comparison the accounts on snow carry via watershed and the snow covering's maps have shown their satisfactory convergence. The basic conclusions of research consist that the aerodynamics laws allow to assume that (with other things being equal) : a) under-windy slopes have more snow in comparison with adjacent slopes; b) at snow weather (snowfall) an increase of wind speed results in increase of snows loss on the under-windy slope; c) at orientation of RB towards to the air flow (RB "is open" to the air flow) basic snow volume should to be accumulated according to along a channel of the river, as a whole); d) at orientation of RB against an air flow (RB "is closed" to the air flow) basic snow volume should to be accumulated in the top part of RB. Depending on topography of RB and wind directioncarry during snowfalls' period various variants of SAI are possible in different parts of RB. Knowledge of the aerodynamics laws and their application concerning a snowfall in mountains allows receive a qualitative estimation of the snow accumulations intensity in mountains.

Keywords: central asia, mountain topography, snow accumulations intensit

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MS013 **Oral Presentation** **5406**

Investigating the effects of topography on the Nigerian weather systems: the rainstorm that wreaked havoc on the Abuja Stadium Velodrome

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Mr. Bennard Orji

Abstract This study attempts to use a full spectrum of in- situ and remot ely-sensed observations fro m meteorological satellite to examine the characteristics of the rainstorm that wreaked havoc on the state-of- the-art velodrome that stood out at the new National Stadium complex, Abuja, Nigeria, on Saturday, October, 2003 , two hours to the closing ceremony of 8th All African Games and socio-economic implication of such damage. Deive and statistical analyses were used to illuminate the features involved in the study. With the aid of meteorologi cal data and s atellite imager y obtained from the Nigerian Meteorological office, it was observed th at th e st orm cold clouds started as small in-situ cells of cumulonimbus clouds in the early ho urs of afternoon over the ro cky high ground areas of the central part of Nigeria. Synoptically, features obser ved also from the NWP products(i.e. chart) show that the storm was initiated due to large thermal forcing over the area, down stream convergence of winds from the ocean observed both at 10m and 900m. Also the evidence of positive vorticity values due to cyclonic turning created around Abuja at 850Hpa chart may have influenced the storm. The storm was not a well defined organized and propagating type due to absence of African Easterly Jets (AEJ) during the period. Also, Inter-tropical discontinuity (ITD) or Inter-Trop ical Convergence Zone (ITCZ) was already dropping southward with the area relatively stable. The main sou rce of en ergy came from insolation, high reflective surfaces provided by the rocky hills that outcrops most of the r egion. The presence of these hills energized the system. The stadium is located at th e win dward or valley of two promin ent h ills (Zuma and Aso), hence the storm may h ave become more vio lent as it descends these hills. Th e maximum gustiness of the storm over the stadium was much greater than 60 k nots. The abse nce of adequate outlets at the velodrome couple d with th is gustiness may have been resp onsible for its destruction; as vortex was likely to have been created inside the velodrome. The rainstorm did not only destroyed property and facilities but also the velodrome of the newly-built stadium being the worst hit. The 8000 seating capacity bowl was shredded into pieces of rags by the heavy winds that accompanied the thunderstorm. Consequently, the multi-million naira wo rth of structure had to be repaired by the construction company at no cost to the nation.

Keywords: rainstorm aej, rocky hills velodrome, satellite imager

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

MS013 **Oral Presentation** **5407**

On Weakly Dissipated Tropical Cyclones over Indochina

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Mio Sugino

Generally speaking, the intensity of tropical cyclones (TCs) rapidly de creases over land . Smaller latent heat flux and larger surface r oughness including orography over land than those over ocean cause this rapid weakening of tropical cyclon es. However, Fudeyasu (2005) reported that a certain number of TCs landed and traverse the Indochina do not die out till they r each the South Asia (ex. the northern India) or the Bay of Bengal. In this paper, TCs landed and p assing over the n orthern Indochina in 1979 to 2005 are studied to extract characteristics of long-lived tropical disturbances or TCs and to find causes of small dissipation rate of their intensity. We compare the vertical structures and attenuating processes using GMS, TR MM, rain gaug e, JRA-25 (JMA/CRIEPI 25 years reanalysis) and JMA Typ hoon Best Track data. The I ndochina is one of the ideal experiment al fields to study attenuation processes of TCs because: 1) It is located in tropics and therefore effe cts of tranformation from tropical to extra- tropical cyclones are n egligible. 2) M any T Cs of variou s ag es land on the Indo china and mov e westward or west-north-westward throughout the rainy seaso n (June-October). 3) Length o f land area is mo re than 1000 km in the zonal direction, which is n early para llel to the direction of TCs m ovements, and is probably on g enough to examin e atten uation proc esses. As a result of our analyis of 98 typ hoons landed Indochina from 1979 to 2005, we found that th e intensity of major part of all ty phoons largely decreases over Annam mountain range just after their landing. However, it is also shown that a certain number o f ty phoons are af fected rather weakly by the Annam ra nge and live lo ngtime o ver the Indochina land mass. We divided all TCs la nded In dochina into a longlived group and a short-lived (normal life) group depend ed on their exponential dissipation ratio s. We compared areas and background humidity of typical cases of b oth grou ps in de tail and found that the longlived members accompanied wider areas of water vapour flux circulat ion and also move into more rich vapour areas. Noticeably some of longlived members increased their vorticity over the middle of Indochina.

Keywords: tropical cyclones, disspiation, indochina

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MS013 **Oral Presentation** **5408**

Resonant response of deep convection to surface hot spots and elevated topography

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Francis Robinson, Yanping Li

Observations show substantial variations of the intensity of tropical and/or summertime deep convection on land th at are not explained by stand ard measur es of convective instability. One feat ure that distinguishes land surfaces is their heterogeneity. The possible importance of this is investigated here by calculating the response of a nonrotating atmosphere to localized, transient su rface heating using both the lin earized equations of motion an d a clou d-resolving configuration o f the WRF (W eather Research and Forecasting) numerical model with moist physics, each in 2D. Both m odels predict that the depth of the resulting surface heat low near storm center will be greatest for a partic ular ho rizontal scale o f heating. The l inear model reveals that t his is a resonant scale deter mined by t he product of the environmental buoyancy frequency, chara cteristic heating time scale , and thickness of the thermal boundary layer, such that the aspect ratio of the he ating matches the r atio of vertical and horizontal wavenumbers demanded by the dispersion relation for buoyancy (gravity) waves. For realistic conditions the resonant horizontal scale is roughly 50 km. The numerical model indicates that o ther measures o f convective intensity, such as updraft speed and storm height, are largely controlled by the depth of the heat low, despite the presence of condition al inst ability and the vigorous growth of moist convective plumes. Predictions here agree with report ed observat ions of storm sev erity over islan ds of differen t sizes. These findings may he lp explain why observed geo graphical variations in st orm intensity defy parcel theory, and indicate that phenomena often attributed to parc el entrainment may instead be d ue largely to stor m-scale dynamical constrain ts. Finall y, we examine the relationship between localize d heating and localized topography in modulating the strength of deep convection.

Keywords: atmospheric convection, geophysical fluid dynamics, cloud electrification

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MS013 **Oral Presentation** **5409**

The Influence of Mesoscale Terrain on Region Climate Change

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Eric Salathe

This paper will describe the results of a series of high-resolution (15-km grid spacing) regional climate simulations made by the MM5 model over the U.S. Pacific Northwest. These simulations were completed for 1990-2000, 2020-2030, 2045-2055, and 2090-2100 by nesting the MM5 with 6-h output from the ECHAM-5 GCM. One of the central goals of this research was to determine the modifications by the regional terrain of the global warming signal apparent in the coarse global GCM. A number of topographic effects will be discussed, such as enhanced warming on mountain slopes where the snow level has risen and the reduction of cooling on the coastal side of major mountain barriers.

Keywords: regional, climate, topography

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MS013 **Oral Presentation** **5410**

Barrier winds and the Ross Ice Shelf air stream across the Ross Ice Shelf Antarctica

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John J. Cassano

The low-level wind field of Antarctica is significantly influenced by the underlying topography. This is particularly true in the Ross Ice Shelf / Ross Sea region. Katabatic winds from the gently sloping Antarctic plateau descend onto the region through the glacial valleys of the Transantarctic Mountains and along the Siple Coast. The steep and confining Transantarctic Mountains, in combination with the cold and stable air masses commonly observed in the region, greatly modulates the air flow associated with cyclones and mesocyclones in the region. This presentation will cover the structure and topographic influences of the low-level wind field in the Ross Ice Shelf / Ross Sea region. Emphasis will be placed on barrier winds along the Transantarctic Mountains and the Ross Ice Shelf air stream (RAS). The RAS is a persistent and strong northward atmospheric mass transport through the Ross Ice Shelf corridor which is associated with barrier winds, katabatic flow, and synoptic influences. The results are based on an analysis of five years of real-time PolarMM5 simulations and a regional network of automatic weather stations (AWS). The combination of these data sources provides a more complete and detailed study than what has been previously available.

Keywords: antarctica, barrier, wind

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MS013 **Oral Presentation** **5411**

Influence of a Viscous Boundary Layer on Trapped Lee Waves

Dr. Francois Lott

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The backward reflection of a stationary Gravity Wave (GW) propagating toward the ground is examined in the linear viscous case and for large Reynolds numbers Re. In this case,the stationary GW presents a critical level at the ground because the mean wind is null there. When the mean flow Richardson number at the surface (J) is below 0.25, the GW reflection by the viscous boundary layer is total in the inviscid limit Re~infinite. The GW is a little absorbed, when Re is finite, and the reflection decreases when both the dissipation and J increase. When J>0.25, the GW is absorbed for all values of the Reynolds number, with a general tendency for the GW reflection to decrease when J increases. As a large ground reflection favors the downstream development of trapped lee wave, the fact that it decreases when J increases explains why the more unstable boundary layers favor the onset of mountain lee waves. The fact that the GW reflection depends strongly on the Richardson number indicates that there are some correspondences between the dynamics of trapped lee-waves and the dynamics of Kelvin-Helmholtz instabilities. Accordingly, and on one classical example, it isshown that some among the neutral modes for Kelvin-Helmholtz instabilities that exist in an unbounded flow when J<0.25, can also be stationnary trapped-wave solutions in the presence of a ground and in the inviscid limit Re~infinite. When Re is finite, these solutions are affected by the dissipation in the boundary layer and decay in the downstream direction. Interestingly, their decay rate increases when both the dissipation and J increase, as does the GW absorption by the viscous boundary layer.

Keywords: trapped lee waves, boundary layer, critical level interaction

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MS013 **Oral Presentation** **5412**

First Results from the 2006 Meteor Crater Experiment (METCRAX)

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The Meteor Crater Experiment (METCRAX) was conducted during October 2006 in the Arizona Meteor Crater near Winslow, Arizona. The crater, a circularly symmetric basin with a 1.2 km diameter and a depth of 165 m, was formed by a meteorite impact 50,000 years ago. The experimental goals were to investigate the evolution of the stable boundary layer within and outside this idealized topographic basin. The observational program was designed to resolve all processes involved in the diurnal cooling and heating of the air contained within the basin. The in-situ and remote sensing equipment, provided mostly by the National Center for Atmospheric Research's Earth Observing Laboratory, included a radar wind profiler with an Radio Acoustic Sounding System (RASS), seven flux towers, a SODAR/ RASS, a rawinsonde sounding system, three tethered balloon sounding systems, 60 temperature data loggers, and seven surface radiation budget stations. During clear nights, a shallow surface inversion with a strength of 5-6 K develops in the lowest 30 m above the crater floor, with an isothermal layer above. Above the height of the crater rim, an additional capping inversion (3-4 K) forms. The air in the crater cools faster than the air above the surrounding plain, leading to a spillage of cold air over the crater rim. However, turbulent eddies shedding off the crater rim frequently lead to mixing within the crater and to erosion of the shallow surface inversion. This presentation will describe the Meteor Crater and its topographic characteristics, the goals and objectives of METCRAX, and the observations. First results from the data analysis will be presented, including the diurnal cycle of cold-air pool buildup and breakup, effects of ambient winds on boundary layer evolution and the role of up- and down-slope flows within the crater.

Keywords: cold air pools, topography

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MS013 **Oral Presentation** **5413**

Topographically forced flows in central California revealed by a network of 25 wind-profiling radars.

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The topography of central California includes the 500 km long Central Valley flanked on the west by the 700 m high Coast range, and on the east by the Sierra Mountains reaching up to 3000 m. Because of the extreme topography, a wide variety of orographically forced flows can occur. As part of the Central California Ozone Study (2000), a network of 25 915 MHz wind-profiling radars was deployed in central California. These profilers provided high-resolution wind profiles in the lowest 3 km, as well as RASS-derived temperature profiles, and the radar moment-derived depth of the turbulent atmospheric boundary layer (ABL). Summer-averaged diurnal time-height cross sections of winds, temperatures, and ABL depths have been computed for each of the 25 profiler sites for a three-month period. Using both the summer-averaged data and daily time-height cross-sections, we document the variability of the mean dynamical fields over the complex topography, as well as the existence of mesoscale vortices, flow splitting, convergence zones, and an up-valley low-level nocturnal jet. Plans to use this data for the evaluation of a regional climate model will be discussed.

Keywords: complex terrain, wind profilers, california

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MS013 **Oral Presentation** **5414**

Coherent Doppler lidar measurements of the sea breeze at Sendai Airport

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Located near the Pacific coast, Sendai Airport is frequently under the influence of a sea breeze that affects the aviation weather. To study the sea breeze at and around Sendai Airport, the coherent Doppler lidar of the National Institute of Information and Communications Technology (NICT) performed measurements of the sea breeze, during the period from August 20 to August 24, 2006. The main objective of this experiment campaign was to obtain a detailed picture of the spatial and temporal structure of the sea breeze around Sendai Airport. The NICT Doppler lidar was stationed 4 km east from the Pacific coast. The NICT Doppler lidar transmits a coherent beam of 2 m infrared light, at a pulse-repetition frequency (PRF) of 100 Hz, with range resolution of 180 m and maximum range of up to 10 km. The vertical-slice scans were carried out parallel to the mean sea-breeze flow and showed the vertical structure of the sea-breeze flow from the surface of the land and sea to several kilometers (usually 1-3 km) above the surface. These scans give radial wind velocities and backscattered intensities in the vertical cross sections. The low-elevation-angle (1 degree elevation) sector/conical scans were also carried out. These scans provided information about the horizontal variability of the sea-breeze flow. On days without interference of morning fog, the development of the sea-breeze layer during morning was detected by the Doppler lidar. The Doppler lidar measurements showed early formation of the layer near the coast and its gradual horizontal and vertical expansion over land and sea. On August 24, the complex structure of the sea-breeze front was observed by the low-elevation-angle sector scans. Near the sea-breeze front, the Doppler lidar detected the strong backscattered intensities in the vertical cross sections, which indicated the low-level cloud development. There was a valuable opportunity to collaborate with another coherent Doppler lidar of the Electronic Navigation Research Institute (ENRI) on August 22 and 23, 2006. The ENRI Doppler lidar was stationed on the rooftop of its Iwanuma Branch about 2.5 km east from the Pacific coast. The ENRI Doppler lidar is operated at a wavelength of 1.5 m, at a PRF of 4 kHz, with range resolution of 29.9 m and maximum range of up to 2.5 km. The vertical profiles of vector horizontal wind up to 1.9km above ground level were retrieved from intersecting vertical-slice scans from the two Doppler lidars. The result of the preliminary dual-Doppler analyses showed the complex stratification of the atmosphere after the passage of the sea-breeze front on August 22.

Keywords: coherent doppler lidar, sea breeze, atmospheric boundary layer

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MS013 **Oral Presentation** **5415**

Stratified shear flow over elliptical mountains: the surface gravity wave drag

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One of the requirements of existing parametrizat ions o f mo untain waves in stratified flo w over orography is a specification o f the surface wave drag. In the Lott-Miller parame trization, for example, this part of drag is based on the calculations of Phillips (1984), which extend previous linear theory results of flow over 2D ridges (Smith 1979) to mountains with an elliptical horizontal cross section. The importance of the effect of vertical w ind sh ear on the characteristics of the surface drag has been extensively reco gnized; ho wever it is no t i n gener al feas ible to calculate the drag a nalytically for complex wind profiles, in order to devise si mple parametr izations. The present stud y addresses the effects of wind shear on the wave dra g exerted by a stratified flow on an elliptical mountain by assuming that the wind varies relatively slowly w ith height, using a WKB approximati on. This approximation must be extended to seco nd-order in the s mall perturbation parameter for the vertical variation of the incoming wind to have an impact on the drag. Using the hydrostatic approximation, and considering a no n-rotating, inviscid fluid , the pro posed mo del pr ovides clo sed-form analytica l expressions for the drag normalized by its va lue in the absence of shear, which are independent of the detailed sh ape of th e orogra phy. T he n ormalized drag depends on a few dimensionless paramet ers involving the fi rst and second derivatives of the wind velocity at the sur face and the st atic stability, a s well as on the aspect ratio of the mountain. This model can be considered an extension of the models of Teixeira et al. (2004) and Teixeira and Miranda (2004), developed, respectively, for 2D and axisymmetric mountains. For simple wind p rofiles, such as a linearly vary ing wind, or a wind that turns with height at a co nstant rate maintaining its ma gnitude, the dependence of the drag on the wind profile parameters is reduced to a dependence on the Richardson number (Ri). The facts that the drag decreases as R i decreases for a linear wind profile, but generally increas es as Ri decre ases for a wind that turns with height, are explained by this simple model. Although some departures from exact linear theory (where closed-form analytical drag formulae do not exist) occur for sufficiently low Ri, the model behaviour is asymptotically c orrect for relat ively high Ri, down to values of Ri of order 1. The drag is found to vary with Ri more rapidly when the surface wind is perpendicular to the major axis of the mountain than when it is parallel. But when the surface wind is at a 45 degree angle to the main axes of the mountain, the compon ent of the drag depending more strongly on Ri is that along the major axis of the mountain.

Keywords: gravity wave drag, elliptical mountains, wkb approximation

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MS013 **Oral Presentation** **5416**

Orogenic Traveling Precipitating Systems in Prediction Models

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At the interme diate grid-spac ing of ~10 km (i.e., next-generation global numerical prediction m odels) deep convection may occur in a hybrid way: implicit by convective parameterization and explicit by under-resolved co nvectively-driven circulations. This hy brid behavior creates issues of a different ki nd than typically associated wit h co nvective parameterization. It has co nsiderable po tential since th e dynamicsof convective organi zation is repre sented to a first approximation by ex plicit circulations. This potential is e xamined In a hierarchical series of sim ulations: clou d-system-resolving simulations represent mesoscale convect ive organization explicit ly, intermediate resolution models involvingthe hybrid approa ch, and idealized dy namical analogs. Warm- season conv ective systems in lee of the Continental Divide of the US cont inent are examined. A first-baroclinic heating co uplet, representing stratiform heating and mes oscale downdr aftcooling, ap proximates important mesoscale aspects o f organized convection and is functionally related to the small-scale convecti on parameterization. The hybrid approach improves the propagation and dyna mical structure of organized precipitating systems and providesa framework for representing organized co nvection in models of intermediate resolution. Moncrieff, M.W. , and C. Liu, 2006: Repr esenting Conv ective Orga nization inPrediction Models by a Hybrid Strategy. J. Atmos. Sci., 63, 3404-3420.

Keywords: hybrid parameterization, mesoscale organization, cloud system models

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MS013 **Oral Presentation** **5417**

Channelling of high-latitude boundary-layer flow

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Strong and variable surface wind conditions are among the main weather hazards in the Arctic. They cause dangerous flying conditions, significant low-level visibility reduction in blowing snow and, through snow accumulation, may block roads and bury entire buildings. Near the coast, where most Arctic communities are located, strong and variable surface winds often have a significant impact on sea state and sea ice conditions, affecting again important transport and travel routes. Due to these hazardous impacts there are concerns about changing prevailing local wind conditions in the context of global environmental change. It is therefore the objective of this study to develop a simple dynamical model that, based only on available surface data, is capable of reproducing the known surface wind statistics at two locations on southern Baffin Island, and to establish linkages with the larger-scale overlying flow. Due to the high stability of the boundary-layer stratification, high-latitude low-level winds over complex terrain are strongly affected by blocking and channelling effects. Consequently, at many low-lying communities in the Canadian Archipelago, including Cape Dorset and Iqaluit considered here, surface winds for the most part are from two diametrically opposed directions, following the orientation of the terrain. Shifts between the two prevailing wind directions can be sudden and are associated with geostrophic wind directions within a well defined narrow range. This close connection between the actual and geostrophic surface wind directions suggests a coupling of the flow below the top of the terrain to the overlying quasi-geostrophic flow. To quantitatively investigate the role of large-scale pressure gradients in the forcing of orographic flow, and to derive criteria for the occurrence of strong winds and sudden wind shifts, a simple dynamical system for the evolution of channelled surface winds is derived from the basic equations of motion, in which stability of stationary along-channel wind directions is described as a function of the geostrophic wind. Based on this stability function, it is shown that, consistent with the observed increase in surface wind speed during extended periods of channelled flow, the conditions for the stability of stationary wind directions are identical with the conditions for positive acceleration. Actual surface winds adjust to a new stable direction as determined by the dynamical system within 3 - 6 h. Over these time-scales and longer it is therefore advantageous to determine the relatively slow evolution of the large-scale pressure distribution, instead of modelling highly variable surface winds directly. The simplified model also offers a tool for downscaling of global climate simulations, and for determining future scenarios for local prevailing wind conditions. However, it does not describe local thermal effects, leading to the formation of anabatic or katabatic wind systems within valleys, or to land sea breezes at the coast.

Keywords: arctic, channelling, flow

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MS013 **Oral Presentation** **5418**

An influence of mountain gravity waves breaking on lee cyclogenesis

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A heuristic mo del is used to study the in fluence of mo untain Gravity Wa ves (GWs) breaking o n lee-cyclogenesis. The model is a Semi-Geost rophic vers ion of theEady model for baroclinic instabili ty adapted by Smith (1984) to study lee cyclogenesis. In this model, the GWs forced by the small-scales of a mountain massive exert a force on the large-scale flow when they encounter directional critical levels (Shutts 1995). This force is taken into account in our model, and produces Potential Vorticity (PV) anomalies in the mid-troposph ere. First, we consider the case of an idealized mountain range such that the orograph ic varian ce is well separated between small-scale and la rge-scale contributions. In the absence of tro popause, the PV produced b y the GW s force has a surface impact that is significant compared to t he surface res ponse due to t he large-scales of the mo untain. For a c old front, the GW s force produces a trough over the mountain and a la rger amplitude ridge immediately downstream. It opposes somehow to the res ponse due to t he large-scales of the mo untain range, which is anticyclo nic aloft and cyclo nic downstrea m. Second, we verify the robustness of the previous result, by a series of sensitivity tests. We change the specifications of the mountain range, and of the back ground flow. We also repeat some experiments by including baroclinic instabilities, or by using t he Quasi-Geostr ophic approximation. Finally, we consider the case of a sm all-scale orographic spectrum representative of the Alps.

Keywords: gravity waves, lee cyclogenesis, turning critical levels

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MS013 **Oral Presentation** **5419**

The effects of the Tibetan Plateau and Iranian Plateau on the Formation of the South Asia High bimodality

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The reanalysisdata show that there exists bimodality in the longitude location of the 100 hPa South Asia High (SAH) during the boreal summer. According to the two preferred regions for the SAH, the SAH is classified into the Tibetan Mode (TM) and the Iranian Mode (IM), respectively. The statistical composites, and case studies, corresponding to the two modes show that the SAH bimodality is strongly related to the climate anomalies over East Asia. The studies on the maintenance mechanism, both from circulation structure and thermal structure, manifest that the SAH has the feature of warm preference. The diagnosis based on the thermodynamic equation further reveals that the TM is closely related to the diabatic heating of the Tibetan Plateau, whereas the IM is more associated with the adiabatic heating in the free atmosphere, as well as the diabatic heating near the surface. A spectral Atmospheric general circulation Model (SAMIL) is used to identify the effects of the land-sea contrast and topographies such as Tibetan Plateau and Iranian Plateau on the formation of the SAH bimodality. The numerical experiments show that, an idealized Eurasiacontinent can itself induce a huge high system over the continent at the high level of the troposphere, which is narrow, weak and southward compared with the observation. When an idealized TP is overlapped on the Eurasia continent, the SAH becomes broader and the center is located right over the idealized TP. Two high centers come out when an idealized IP is further overlapped, which resembles the bimodality of the SAH in observation. The above step-by-step idealized experiments first confirm the fundamental effect of theEurasia continent on the occurrence of the huge SAH in summer. The existence of the huge topography such as Tibetan Plateau and Iranian Plateau play an important role in the pattern variation of the SAH. It verifies the contribution of the dynamical and thermal effects of the Tibetan Plateau and Iranian Plateau on the formation of the SAH bimodality.

Keywords: sah bimodality, tibetan plateau, iranian plateau

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MS013 **Oral Presentation** **5420**

Numerical simulation of the moist stratified flow over an idealized three-dimensional mountain: conditional unstable flow

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The properties of orographically induced precipitation are strongly dependent on the stability and moisture content of the impinging airflow and orographic profile. In present study, a series numerical experiment to the quasi-steady stratified flow over an idealized three-dimensional mountain with an upstream profile of uniform wind speed, constant moist buoyancy frequency and constant relative humidity are undertaken.In the three-dimensional simulation, four flow regimes, which are different from two-dimensional cases, are identified: (1) an downstream propagating convection mode (2) an upstream and an downstream propagating convections mode (3) an over-peak quasi-stationary and an downstream propagating convections mode (4) an downslope quasi-stationary and an downstream propagating convections mode.The sensitive simulation with a lower CAPE sounding demonstrates that the decreased initial convection makes the flow regime shift back to the terrain modified flow as dry cases. The simulations with different aspect ratio and shape of terrain emphasize the importance of convergence in 3-d environment.

Keywords: orgraphyconvectionregimescape

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MS013 **Oral Presentation** **5421**

The Influence of Mountains on the Vorticity Sources of the Southwest Vortex

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Southwest vortex (SWV) is the most important perturbations due to the large scale orographies in China. The michanism of SWV formation and their movement are studied using mesoscale numerical model ARPS. The main parts of China topography, which are very important for the formation of SWV, are simplified as three parts, the Tibetan plateau, the Hengduan cordillera and the Sichuan basin. Ideal constant-stability flows with different wind speed and/or direction are applied to the real and the simplified topography. The simulations show that:There are three vorticity sources contributing to the formation of the SWV, one is along the steep slope on the conjoint region between Tibetan plateau and Sichuan basin (I), one is tailing from the southeast edge of Hengduan cordillera (II), and the third is from the lee trough near the northeast side of Tibetan plateau (III). The distribution and importance of the three sources are corresponding to the climatic statistical regions where SWV formed in high frequency.The contribution of part I is direct and quick, where the Sichuan basin attracts and collects the vorticity around, and finally form a very strong vortex, also it prevents the vortex from moving out the basin till the vortex is violent enough. Part II is main and important for the early-stage movement of SWV. Part III is not obvious as part I and part III, but the lee trough is significant for the subsequent movement and development of the SWV.It is the best condition for the formation of SWV when Sichuan basic locaded leeside of Tibetan plateau and Hengduan cordillera. Both southwest and nothwest wind do not favor the formation of SWV while stronger west flow can make the vorticity inside the SWV a more complex pattern and reduce the stability of the vortex, thus, it willl drift away from Sichuan basin more easily.After the vortex breaks far away but before new vortex forms, a very long vorticity (or potential vorticity) banner can extends over the middle and lower reaches of Yangtse River from the southeast edge of Hengduan cordillera. There are evident vorticity (or potential vorticity) perturbations propagating along the banner. Under certain condition, this may be an effective source of disturbance which can induce severe weather over the middle and lower reaches of Yangtse River.

Keywords: southwest vortex, vorticity source, tibetan plateau

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MS013 **Oral Presentation** **5422**

Numerical simulation of orographic precipitation in Madeira Island

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Two full years of numerical simulations with MM5 and WRF mesoscale models are used to evaluate the performance of those models in quantitative precipit ation forecasts in the Island of Madeira. The two years correspond to one we t year and one dry year, chosen from th e climatological record . The simulations use ECMWF reanalysis data as boundary conditions and results are evaluated by comparison with observations in a network of weather stations, at different altitudes. Simulations test the sensitivity of both models to horizontal resolution, from 6km down to 1km, to vertical resolution, from 20 to 40 levels, and to options in the para metrization of microphysics and bo undary layer. Re sults indicate a positive response to increased horizontal resolution, but, in general, an underestimation of precipitation by MM5 and overestimation by WR F, for the chosen parameters. Some case studies of strong precipitation are studied in more detail, using also the research model MesoNH.

Keywords: precipitation, orographic

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MS013 **Oral Presentation** **5423**

The effect of vertical wind shear on the gravity wave torque and its impact on the planetary angular momentum budget

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The atmosphe re exchanges angular momentum with the surface o f the Earth through different processes and at different horizontal scale s. Gravit y wav e drag plays a very important role at th e mesoscale. Topographic features not explicitly represented in larger scale numerical models may excit e internal gravity waves, which are able to transpor t momentum from the globe to the atmosphere. This generally has a decelerating effect on the mean atmospheric circulation. Recent developments (Teixeira and Mirand a 2004, 2006) made it po ssible to include ver tical wind she ar effects in h ydrostatic non-rotating drag f ormulae analogous to those used in curre nt parameterizati on schemes (e.g .Lott and Miller, 1997). The impact of the inclusion of these effects is estimated h ere using ten years of ERA-4 0 Reanalysis dat a (1992-2001) and USG S GTopo30 topogra phic data. Geog raphical distributions of the gravity wave drag are analyzed, as well as latitudinal profiles of the torque applied on the Earth surface by this force. The seasonal cycle exhibited by these profiles is substantially affected by the i nclusion of shear in the drag formulae. The newly obtained global gravity wave torque time series are also used in conjunction with estimates of the remaining terms (the torques due to form drag, viscous and turbulent stress and the resolved mountains - obtained fr om ERA- 40 data) to analyze the global angular momentum budget.

Keywords: parametrization, wave drag, shear

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MS013 **Oral Presentation** **5424**

The isotopic composition of water vapor and the concurrent meteorological conditions around the northeast part of the Tibetan Plateau

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The stable isotopic ratio of water vapor (δ18O and δD) was measured near July-1st Glacier (39.25N, 97.75E, 4250 m) inNorthwest China. From 11 to 17 August 2003, we collected and then analyzed atmospheric samples at July-1st Glacier (Qiyi) and a base camp (BC), that was 4km from Qiyi. Then the temporal change of the isotopic composition was compared with the atmospheric circulation fields using and European Centre for Medium-range Weather Forecasts (ECMWF) objective analysis dataset. After a snowfall in the early afternoon of the 14th, a strong northerly wind was observed in the evening. The isotopic analysis revealed a clear difference in the evening of 14th, which showed heavierδD (andδ18O) and higher d-excess compared with those of the previous period. The snowfall and the strong northerly wind that followed were identified with the passing of a deep trough that was observed at 500 hPa and dry air from the northwest. A back trajectory analysis revealed that the dry air from the northwest came from the upper troposphere/lower stratosphere. We also found a diurnal change in the isotopic composition. As the day progressed from noon to late evening, the values of δD (andδ18O) became smaller (lighter) and the values ofd-excess became higher. These changes occurred during a northerly valley wind. We suggest here that these changes were observed because BC and Qiyi were located an atmospheric region where the Tibetan Plateau air mass mixes with that from the northerly arid regions. Air from the Tibetan Plateau has relatively high δ18O and δD values (relatively heavy water) and relatively low d-excess values. As the air from the northern desert has relatively small δ18O, relatively small δD values and relatively high d-excess values, the valley wind that prevails in afternoon through evening must be bringing air from the northern desert to our site. We believe that analysis of the isotopic ratio of water vapor should be useful to understand the continental and local hydrological circulation over mountaneous terrains, and to interpret the ice core records in paleo-climatological studies.

Keywords: isotope, tibetanplateau, watervapour

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MS013 **Oral Presentation** **5425**

Mountain waves entering the stratosphere

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Bryan K. Woods, Jorgen Jensen, William A. Cooper, James D. Doyle, Qingfang Jiang, Vanda Grubiić

Using the new NSF/NCAR Gulfstream V and the U. of Wyoming King Air research aircraft, six cases of Sierra Nevada mountain waves entering the strato sphere were surveyed with126 cr oss-mountain legs. The goals were to identify the influence of the tropopause, and to distinguish. background wind layering from wave perturbations. Three of the diagnostic methods utilized the new GPS altitude measurements. In the stratosphere, wind layering was fo und, heaving up and down in the waves, with magnitudes up to 10m/s and vertical scales of 100 to 200m. The ozone and water vapor layering correlated with Bernoulli function and cross-flow speed, suggesting that the stratosphere has a c hemical-dynamical layered texture arising fro m horizontal interleaving. Methods for distinguishing layers from waves are discussed. GPS altitude-corr ected static p ressure was used to comp ute the vertical energy flux , confirming the Eliassen-Palm relation between momentum and energy flux (EF=-U*MF). No jump in MF or EF was de tected at the tropopause. The EQuipartition Ratio (EQ R=PE/KE) jumps across the tropopause, indicating partial wave reflection. In one ca se (April 16, 2006) systema tically reversed momentum and energy fluxes were found in the strato sphere above 12km. An explanation is proposed related to secondary generation near the critical level at 21km.

Keywords: mountain waves, stratosphere

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MS013 **Oral Presentation** **5426**

Orographic precipitation and isotope fractionation

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We estimated the Drying Ratio (DR) for orographic precipitation in the Mendocino Coastal and Sierra Ranges in California using three independent methods. Balloon soundings show a constant ratio of WV fluxes at upstream and downstream locations, giving a DR~32% for the combined ranges. Raingauge data show a constant ratio of precipitation to upstream WV flux, giving DR~30%. Deuterium and oxygen isotopes from streamwater in June and September show a strong fractionation across the ranges giving DR~25% for the Coastal Range and 35% for both ranges. A tuned linear downscaling model suggests that some precipitation enhancement mechanism, such as roughness enhancement probably operates over the Coastal Range. Sapwater isotopes also show a strong eastward fractionation, confirmed the DRs derived from stream water. Compared with the corresponding mountains in South America, the North American case has a smaller DR.

Keywords: orographic precipitation, stable isotopes

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MS013 **Poster presentation** **5427**

Climatology of the low-level wind over the La Plata River Estuary of South America obtained with a mesoscale boundary layer model forced with local weather observations

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A dry, hydrostatic and incompressible mesoscale boundary layer model is used to simulate the low-level wind field climatology over the La Plata River estuary -300 km long and a variable width between 40 km and 200 km. The model climatology is the ensemble result of a series of forecasts, each one obtained by forcing the model with a different upper and lower boundary condition defined from the local weather observations. The upper boundary condition consists of a given value of the wind at the top of the model, defined from the local radiosonde station. The lower boundary condition consists of a surface heating function defined from the temperature observations at the surface weather stations of the region. The study conducted during a 25- year period reveals a general good agreement between the observed and the modeled wind field climatology. Model results are better at the river spring that at the river mouth. The overall rms value of the relative model errors is 35% for wind direction and 21% for wind speed. The errors vary throughout the day, with the minimum in the morning and afternoon and the maximum at night.

Keywords: low level wind climatology, sea land topographic effects, numerical modeling

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MS013 **Poster presentation** **5428**

Promoting Sustainable Human Settlements and Eco-City Planning Approach: Southeastern Anatolia Region and Southeastern Anatolia Project (GAP)

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In the recent years, there have been many opportunities flourishing through the development of Turkey. One of these is unvalued rich agricultural and hydro-sources in the Southeastern Anatolia Region. The Southeastern Anatolia Project (GAP), one of the most important projects to develop the remarkable natural resources of the world, is considered as a chance to make use of rich water and agricultural resources of the Southeastern Anatolia Region. In the recent years, the concept of promoting sustainable human settlements and eco-city planning approach have been included into the GAP Project. And by applying these concepts in real projects caused remarkable results through development of the region. The aim of this study is analyze the concepts of promoting sustainable human settlements and eco-city planning approach in the GAP Project that has been still processed. In the first section, the region of Southeastern Anatolia and the GAP Project will be introduced briefly. In the second section, the stages of GAP Project and the project existing will be analyzed. In the third section, the projects and sub-projects used for promoting sustainable human settlements will be introduced. In the last and fourth section, a series of policies and strategies for providing the process of settlements which is optimal and harmonizes with eco-system will be given.

Keywords: promoting sustainable human se, eco city planning approach, land use

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MS013 **Poster presentation** **5429**

Studying the characteristics of the rainstorm that wreaked havoc on the Abuja Stadium Velodrome using In-situ and Remote Sensing Observation and socio-economic Implications

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Mr. Bennrad Orji

This study at tempts to use a full spectrum of in-sit u and remotely-sensed observations from meteorological satellite to examine the characteristics of the rainstorm that wreaked havoc on the state-of- the-art velodrome that stood out at the new National Stadium complex, Abuja, Nigeria, on Saturday, October, 2003 , two hours to the closing ceremony of 8th All African Games and socio-economic implication of such damage. Deive and statistical analyses were used to illuminate the features involved in the study. With the aid of satellite imagery obtain ed from the Nigerian Meteorologic al office, it was observed that the storm cold clouds started as smal l in-situ cells of cumuloni mbus clouds in the early hours of afternoon over the rocky high ground areas of the central part of Nigeria. Synoptically, features observed also from th e NWP produ cts(i.e. ch art) showed that the sto rm was initiated due to large thermal forcing over the are a, down strea m conver gence of winds fro m the ocean b oth at 10m and 900m. Also the evidence of positive vorticity values due to cyclonic turn ing created around Abuja at 850Hpa chart may have influenced the storm. Th e storm was not a well defined organized and propagating ty pe due to ab sence of Afric an Easter ly Je ts (AEJ) during the period. Inter-tropical discontinuity (ITD) o r Inter- Tropical Co nvergence Zone (ITCZ) was already dro pping so uthward. The main source o f energ y was from insolation , high re flective surfaces provided by the r ocky hills tha t outcrops most of the region. The presence of these hills energizes the system. The stadium is located at the windward or valley of two prominent hills (Zuma and Aso), hence the storm may have become more violent as it d escends these hills. The ma ximum gustiness of the stor m over the st adium was m uch greater than 6 0 knots. The a bsence of adequate ou tlets at the velodrom e coupled with this gustiness may ha ve bee n responsible f or its destruction; as vortex was likely to have been crea ted inside the velodrome. The rainstorm did not only des troyed prop erty and facilities but al so the velodrome of the newly-built stadium being th e worst hit. The 8000 se ating capacity bowl was shredded into pieces of rags by the heavy winds that accompanied the th understorm. Co nsequently, the m ulti-million naira worth of structure had to be repaired by the construction company at no cost to the nation.

Keywords: rainstorm isohyets rocky hill, velodrome satellite imagery, nwp products aej itcz

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MS013 **Poster presentation** **5430**

Troposphere as a wave-guide for buoyancy waves

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Rein Rm

Impact of the thermal stratification and wind distribution to the tropospheric wave-guide formation is investigated. A formerly developed three-dimensional linear model, allowing for optional wind and temperature vertical distributions, is applied to simulate the stationary orographic wave fields in the troposphere and lower stratosphere up to heights 30 35 km. Modelling bases on the stationary solution of a spatially staggered, semi- implicit, Semi-Lagrangian, two-time-level wave equation. The US 1976 standard atmosphere temperature distribution and a model with the constant tropospheric and zero stratospheric temperature lapse rates are applied as the most typical thermal stratification examples. The modelled reference wind fields are linear and hyperbolic unidirectional shear wind profiles. For wave generation an isolated mountain ridge, perpendicular to main wind direction, is applied. The most prominent wave propagation feature is the wave reflection on the tropopause and formation of a tropospheric wave-guide. The wave-guide arrives at the constant wind conditions already. However, a positive wind shear in the troposphere will enhance the guide essentially. A wave-train occurs in the guide which may reach thousands of km-s down-stream if the turbulent dissipation is absent. Secondary effects like a wave-train wiggling can appear in certain conditions. The wiggling occurs at the weak wind shear and disappears with the wind-shear strengthening. The wave-guide formation is accompanied by partial refraction of waves into the stratosphere with propagation of some fraction of wave energy in stratosphere and formation of an elongated, obliquely down-stream propagating stratospheric wave-train. The tropospheric wave-train amplitude is most determined by the intensity of the wind shear. In this respect, the linear and hyperbolic wind profiles with the equal shear have approximately the same effect on wave guide formation. Impact of tropopause and wind shear to the wave-drag size is estimated for different model conditions.

Keywords: buoyancy waves, wave guide, wave drag

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MS013 **Poster presentation** **5431**

Topographic gravity waves in heterogeneous flows

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In the prese nt study we r eview recent develo pments of GWD theory and perform a n umerical estimation of the impact of different neglected te rms in GWD computation, using rean alysis data and GTOPO30 topography. Gravity waves generated by mesoscale top ography are a n important glob e-atmosphere co upling pro cess, being a majo r el ement of the glob al angular m omentum cycle. Parametrization of that process in large scale mode ls has been mostly based on li near theory of homogeneous (con stant U an d N) flow past idealiz ed bell-shaped isolated topography, with empirical corrections for non-linear effects, validated by num erical experiments with mesoscale m odels (e.g. Lott and Miller 1997). Heterogeneity of the background flow, as well as ro tating and non-hydrostatic effects, are generally not considered, due to the lack of simple formulas able to deal with those effects. Recent theoretical an d numerical results (Teixeir a an d Mirand a 2004, 2006), however , have shown the possibility of obtaining appro ximate analytical ex pressions for gravity wave drag pr oduced by non-rotating sheared flo w past iso lated mo untains, usable fo r parametrizatio n purpo ses. Altho ugh no t directly usable as a parametri zation tool, due to its numerical cost, it is also possible to directly assess the importance of rotati on, non-hydrostatic an d anisotropic topogra phic effects in linear GWD estimation, using close numerical formulas (Miranda and James, 1992).

Keywords: gravity wave drag, shear, parametrization

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MS013 **Poster presentation** **5432**

Internal boundary layer structure at the Alcantara Space Center Facilities

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The Internal Boundary Layer (IBL) is an important meteorological occurrence for flows with a step change of the surface roughness. This work presents a numerical study of the IBL formed by a reverse atmospheric step flow with an abrupt surface roughness change, from the sea surface to a continental vegetation cover. So, the flow over the coastal cliff site located in the region of the Alcantara Space Center Facilities (ASCF) (219 S; 4422 W - Brazil) is simulated. This cliff has a height of 50 m and in its neighborhood a rockets launching pad is located. A two- dimensional flow program was used for this study. The governing equations were written using the vorticity-velocity formulation. High order compact finite differences schemes were used for the spatial derivatives. The time integration was performed with a 4th order Runge-Kutta scheme. The step was specified through the immersed boundary method. On the other hand, observational data (ECLICA experiment). showed, through an analysis of (i) peaks of the wind gusts,(ii) the instantaneous amplitude of the wind gusts and (iii) the turbulent intensity measured with anemometers located in towers in the continent (B 50 m and C - 100 m away from the cliff, with heights of 10 and 15 m, respectively), that the IBL height is well defined at the site. It was also noted that the top of the IBL stays between the heights of 4,5 and 9 m anemometers of tower B, and that it is higher than 15 m at the tower C. The numerical simulations were made for the inclinations of 30, 45, 70 e 90 degrees because the cliff presents an irregular form. The results showed the formation of the IBL with a good agreement with the observational data. Also, through this method one may determine the values of the IBL at any distance from the cliff (discontinuity point), and other numerical studies may be carried out to find under which conditions the undesirable effects of the IBL are minimized, especially during the launching of rockets.

Keywords: internal boundary layer, method of immersed boundary, compact schemes of high order

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MS013 **Poster presentation** **5433**

Extreme wind event over Canary Islands related to the extratropical storm Delta: sensitivity study with a limited area model

Mr. Carlos Marrero

Oriol Jorba, Emilio Cuevas, Jos Mara Baldasano

Abstract On 28-29 November an extratropical storm affected Canary Islands causing significant damage related to high sustained wind and intense gusts over some islands of the archipelago. Delta was the twenty-sixth tropical or subtropical storm of the 2005 Atlantic hurricane se ason. I t represents an unusual meteo rological pheno mena fo r that regio n, and its impacts where underestimated by the different meteorol ogical f orecasts (ECM WF an d HI RLAM) prior the arri val of the l ow near Canar y Islands. In this contributi on, a sensitivity study is perfor med with the Advanced Res earch Weather Research & Forecasting Model (WRF -ARW) to analyse the causes of the development of high inte nse winds registered in several islands of t he archipelago. The islan ds of Tenerife an d La Palma were th e most affected. The maximum wind gust r ecorded at La Palma was over 45 m/s, an d at Tenerife th e maximum gust at the coast was around 35 m/s an d ov er 60 m/s in mountain top. A total of 30 simulation cases were designed modifying the dimens ions of the do main of study, the ho rizontal and vertical resolution (27 to 1 km horizontal resolution, 31 to 61 vert ical layers), an d the p hysical parameterizations. The wide range of simulations allows us to explor e the role of the topography in such extreme event, and it helps to identi fy the major factors that contribute to the development of strong winds and gusts. Variations in vertical static stability, vertical windshear and the intense synoptic winds o f the so uthwestern part o f Delta were th e main characte ristics that contributed to the development and amplification of intense gravity wa ves while the larg e-scale flow in teracts with the complex topography of the islands. The ensemble re sults depict the vari ability of the numerical model used while applying different available configurations. The surface wind flow variability is discussed, and the major sensitivity parameters of the model configuration are identified.

Keywords: mesoscale modelling, delta extratropical storm, sensitivity study

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MS013 **Poster presentation** **5434**

Mountain lee waves and their sensivity to the orographic shape

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A multi-layer analytical lee wave model and a 2D nonlinear non-hydrostatic numerical model are used to study idealized lee waves, a nd assess t he r elative im portance of nonline ar effe cts in the dynamics of these waves. The analytical mode l, previously validated with published results for a symmetric orography, was adapted for flows over arbit rary obst acles. The numerical model, which is suitable for simulating flows from the mic roscale up to the meso scale, was validated against experimental and field data relevant f or Engineering and Meteorological a pplications. The present results show that, in non - linear conditio ns, lee waves are very sensitive to asymmetries in the orography, so that their wavelength and amplitude change significa ntly with incre asing asymmet ry, and present an upstream shift, when compared with analytical solutions. The an alytical model showed very little sensitivity to the orography asymmetry, suggesting a poor response in many real flows.

Keywords: lee waves, orography, multi layer

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MS014 **5435 - 5458**

Symposium
Interactions of Land Cover and Climate (ICCL)

Convener : Prof. Meinrat O. Andreae

Land cover both responds to the climate and affects the climate, and these interactions are a major focus of the IGBP core project Integrated Land Ecosystem Atmospheric Processes Study (iLEAPS). Changes in land cover are now recognized as a factor that has contributed to changes in climate on all scales from local to regional and even global. This symposium invites papers on the full range of topics relating to the interactions of changes in land cover and condition and in climate, including changes relating to deforestation, agriculture, and other development; feedbacks relating to albedo, roughness, carbon storage and fertilization, trace gas fluxes, and other biogeochemical cycles; and impacts relating to ecosystem shifts, melting of permafrost, and water resources and soil moisture

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MS014 **Oral Presentation** **5435**

Interactional effects of land cover and rainfall on soil moisture regime and sediment yield in Northeastern Region of India

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The vegetation type and density is mainly influenced by the amount of rainfall and human interventions, besides other climatic factors like temperature. Changes in water regime are linked with climatic fluctuations as well as environmental changes over time. So, the precipitation, vegetation and groundwater quality and quantity are interlinked and the extent of linkage has spatial and temporal variations. The northeastern region of India, having an area of 255090 km2, is predominantly hilly. The average annual rainfall is 2450 mm, varying in time and space. Mismanagement of rainwater has rendered the whole hydrological set-up in the region in a fragile state. This is further aggravated by the prevalence of shifting cultivation in an annual area of 386 9 km2. This land use practice, in which the land vegetation cover is bare minimum, results in about an annual loss of 88.3 million tones of soil and 225 thousand tones of nutrients from the region. This has caused denudation of hill slopes and, silting of river channels and floods in the plains. Since, shifting cultivation involves deforestation and in-situ burning of forest material, and more and more area is being brought under the practice to sustain fast growing population, a declining trend in rainfall has been recorded due to decrease in vegetation cover over land and other resource depleting anthropogenic factors. A multi-disciplinery, long term investigation is in progress in northeastern region to study, intra alia, the interactional effects of land cover and rainfall on the sediment yield, soil moisture regime, groundwater recharge and runoff. The land cover (uses) are ; livestock based (maize for fodder, oats, rice-bean, pea, guinea grass, tapioca etc.), forestry (Alder exbucklandia, Albizia lebbek, Acacia auriculiformis etc.), agriculture (rice, maize for grains, ginger, beans etc.), agro-forestry (forest and agricultural crops), horticulture (guava, citrus, pear, lemon and vegetable crops) and shifting cultivation (mixture of crops). The sediment yield varied from 9 to120 tkm2 in livestock based land use to 1300 and 4580 tkm2 in shifting cultivation, when the annual rainfall was 1992 mm and 2705 mm, respectively. The annual runoff varied from 15.7 mm to 416.2 mm due to the interactional effects of land cover and precipitation. Minimum soil moisture up to 20cm soil layer, was 5.6% and maximum, 27.2% in October due to various land covers and amounts of rainfall. The groundwater recharge varied from 149 mm in shifting cultivation to 1328 mm in land covered with grasses and fodder crops. Significant variations in sediment yield, groundwater recharge, moisture regime and runoff were observed due to land cover in different land use systems and amount of the rainfall received.

Keywords: landcover, rainfall, interaction

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MS014 **Oral Presentation** **5436**

Impact of a greener West Africa on the Mediterranean climate.

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Dalu Giovanni, Segnalini Maria

On the global scale, the total incoming solar energy is almost perfectly balanced by the energy radiated by the Earth towards outer space. However, even if the imbalance between the shortwave solar radiation and outgoing longwave radiation is small on a global scale, it can bring significant changes of the climate trend. On a time scale of 10000 years or longer, this trend were mainly due to the natural internal processes or of extraterrestrial origin; while, on a time scale of a millennia or of a century, man may have had a significant role, specifically on the regional climate variability in regions we have targeted. At this space scale, the variability results from rather complicated nonlinear feedbacks between many scales. In the last ten thousand years there have been substantial land surface changes in northern hemisphere. In fact 8000 thousand years ago glaciers covered the land as far south as 45-40 degree north. While, 5000 thousand years ago, North Africa was vegetated and enjoyed a reasonable humid climate, and the Middle East was fertile and cultivated, presently North Africa and the Middle East are in large part deserts. In the last few millennia the regional climate has changed from cold to warm several times, favouring the blooming or dooming important civilizations in regions of the Northern hemisphere. Several clues suggest a decline of solar activity during the Maunder Minimum (about 1645-1715) caused a decrease of the radiative forcing of some where between -0.5 and -1.5 W/m**2. Subsequent rise of solar activity to the present level may have contributed to the Little Ice Age and to the warming thereafter. Solar forcing since 1850 has been tentatively estimated at between +0.1 and +0.5 W/m**2. These causes and their synergies, like the changes in the orbital parameters of the Earth and the changes of the interaction between atmosphere, vegetation and the oceans have been certainly the major actors in the greening of Sahara in the middle Holocene, mainly due to a strong vegetation - precipitation feedback and the abrupt desertification of North Africa around 5500 years before present. It is well known that the main centres of the low wavenumber atmospheric planetary wave activity are in the North Pacific North America region and in the North Atlantic Eurasian region. The phase and the amplitude of the se planetary wave pattern have a paramount impact on the storm track position upstream of the North America and of the Eurasian continents, and, therefore, on the distribution of the temperature and precipitations in these areas. The atmospheric perturbations are sensitive to the meridional distribution of the zonally averaged atmospheric flow, but on a regional scale, the patterns of these perturbations are very sensitive to the non-zonal component associated to low wavenumber planetary waves. Using a low resolution model of the atmospheric dynamics on a sphere, we examine the impact of a greener North Africa on the deformation of the large scale westerly flow over the North Atlantic and the Mediterranean region, and on the large scale easterly flow over North Africa. Specifically we investigated on the relative position and intensity of the North Atlantic anticyclone and on the anomaly of the position and intensity of the Libyan high induced by a more northerly penetration of the West Africa monsoon.

Keywords: land atmosphere interactions, regional climate, landuse landcover change

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MS014 **Oral Presentation** **5437**

Urbanization and climate change in Varadero

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Scientist Group Researcher

Varadero beach is located in the Hicacos Peninsula in the north coast of Matanzas province in Cuba, the biggest island in Caribbean Sea. Varadero is one of the most important touristic places in Caribbean. It has around 20 km in length and around 1-2 km in width; its height is between 5 10 m above sea level. The physic-geographic conditions in Varadero make it vulnerable place to environmental change. Its geographic position, its exposure to sea-level arise, flood, drought, changes in temperatures, sunshine, winds, hydrology, its fragile ecosystems, the natural resilience, are aspects of its natural vulnerability to climate change. The antropogenization process, and the land cover change analyzed trough of urbanization more the touristic exploitation evolution add new and deeper vulnerability to this natural vulnerable space. Its human settlement, its economy and its ecosystems make Varadero a vulnerable place to global change. A sight to the climate change analysis in Varadero allow know about variability in the climate in last decade in Varadero, future climate scenarios, determinate vulnerabilities and impacts in tourism, the main economic activity, and social and environmental vulnerabilities and impacts. This work, analyze the physic-geographic and socio-economic diagnostic, the future perspectives, the climate variability and future climate change scenarios, the natural vulnerability, its evolution with the antropogenization process, the potential impacts by climate change, and with the information develop adaptation measures addresses to the future sustainability in Varadero.

Keywords: antropogenic vulnerability, impacts, adaptation

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MS014 **Oral Presentation** **5438**

Estimation of a vertical flux of fine-dispersed arid aerosol in the absence of dust storms

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Systematization of experimental studies an d correlation analysis of measu rement resu lts allow on e to distinguish thr ee different st ates that char acterize correl ations between the mass c oncentrations of particles of different fractions: (1) wind removal, (2) thermo-convective em ission, and (3) intermediate state, when the elements of (1) and (2) ar e present. On the basis of the analysis of measurements of fine-dispersed (less than 0.4 mcm) desert aerosol outflux under the assumption that the mechanism o f air mixing in the atmo spheric near- surface layer at a la rge vertical temperature gra dient (surface temperature 50-60C, relative humidity 20- 30%, wind speed 2-3 m/s) almost do es not differ from th e mechanism of free convection, the fo llowing empirical for mula is prop osed to est imate th e ou tflux of fine-dispersed (less than 0.4 mcm) desert a erosol at relative humidity < 0,3 and cloud amount < 2: F=k*[T(2)-T(0.5)]^(1/2)*(dC/dz), wh ere F is th e vertical f lux of fine-d ispersed particles from an ari d surface, k = 0 ,0325m2/(K*s), (relative humidity at a height of 1,5 m, in %,), T is temperature (a t heights o f 0, 5 m and 2 m) , and C is the mass co ncentration o f fine- dispersed particles (<2 мкм at heights of 0,5 and 2,5 m). With the use of this formula, a quantitative e stimate of th e outflux of fin e-dispersed arid aerosol is obtained: F = 0.2 mcg/(m^2*s) for a vertical flux of particles from an arid surface. The lower atmospheric bo undary layer has been sounded (in the Tsimlyansk region) with the acoustic locator Latan-3 soda r developed at the A. M.Obukhov Institute o f Atmo spheric Physics, RA S under the conditions close to those of desert areas in Kalmykia. Under convection, the diameters of the horizontal sizes o f intermittent hetero geneities at a heigh t of 50 m above the underlying surface are between 10 an d 500 m. The vertical velocity of floa ting structures range s between 0.5 and 2 m/s. A special system with the use of an aerosol chamber with a laser aero sol co unter LAS (an auto matic instrument) measuring mass concentration s of aero sols has been deve loped to carry out laborator y experiments on fine-dispersed arid aerosol emissions. A qualitative chemical analysis of samples is made with the use of an X-ray unit for a spectral analysis (SPEKTROSKAN MAKS-G). The investigations were supported by the ISTC project 3032, RFBR grants RF 0 5-05-90596-NNS_a, 06-05-65 270-a, 06-05-08086-ofi-a, and 06-05-65216-a.

Keywords: aerosol, outflux, estimation

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

MS014 **Oral Presentation** **5439**

Climate change and water resources in Central Asia: what can we speak earnest about?

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Now there is no expert who would have arguments against fact of global air-temperatures increase (ATI). It is proved that XX century is the warmest century of the left Millennium, and 1990s are warmest decade of XX century. The disputes are reduced basically concerning sizes of ATI and its consequences for human ability to live. In particular, according to various Climate Changes Models (CCMs), ATI is expected in limits 1.4-5.80 C to 2100 in comparison with 1990. In this context, to the external and easily proved factors it is possible to relate: for global scale - observable for last decade destruction of the Antarctics shelf ice, and for regional scale - reduction of the glaciers' area in Pamir and Tang-Shan mountains in Central Asia (CA). CA concerns to regions with sharp water deficiency, therefore questions of ATI influence on water dynamics and other factors connected to water use are rather important. The Aral Sea Basin (ASB) is a part of CA. The ASB surface water resources (WRs) are equaled 116.5 km3/year for the multi-year period, from which in the Syrdarya river basin (RB) 37.2 km3, and in the Amudarya RB 79.3 km3 are formed. Regional CCMs show that during nearest 25 years essential WRs change will not take place in the ASB, for Amudarya RB their reduction is expected about 2-4 %, and for Syrdarya RB it is increased on 3-4 %. As it is visible they are in limits of mistakes of river flow's measurements). However, for the relatively small RBs the essential changes of WRs can be observed. E.g., in the Chirchik-Akhangaran RB (CARB; watershed area - about 22000 km2), wich is located on the territory of Kazakhstan, Kyrgyzstan, Uzbekistan, increase of river flow (RF) can make up to 6-8 % (Chirchik river), and reduction of RF - up to 6 % (Akhangaran river) during the vegetation period (April-September). In this connection, the following questions concerning consequences of climate change in CARB are represented as deserving attention: a) reduction of glacier areas on 15-20 % to 2030; b) reduction of RF's glacier part on 3-5 %; c) Increase of RF's rain part on 7-10 %; d) reduction of the snow covering; some others. Accordingly, RF's seasonal dynamic will change considerably, and the repeatability of the high waters phenomena will be raised. At the same time, such consequences require critical consideration: a) growth of the air-drought in the summer months; b) change of vegetation of irrigated plants; c) change of growth rate and efficiency of agrarian cultures; some others, which depend on weather conditions. Variability of the weather parameters (air temperature, humidity, etc.) is much more for various years and seasons, in comparison with changes, which are predicted by experts on climate.

Keywords: central asia, climate change, water resources

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MS014 **Oral Presentation** **5440**

Photosynthesis, respiration and isoprene emission in relation to rising temperature and drought kinetics in one-year-old Populus nigra saplings

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Isoprene is the most abundant hydrocarbon released by plants. Isoprene influences the oxidative capacity of the troposphere (Zimmermann et al., 1978) and it is a substrate for ozone production in polluted air (Chameides et al., 1988). Global Change events such as drought coupled with rising temperatures, may have contrasting effects on biogeochemical carbon cycles (Fang et al., 1996), regarding both photosynthetic carbon assimilation and isoprene emitted by forests (Sharkey and Loreto, 1993). To improve our understanding on the acclimatory responses of isoprene emission (IE), photosynthesis (A) and respiration (R) to rising temperatures and soil water availability (FASW), we grew one-year-old Populus nigra saplings at two different temperatures (25 and 35 C). IE and A did not acclimate to high temperatures. In well-watered non-stressed plants, high temperature doubled IE and decreased A by 30%, whereas R acclimated to high temperatures showing a not significant increase of 15%. Moreover, plant photosynthetic activity started to decrease at FASW of ~75% and ~85% at 25C and 35C respectively. Drought did increase the IE to A ratio, because IE was inhibited with a slower kinetics than A at the two different temperatures. We conclude that future warmer and drier climate will 1) significantly increase trophospheric isoprene load depending on the severity of drought, and 2) strongly reduce photosynthetic carbon assimilation.

Keywords: isoprene, photosynthesis, drought

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

MS014 **Oral Presentation** **5441**

CO2, heat and water vapor profile within a canopy in a tropical rain forest at Peninsular Malaysia

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The ambient CO2 concentration ([CO2]), air temperature, and relative humidity of a tropical rain forest at Pasoh, Peninsular Malaysia, were measured intermittently over a 3-year period from the forest floor to the top of the canopy. Diurnal changes in the storage fluxes showed no obvious seasonality. The CO2 storage flux (Sc; μmol m-2 s-1) decreased after sunrise and reached its negative peak earlier than the CO2 eddy flux measured over the canopy (Fc; μmol m-2 s-1). The sensible heat and latent heat storage fluxes (Qa and Qw; W m-2) increased with the eddy fluxes measured over the canopy (H and λE; W m-2), and reached their positive peaks earlier than the eddy fluxes. Mean diurnal Sc, Qa, and Qw ranged from 12.7 to 3.2 μmol m-2 s-1, 15 to 27 W m-2, and 10 to 20 W m-2, respectively. Compared to the ranges of mean diurnal Fc (14.7 to 4.9 μmol m-2 s-1), H (12 to 169 W m-2), and λE (1 to 250 W m-2), the contribution of these storage fluxes, especially in the case of CO2, is significant and should be considered when estimating gas exchange between the forest and the atmosphere. At night, the friction velocity (u*) increased while [CO2] decreased, especially at lower heights, and the contribution of Sc to the net ecosystem exchange (Fc+Sc) was reduced; however, Qa and Qw were not heavily influenced by u* at night. On the other hand, as the cumulative solar radiation increased, the amplitude of the diurnal changes in Qa and Qw generally increased, while Sc was largely unaffected. We conclude that Sc is higher in tropical rain forests than in other forest types due to excess CO2 produced by nocturnal respiration in the ecosystem and by a lack of air mixing at night. The nighttime contributions of Qa and Qw were similar to those in other types of forests due to the lack of a sizable source/sink.

Keywords: storage, flux, exchange

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

MS014 **Oral Presentation** **5442**

Monitoring of climatic changes effects on forested areas by satellite remote sensing

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The climate system responds in complex ways to changes in forcing that may be natural (e.g., variations in the magnitude of solar radiation reaching the top of the atmosphere) or human-induced (e.g., changing atmospheric concentrations of greenhouse gases).Climate-induced changes at the land surface (e.g., through more intense and higher frequency droughts) may in turn feed back on the climate itself, for example, through changes in soil moisture, vegetation, radiative characteristics, and surface-atmosphere exchanges of water vapor. Forest systems situated in the neighborhood of large urban areas are very sensitive to local, regional and global climatic change. Studies of their biophysical attributes are crucial to understanding the dynamics of forest ecosystems under human disturbance. Knowledge on biophysical properties of forest vegetation retrieved from satellite images enables to improve monitoring changes due to anthropogenic and climatic influences. The study covers a forested area situated in the north-eastern part of Bucharest town, Romania. The research aims at establishing the changes in biophysical parameters from optical and micro wave satellite images provided by IKONOS, Landsat TM and +ETM, MODIS and SAR. Thresholding based on biophysical variables derived from time trajectories of satellite data is a new approach to classifying forest land cover via remote sensing at coarse resolutions. This approach is attractive because it is much simpler than conventional alternatives. Further, it operates on biophysical variables and thus should be more robust than more data dependent techniques. The input data are composite values of the Normalized Difference Vegetation Index (NDVI). Associated with these values are radiances in three thermal bands that are used to estimate surface temperature. The classification algorithm, accepts mean growing-season NDVI, mean growing- season near- infrared radiance, NDVI amplitude and surface temperature as input parameters for the composite NDVI and surface temperature data. The units recognized are broad life-form vegetation classes, such as evergreen needle leaf forest, evergreen broadleaf forest, shrubs, etc. They are compared to a ground truth map.Classification accuracies are variable, depending on the class and the comparison method as well as function of season of the year. Our analysis indicates a potentially application of threshold techniques to land-cover classification and changes analysis due to climatic effects as well as for forest biomass assessment. Specific aim of this paper is to assess, forecast, and mitigate the risks of climatic changes on forest systems and its biodiversity as well as on adjacent environment areas and to provide early warning strategies on the basis of spectral information derived from satellite data regarding atmospheric effects of forest biome degradation .

Keywords: climatic changes, forest system, satellite remote sensing

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

MS014 **Oral Presentation** **5443**

Coupling of drought and C emissions from biomass burning in Indonesia

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Biomass burning due to land cover change in Indonesia represents a singularly large source of C emissions at a global scale. The most severe burning is associated with agricultural activity in peatlands, which due to draining, have reduced ability to retain soil moisture. As a result, these large C pools are susceptible to deep sub-surface combustion during anomalously dry periods. In this study, we quantified the relationship between drought and severe emissions from 1997 to 2005 for five key regions in Indonesia. We also considered the extent to which C emissions estimates prior to 1997 could be reconstructed using a novel interpretation of synoptic meteorological records. Monthly C emissions data were obtained from the Global Fire Emissions Database (GFED), which combines several sources of satellite-detected hotspots with a biophysical model to estimate emissions of aerosols and trace gases. Monthly indicators of drought were obtained from 3 different sources: the NCEP gauge-based Global Land Precipitation dataset (PRECL), the NASA satellite-based Global Precipitation Climatology Project dataset (GPCP) and the NCEP moisture balance-based (SOILM) dataset. Using a non-linear piecewise statistical model, we determined that severe emissions are threshold-driven and occur during positive ENSO phases. The biggest emissions source was southern Kalimantan, which represented 74% of the 420 Tg emitted during the September peak of the 1997 haze disaster. In this region, the model was extremely well fit (r2 = 0.93), and used to determined that severe emissions events have occurred when the 3-month total rainfall was less than 460mm. Over eastern Kalimantan (r2 = 0.84), the most severe burning was associated with a 3-month total of less than 210 mm, and over southern Sumatra (r2 = 0.95), with a 4-month total of less than 340 mm. In southern Papua (r2 = 0.99), previously unidentified as a major emissions source, the most severe burning was associated with a 5-month total rainfall of less then 540mm. Importantly, severe emissions in central Sumatra were not closely associated with any of the moisture indicators and appear decoupled from the local climate. In general, the use of satellite-derived GPCP rainfall provided a clear advantage over the gauge-based estimates, whereas the more sophisticated soil moisture model was not useful. This has important implications in the development of operational drought-monitoring systems used to evaluate the risk of severe haze.Furthermore, we determined that the GFED emissions estimates for several key regions are strongly correlated with the atmospheric extinction coefficient derived from visible range observations. The C emissions in southern Kalimantan, for example, were highly correlated (r2 = 0.96) with the extinction coefficient in the city of Palangkaraya. This relationship was used to identify a 94Tg event in September of 1982 and a 76 Tg event in September of 1994, compared to the September 1997 peak of 146 Tg. The drought conditions under which these earlier events occurred was consistent with the threshold estimated from the GFED data.

Keywords: biomass burning, emissions, indonesia

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

MS014 **Oral Presentation** **5444**

Modelling impacts of land-use on regional climate: uncertainty due to model parameterisation and changes in vegetation parameters

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As an Australia-China bilateral proj ect on climate change for studying i mpacts of land-use and la nd-surface processes on regional and global climate, this study presents res ults from a series of Australian Bureau of M eteorology Research Cen tre (BM RC) clim ate model simu lations of lan d-use in on region al climate and Australia-Asian monsoon system. Six pa irs of 54-yr BMRC model integrati ons using mult i land-surface co nfigurations allo w us to explo re the de gree of uncertainty in the model land-use simulations caused by land-surface modelling itself. The climate impa cts of land-use are assessed by applying two sets of surfac e vegetation datasets in the model: one represents current vegetation coverage in and the other approximates its potential vegetation coverage without human intervention. A pair of 5-me mber ensemble simulations has been conducted to allow us to c ompare the model-simulated land-use signal to its in trinsic variability. Results showed that imposed land-use changes ca n alter regional climate simulated by the model, larg ely du e to changes in surface albedo and surface roughness. Such processes are affected in only a secondary manner by different land-surface modelling configurations. Furthermore, using a n extreme vegetation change scenario by replacing all its potential vegetation with mixed farming, the model-simulated reduction in summer monsoon pr ecipitation and the cooling effect in northern winter season are nearly doubled, while the warming effec t in its summer season remain the same. The spatial patterns of the model responses become more manifested but the underlining physics and dynamics remain the same which further reaffirm the processes identified in the model previou s simulations. Due to strong rainfall variations in the Asi an monsoon, l and-use climate impacts operate effectively under two differ ent regimes of surface energy balance: radiation-controlled and e vaporation-controlled. During its sum mer seaso n, b ecause o f larg e mo nsoon rainfall, the LU C effect on surf ace energy ba lance is evaporation-co ntrolled. Reductio n in surface ev aporation is the primary factor, together with changes in cl oud radiat ive f orcing, in explaining the war ming effect i n surface. While, in its winter time, the role of surface evaporation becomes weak and changes in surface energy balanc e due to LUC is more radiatio n-controlled, with the in creases in surfac e albedo in LUC leading to a reduction in surf ace net radiation and a net cooling effect of LUC. Acknowledgement: Part ofthe study is co nducted under an Australia- China climate change bilateral project between BMRC and China Meteorological Administration and supported by the Australian Greenhouse Office.

Keywords: land use, china, uncertainty

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MS014 **Oral Presentation** **5445**

Effects of Land-Use Pattern on the Bidirectional Ammonia Exchange between the Atmosphere and Biosphere

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Ammonia is a major contributor to secondary aerosol formation in the atmosphere. Ammonium aerosol affects Earths radiative balance, both directly by scattering incoming radiation and indirectly by acting as cloud condensation nuclei. Ammonium aerosol can cause regional atmospheric pollution, decrease visibility, and affect human health. The bi-directional exchange of ammonia between the atmosphere and biosphere can influence the nitrogen status of terrestrial and aquatic ecosystems, and can cause shifts in plant species composition. The heterogeneities of the Earth surface caused by land-use patterns affect the atmosphere-biosphere ammonia exchange. A new multi-layer canopy resistance model for the bi-directional ammonia exchanges is couple with the Land Information System (LIS), and is used to investigate this effect. We examined effects of land-use change on the bi-directional ammonia exchange in the southeast region of where is characterized by relatively high ammonia emissions originating from animal production and fertilizer use, and high ammonia depositions. The results are analyzed and discussed in this study.

Keywords: land, ammonia, exchanges

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

MS014 **Oral Presentation** **5446**

Assessing the climate impact of a large water reservoir

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In February 2 002, the lock gates of the new Alqu eva dam in the Guadiana River in Portugal were closed, establishing a water reservoir that will cover an area of 250 km2. It will be the largest European artificial lake. The impacts of the Alqueva Lake, st udied with the aid of simulations of the mesoscale model MesoNH (Lafore et al., 1998), were shown to depe nd critically on the water surface temperature. The MesoNH model, like most me soscale and weather forecast mode ls, doesnt include an explicit representation of the evolution of lake temperature, which is maintained constant over the integration period. An im proved represen tation of th e lake physical processes is needed in order to bette r understand wa ter balance in the Mediterranean climat e.Existing 1D lake mo dels, as LAKE (currently being developed by Lykossov and Stepanenko at Moscow Univ) and FL AKE (developed by Mironov at DWD and curr ently operational within the DWD Lokal Model), have been tested and cal ibrated for the Alqueva reservoir. Ini tial c onditions, atm ospheric fo rcing fields and other required parameters have been provided by in-situ observations. Model output , namely the evolution of temperature profiles and of the surface temperature will be compared with observed profiles and s urface temperature obtained by remote sensing.Some numerical experiments with the mesoNH atmospheric model coupled with t he lake model have been perfor med in order to study th e impact diurnal cycle of lake temperature on the local atmospheric boundary layer structure.

Keywords: lake models, mesoscale, evaporation

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

MS014 **Oral Presentation** **5447**

A new approach of oxygen data acquisition and methods of data interpretation (the measurement system plant vital□ 5000)

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The experiment was carried out to get inf ormation about the dependence of the sev eral groups o f plants on temperature varia tion. Oxygen is very important element f or life on the Earth, it has photosynthetic origin. P hotosynthesis keeps th e O2 co ncentration co nstant in the atmosphere, in the ocean. Oxygen takes part in th e formin g of oz one layer of molecules of water an d carbon dioxide participating in the hothouse effect. The ex periment was passed in the f ield and under lab conditions, with plants of C3-type. As the control condi tion, the basic reaction of plants, meteorological information about the air and soil (surfa ce) temperature was us ed. The other para meters of mea surement were kept constant l ight, quantity of material under inve stigation. The works were carried out in Strausberg (Germany), near Berlin. To collect data the measurement system Pla nt Vital 5000 was used. The O2 sensor of electrochemical a Clark type. The oxygen concentration in the target (small disc of leaf) in the dark and unde r illumination is recorded and can be described by 10 pa rameters. For the analysis of parameters variation the statistical methods were us ed, al lowing us to determine the distribution of parameter values and marked out the dependence on temperature variant s (5, 15, 25, 3 5) at meadow grasses, water plants, conifers trees, leaf-bearing tr ees and agricultural plants. The work allowed us to create models of ch anges i n oxygen prod uction plants, which are det ermined by temperature. The results of this research can b e adopted in the collec tion of data abou t oxygen, modeling of process of oxygen dynamics and stress reactions of plants.

Keywords: oxygen, plants, modeling

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

MS014 **Oral Presentation** **5448**

Assessment of irrigation requirements of the Chemlali Olive Tree conducted under environmental conditions

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Water scarcity in the Mediterranean region is reinforced by severe climatic conditions especially in arid and semi arid regions. In , Tunisia added to limited water resources, irrigated lands were being very extended. To asses the most suitable period for irrigation is very important in order to better manage water use. The water requirements of olive tree (Olea europaea L. cv Chemlali), during growth and rest phases, were assessed in fifteen-year-old olive trees grown under environmental conditions in arid region characterized by high temperature and high light intensity. Trees were subjected to three irrigation treatments, I0, I1 and I2 corresponding respectively, to 0, 33 and 66% of Crop Evapotranspiration (ETc) by a drip irrigation system , taking rainfall into account. Water deficit (I0) affected enormously photosynthetic performances and water status of rain-fed plants, if compared to irrigated ones, during growth phase and to a lesser extent in the rest phase. Photosynthesis and stomatal conductance of rain-fed plants were respectively 57 and 40% lower than those conducted under milder water contribution (I1). For all treatments, the maximum of photosynthetic activity was reached during the intense vegetative growth phase. As well in rain-fed plants, net photosynthesis (Pn) of irrigated ones was reduced during the rest phase occurring under harsh environmental conditions. The water supply would not be the only survival factor for these plants; it will be without benefits for photosynthetic performances activities if applied under unfavourable climatic conditions inducing the rest phase of the olive tree. Under critical conditions, olive trees reduce their activity and have to enter in a rest phase in order to avoid damaging its survival mechanism. Indeed, high relationships were determined between photosynthetic activity and air temperature and light intensity. In I0 treatment, olive yield (26 Kg/tree) was statistically lower than those of irrigated plants (35 and 37 Kg/tree, respectively in I1 and I2). On the light of these results, we can assume that the most suitable period for olive tree irrigation is the vegetative growth phase. The non statistically slight differences in olive yield between the irrigated treatments will not cover the expenses of water loss when applying water supply at 66% of ETc, especially in arid region characterized by scant and irregular rainfall. Water supply at 33% of ETc could meet the needs of the Chemlali olive tree without impairing photosynthetic performances; and thus growth, and olive production.

Keywords: arid region, olive tree, water requirements

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

MS014 **Oral Presentation** **5449**

A 50-Year-ago of climate change in the South of Tunisia: an assessment for the future

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The climate of a region is the average weather which is experienced over a long-period of time. Rainfall and temperature are the most important e nvironmental parameters determining the location c limate. Climate change of , located at the northern part of Africa , was controlled for a-half-century period from 1952 to 2005. During the first 25 years, the temperature and precipitation average were about 19C and 300mm, respectively. For the last 25 years (from 1978 to 2005), the te mperature a verage was at 2C higher tha n t hat characteriz ing the period between 195 2 and 1977. The increase i n temperature average was accompanied with a decrease in precipitation average (200mm). The important evapotranspiration rate, due to the increase in air temperature, and the decrease in rainfall amount led to the extensio n o f salinize d lands, u nfavourable for the cultivation of most cultivated crops, and limitation of w ater resources. The landscape of the south of expresses well the aridity of this region. Such tendencies are develope d for the cultivation of salt-tolerant crops an d such programs are planed for the management and the reuse of waste water.

Keywords: arid region, olive tree, water requirements

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

MS014 **Poster presentation** **5450**

An impact of carbon/nitrogen interaction on the feedback between climate and a terrestrial carbon cycle.

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A number of observational studies indicate that the carbon uptake by terrestrial ecosystem and its response to changes in climate conditions depends on interaction between carbon and nitrogen dynamics. However, many of the terrestrial ecosystem models used for climate change study do not take this effect into account. We study the global impact of carbon/nitrogen interaction on the feedback between climate and a terrestrial carbon cycle by means of numerical simulations with Earth System model of intermediate complexity. Two versions of terrestrial ecosystem model (TEM), with (standard version) and without interaction between carbon and nitrogen cycles were used in this study. Feedback between the climate and terrestrial carbon cycle is examined by comparing results of Earth system model with various climate sensitivities to an increase in atmospheric CO2 concentration. Our results show that the interaction between terrestrial carbon and nitrogen changes both the sign and a magnitude of the feedback. In the simulations with the carbon only version of TEM, surface warming significantly reduces carbon uptake by both soil and vegetation leading to the positive carbon cycle - climate feedback. In contrast, if gross primary productivity is limited by nitrogen availability, climate change related increases in carbon uptake by vegetation exceeds an increase in soil carbon decomposition. As a result, the feedback between climate and terrestrial carbon uptake becomes negative, with the exception of very strong surface warming (in conjunction with high climate sensitivity) when terrestrial ecosystem becomes a carbon source. In spite of that, for small or moderate increase in surface temperature standard version of TEM takes less carbon than the carbon -only version, resulting in a larger increase in atmospheric CO2 concentration for a given global carbon emission.

Keywords: carbon cycle climate feedback

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

MS014 **Poster presentation** **5451**

Large Seasonal Swings in Leaf Area of Amazon Rainforests

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Despite early speculation to the contrary, all tropical forests studied to date display seasonal variations in the presence of new leaves, flowers and fruits. These past studies were focused on the timing of phenological events and their cues, but not on the accompanying changes in leaf area which regulate vegetation-atmosphere exchanges of energy, momentum and mass. Here we report, from analysis of five years of recent satellite data, seasonal swings in green leaf area of about 25% in a majority of the Amazon rainforests. This seasonal cycle is timed to the seasonality of solar radiation in a manner that is suggestive of anticipatory and opportunistic patterns of net leaf flushing during the light rich dry season and net leaf abscission during the cloudy wet season. These heretofore unknown seasonal swings in leaf area are critical to initiation of the transition from dry to wet season, seasonal carbon balance between photosynthetic gains and respiratory losses, and litterfall nutrient cycling in moist tropical forests.

Keywords: phenology, biosphere atmos interactions, remote sensing

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MS014 **Poster presentation** **5452**

Evaluating the impacts of climatic and land use/cover changes on hydrological processes with a hydrological and vegetation dynamic coupling model in a large basin of the Loess Plateau

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The hydrological processes and vegetation dynamics are intimately coupled. The vegetation conditions are varying from year to year due to climatic variability, especially the precipitation, in the semi-humid and semi-arid catchments. A process-based model that couples the hydrological processes and vegetation dynamics is developed to investigate the responses of hydrological processes to climatic and land use/cover change in Wuding River Basin, a large basin of the Loess Plateau, China. Datasets of vegetation leaf area index derived from Terra-Modis products are used to illustrate the annual variation of vegetation conditions. Since the mid of last century, the annual mean air temperature in the basin tended to increase and precipitation appeared no tendency, but with a lower amplitude of annual variation in the basin. From the simulation, it is shown that the actual evapotranspiration had similar tendency with precipitation, whereas the vegetation net primary productivity (NPP) increased with a rate of 0.6 gC m-2 a-1, and water use efficiency increases due to fertilization of air CO2 enrichment. The simulations also show that vegetation cover fraction responses noticeably to precipitation pattern and distribution, which may cause as high as 8% of total discharge. Under scenario of the cropland turning into grassland, the stream flow is affected significantly. The annual amounts of stream flow are also sensitive to precipitation variations by increasing from 11% to 25% with 10 % precipitation increment. The research shows the necessity to incorporate the vegetation dynamics in hydrological modeling for reliable predicting the impact of climatic and land use/cover changes on hydrological processes.

Keywords: hydrological processes, vegetation dynamics, climate change

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

MS014 **Poster presentation** **5453**

The land-use changes in the Brazilian Amazonia and the consequences on the regional precipitation over southern South America for the 2071- 2100 period, as evaluated with the regional climate model precis

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Currently the major problem in the Brazili an Amazon ia is deforestation . This is a common practice resulting carried out for crop land expansion , e.g. , 3,6 millions hectares (ha) during 2001-2004. The Brazilian state of Mato Grosso has both the highest deforestation rate and t he l argest soybea n production increase since 20 01. This state alone accounted for 87% of the increase in cropland area, and 40% of new deforestation during this period alon e. Important land-surface changes in the northern part of South America have occurred, sim ilar to other regions of the World. Neverthele ss deforestation is more intens e there. The landuse cha nges of such magnitude co uld pro duce negative effects in the region's climate, due to cha nge in albedo and mo isture, which could result in changes in soil and atmospheric humidity, convective activity, hydro logic cycle and other effects at a regional level. In this work the Regional Climate Model PRECIS (Providing Regional Climates for Impacts Studies) developed for The Hadle y Center UK is used. This m odel has a ho rizontal reso lution o f 50/25 Km and vertical resolution 19 levels and r uns with the HadAM3P, HadAM3P A2, HadAM3P B2 datasets . Model runs a re carried out evaluate the effects of land-use changes in the Brazilian Amazon in the deforested area itself and over North and Central A rgentina (Chaco and the Pampas) during a 30 years period (2071-2100). The climate parameters analysed are primarily precipitation and relative humidity, also the consequences like drought, flooding and changes in regional precipitation

Keywords: deforestation, land use, precipitation

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

MS014 **Poster presentation** **5454**

The influence of irrigation and urbanization in the climate of the metropolitan area of Granada (South-Eastern Spain): a case study of the 2003 heat-wave

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Anthropogenic land-use changes can have a substantial impact on the climate of the earths surface. Replacing natural vegetation or irrigated land with roads and buildings alters the local surface properties and, therefore, the energy balance by increasing sensible heat fluxes and decreasing latent heat fluxes. As a consequence, urban development alters the climate at local and regional scales. Intensive irrigation is used extensively in southern Spain to overcome rainfall deficit in summer, resulting in unnaturally high evapotranspiration fluxes. In this work we analyze the influence of irrigated land on the climate of the metropolitan area of Granada. This urban area with 500.000 inhabitants extends over 400 km2 of a mostly flat region surrounded by several mountains ridges, including the Sierra Nevada in the eastern part of the area, with the highest peak in the Iberian Peninsula (Mulhacen, 3479 m). In the central part of this metropolitan area there are roughly 150 km2 of irrigated agricultural land. A byproduct of the agricultural activities in this area is that this urban area shows an artificial mild climate during summer, particularly regarding the minimum temperatures. The metropolitan area of Granada has experienced rapid and extensive changes in land use over the last 20 years, replacing irrigated areas by urban areas. It is expectable that the urban growth will continue within the next decade, possibly at an even higher rate. In this work we have evaluate the impact of the irrigated land in the summer climate of the large urban area of Granada. In particular, we analyze the effect on climate of the agricultural activities during the 2003 heat-wave by using the PSU/NCAR mesoscale model MM5. Three 72 h 1km resolution simulations were performed, one of them using current land uses and the others using future land use scenarios characterized by an increased urban area. Results show an increment in surface and air temperature, especially at night, which affects both the modified area and their surroundings in the two scenarios compared to current land uses. These results are in agreement with the fact of that the observed mortality rates in Granada during the 2003 heat-wave were substantially lower than those observed in nearby regions. This fact reflects, at least partially, the impacts of the irrigated area surrounding Granada. Since the 2003 heat wave event seems to be consistent with projected climate changes, these results could be regarded as a warning for what the combined effect of land-use changes and climate change could give rise in urban environments in the Mediterranean region.

Keywords: land use changes, granada spain, heat wave

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

MS014 **Poster presentation** **5455**

Modeling the regional climate impact of boreal lakes

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It has long been known that the land surface plays a crucial role in the global climate system. Processes governed by complex topogr aphy or heterogeneitie s in surface vegeta tion and soil properties are frequently a nalyzed using high reso lution regio nal climate models coupled with elaborate soil-vegetation-atmosphere transfer (SVAT) schemes. Such s chemes model the moisture and energy balance of soil, vegetation and sn ow, generally incorporati ng a sophisticated treatment of radiative and turbulent exchange with the overly ing atmosphere. One surface type that is normally disregarded in climate models is lake, even though it is well known that fluxes of heat, moisture, and momentum can be significantly different in the presence of open wa ter. This is due to the large diff erence in heat capacity, roughness le ngth, and albedo of water compared with nearb y soil and vegetation, as well as differences in the vertical transfer of heat in the water column compared with that on land.In this study, the impact of boreal lakes on the regional climate is eval uated though a series of mu lti-year regi onal climate model experiments over central Canada. High resolution (~ 25 sq uare km) is ac hieved through a cascading sequence of simulations in order that the boreal lakes are resolved on the model grid. Lake surface tempe ratures and ic e cover are specified in this initial series of experiments based on the NOAA/University of Miamis 4 km resolution AVHRR Pathfinder project, and the gross impact of the lakes on the local b oreal climate is estimated by compar ison with control sim ulations where the lakes have been replaced by soil and v egetation consistent wi th the nearby la nd s urface. B ecause mo st bo real lakes are sub-grid scale in current generati on c limate and numerical weather prediction models, th e development of a 1-dimensional lake parameterization module for the SVAT used in Canadian models, known as the Canadian Land Surface Sch eme (CLASS), will also be d iscussed. This m odel (iteratively) computes the surface energ y balance a nd solves the 1- dimensional he at equatio n u nder specified atmospheric forcing. Turbulent mixing is parameterized based on an integ rated turbulent kinetic energy approach developed in the 19 80s for modeling lake and oceanic mixed la yers. The model represents a tile in the land surface mosaic of CLASS.

Keywords: lakes, modeling, climate

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

MS014 **Poster presentation** **5456**

Mesoscale simulations of the land-surface effects of historical deforestation in a moist continental climate regime

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Jason Butke, Daniel J. Leathers, Kevin Brinson, Elsa Nickl

An enhanced knowledge of the feedbacks from land-surface changes on regional climate is of great importance in the attribution of climate change. To explore the effects of deforestation on a mid-latitude climate regime, we conducted three ensembles of simulations using the Pennsylvania State University/National Center for Atmospheric Research Mesoscale Model (MM5) coupled to the NOAH land-surface model. These simulations represent landcover conditions across northern Pennsylvania (in the mid-Atlantic United States) before and after extensive logging occurred in the late 19th century. The pre-logging ensemble assumes a vegetative cover composed of an evergreen needleleaf forest, while post-logging experiments prescribe sparse vegetation and bare ground to simulate clear cut logging. A third ensemble represented current landcover conditions with a deciduous broadleaf forest. An ensemble of five one-month integrations was conducted for both summer (August) and winter (February) under each landcover scenario. The results of these experiments show a distinct seasonality in the response of the climate system to deforestation, with much stronger effects arising during the summer. In August, deforestation causes a repartitioning of the surface energy budget, beginning with a substantial decrease in the latent heat flux (>60 W m-2) across the landcover forcing area. Concomitant with this decrease in evaporation, sensible heat flux increases and the mean two-meter air temperature warms by approximately 1.5C. Increases in sensible heat flux lead to a 100 meter increase in the height of the atmosphere boundary layer over the deforested area. Surface atmospheric mixing ratio and convective precipitation decrease under clearcut conditions. Interestingly, average soil moisture to a depth of 1.5 meters increases due to reductions in vegetative interception and transpiration. The February simulations showed the effects of deforestation in low-sun months to be mostly insubstantial. The strong response of the climate system to deforestation implied by these simulations suggests that surface changes can appreciably affect regional climates. Thus, the role of human-induced and naturally occurring landcover variability should not be ignored in the attribution of climate change.

Keywords: deforestation, land surface feedbacks, regional climate

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

MS014 **Poster presentation** **5457**

Evaluating Modeled Vegetation Phenology Over North American Continent With Satellite and Ground-based Observations

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The two-way interaction between vegetation and atmosphere plays an important role in global energy, water, and carbon cycles. The strong seasonal and interannual variability of leaf area index (LAI) and its vegetation-dependent spatial heterogeneity influences the short-term weather forecast and seasonal climate prediction. Therefore prognostic simulation of land-atmosphere interaction with respect to climate variability and change is crucial, and requires realistic representation of transpiring leaves in response to diurnal, seasonal, interannual, and longer-term changes in weather and climate. In this paper, three existing prognostic phenology models are selected to simulate vegetation growth over North American continent. These include the Community Land Model version 3 CLM3-CN, CLM3-DGVM, and the Simple Biosphere Model Version 2.5 with Growth Season Index (SiB2.5-GSI). Derived from North American Regional Reanalysis (NARR) product, the gridded atmospheric forcings covers entire North American Continent at 32-km grid-spacing, and spans a time period from1979 through present at a 3-hour time-step. Measurements from the AmeriFlux network will first be used to exam NARR data, then to validate CO2, water, energy, and momentum fluxes simulated by three selected models. Both ground-based LAI measurements (at points) and satellite remote sensing NDVI product (spatial) will be used to evaluate three models capability to reproduce the observed vegetation phenology, and to improve the phenology parameterization schemes in three models. Our initial effort will focus on process-scale at eddy flux tower sites, then aggregate to increasingly large area of North American Continent. The models sensitivities of simulated LAIs and surface fluxes in response to interannual temperature and precipitation variations will also be analyzed. Our ultimate goal is to build a multi-scale vegetation modeling system with prognostic vegetation phenology that can address the strong spatial heterogeneity, the seasonal and interannual variability of vegetation distribution and its associated biophysical parameters within the terrestrial water and carbon cycle.

Keywords: vegetation phenology, climate variability, models and observations

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MS014 **Poster presentation** **5458**

From biogenic through anthropogenic emissions: changes in the patterns of wet and dry deposition in Brazil

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

Wet and dry deposition plays an essential role in the functioning of the biogeochemical cycles of carbon and nitrogen since it acts as a source of nutrients to ecosystems. This paper describes the relationship between biogenic emissions from tropical forests and the concentration of organic acids and nitrogen in rainwater and aerosols. We also address ed how the anthropogenic activities are changing the concentration and deposition patterns of ca rbon and nitrogen in . For that, it was colle cted rainwater and aerosol (fine and coarse mode) samples in different sites in Southeas tern Brazil and in Amazonia . Land cover and land-use c hanges are probably responsible for the spatial variability found in precipitation and aerosol chemistry. As a consequence of the anthropogenic activities significant rainfall acidity was detected (VWM pH = 4.5). The origin of the free acidity in rainwater is different in each site and come out to be linked to the land cover. Organic acids appear to control the acidity in remote areas while in other sites inorgani c acidity has been dete cted. In addition, land-use chang es, mostly the conversion of primary forest to pastu re or croplands by biomass burning, are altering the concentration and the patte rn of organic acids in rainw ater. Th e com position of rai nwater and aerosols in the disturbed sites appears to be controlled mostly by t wo sources: biomass burning and industrial emissions, and in the remote areas by biog enic emissions and marine influence. Additionally, nitrogen deposition was significantly higher in the disturbed sites and organic ca rbon deposition was significantly lower in these sites. Indeed, N wet deposition increa ses from an an nual rate of 3.0 kg .N.ha-1.yr-1 in pristine areas to an annual rate o f 5. 6 kg.N. ha-1.yr-1 in disturbed regions. Mo reover, the pattern o f organic acids such as the rate of formate to acetate also has been changed due to biomass burning. We can anticipate that these large perturbations in the nitrogen and carbon deposition patterns hav e important deleterious consequences for the ecosystem functioning.

Keywords: land use changes, atmospheric deposition, brazil

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

MS015 **5459 - 5519**

Symposium
Extreme Weather and Climate Events: Past Occurrences and Future Likelihoods (ICCL)

Convener : Dr. Lisa Alexander
Co-Convener : Dr. Xuebin Zhang

The vulnerability of society to climate variability and change is likely to depend more on changes in the intensity and frequency of extreme weather and climate events than on changes in the mean climate. This is the case because extremes usually have strong impacts on society and a small change in the mean condition can cause a large change in the likelihood of an extreme. This symposium invites papers that document past occurrences and future projections of extreme weather and climate events, especially as a result of changes in the climate and other factors. Papers reporting on observed changes, comparisons with model-simulated changes, projections of future extremes, physical processes leading to extremes, and quantification of uncertainties are invited

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MS015 **Oral Presentation** **5459**

Climate change impact assessment on Indian water resources

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Sandhya Rao

The initial ana lysis had reve aled that the GHG scen ario may deteriorate the conditio ns in terms of severity of dro ughts and intensity of floods in various parts of the countr y and that the re is a general reduction in the quantity of the available runo ff under the GHG sc enario. This pap er presents the detailed analys es of two rive r basins with maximum effe ct with respec t to dr ought and floods. The National Communication (NATCOM) project was undertaken by the Ministry of Environment and Forests, Government of India to pr epare Indias initia l communi cation to the UNFCCC . On e of the sub-components of the study was to quantify the impact of th e climate change on the water resources of India and wa s handled by the a uthors. A distri buted hydrological model namely Soil and Wa ter Assessment Tool (SWAT) has been used on all the major river basins of the country but for t he Brahmputra river basin. The study uses the HadRM2 daily simulated weather data for control (present) and GHG (future) conditions to determine th e water yield under the res pective scenarios. A total of 40 years o f simul ation o ver 12 river basins of the co untry have been c onducted, wherein 20 ye ars belonging to control and the remaining 20 years for GHG climate scenario. The predictions of the impact of climate change on the water resources were made with the assumption that the land use s hall not change over time. Moreover, the impact of manmade changes such as da ms, diversions, etc. were also not incorp orated in this pre liminary study. Each river b asin has also been further s ubdivided into reasonable sized sub-basins so as to account for spatial v ariability of input as well as outputs. It has been observed that the impa cts of climate change are no t unifo rm o ver the co untry a nd are varying across the river basins as well as within the basins. The initial analysis re vealed that th e GHG scenario may deteriorate the prevailing variability of the river basins. There a re basins whe re severity of droughts is pr edicted to inte nsify in future and on the ot her hand there are basins where intensity of floods is going to increase resulting in frequency and ma gnitude of flooding. This pap er presents the detailed analy ses of two river basins wit h maxim um e ffect with respect to drought and floods respectively. Since the last si mulations were made , the Hadley Centre has come out with a revise d version namely HadRM3 o f th e simulated w eather da ta for control and G HG. The paper also presents the differences the new version creates in the assessment of climate change impacts in the two selected basins.

Keywords: climate change, water resources, swat model

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MS015 **Oral Presentation** **5460**

Heat waves, drought, death, and wildfire: linking climate extremes and impacts in the extratropics

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Starting from the IPCC AR4 Working Group I assessment of climate and weather extremes, the link between changes in extremes and changes in their impacts, in the extratropics, is discussed. Heat waves and drought are two climate extremes that appear to have increased in recent decades, are expected to continue to increase, and have the potential to cause severe impacts in the extratropics. Three examples of studies to determine whether changes in climate/weather extremes have been leading to increased impacts are presented. The first study relates to extremes of daily temperatures. The link between hot days/nights and increased mortality is demonstrated for Melbourne, Australia. A threshold has been identified above which excess mortality of the elderly occurs. This threshold does not represent short-term mortality shifting. Then the pattern of changes in temperature extremes across Australia is examined, to determine if there is evidence that changes in these extremes might be leading to increases in heat-related deaths. The second and third examples relate to the influence of drought on suicide rate and on wildfire. The evidence linking Australian drought to suicide and to increases in wildfire is presented, and the question of whether increased drought in recent decades could be leading to increased fire and/or suicide is considered. Drought does lead to increases in the suicide rate, and drought (as well as temperature) is linked closely to wildfire behaviour. Thus, an increased propensity to drought might be expected to lead to increased suicide and wildfire. However, in all these cases (heat-related mortality, drought-related suicide, and wildfire) the link between climate change and impacts is somewhat complex, even if the link between climate variations and the impact variable is straightforward.

Keywords: climate change, climate impacts, climate extremes

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

MS015 **Oral Presentation** **5461**

The climatic importance of South Atlantic hurricane Catarina (2004)

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Ian Simmonds

Sea Surface Temperatures (SSTs) warmer than 26.5oC and Environmental Vertical Wind Shear (EVWS) lower than 8 m/s offer ideal conditions for Tropical Cyclone (TC) development. Thus it has been accepted that hurricanes could not form over the South Atlantic Ocean due to the very intense climatological EVWS and not sufficiently warm SSTs over the basin. This concept is now under review after Catarina hit southern Brazil in March 2004 after undergoing Tropical Transition (TT) over relatively cool waters. This was the first documented time when a system reaching a category I hurricane strength (Saffire-Simpson scale) made landfall anywhere in the South Atlantic basin (Pezza and Simmonds 2005). This is not to say that a phenomenon like Catarina had not existed in the past, but there is evidence that at least during the satellite era this is unprecedented. Catarina generated much discussion and controversy in the community as to how it should be named (which also depends on cultural backgrounds) and as to what its hybrid structure really was. This hurricane represents a mark in Southern Hemisphere meteorology prompting the weather services to improve their forecasting and alert system in a time of climate change. It also draws the attention of the global meteorological community for the increasing need to develop a more modern system of classification of cyclones. Pezza and Simmonds (2005) proposed a large scale blocking mechanism leading to persistent low EVWS to explain how this extremely rare event was formed, and such ideas have recently received further support in the literature (McTaggart-Cowan et al 2006). A possible hemispheric link with the positive phase of the Southern Annular Mode (SAM) has been found, pointing out to the possibility of more frequent storms if the SAM continues to increase under global warming conditions. We are currently working on further evidence for this association and the new results will be communicated in the peer-reviewed literature. Advances in modeling and the local observing network are expected to throw further light into a possible hurricane (and extreme weather and climate events in general) climate prediction scheme for the region in the future. McTaggart-Cowan, R., Bosart, L., Davis, C.A., Atallah, E.H., Gyakum, J.R. and Emanuel, K., 2006: Analysis of hurricane Catarina (2004). Monthly Weather Review, 134, 3029-3053. Pezza, A.B., and Simmonds, I, 2005: The first South Atlantic hurricane: Unprecedented blocking, low shear and climate change. Geophysical Res. Letters, 32, doi:10.1029/2005GL023390.

Keywords: tropical cyclones, blocking systems, souther annular mode

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MS015 **Oral Presentation** **5462**

Analysis of recent changes and potential future developments of the wind, wave, and storm surge climate: the North Sea area

Dr. Ralf Weisse

Hans Von Storch, Andreas Pluess, Katja Woth, Frauke Feser, Heinz Guenther, Iris Grabemann

A comprehensive analysis of the regional wind, wave and storm surge climate for the North Sea area is presented. The analysis is based on a consistent series of high-resolution multi-decadal hindcasts and climate change scenarios for the atmosphere, ocean waves (sea state) and storm surges. In addition, observed and reconstructed storm indices are considered. It is first shown that the met-ocean hindcasts reasonably describe the observed conditions, in particular the statistics of extreme events. It is further demonstrated that the storm activity as well as related changes in ocean wave and storm surge statistics have undergone considerable variations in the recent past but exhibit no clear trend. From the climate change scenario runs climate change signals for wind, waves and storm surges are determined and assessed against the long-term variability estimated from the hindcasts. In addition, uncertainties caused by the application of different models as well as different climate change scenarios are quantified. For storm surges, rather similar climate change patterns that exceed the variability estimated from the hindcasts were identified among all models and scenarios. For the sea state, the uncertainties caused by the application of different models are of the same order of magnitude as the signals themselves. Although the method has been applied here to assess regional climate change projections for the North Sea it may be applied in a similar way to other regions as well. An outlook for application in the Baltic Sea area will be given.

Keywords: wind storms, ocean surface waves, storm surges

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MS015 **Oral Presentation** **5463**

Analysing the present, past and future Tropical Cyclone activity, as simulated by a suite of IPCC Coupled Global Climate Models

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Colin Jones

Tropical cyclones (TCs) are a temperature dependent phenomenon, forming only over tropical waters exceeding a threshold of ~ 26C. Hence, it is anticipated that an increase in tropical Sea Surface Temperatures, as a consequence of increased concentrations of greenhouse gases, will have an impact on these systems. However, since TC development is also influenced by other climatic factors, their response to increasing levels of greenhouse gases is extremely complex. The exact nature and sign of any future changes in TC activity remains an open question. Since Global Climate Models (GCMs), due to their coarse resolution, cannot resolve TCs, studies that have looked at the response of TC-like systems in GCMs with increasing levels of greenhouse gases have often produced contradictory results. To circumvent this problem a different approach is pursued here, whereby the temporal evolution of the main large-scale climatic fields controlling TC formation are analysed and used to infer the number of TCs in a given basin. This approach appears more suited to the present resolution of GCMs. The main variable used in our study is the TC Yearly Genesis Parameter (YGP), pioneered by Gray (Gray, 1975). The YGP consists of 6 large-scale parameters, 3 dynamical and 3 thermal, the variability of which have been shown to correlate strongly with annual numbers of TCs at the ocean basin scale. A second, similar large-scale parameter, the Convective-YGP (Royer et. al. 1998) has also been used. In the Convective-YGP the 3 thermal parameters (SST threshold, mid-tropospheric relative humidity and the vertical gradient of moist atmospheric stability) are replaced by a single parameter, the model-simulated convective precipitation. The YGP and Convective-YGP can both be used to infer basin-scale TC activity. We first analyse the YGP and Convective-YGP for the period 1983-2002 derived from the ERA-40 reanalysis data, to show that they both give a reasonable global number and spatial distribution of implied TCs when compared to observations. We then investigate the 20th century climate of six GCMs whose simulations were submitted to the IPCC for the 4th assessment report. This is done to establish that the GCMs give a reasonable estimate of the present (1983-2002) number and geographic distribution of TCs. We further extend the GCM analysis backwards in time, through the 20th century, to investigate if the models suggest a trend in inferred TC numbers. Finally we assess the trend in inferred TC activity in the six GCMs, using 3 different emission scenarios for each GCM (a total of 18 realisations of future TC activity). This allows a probabilistic estimate to be developed for potential future TC activity as given by the YGP and Convective-YGP and to determine if statistically significant changes are predicted by the GCMs.

Keywords: tropical cyclone, gcms, yearly genesis parameter

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MS015 **Oral Presentation** **5464**

Crossing scales and crossing swords: Climate extremes, proactive decision-making and adaptive management in practice

Dr. Roger Pulwarty
IAMAS

Societal impacts of changing environments include primary or direct effects (increased/decreased soil moisture, loss of life, crop and building damage etc.), secondary or indirect effects (displacement, illness) and, higher order or systemic effects (debt, loss of livelihood, environmental degradation). The progression of vulnerability to changing events is constructed from: (1) the timing, magnitude, spatial extent, and duration of the physical hazard i.e. risk of occurrence over time; (2) exposure in regions of risk e.g. population, property; and, (3) adjustments that have been put into place over time e.g. levees; and, (4) the capacity to respond and recover. Recognition of the dynamic nature of risk has led to increased calls for decision support and services rising on par with more traditional axes of assessments i.e. characterizing the integrated physical and social system. The expectation is that increasing the rate at which policy makers and resource managers acquire knowledge about environment-society interactions will result in improvements in the quality of public and private decisions before particular thresholds are crossed or immediately after wards e.g. mitigating future risk through land-use change. Much recent work has shown that this expectation is most difficult to meet when decision stakes are high, uncertainty is great, technologies are new, experience is limited, and there are unequal distributions of burdens and benefits. More is at work here than trends in population and affluence. Learning is of strategic importance in the decades-long process of adapting to climatic change and variability and in identifying lessons from past and current practices. Two complementary concepts, policy windows of opportunity and adaptive management, have been identified as facilitators of learning in the context of changing baselines, and of the use of lessons to inform governance. Experience has shown that long-term environmental problems can seldom be dealt with by single discrete actions or policies but respond only to continuing, sustained efforts at learning from event to event, supported by steady public attention and visibility. However, as in diverse contexts such as ENSO-related impacts in Latin America and hurricane and drought impacts in the U.S., the cumulative short-term risk adjustments to smaller events can actually produce greater vulnerability to future events e.g. through induced development along levees. Thus, the evolution of responses in the short-term can appear logical and be consensus-based but might actually increase long-term risk. Policy windows that offer entry points through these barriers can be created by triggering or focusing events, such as disasters, as well as by changes in government and shifts in public opinion. Such windows have been identified as offering opportunities for including long-term climate adaptation into risk reduction plans, especially after particularly severe or visible events such as Hurricanes Andrew and Katrina, the Mississippi floods (1993), the 2003 heat wave in Europe, or slow-onset severe drought. None of these can be designed optimally a priori because of uncertainties and confounding factors as diverse as land use tenure and risk perception .We illustrate the benefits and limits in employing linked concepts such as adaptive management and policy windows in responding to climatic extremes especially as the statistics of drivers of vulnerability change over time. We show that moving beyond more broad-based assessments requires approaches that are not only communicated in context, but that are also action-oriented and reflectively interactive among participants about their roles and requirements of various public and private institutions. In addition, responding to extremes in the context of changes in the base state (e.g. through climate change) must be placed within the context of adaptation to climate across time-scales (as lessons are learned and incorporated from extremes and inter-annual variability through change) and across diverse administrative units. Cases are drawn from responses to variations in extremes such

as hurricanes and floods, slow onset events such as droughts, and longer term ecosystem management strategies at the watershed scale. We conclude by showing how evolutionary or learning-based approaches to assessmentand adaptation can and has entered into practice.

Keywords: vulnerability, policy windows, adaptation

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MS015 **Oral Presentation** **5465**

Large Scale Signatures of Extreme Weather Events in the California Central Valley

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This presentation discusses the large scale weather patterns that have been associated with extraordinary weather events affecting the Central Valley of California USA region and beyond. Various event types have been studied, but these 3 will be emphasized in this presentation: severe freezes, heavy rain, extreme heat wave onset. Data from the satellite era are analyzed to identify statistically significant parts of various meteorological fields. Not surprisingly, the up stream fields of temperature and geopotential prior to the event have large meridional excursions. The pattern: is far larger than the region having extraordinary weather; can be traced back in time; and is sometimes suggestive of the theoretical dynamics concept of downstream development. Most such large scale features are intuitive and known to local forecasters (and that provides a check upon our methodology). Less apparent may be the prominent role played by a ridge (in height and thermal fields) downstream over the southeastern prior to heat waves and hard freezes. For example, several extraordinary weather types are preceded by a ridge either over Alaska (hard freezes and heavy rain) or just west of Alaska (heat waves). While the Alaskan ridge passes a significance test highly, for the extraordinary event to affect California requires the presence of the southeastern ridge, too. The statistical analysis consists of compositing a dozen target event periods and random bootstrap resampling. Such large scale patterns are resolvable by most climate models and provide an alternative approach for downscaling model results.

Keywords: california, extreme, events

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MS015 **Oral Presentation** **5466**

The impact of climate change on frost occurrences in Australia

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This study focuses on quantifying both the effect of mean and variance changes in the impact of climate change on extremes, looking at one particular case. The area of interest is the Murray- Darling Basin, which is covered by an important network of climate stations with long daily records. This is an important agricultural area strongly impacted by frost. Furthermore, frost occurrences are observed during winter months with a frequency from 30% in the mountainous South-East to less than 1% in the North and Western part of the basin. In order to study the combined effect of the mean warming and variance effect, estimates of the mean warming for minimal temperatures are derived from Direct model outputs (DMO) using climate model simulations archived in the IPCC AR4 database, using differences between simulation of the climate of the 20th century and of the 21st century forced with different emission scenarios. The mean anomalies are applied to observed series and compared with results obtained using a downscaling technique developed for daily temperature extremes (Tmin and Tmax) in the region and applied to the same IPCC AR4 simulations. In this study, the DMO and downscaled temperature series estimate of frost occurrences for the current climate are compared to evaluate the benefits of using a statistical downscaling method for local climate extremes. Furthermore, the impact of emissions scenarios on frost occurrences are compared between DMO and downscaled series to evaluate the importance of reproducing the observed probability density function of local temperature in order to infer future changes for climate extremes. Finally, the contribution of the mean and variance effect across the range of climate simulations is assessed and the importance of the variance effect is evaluated.

Keywords: frost, reduction, mean and variance

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MS015 **Oral Presentation** **5467**

The influence of the atmospheric circulation on long-term temperature trends and extremes: observed and modelled relationships

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Using long-term homogeneous temperature series for north-western Europe, significant positive trends are identified in daily minimum and maximum temperatures over the last 100 years and longer. Significant trends are also identified in indices of extreme events defined using percentile thresholds. A regression model based on the relationship between temperature and three airflow indices is used to examine the influence of the synoptic circulation on these events. In particular, the question is posed as to whether long-term trends in either the mean temperature or in extreme events may be attributable to changes in the circulation. The role of the persistence of circulation regimes in determining the occurrence of extreme temperature events is also discussed. The use of models to project future changes in extremes is an important aspect of research into impacts likely as a consequence of global climate change. Six regional climate models (RCMs) from the EU PRUDENCE project are used to examine model uncertainty by comparing their skill in reproducing temperature and circulation climatologies, including extremes, for the 1961-1990 control period. The results are discussed within the context of developing a framework for the production of probabilistic scenarios of climate change impacts.

Keywords: temperature, extremes, rcms

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MS015 **Oral Presentation** **5468**

Quantifying the change in extreme seasonal precipitation events under global warming using a grand ensemble experiment

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Estimates of future precipitation extremes are subject to much uncertainty. Uncertainties in emission rates, climate model structures, parameterisations and initial conditions add to the uncertainties in the prediction of extremes simply due to rarity of such events. Here, we produce probabilistic predictions of seasonal changes in extreme precipitation for regions across the globe using results from the climateprediction.net experiment. In this experiment, a coupled atmosphere-ocean global climate model was run in grand ensemble mode for a transient integration from 1920 to 2080, varying parameter values, initial conditions and forcing scenarios. Here, we examine changes separately for each forcing scenario but examine the uncertainties introduced by different parameterisations and initial conditions. We use extreme value analysis to define extremes of precipitation. We fit the Generalized Extreme Value distribution to annual maxima using L-moments, to estimate extremes with return values of between 5 and 50 years for different time slices within the transient integration. We then apply the principle of equal weighting of the results from different models in the production of probability distributions of change for different regions of the globe. This allows us to establish which regions are most sensitive to the impacts of global warming on precipitation extremes, and the likely rates of change.

Keywords: grand ensemble, probabilistic estimates, precipitation extremes

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

MS015 **Oral Presentation** **5469**

Using probablistic representation of RCM rainfall to quantify uncertainty in future UK regional rainfall

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Major floods and record wet spells, such as the autumn/winter 2000/01 UK floods and summer 2002 European (Elbe) flooding, have created a concern about possible impacts on the built and natural environment under a future climate, where extreme rainfall events are expected to be more frequent. To assess frequency and magnitude of such events, regional climate models (RCMs) are used to generate rainfall fields for a future climate. However, large uncertainties surround the regional distribution of change and impacts on spatial-temporal rainfall patterns. An improved understanding of uncertainties surrounding the projected rainfall extremes can be gained by using results from several different RCMs. Here, we analyze how different RCMs characterize rainfall extremes in a number of regions of the UK that are considered to have homogenous rainfall characteristics. We use a selection of models that encompasses two different driving Global Climate Models and four different RCMs, thus maximizing the uncertainty range of response. For each region and model, we study the probability densities of 1 and 10-day RCM rainfall amounts associated with the 5 and 25 year return period for a control period (1961-90) and for a future period (following the SRES A2 2071-2100 scenario). Return period magnitudes were estimated using a combination of Regional Frequency Analysis and Extreme Value Analysis, where a Generalized Extreme Value (GEV) distribution was fitted using the method of L-moments to annual maxima series of 1 and 10-day rainfall totals. Probability densities were generated using 10 000 samples of return period estimates, derived from bootstrap samples of regionally pooled annual maxima series. Probability densities based on RCM rainfall for the control period were validated using observed rainfall, and changes in magnitude between the results for the control and future period are discussed.

Keywords: rainfall, regional climate models, probabilities

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

MS015 **Oral Presentation** **5470**

Trends in Turkey climate extreme indices from 1971 to 2004

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Mesut Demircan, Ilker Alan

Given the complexity and global nature of the climate system, cooperative activities within international and interdisciplinary programs are indispensable for monitoring and predicting climate change. Extreme climate events usually have strong impacts on society and a small change in the mean condition can cause a large change in the likelihood of an extreme. A joint WMO CCl/CLIVAR Expert Team (ET) on Climate Change Detection, Monitoring and Indices has defined 27 core climate indices mainly focusing on extreme events using freely available software, RClimDex, developed and maintained on behalf of the ET by the Climate Research Branch of Environment Canada.. Indices have the advantage that they can be freely exchanged within the international scientific community. The complete list of the 27 indices, RClimDex software and users guide are available from http://cccma.seos.uvic.ca/ETCCDMI. RClimDex creates 27 core indices after performing several QC checks on the raw data. The information provided by the indices not only includes how the mean values changed over time but how the statistical distribution of the data changed. Also results give us very important information about the trends in extremes. We have run RClimDex for 100 stations in Turkey for the period from 1971 to 2004. We selected the same data period in order to compare stations outputs for the same climatic period. To provide an overall picture of climate variation in the country, we computed average trends for every index, relative to the period 1971-2000. The results show that numbers of summer days and tropical nights have been increasing all over Turkey while ice days and frost days decreasing. Summer days have increased about 6 days per decade. Most of the trends are statistically significant at the 5% level. Growing season length has increased over Turkey except for coastal regions. This will be have a positive effect on summer agricultural products but some negative affects will be experienced by orchards for example which rely on cold conditions. Maximum of maximum, minimum of maximum, maximum of minimum and minimum of minimum temperatures have increased at most stations. Warm days and warm nights have been increasing all over Turkey while cool days and cool nights have been decreasing. Warm spells have increased while cold spells have decreased. Diurnal temperature range has increased in most inland stations while it has decreased along coastal areas. Trends in simple daily intensity index have been increasing in most of the stations even mean annual total precipitation declined in 30 stations located in the Aegean and inland Anatolia. The number of heavy precipitations days have been increasing especially in the Black Sea and Mediterranean regions and usually cause extreme flood events. The maximum one-day and 5 days precipitation have also increased except eastern Marmara and south Anatolia region. Consecutive dry days have decreased especially in Konya, Karapınar, Ceylanpınar and Iğdır which are suffering drought problem but unfortunately there are increasing trends in Marmara, Aegean and the Black Sea Region. Consecutive wet days have increased especially in eastern parts of the Marmara and around Afyon, Burdur, Niğde, Sinop, Sivas, Rize, Kilis and Muş while decreasing in the Aegean and Konya. In summary, in general there are large coherent patterns of warming across in the country affecting both maximum and minimum temperatures but there is a much more mixed pattern of change in precipitation.

Keywords: extreme, climate, indices

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

MS015 **Oral Presentation** **5471**

Extreme wind waves worldwide from the VOS data and their changes over the last 50 years

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JMS008 IAMAS IAMAS

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Wind wave observations from Voluntary Observing Ships (VOS) are available for more than 150 years and represent the longest record of wave characteristics in comparison to the satellite data and numerical model hindcasts. Although before the WW-II the data are sparse, for the last 50 years, especially in the Northern Hemisphere Oceans VOS data are characterized by quite dense sampling and may successfully compete with the model and satellite data. In contrast to the other data sources, VOS data initially provide separate estimates of wind sea and swell (from which significant wave height (SWH) can be further computed) and, thus, allow for a separate analysis of wave statistics in extreme wind seas and swells. We used in our analysis visual wave observations from the ICOADS archive of marine meteorological variables, covering the period form 1784 to 2004. After the initial data quality control and multiply consistency checks the visual data were used to estimate characteristics of extreme waves over the World Ocean north of 20S. The two methods of the estimation of extreme wave statistics were applied. First, the initial values distribution method (IVDM) was used. In this method extreme wave statistics were estimated form the tails of distribution functions fitted to all wave observations for different sizes of the grid cells from 4-degree to 20-degree. The results reported considerably smaller estimates of extreme wave heights in comparison to those reported by altimeter data and WAM model hindcasts. Thus, the highest 100-year return value in the North Atlantic was about 17 meters. In the next step, extreme wind waves were estimated from the peak-over-threshold (POT) method. For the application of POT to the irregularly sampled VOS data we developed a statistical methodology of the determination of storm durations and storm wave peaks. The methodology was validated using 6-hourly WAM data. Application of the POT method to the North Atlantic and North Pacific has shown 100-year return values in significant wave height higher than 22 meters, that is already comparable to the estimates derived from the model simulations. Separate estimates of extreme wind seas and extreme swells, derived from the VOS data demonstrated that extreme values of SWH are largely dominated by seas. Finally, interdecadal variability of statistical characteristics of extreme waves was considered. Interdecadal changes in extreme waves may amount to several meters and demonstrate out-of-phase behavior in the North Pacific and North Atlantic. The reasons for this phenomenon are discussed in terms of modes of atmospheric circulation variability over the Northern Hemisphere.

Keywords: wind waves, extremes, storms

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MS015 **Oral Presentation** **5472**

3-D Tsunami Coastal Hazard Mapping: The Hyperdem Project

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In February 2006, a team of researchers, technologists and technicians of OGS (National Institute of Oceanography and Applied Geophysics) and technicians of Helica srl went to Sri Lanka to monitor the shores affected by the tsunami occurred on 26th December 2004. The project, called HyperDEM and funded by the Italian Ministry of Foreign Affairs, was based on the integration of four remote-sensing techniques: airborne LiDAR, airborne Hyperspectral, spaceborne SAR and high-resolution spaceborne multispectral. It started in autumn 2005 and was completed in summer 2006, after the acquisition and processing of an outstanding data volume of about 2.7 TeraBytes. It was possible to investigate an area of about 2200 km, located in the Western and Southern part of the island, and to value the impact that the tsunami had on the terrain morphology. A detailed analysis of some sites, described as very damaged by official founts, was done. In this paper we present a tsunami or storm-surge prone modelling of coastal areas in Sri Lanka. These models help the civil protection plan the escape ways through which people can reach the closest safe place, at any moment and wherever they are, during an alert situation, independently on the availability of a regional tsunami alert system or not.

Keywords: tsunami, hazard

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MS015 **Oral Presentation** **5473**

Assessing IPCC AR4 model simulations of present and future changes in extreme daily precipitation

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Changes in the frequency or intensify of extreme weather and climate events could have profound impacts on both human society and the natural environment. Indicators based on the observed daily precipitation during the second half of the 20th century suggest that, on average, the world has become wetter, and wet spells produce significant higher rainfall totals now than a few decades ago. It is of great interest to evaluate the ability of the current generation of climate models to simulate observed extreme rainfall distributions and their trends. But the lack of comparable long-term global gridded daily observations often leads to a deferral of model evaluation or limited evaluation of only the mean precipitation climatology. Additional difficulties arise from the scaling issue when comparing the extreme events among the observation and models with different spatial resolution. The interpretation of model output as point estimate vs. areal mean and the spatial interpolation schemes both can have strong impact on the outcome of validation and comparison. With appropriate consideration of the spatial scale of the observed and simulated data, the present-climate extreme precipitation events simulated by IPCC AR4 climate models are evaluated. For the continental US and East Asia, the daily extreme rainfall distribution is reasonably simulated. The common model bias is the reduction of spatial variability (underestimate in higher extremes and overestimate in area where daily extreme rainfall is small). The bias resembles to the systematic error in the annual mean precipitation simulation. The model simulations for the past trends in the extreme precipitation over the 1961-2000 period are inconsistent with observation (in US and East Asia) and no common features found among different models. Model ensemble mean projections for the 2081-2100 period show that, except subtropical arid region, extreme daily rainfall almost increase everywhere with larger percentage increase in the tropics. With the model reliability information, the common characteristics of future projection of simulated changes in extreme precipitation from IPCC AR4 models and their uncertainties will be assessed. Probabilistic projection of future change provides model uncertainty information to the impact studies and risk-decision analysis should be encouraged.

Keywords: extreme, precipitation, climate

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MS015 **Oral Presentation** **5474**

Changes in the western European daily temperature PDF and its implications for heat waves and extreme temperatures

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We analysed a new dataset of 54 high quality homogenized daily maximum temperature series from western Europe to define more accurately the change in extreme warm Daily Maximum Temperature (DMT). Results from the daily temperature homogeneity analysis suggest that many instrumental mearsurements in the late 19th and early 20th century were warm biased. Correcting for these biases, over the period 1880 to 2005 and looking at the summer season, the length of summer heat waves over western Europe has doubled and the frequency of hot days has almost tripled. Summer DMT Probability Density Function (PDF) show significant changes in the mean (+1.6+-0.4C) and variance (+6+- 2%). We present these results within the frame work of extreme value theory and fit statistical models to explain the duration, frequency and intensity of heat waves and extreme temperatures. These conclusions help further the evidence that western Europe's climate has become more extreme than previously thought and that the hypothesized increase in variance of future summer temperature has been a reality over the last 126 years in western Europe.

Keywords: extreme temperature, europe, extreme value theory

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MS015 **Oral Presentation** **5475**

Trends in climate extremes and implications to agriculture over southern Africa

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Southern Africa is a semi-arid region whose climate varies significantly and with high vulnerability to extreme events. This inter-annual time scale variability suggests future climate changes will exacerbate societal vulnerability. For a region that has more than 70% of its population relying on agriculture directly or indirectly, the climate has significant bearing on livelihoods and the economy. It is common knowledge that changes in the frequency or intensity of climate extremes has profound impact on nature and society. Since the last decade, seasonal rainfall has become more erratic, with recurrence of heavy rains and floods, and droughts, which often result from, prolonged mid-season dry spells. This has impacted heavily on agriculture and society through poor crop yields, poverty, disease and malaria epidemics especially among the poor rural communities. This study is on observed trends in climate extreme events over southern Africa with central focus being over Zimbabwe. A selection of climate extreme indices calculated is presented and implications to nature and society addressed. Some physical explanation of the causatives at regional scale is analysed through the ERA-40 reanalysis data and the land-atmosphere sensitivity simulations done using a regional climate model, RegCM3. The variable climate has increased risk in agricultural practice affecting the decision making process. This study makes an attempt to merge historical knowledge with future climate change projections and relate with impacts on agricultural production and economic output. Proposal of factors to consider in climate extreme definitions will be incorporated.

Keywords: climate, agriculture, land atmosphere

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MS015 **Oral Presentation** **5476**

Extreme Years of Monsoon Rainfall With Statistical relationship Over India

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The Paper deals with the Variability of Summer monsoon Rainfall during normal,flood and drought years over India. during flood years ,the monsoon rainfall increases over the entire country and large area under 100cm isohytel covers Orissa and adjoining Madhya Pradesh (M.P.). During drought years the rainfall amount decreases over the entire country and isohytel of 100cm. shrinks to almost a point. The variability of monsoon rainfall from flood to normal and drouht years depends upon the number of depressions ,low pressure area which form over the North Bay and move inland.

Keywords: monssonvariability, normalyearfloodyeardroughtyea, isohytel

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

MS015 **Oral Presentation** **5477**

Relating hydrological extremes with area a case on extreme floods in South Central Nepal

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Ganga Tiwari

Flash floods, debris flows and landslide disaster on the steep sloping terraces of hilly region are so challenging that even a real time hydro-meteorological forecasting system would not applicable for all cases in Nepal. Flash floods localize in short ranges with respect to time and distance. These are very difficult to catch in time and to measure. On the other hand such phenomena are need to be assessed for sustainable design of hydro- structures and relocate the settlements from risk areas. So a study was carried out to find the suitable relationship between area and extreme floods as well as area and extreme rainfall depths. Analysis is mainly based on the case of torrential rains in July 1993 over south central Nepal, which caused floods, and debris torrents that were probably worst in the disaster history of Nepal in damaging lives and properties in 20th century. A relation for rainfall depth and other relation for specific flood are presented in this paper.

Keywords: south central, nepal specific

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MS015 **Oral Presentation** **5478**

Land-atmosphere coupling, extreme events, and climate change

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Daniel Lthi, Michael Litschi, Christoph Schr, Bart J.J.M. Van Den Hurk

In a recent st udy (Senevirat ne et al. 200 6, Nature), we investigated the role of land-atmosphere coupling for Eu ropean summer temperature variability and associated heatwaves in present and future climate. Our r esults indicate that the stro ng incr ease in summer temperature variability projected i n Central and Eastern Europe is mainly due to fee dbacks bet ween the land surface and the atmosphere. Furthermore, they s uggest that land-atmosphere intera ctions increase climate va riability in this region because climatic regimes in Euro pe shift no rthwards in respo nse to increasing gr eenhouse gas concentrations, creating a new transitional climate zone with strong land-atmosphere coupling in Central and Eastern E urope. In this contribution, we first pr ovide a brief overview of the main results of this study, and then discuss more re cent ex periments of two types: 1) region al clim ate simu lations investigating the impact of land-atmosphere coupling for intra-annual in addition to inter-annual climate variability; 2) global climate model experiments with the ECHAM5 GCM, carried out in the context of the Dutch/German/Swiss ESSENCE project, which allow a gl obal assessment of the role of lan d-atmosphere interactions for climate change. In addition to analyses on summer temperature variability, we will also discuss the extent to which soil moisture-atmosphere coupling is relevant for precipitation variability and heavy precipitation events R eference: Sene viratne, S.I., D. Lthi, M. Litschi, and C. Sch r, 2006: Land-atmosphere coupling and climate change in Europe. Nature, 443, 205-209.

Keywords: heatwaves, heavy precipitation, land climate interactions

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MS015 **Oral Presentation** **5479**

Detecting meteorological extreme events in sediment data from Eifel Maar Lakes

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Prof. Frank Sirocko, Dr. Andreas Walter, Prof. Heini Wernli

Starting in 1999, the ELSA (Eifel Laminated Sediment Archive) project group at the University of Mainz has made several core drillings in maar lakes (some of them dried out) in the Eifel region in western Germany. Thereby a continuous record of sediment data for the last 150.000 years could be provided. This record serves as a highly valuable climate archive - in this study we explore its suitability to serve as a proxy for extreme weather events in the Holocene. In order to do this, we compare the sediment data for the last century, that have recently become available, mainly through two freeze drillings in the "Schalkenmehrener Maar" and the "Ulmener Maar", with meteorological and hydrological data. Because the upper parts of the cores are not laminated, their chronology for this period is primarily based on CS137-measurements. We use weather data from stations in the Eifel region, provided by the German weather service, and from the ERA40 reanalysis of the European Center for Medium-Range Weather Forecast. Runoff data is taken from the river Mosel and other smaller rivers in the region. Based upon these meteorological data, we identify extreme weather events, that is severe storms, floods, droughts and extraordinary hot and cold periods, and try to establish a link with the sediment data (e.g. the time series of grain size). For the detection of meteorological droughts, the Effective Drought Index (EDI) is applied. With this method, we are able to identify for example the 1990 storm season in the sediments, during which especially the storms "Vivian" and "Wiebke" led to great damages in Europe. The results of the comparison are used to calibrate the sediment record, so that it can serve for detecting extreme events throughout those periods in the Holocene that are not covered by direct measurements. Furthermore, the meteorological data can give information about the spatial coherence of those extreme events within Central Europe.

Keywords: extreme weather, sediments

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MS015 **Oral Presentation** **5480**

Detection of trends in occurrence of rare events: Theory and application to extremely high temperature in the stratosphere

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In this study, a nonparametric test to detect trends in the occurrence of rare events is presented. We can test the trends with the distribution under the null hypothesis of the statistic based on the sum of position of events. We examine trends in the occurrence of extremely high temperature events in winter months with the test. Statistically significant increasing trend are detected at 10hPa on December and 30hPa on January, and significant decreasing trends are detected at 10 and 30hPa on February and March. This result suggests that the extremely high temperature events tend to increase in early winter, and they tend to decrease in late winter. Trends in occurrence of the stratospheric sudden warming events are also examined. A significant increasing trend is detected on January.

Keywords: rare events, stratospheric sudden warming

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MS015 **Oral Presentation** **5481**

Interannual variability of summertime extreme significant wave heights in the western North Pacific

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Significant wave height (SWH) is a crucial factor in the design and operation of offshore industries and the selection of ship routing. Understanding the longterm variability of SWHs may therefore contribute to sustain the maritime safety. In the boreal summer, the coastal areas of east Asia is heavily impacted by high waves caused by tropical cyclones (TCs). It is important to understand the characteristics of the past summertime wave climate in the western North Pacific (WNP) and to apply this knowledge to predict the future wave climate, since some global climate models project increases of TC intensities with CO2induced warming. We present the relationship between the interannual variability of the summer (June-August) mean of the monthly 90th percentile of SWHs (H90) in the WNP and climate change using the ERA40 wave reanalysis. It is found that the increase of H90 is correlated with cyclonic surface wind anomalies in the WNP which links with warm SST anomalies in the Nino-3.4 region during the ENSO developing years. In particular, the first principal component (PC1) of H90 is found to be closely related to the zonal anomaly averaged over the region 5N15N and 130E160E (U10N). The positive U10N anomaly may be associated with an eastward extension of the monsoon trough off the east coast of the Philippines, which causes an eastward shift of TC occurrence. In fact, the mean position of TC occurrence during the typical seven high wave years shifts southeastward compared to that during the typical seven low wave years, so that TCs further develop while traveling longer distances until they encounter the continent or cool mid-latitude water.

Keywords: wave climate, tropical cyclone, interannual variability

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MS015 **Oral Presentation** **5482**

Future changes in extreme precipitation projected by 20-km-grid AGCM with L-moment method

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Water related disasters such as flood and landslide caused by heavy rain sometimes lead to serious economic and human loss. Therefore, there is much public attention to future changes of extreme precipitation accompanied by global warming. In this study, the annual maximum daily precipitation (AMP) is focused as an extreme index and its future changes are investigated using a 20-km-grid AGCM which is developed by MRI-JMA (Meteorological Research Institute and Japan Meteorological Agency). Phenomena such as those for heavy precipitation are local, so that the AMP is very sensitive to model horizontal resolution. However, from the result of author's another study, the AMP simulated by the 20-km-grid AGCM is directly comparable with rain gauge observation except certain areas. Two 20-year runs, the present and the future, are conducted by the model. The target periods are at the end of the 20th and 21st Century, respectively. Both simulations are forced by the adequate SST and the greenhouse gas concentrations. The PDF (probability distribution function) and the return value of the AMP are analyzed and estimated by L-moment method. From the results of L-moments ratio diagram which is a scatter diagram of L-skewness versus L-kurtosis, the simulated AMP obeys GPA (generalized pareto distribution) in many regions, both the present and the future. Meanwhile, previous studies shows that the observed AMP generally obeys GEV (generalized extreme value distribution). Therefore, the simulated PDF of the AMP may insufficient in kurtosis. Future change of L-location increases in most part of land area. However, high-order moments such as L-CV, L-skewness and L-kurtosis show strong spatial variability and no noticeable change in spatial average, except western Atlantic Ocean, western Indian Ocean, western Pacific Ocean and so on. These imply that form of the PDF does not largely change, just shifts toward large value, in most part of the area. However, in such areas as those listed above, upper tail of the PDF extends more toward large value, which is mainly caused by intensified tropical cyclone. Return value of the AMP estimated by L-moments increases remarkably in many areas which indicates the magnitude and frequency of heavy rain will be large in the future.

Keywords: climate model, future change, l moment

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MS015 **Oral Presentation** **5483**

What do we really understand about natural disasters?

Dr. Nina Shapovalova
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It is well known that the Earth System consists of many various components, which interact in non-linear ways on very different spatial and temporal scales. For a better understanding of the dynamics of extreme environmental rapid rate events stronger links between key characteristics must be revealed in time and space. In this context a non-traditional interdisciplinary research has been made. Practically an unknown development mechanism of ultra-polar anticyclones contributing to the intensification of meteo-climatic hazards at regional and local levels has been found. A strong temporal synchronization in a cyclic behavior of both, the anticyclonic activity and the Earth rotation irregularity was discovered. It was reasonable to suppose that a lifetime of these cycles is determined by the causes that lie outside the Earth and are astronomical in nature. Electrodynamical interpretation of the causes proved to be useful not only for prediction of abrupt natural changes (like hurricanes, earthquakes, tsunami, etc.) but also for a social and technical risk management.

Keywords: meteo climatic hazards;, earth rotation irregularity;, anticyclonic activity

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MS015 **Oral Presentation** **5484**

Indices for Extreme Events in Projections for Anthropogenic Climate Change

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Climate model simulations as preformed with the coupled ocean-atmosphere general circulation model (ECHAM5/MPI-OM) of the Max Planck Institute for Meteorology, Hamburg can be helpful to make projections about changes in the future climate and, in particular, in the probability of extreme events. First, indices for climate extremes, which characterize moderate, statistically robust extreme events such as the maximum length of a drought period or the maximum 5-day precipitation amount as a flood indicator, were calculated for the 20th century and two future scenarios (A1B and B1). Significant changes in these indices with distinct regional and seasonal patterns can be seen in both scenarios. Secondly, a parametric approach considers the statistical behavior of the tail of a precipitation probability distribution. In particular, extreme events within a time series of daily precipitation data (20th century and future scenarios) were approximated by the Generalized Extreme Value (GEV) distribution with constant and time-dependent parameters. The behavior of the distributions parameters was analyzed in respect to changes in the extremes. In the future simulations, similar regions affected by a strong increase of extreme precipitation events could be identified as with the indices for precipitation extremes.

Keywords: indices, gev

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MS015 **Oral Presentation** **5485**

Human contribution to rapidly increasing frequency of very warm Northern Hemisphere summers

Dr. Gareth S. Jones
IAMAS

The European summer of 20 03 was exceptionally warm and it has been shown that it is likely that human influe nce has at least do ubled the risk o f such a hot summer. We e xamine observed and simulated regional summer temperatures throughout the Northern Hemisphere and detect the dominant influence o f anthro pogenic facto rs almo st everywhere. We show that, what 20- 40 years ago were infrequent hot summers, occurring 1 year in 10, are already much more common. We are currently at rapidly increasing risk of hot summers, with proj ections suggesting continuing shar p increases of incidence in the near future.

Keywords: summer, climate, detection

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MS015 **Oral Presentation** **5486**

Changes in temperature probability distribution function in Italy over the last half century

Dr. Michele Brunetti
ISAC-CNR ISAC-CNR IAMAS

Michele Brunetti, Mara Felici, Maurizio Maugeri, Teresa Nanni, Antonio Speranza

Daily time series of minimum and maximum temperature, from 67 Italian stations, for the period from 1951 to 2004, are investigated. The records were homogenized on daily bases and clustered into two climatically homogeneous sub-regions, by means of a Principal Component Analysis. Average daily series were calculated for the two sub-regions, and for the whole area. The average series were analyzed to identify any changes in the probability distribution function, with particular attention to the two tails of the distribution. The number of events below and above some defined thresholds were calculated and studied to highlight any changes in their frequencies. Moreover, changes in temperature probability distribution function were analyzed in detail, by choosing a dense set of percentile values and studying their relative and absolute trends over the examined period.

Keywords: daily temperature, probability distribution, percentile

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MS015 **Oral Presentation** **5487**

Advances in subsampling methodology for analysis of nonlinear atmospheric time series

Prof. Alexander Gluhovsky
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Commonly employed methods of time series analysis are based on assumptions that are often unrealistic for atmospheric and climate data. These include the assumption of a linear model for the observed time series and the assumption that observations follow a normal distribution, while some important variables (e.g., the precipitation amount) have heavy-tailed distributions. It will be discussed in the talk as to how modern resampling methods become instrumental in obtaining reliable inference from meteorological and climatological time series without making questionable assumptions about the data generating mechanism. In particular, computing subsampling confidence intervals for characteristics of nonlinear time series will be addressed (necessary for reliable comparisons between models and observations and between models) as well as employing subsampling in the analyses of extreme events (e.g., to find out whether their probabilities are changing with times, based on regional climate models). This work is supported by the National Science Foundation Grants ATM-0514674 and ATM-0541491.

Keywords: time series, subsampling, extremes

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MS015 **Oral Presentation** **5488**

Wave climate of the Southern Australian Margin: A response to variable atmospheric forcing over the Southern Ocean.

Dr. Mark Hemer
CSIRO CSIRO Marine and Atmospheric Research IAMAS

The Southern Australian margin is exposed to some of the most energetic surface ocean waves of the global ocean, but contains very few observations. Analysis of the ERA-40 re-analysis wave record shows a significant increasing trend in the Southern Ocean significant wave heights (Hs), particularly south-west of the Australian continent. The trend in the monthly 99th percentile Hs is almost twice that of the monthly mean Hs, indicating that the trend is predominantly in response to an increase in large wave events in the Southern Ocean. Large wave events observed along the southern Australian margin are typically generated by extra-tropical southern hemisphere cyclones located in the Indian Ocean sector of the Southern Ocean. Recent studies indicate significant changes in the synoptic environment south of 40S over recent decades, interpreted as being associated with the bias towards high-index polarity of the Southern Annular mode. Variability of position and intensity of the southern hemisphere cyclones in response to longer-term trends may have important implications for the wave conditions experienced on the southern Australian margin, and the consequent coastal response experienced via wave-runup impacts, and longshore transport changes. A network of mid-inner continental shelf wave-rider buoys located along the southern Australian margin, separated by almost 3000-km, have been analysed. These records include a 10-yr record from Rottnest Island at the western end of the margin, a 6-yr record from Cape de Couedic in the central portion of the margin, and a record spanning 20 years from Cape Sorell, at the south-eastern end of the margin. Spatial coherence between simultaneous buoy records show that wave events are easily tracked in the wave record as they propagate eastwards along the southern Australian margin. Maximum correlation between records indicates that wave events at Cape Sorell lag those at Rottnest by approximately 80 hours, and at Cape de Couedic by approximately 7 hours. The location and intensity of generating cyclones for the N-largest wave events of each year of record have been tracked from the NCEP-NCAR re-analysis MSLP, and the relationship with wave properties (height, period and direction) investigated. Statistics obtained point out a weak variability of peak directions (almost all wave events coming from the same 10 sector), regardless of cyclone position, with highly energetic, strongly seasonal, extreme events. Interannual variability of the storm count is large, and relationships to climate indicators is being investigated.

Keywords: surface, ocean, waves

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MS015 **Oral Presentation** **5489**

Some Aspects of an Increasing Trend of Extreme Rain Events Over India

Prof. Venugopal Vuruputur

B. N. Goswami, Debasis Sengupta, M. Madhusoodanan, Prince K. Xavier

By analysing a new 1-deg by 1-deg daily rainfall data set, we show a significant increasing trend in the frequency and the magnitude of extreme monsoon rain events and a decreasing trend in the frequency of moderate events over central India in the past fifty years. With the help of these results, we offer a plausible explanation for the stability of the seasonal mean rainfall, which has remained a puzzle to-date. Our analysis also suggests that the extreme events are more often randomly distributed than spatially clustered. Some results on the spatio-temporal organisation of droughts will also be discussed.

Keywords: extreme rain events, indian monsoon

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MS015 **Oral Presentation** **5490**

Evaluating hurricane maximum potential intensity under enhanced greenhouse conditions

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Recent changes in hurricane activity in the North Atlantic have generated interest in possible impacts of greenhouse-related warming on tropical cyclone activity in ocean basins around the world. Analysis of the observational record is difficult because of the lack of consistent observing technologies over the observational record and the role of interdecadal variability. Long period climate simulations cannot resolve the detail of convective processes in tropical cyclones and alternative methods must be applied to analyse possible changes in tropical cyclone activity in enhanced greenhouse conditions. The maximum potential intensity of tropical cyclones is used in conjunction with reanalysis data and climate model results from the WCRP/CMIP3 archive to assess likely impacts of climate change tropical cyclone activity. MPI correlates with cyclone activity in at least some basins and has been shown to characterise the cyclone season in a number of locations. Two algorithms for computation of MPI are applied to a range of climate models for the AMIP2 period and the results are compared on the basis of length of cyclone season and on the basis of potential intensity. To avoid making assertions about the characteristics of individual storms, MPI is used to characterise the cyclone season, in terms of length of the season and the peak (potential) intensity. There is considerable variation between GCMs in terms of modelled thermodynamic potential intensity. Based on performance in AMIP2 and availability of model output, the MPI algorithms are applied to future predictions of greenhouse climate from the WGCM CMIP3 archive. The predictions of thermodynamic potential intensity computations from these climate models are evaluated as potential indicators of future changes in cyclone activity.

Keywords: tropical cyclone, climate model, intensity

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MS015 **Oral Presentation** **5491**

Global projections of extremes in river discharge in a changing climate by MIROC high-resolution simulation

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Shinjiro Kanae, Taikan Oki, Seita Emori, Masahide Kimoto

This paper show projecting future changes in extremes (flood and drought) of river discharge simulated by a relatively high-resolution (T106, approximat ely 1.1 degree) coupled ge neral circulation model (GCM) under the A1b global warming scenario. The present-day GCM simulation was firstly checked with available discharge ob servation and simula ted dis charge by a 100-year (190 1-2000) off-line simulation of a land surface sub-module implemented in the GCM. Re sult showed that the GCM well reproduced th e ch aracteristic of severe floo d an d drou ght in historical r ecord. T he frequ ency of very large floods was projected to increase over many regions, except f or continentalNorth Americaand middle to western regions in Eurasian continent. Globally, the drought frequency was shown to increase in most region s except over t he northern high latitudes, eastern , and ea sternEurasia. Changes in flood and drought are not simply explained by ch anges in annual precipitation, annual evapotranspiration, or differences between annual precipitation and annual evapotranspiration. Several regions were projected to have increa ses in bo th flo od frequency and dro ught frequency in t he future. S uch regio ns were basins where precipitation patterns may cha nge so as to d ecrease precipitation days b ut increase da ys with heavy rai n. Because the predicted future change s in floods and droughts varied am ong rivers and sub-basins, projections of disastro us extremes in discharge using high- resolution GCMs will beco me important for local risk assessment.

Keywords: gcm, flood, drought

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MS015 **Oral Presentation** **5492**

Influence of temperature measurement precision on the computation of percentile based temperature indices

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Climate Research Division Environment Canada IAMAS

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Percentile based temperature extreme indices are the annual counts of daily minimum (or maximum) temperature being greater than its 90th percentile or smaller than its 10th percentile estimated from a base period. They are part of the indices recommended by the CCl/CLIVAR Expert Team for Climate Change Detection and Monitoring, and are used for the monitoring and detection of human induced climate change. Here we show that the precision of temperature measurement can have strong impact on the values of those temperature indices. Relatively coarse resolution in temperature measurements in (1.0C), in the (0.5F), and at some Canadian stations (0.5C) results in mean values of those indices averaged over the base period being quite far away from the nominal level. Adding a small random number to the daily temperature to improve temperature resolution to 0.1C has an effect to overcome this problem.

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MS015 **Oral Presentation** **5493**

Weather hazards in the United States and The Madden-Julian Oscillation

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The occurrence of extreme weather event s such a s heavy precipitation, high s urface wind speeds a nd low temperatures are freq uently asso ciated with severe a nd ha zardous conditions with majo r so cio-economic impa cts. On intraseasonal time scales, th e Madd enJulian oscilla tion (MJO) is t he dominant mode of tropical intraseasonal variability and is most active in the boreal winter. The MJO influences the patterns of precipitation in the global Tr opics an d in portions of th e extratropics including the occurrences of extreme events and the skill of numerical weather forecasts. This study uses reports of storm events (e.g. avalanche, co astal event, drought, earthqua ke, flooding, fog, hail, heat, hurricane/tropical storm, landslide, lightning, severe thunderstorm, tornado, tsunami, volcano, wildfire, wind and winter weather) (1960-2005) to estimate the modulation of the MJO on th e frequency of weather hazards in the United States during winter.

Keywords: madden julian, weather, hazards

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MS015 **Oral Presentation** **5494**

What can models tell us about future changes in extremes?

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This paper describes an approach to analyzing changes in the risks of rare extremes in climate variables such as temperature and precipitation, and applies that approach to several observationally based data sets as well as a large number of models that have contributed simulations to the multi-model archive at PCMDI. Overall, the climate models simulate present-day warm extremes reasonably well on the global scale, as compared to estimates from reanalyses. The model discrepancies in simulating cold extremes are generally larger than those for warm extremes, especially in sea-ice covered areas. Simulated present-day precipitation extremes are plausible in the extratropics but uncertainties in extreme precipitation in the tropics are very large, both in the models and the available observationally based data sets. Changes in warm extremes generally follow changes in the mean summertime temperature. Cold extremes warm faster than warm extremes by about 3040%, globally averaged. The excessive warming of cold extremes is generally confined to regions where snow and sea-ice retreat with global warming. With the exception of northern polar latitudes, relative changes in the intensity of annual precipitation extremes generally exceed relative changes in annual mean precipitation, particularly in tropical and subtropical regions. Consistent with the increased amplitude of extreme precipitation, waiting times for present-day extreme precipitation events are reduced almost everywhere, with the exception a few subtropical regions. The multi-model multi-scenario consensus on the projected change in the magnitude of globally averaged extreme precipitation is that there will be an increase of about 6.2% with each K of global warming, with the bulk of models simulating values in the range of 410% K−1.

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MS015 **Oral Presentation** **5495**

Atlantic Hurricanes and Climate Change

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The possible relationship between anthropogenic cl imate change and hurricane or tropical cyclone activity has been a topic of g reat interest a nd discussion. In November 2006 at the Sixth International Workshop on Tropical Cyclones, a consensus statement was prod uced, drawing on input from over 120 attending hurricane researchers. Among the co nsensus conclusions was the foll owing: Though there is evidence both for and against the existence of a detectable anthropogenic signal in t he tropical cyclone climate record to date, no firm conclusion can be made on this point. The basis for this conclusion and other conclusions of this group will be revie wed along with an update of more recent relevant research results. As a step toward using models to furt her inform this debate , a new dyna mical modelin g framework fo r simulating Atl antic hurricane activity is intr oduced. The model is an 18-km grid non-hydrostatic regional model, run over observed specified SSTs and nudged toward observed time-varying large-scale atmospheric conditions (Atlantic domain wavenumbers 0-2) derived from NCEP Reanalyse s. Using this perfect large-scale model approa ch for 26 recent August-October seasons (1980-2005), we find that the m odel successfully reproduces the observ ed multi-decadal inc rease in numbers of Atlantic hurricanes and several other tropical cyclone indices over this period. For example, th e correlati on of simulated vers us observed annual hurrica ne counts (1980-2005) is 0.77. The model simulates hurricanes intensities of up to category 3 on the Saffir-Simpson scale (~950m b). On interann ual time scales, the model reproduces the observed ENSO-Atl antic hurricane covariation reasonably well. We conclude that the model appears to be a feasible to ol for exploring mechanisms of hurricane frequency variability in the Atlantic (e.g. , shear vs. potentia l intensity impacts). The model may potentially make useful simulati ons/projections of pre-1980 or 21st ce ntury Atlantic hurr icane activity. However, the reliability of these projections will depend on obtaining reliable large-scale atmospheric and SST conditions from sources external to the model.

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MS015 **Oral Presentation** **5496**

Temporal variability of atmospheric surface characteristics in the Eastern Canadian Arctic

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In several interview studies with long-term residents of the Canadian Arctic it has been mentioned that the surface weather conditions and particularly winds have become more variable. Because of this and perhaps other factors there are indications that traditional forecasting methods no longer apply. This changing variability on timescales of hours up to a few days and the more frequent occurrence of extremes is impacting everyday activities by creating new and unforeseen hazardous and often life threatening situations. It is a quite different form of environmental change compared with gradual trends of annual or longer-term climatic conditions, as it characterises the degree (both in magnitude and timing) of deviations from the mean conditions. Due to the social relevance, the objective of this study is to determine surface weather variability on these short time-scales through an examination of hourly meteorological surface data fromtwelve locations across the eastern Canadian Arctic. Only those stations are selected, for which at least 20 years of uninterrupted data records are available, without any significant changes to the instrumentation and reporting practices. The surface variables considered are pressure, temperature, and independently wind speed and direction. Two measures of variability are analysed: variances, as well as mean squared hourly tendencies averaged over periods from 1 hour to 30 days. Interannual variations in annual values of these variables are then determined for all locations and compared with changes in the associated annual Fourier spectra. Due to the large area involved, significant differences exist between longer-term trends in measures of variability at different locations. Moreover, due to the large geographical differences even between relatively close stations, there is no consistent spatial pattern. Even at individual stations, interannual variations differ significantly between different measures of variability. However, despite these differences, several common characteristics can be identified. At all locations, the temporal variations of mean squared hourly tendencies averaged over different periods are highly correlated with temporal variations of the sums of all spectral components corresponding to frequencies greater than a certain limit. This limiting frequency is roughly the same at all locations and decreases inversely proportional with the averaging interval. Even without a change in variances, associated with a shift of spectral energy between low- and high-frequency bands there is therefore a change in variability as measured by mean squared hourly tendencies on a particular time-scale. It is shown that at all locations considered in this study the largest interannual variations in the transfer of spectral energy occurs across frequencies fluctuating between 10 and 100 per year. This corresponds to changes in mean squared hourly tendencies averaged over periods of 15 days. While interannual variations are large, there are few persistent trends in any of the analysed measures of variability.

Keywords: arctic, spectra, weather

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MS015 **Oral Presentation** **5497**

Future Changes in Dry Days Associated with Global Warming

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Global warming seems to affect remarkably not only rises of surface air temperature but also changes in precipitation. In the present study, we concentrate on 'dry day', defined as the day with daily precipitation less than 1 mm/day, which is closely associated with disasters such as drought. We evaluate future changes in dry days associated with global warming, using the last 30-year results of 20th century reconstruction and 21st century projection based on an emission scenario of greenhouse gases and aerosols, A1B, performed with a high resolution atmosphere-ocean coupled general circulation model, MIROC, developed cooperatively by CCSR/NIES/FRCGC. The model has roughly 1.1°-1.1° horizontal resolution and 56 vertical levels for the atmosphere. We use 1°-1° grid daily precipitation data of GPCP, which are estimated from multi-satellites observations, for validating the model's 20th century reconstruction. For each grid, we calculate four indices on dry days, that is, annual dry days, consecutive dry days, mean consecutive dry days, maximum consecutive dry days, which mean the total number of days without precipitation per year, the number of consecutive days without precipitation, the averaged number of consecutive dry days, the maximum number of consecutive dry days per year, respectively. Furthermore, we evaluate histograms of the consecutive dry days for some specific regions characterized by the indices. We first confirm that the model sufficiently well reproduce GPCP regarding amount and geographical distribution of the four indices and regarding the histograms of consecutive dry days of some specific regions, especially for the land areas. According to the future projection experiments with the model, dry days generally increase (decrease) in the regions where precipitation decreases (increases). The regions with remarkable increase in dry days are the Mediterranean basin, middle and southern Africa, Southeast Asia, southern North America, and South America. On the other hand, the regions with remarkable decrease in dry days are the northern hemisphere high latitude band and the Asian inland. We investigate changes in the histograms of the consecutive dry days for the regions mentioned above. The characteristics of changes in each consecutive dry event that cannot be clarified by the indices are revealed by the histograms of consecutive dry days. For example, the Mediterranean basin, which is shown to have the drying trend by the indices (e.g., the mean and maximum consecutive dry days become 1.3 times and 1.3 times, respectively), shows that the consecutive dry events exceeding 200 days become 3.2 times (extremely large) larger than the present. Appropriate combinations of the advantages of the histogram and indices of the consecutive dry days have a possibility of contributing to the estimate of the influences of the changes in dry events on human beings.

Keywords: precipitation, dry, histogram

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MS015 **Oral Presentation** **5498**

Changes in the frequency of societally relevant extreme events over North America

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Selected results from the recent US Climate Change Science Program (CCSP) Synthesis Product 3.3, on Extreme Events (specifically Chapter 3 on Future Climate Changes) will be presented. These results rely on many presented in the IPCC WG1 Chapter 11 on Regional Projections but also include more recent work. Extremes considered include those on daily to seasonal timescales: heat waves, precipitation intensity, seasonal drought, intensity and frequency of tropical cyclones, and extra tropical storms. Future needs for research are described. Resources are needed to develop and produce climate simulations that include important scales and processes of extreme events, especially short-term extremes such as strong tropical and convective storms, which at present are smaller than the resolution of most global climate models More effort should be dedicated to showing how the physical processes producing extremes are changing in both observations and models. Finally comments will be made on the relationship between physical extremes and extreme societal impacts.

Keywords: extremes

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MS015 **Oral Presentation** **5499**

Relation of heavy snowfall and cloud-top heights observed around the Japan Islands in Dec. 2005, estimated from objective analyses and forecasts of cloud-resolving model

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Cloud-top heights of cumulonimbi are almost estimated from the level of neutral buoyancy (LNB). A low-level humid air is lifted adiabatically from the originating level to the lifting condensation level along the dry adiabat, and it is lifted further along the moist adiabat. The upper point at which the moist adiabat crosses the profile of Temperature is the LNB. The higher equivalent potential temperature makes the LNB higher. Over the Sea of Japan in winter, a near-surface air gets the sensible and latent heat from relatively warm sea surface. This air-mass transformation becomes large when the fetch becomes longer and the temperature distance between sea surface and cold air-mass becomes larger. Therefore, the low-level equivalent potential temperature becomes higher around the Japan-Sea side of the Japan Islands, and consequently cloud-top heights become higher there. It should be noted that the Japan Islands are located on the downstream side of the Sea of Japan for the winter monsoon (i.e., northwesterly winds). The LNB around the Japan-Sea side of the Japan Islands is statistically examined using 6-hourly Regional Objective Analysis Data (RANAL, horizontal resolution: 20 km) of the Japan Meteorological Agency (JMA). The statistical period is December and January in 2001-2005 winter seasons. The relation between Dec. 2005 heavy snowfall and cloud-top heights is comparatively examined from the horizontal distributions of averaged LNB in Dec. 2005 and the other years. The averaged LNB in 2005 is higher than 700 hPa, and it becomes exceeding 50 hPa higher than that in the other years. The appearance rate of LNB in 2005 is also 20-30 % higher. Therefore, heavy rainfall in Dec. 2005 was caused by the environmental condition under which cumulonimbi not only easily form, but also develop higher. The consistency between cloud-top heights and LNB is examined using the predicted results of a cloud-resolving model (JMA nonhydrostatic model with the horizontal resolution of 1 km, CRM). The initial and boundary conditions of CRM are produced from the 12-hour forecasts of JMA nonhydrostatic model with the horizontal resolution of 5 km (its initial and boundary conditions are produced from the RANAL). The precipitation is calculated using a bulk-type microphysics scheme in which the mixing ratios of cloud and ice cloud, rain, snow and graupel are predicted. 9-hour forecasts are performed 4 times a day by the CRM, and 3-9 hour predicted data are used in this study. The precipitation distribution predicted by the CRM well reproduced that of JMA Radar-Raingauge analyzed precipitation (R-A), although the precipitation amount is overestimated. This overestimation could be brought from the underestimation of R-A. Averaged cloud-top heights in Dec. 2005 predicted by the CRM are higher over plain areas (about 680 hPa). Meanwhile, they are relatively lower over mountainous areas, because clouds formed by updrafts on the slope are included. The vertical profiles of appearance rate of predicted cloud-top heights show that the LNB in Dec. 2005 appears exceeding two times over a 600-hPa level more frequently than in Jan. 2006, and the vertical level with the maximum frequency is exceeding 50 hPa higher. In other words, the higher development of snow clouds caused the heavy snowfall in Dec. 2005. The vertical profiles of appearance rate of LNB, estimated from the results of CRM, well correspond with those from the RANAL. In the profile of Dec. 2005 over the sea, the appearance rate of LNB over a 600-hPa level is remarkably higher than that of Jan. 2006. The comparison of heights between cloud tops and LNBs shows that cloud-top heights appears with about an half frequency of LNB, and the vertical profiles of appearance rates of LNB over the sea are very similar to those of cloud-top heights on the land. This indicates that snow clouds

forming over th e sea develop on th e lan d.For ou r fu ture works, the relation of predicted cloud-top heights by the CRM to those observed by meteorological radars should be examined.

Keywords: heavy snowfall, cloud resolving model

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MS015 **Oral Presentation** **5500**

Cold and warm spells in Poland frequency, trends and relations to atmospheric circulation

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Instrumental observations of European temperature records have revealed a warming since the end of the nineteenth century (Houghton, 2001). This warming should express by a greater number of days warmer than normal and a lower number of colder than normal days. The aim of this paper is to describe the variability of occurrence of warm and cold spells. Warm and cold spells are defined on a site and day specific way on the basis of the reference period 1961-1990. For each calendar day the mean and standard deviation were calculated for a five day window centered on this calendar day. The day was numbered among cold (warm) when the temperature on this day was at least 1.5 standard deviation lower (higher) from the reference period mean value. Such analysis was performed for daily minimum and daily maximum temperature. The number of consecutive cold (warm) days was called the length of cold (warm) spell. Records of the longest spells in seasons and in the year together with records of seasonal and annual frequencies of warm and cold days were calculated and their long-term variability was analysed using different methods: linear and piecewise regression estimated by the least square method with Student's t-test, and Sen's slope with Kendall tau test (Sen, 1968).The daily minimum and maximum temperatures from nine Polish stations (Hel, Chojnice, Kalisz, Lodz, Poznan, Pulawy, Siedlce, Zakopane and Sniezka) in the period 1951-2006 were used. Additionally the synoptic patterns accompanying the occurrence of warm and cold spells were distinguished. To do this the daily gridded geopotential heights from levels: 850, 700 and 500 hPa and sea level pressure values from NCEP/NCAR reanalysis were used. The sets of cold (warm) days in spells lasting at least five days were established. The day was defined as cold (warm) if it was cold (warm) on at least two stations. For these sets the composite maps for all geopotential levels and sea level pressure were prepared in each season separately and analysed. The work was supported by EC under project STATME-MTKD-CT-2004-014222References:Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, and D. Xiaosu, Eds., 2001: Climate Change 2001: TheScientific Basis. Contribution of Working Group I to the ThirdAssessment Report of the Intergovernmental Panel on ClimateChange (IPCC). CambridgeUniversityPress, 944 pp.Sen PK, 1968, estimates of the regression coefficient based onKendalls tau. Amer. Stat. Assoc. J 63: 1379-1389.

Keywords: cold spell, warm spell, variability

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MS015 **Oral Presentation** **5501**

Multi-indices analysis of Scandinavian Storminess in last two hundred years

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One of the most impor tant i ssue in potential climat e cha nges in mid-la titudes is variability of e xtra-tropical cyclones. Theoretical considerations and various model simulations suggest increased number of deep cyclones and poleward shift of storm tracks. Analysis of the observed data can provide information if such tendencies are present in historical re cords. Among different storminess indices, t hese based on the point pressure measure ments allow to extend st udies on the cyclone activity to the beginning of regular meteorological observations. In this studies eight proxies have been determined on the base of thrice-daily pressure data fr om Lund, sou thern Swede n (period 1780-2005) and Sto ckholm (period 1820-2005): annual number of pressure observation be low 980hPa, intra-annual 1-p ercentile of the pressure data set, annual n umber of absolute pressure tendencies exceeding 25 hP a/24h, intra-annual 99-percentile of the abso lute pressure differences in 8 h, annual pressu re variance in the frequenc y band 0.3˜0.6[1/day], ratio of the annual pressure variance in the frequency band 0.3-0.6[1/day] to the pressure variance in the freq uency band 0.1-0.3[1/day], and two indices based on the idea of wavelet transformation. For each stat ion, the overall long-term variability of the indices agree, but the high frequency variability differ. In general indices at st ation are highly correlated ($p<0.01$). The correlation between the two sites is also very high (0.54-0.68 depending on the index). However, results show that an analysis based on one index only can be misleading. Instead a ge neral information on secular changes in storminess can be extracted from a set of proxies (like 8 indices presented here). A principal component analysis pro vide a go od to ol such ex traction. The first PCs fo r Sto ckholm and Lund are highly correlated (correlat ion coefficient = 0.75) an d they are in good a greement with other studies. The presented approach allows to extend knowledge on deep cyclone activity further back in time than previous studies. Results show that there is no evidence for extraordinary intensification on the cyclonic activity in last decades.

Keywords: storminess

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MS015 **Oral Presentation** **5502**

Extreme events in Asian Monsoon region under the Global Warming

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In order to control water resources in the face of drought, flood, and soil erosion, which frequently present a serious threat to human life and natural ecosystems, predictions and risk assessments are being required more frequently by policy-makers. Hydrological predictions that account for global climate change use general circulation models (GCMs) in the main. Despite numerous studies, coarse spatial resolutions (those with grid spacing of approximately 300 km) and uncertain physical processes particularly limit in representing the terrestrial water/energy interactions and the variability and extremes in systems such as the Asian monsoon, thereby very restricted amount of regional-scale estimates are available to planners. In these days, ensemble experiments with relatively hi- resolution (T106) GCM become to be possible in the virtue of improving computer's ability. This study investigate the changes of extreme precipitation during the Asian summer monsoon. Results from time-slice ensemble experiments using a high-resolution 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. In contrast, dynamic changes rather limited the intensification of mean precipitation.

Keywords: extreme, gcm, monsoon

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MS015 **Oral Presentation** **5503**

Global Warming and the Tropical Cyclone Climatology as Simulated in a 20-km-mesh Global Atmospheric Model

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Influences of th e global wa rming on th e tropical cyclone climatology have been investigated by numerical experiments using a glo bal atm ospheric model with approximately 20-km grid size. Thi s horizontal resolutio n is unprecedentedly high as a climate model for global warming simulation. The computation has been performed on the Earth Simulator, one of the wo rld's most powerful computers. Results of exp eriments suggest that the number of tr opical cyclones in a warmer climate is globally reduced by ab out 30% com pared to the present-day climate. Co ntrastively, the num ber o f intense tropical cyclones increases o n the global scale. The maximum surface wind speed for the most inte nse tropical cycl ones generally i ncreases under the greenhouse-warmed condition. On average, thes e findings suggest a possibility of higher risks of more devastating tropical cycl ones across the globe in a future greenhouse-warmed climate. Additional experiments have been co nducted with vario us conditions of warmer sea surface temper atures. The results indicate that intensification of trop ical cyclones is more significant under larger climate warm ing. It is also suggested that basin-scale changes in the number of tropical cyclones could be consist ent between the war mer climate experiments except for a case with rather unrealistic setting of sea surface temperature.

Keywords: global warming, climate model, tropical cyclones

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MS015 **Oral Presentation** **5504**

Climate extremes indices - comparison of RCM downscaled ERA40 and GCM scenarios

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The Rossby Centre has just completed a large set of climate indices (indices of climate extremes) commissioned by a Swedish Government Inquiry. Taking an unorthodox approach, we allowed free requests (within practical and possible limits) from the members of the committee working groups on the basis of the general and vague information that ...regional climate models does not only produce climate averages but do simulate the evolution of weather conditions over time.... Examples of some previously defined climate indices were drawn from the MICE/PRUDENCE/ STARDEX project consortium and from the European Climate Assessment (ECA). In essence, this is what might be viewed as Participatory climate modelling. Some of the requested climate indices followed established concepts and/or were specified in enough detail to be directly calculated. However, a few ideas for indices were expressed in rather conceptual terms of possible impacts of what was perceived as climate extremes from an impact point of view. Within the limited time available, these requests could only as first order approximations be transformed into simple climate indices. The general methodology was to use the Rossby Centre regional climate modelling system (RCAO and RCA3) to downscale, to ~50 km resolution, several GCM climate change simulations, as well as ERA40 + ECMWF operational data as present day reference. All indices were calculated based on daily data from several model runs.For all indices one index value was calculated for each year in a time period and then averaged to form the final index value for the period. Depending onthe index,separate calculations were done for each season and/or month. The following time periods were analysed 1961-90, 1991-2005, 2011-40, 2041-70 and 2071 - 2100. Here, we give an overview of theproject and select a few indices to illustrate in more detail our results and preliminary conclusions regarding model performance, climate change signals between different lateral boundary conditions, and the reliability of different index classes.

Keywords: indices of climate extremes, regional climate model, era40 sres scenario

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MS015 **Oral Presentation** **5505**

Development of a daily grid precipitation dataset over the East Mediterranean: extreme events in the analysis dataset

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Recent high- resolution atmo spheric general circulatio n mo dels can simulate extreme events in precipitation. However, curr ent observed precipitation p attern is not well reported due to lack o f progress in d ata assembly especially over the Ea st Mediterranean re gion. Therefore, quantitative estimate of observed daily precipitation and its time-space variability are inevitably important in order to assess the imp acts of global warming to local hydrol ogical resources. Xie et al. (2007) developed an algorithm to cr eate daily grid precipitation product based on rain ga uge data over East Asia . We are developing a s imilar dataset over the East Mediterranean region (15E-70E, 15-55N). We first define monthly climate normal by using the 1222 monthly station data and 2194 station daily precipitation data from individual sources from , Israel, Turkey, Iran,GHCN ver2b and GTS network. First, daily climatology was defined, a nd then daily ratio to the daily climat ology is analyzed into 0.05 degree g rid boxes. The characteristics of precipitation , such as extreme ev ents are compared from the original d ata and those in gridded valu es on 0.05, 0.1, 0.25 and 0.5 degr ee. Similar worksare undertaken as a project Asia n Precipitation -- Highly-Res olved Observational Dat a Integration Towa rds Evaluation of the Water Resources (APHRODITE's Water Reso urce; URL:http://www.chikyu.ac.jp/precip/aphrodite.htm) funded by the Ministry of Environment, Japan.

Keywords: precipitation, raingauge, analysis

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MS015 **Poster presentation** **5506**

Extreme Weather and Climate Changes : Integrating Human Dimensions and Coastal Zone Management During Tsunamil Disaster

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The fishery sector is gaining importance in Global Economy. Aquacultur e has emerge d as one of the most promisin g industries i n the world with consid erable growth potential and it is expected to contribute about a quarter to the global fishery harvest by year 2000. Availability of water is a constraint in a no n-irrigated agriculture system. Aqua farmin g has a multidimensional context i n perspective agricultural growth. It is tool for utilizing l and and water (Ground- surface, river, lak es and coastal) more economically and optimally to in crease productivity, of both, land and wa ter, through sustainable agriculture for global food sec urity. The countries in the Asia-Pacific region have vast and varied aqua farming resources Often these are the main source of su rface as well as ground water irrigation in this region . Overu se of grou ndwater, river floodin g due to cloud br usts,quality a nd catchment s characteristics along coastal and esturine regions causes long term impacts on environment and diverse problems in many co untries reducing the cultivable ar ea resulting in reduct ion in agricultural and aquaculture production in global economy. This paper focuses on the integration of human dimensions for Tsunami , coastal zone management and human use of oceans including Surface and ground water along coastal regions with special reference to di saster prone regions and their int errelationships quality, policy and management and issues with reference to impacts of extreme weather and climat on aquaculture and its impacts on the global e nvironment .The paper also deals with the management of extreme weather and climate events along coastal zo nes during nat ural disasters suc h as cyclones, hurricanes , heavy rains, flash floods and Tsunami.

Keywords: extreme weather, climate changes, human dimensions

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MS015 **Poster presentation** **5507**

Recent change in frost dates, frost days and the frost-free season in Iran

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It has become clear from the observed records that global temperatures increased approximately 0.6C over the twent ieth century. Given these observed temperature cha nges, one of the major questions about potential climate chang es is how extreme even ts might change. Although the climatic changes that have take n place in geological time pe riods are great and of much importance, he re we mainly focus on rapid and recent changes in frost dates, frost days and the frost-free season. Changes i n the frequency of frosts can be s urprisingly large fo r seemingly modest mean changes in cli mate and are often the mos t sensitive asp ects of climate change for ecosystem and societal res ponses. In this investigation the long term data of frost days, free frost period, dates of last spring and first fall frost in Iran during 1951-2003 span were studied in 45 meteorol ogical stations. Results show that positive and negative trends have occurred during this period in Iran. More than 80% of area of the country has experienced positive trend in Minimum temperature.

Keywords: frost, global warming, iran

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MS015 **Poster presentation** **5508**

Extreme temperature events in South Korea and their imapcts on human health

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Temperature extremes in South Korea during the past 40 years (1961-2000) are investigated to assess the impacts on health. Occurrence frequency and d uration of extreme temperature e vents are also investigated. The result shows that the maximum and minimum temperatures are gradually increased in Seoul. Howev er, in the background station (e.g ., Daegwanryeong) the increasing rates of the temperatures are relatively small. The resul t implies that the urbanization in the lar ge city as well as global warming plays a major role in heatin g the ur ban atmosphere. Extreme temperature in late July and early Aug ust of 1994 ov er South Korea caused m ajor heat-related deaths. Daily deaths in Seoul were exponentially increased with the daily maximum temperature. The threshold temperature in Seo ul was found to be 31.2˜ provided that it is determined by a two-phase regressio n model. The meteorological causes of abnormal hot weathers in late July of 1994 an d their consequences of human health will be presented.

Keywords: extreme temperature, heat wave, mortality

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MS015 **Poster presentation** **5509**

Northeast Unites States temperature and precipitation extremes

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Raymond Bradley

Recent efforts to image and key historical data by the NOAA Climate Data Moderni zation Program (CDMP) have enabled new long-term data sets to be created in the United States. D aily records dating from the mid 1800s have b een compiled from the Fo rts, United States Historical Climate Networ k (USHCN) an d Cooperative Network (C OOP) data sets to c onstruct long-term temperature and precipitation r ecords for the Northeast . Extensive qual ity control of the data was performed and inhomogeneities identified. Adjustments fo r temper ature inho mogeneities have been made using th e method of Della-Marta and Wanner (2006) which adju sts for changes in the mean and higher-order moments. No homogenization pro cedures were carrie d out on the daily rainfall data. Analysis of the changes in te mperature and precipitation extrem es was performed using indices defined by the ETCCDMI. With these new data compilations extending from the mid 19th century, changes in extremes spanning the l ast 150 years can be examined for the first time, pr oviding a unique perspective on anthropogenic climate change in this part of the United States.

Keywords: extremes, temperature, precipitation

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MS015 **Poster presentation** **5510**

The influence of the atmospheric circulation on twentieth century UK precipitation variability and extremes: observed and modelled relationships

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Using homogeneous precipitation series for the UK, recent trends in extreme daily rainfall indices are examined. Three airflow indices are used to examine the influence of the atmospheric circulation on precipitation extremes and the strength and variability of this relationship across the UK. The relationship between precipitation amount and these airflow indices is used to examine whether the synoptic circulation can be used to explain precipitation variability on different timescales, including recent increases in the frequency of extreme events over parts of the UK. Climate models project a varied hydrological response to climate change across the UK in the coming century and such uncertainty presents problems for the impacts community. Comparing individual models indicates that their relative skill in reproducing different properties of precipitation varies spatially and temporally. As part of a framework to develop probabilistic scenarios of climate change impacts, six regional climate models (RCMs) from the EU PRUDENCE project are used to examine model uncertainty. This is achieved by comparing their relative skill in reproducing not only mean precipitation and the frequency of extreme events, but also whether these may be explained by weaknesses in the representation of the atmospheric circulation and its relationship with precipitation.

Keywords: precipitation, extremes, circulation

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MS015 **Poster presentation** **5511**

Probability estimates of recent temperature extremes: comparison of extreme value distributions and stochastic modelling approach

Dr. Jan Kysely
IAMAS

The most frequently used statistical approaches applied to estimate recurrence probabilities of extreme events are those based on modelling either the upper tail of the distribution of the examined variable or its time series as a whole. In the former case, the estimation procedure makes use of block maxima (usually leading to the Generalized Extreme Value distribution) or peaks-over-threshold (leading to the Poisson process model and the Generalized Pareto distribution). In the latter case, a long series of the examined variable is generated by means of a stochastic model (an autoregressive model being frequently employed for daily temperature), and probabilities of extreme events are derived from the simulated artificial series. The present study focuses on a comparison of the applicability of the two approaches in estimating probabilities of recent temperature extremes, particularly heat waves and unusually high daily temperatures observed in central Europe during summers of 2003 and 2006. A specific attention is devoted to the settings of the peaks-over-threshold analysis (the threshold used to delineate extremes, and the minimum separation time between events so that their independence is preserved) and estimating the order of the autoregressive model for daily temperature. The statistical framework yields also estimates of future changes in the occurrence and severity of heat waves under scenarios of the mean temperature change based on climate model outputs.

Keywords: extreme temperature events, heat waves, frequency estimates

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MS015 **Poster presentation** **5512**

Physical phenomena and economic impacts of an extreme event in Calabria (south Italy)

Dr. Olga Petrucci

A.A. Pasqua

The present work deals with the causes (triggering rainfall) and effects (damage to society and environment) of one of the most important extreme rainfall events which occurred in Calabria (South Italy) during the last century. Between the end of 1972, and the beginning of 1973, during about 30 days, a lot of downpours hit almost the entire calabrian region: in several rain-gauges the daily rainfall recorded the maximum value of the century. The rainfall, also characterised by high cumulate value, triggered a lot of damage all over the region. For the purposes of this work an unpublished archive of Department of public works has been acquired and examined in order to re-enact the framework of damage in one of the most severely hit provinces of Calabria named Catanzaro. From the above said archive, data concerning landslides, floods, and sea storms were obtained checking a huge amount of documents, mainly concerning applications for damage compensation sent from people to the Department. Data obtained were organised chronologically and sorted for municipality in a specific database. An estimate of economic damage has been attempted based on the amount of funds allocated by the Department to people for damage compensation. The obtained values were used to calibrate a procedure for damage estimation, proposed in preceding works, and based on a Local Damage Index, obtained multiplying the value of elements damaged and the percentage of damage (classified in three levels) affecting it.

Keywords: calabria, historical data

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MS015 **Poster presentation** **5513**

Meteoinformatics: Reducing the extreme weather and climate Impacts on the Citizes and infrastructures of a coastal city

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In this study we try to investigate the rel ative climatic variations over Lagos that often ensue in soil erosion following excessive floods, using 60 years rainfall data of the area. Also used is 7 years data on vehicle theft and recovery from the state police command headquarters; to examine the characteristics of weather and climate of the city in the recent time and their impacts on the rate of stealing of vehicles by hoodlums in the city, the rate of its recovery and condition of the citys infrastructure (roads); as well as the rate o f resources wastage (vehicles not reco vered) attributable to the acti vities of these miscreants in the society. The methodologies used were the time series and variability analyses. Results show a decreasing trend of rainfall with noti ceable climatic variations, which appeared as fluctuations of wet and dry years in every 2-3 years. Most of these variations are not unconnected with the inadvertent weather modifi cation associat ed with the ur banization rate and anthropogenic activities in the state . This often results in intense rainfalls of short duration, which leads to soil splashing, lost of soil and road deterioration. Further result showed a seas onal variation of vehicles stolen in t he city, indicating tha t both weather and climate affects not only the road co nditions, but also the crime rate. Weather has both positive and negative effects on the activities of the hoodlums. Sometimes when rainfall increases, it enhances their activities and mo re vehicles are stolen, and vice-v ersa, especially between the month of May and September. In contrast to this however, it is also observed that between October and January, which are less wet and festivity periods, inverse relationship existed between the rai nfall magnitude and rate of stolen vehicles. This study also revealed that thes e robbers may be employing different modes of operation for different seasons, but due to inertia, they have the tendency of continuing with a particular m ethod, even w hen the prevailing weather co ndition has changed. Further results show that weather and climate als o influences the rate of recovery of stolen vehicles by the police. The peak of vehicle recovery occurr ed during the dry season indicating that the police may b e under equippe d to cope with the hoodlums strategy an d high rate o f stealing o f vehicles during the peak of rainy season. Resources wastage (stolen vehi cles not rec overed per year) attr ibutable to the activities of th e hoodlums in the state are in th e range of 32-66.5%; with 1998 being t he nadir of the losses, followed by 1999. To safeguard lives and properties, the meteoinformatics synergy employed by Nigerian M eteorological Agen cy (NIM ET) i n redu cing th e impacts of weather- and climate-related disasters on the citizens is highlighted and invariably managing the problems of crime-meteorology.

Keywords: climatic variations, crime meteorological, rainfall urbanization

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MS015 **Poster presentation** **5514**

Formation Mechanism of Simulated Large-Scale Climatic Cold Region in Middle Troposphere over the East Siberia in December 2005 using a Regional Climate Model

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Formation mechanism of intensified climatic large-scale cold region around East Siberia in December 2005 is investigated using a regional climate model. It is reported that the intensified cold region causes the severe weather and brought a heavy snow amount over the northern part of Japan. There were many serious damages such as huge power failure due to the heavy snowfall in the late December. In the simulation, the 6-hourly NCEP reanalysis data is used as the initial and lateral boundary condition. The calculation domain is covered in the large part of the southern area of the East Siberia and Japan. First, the sensitivity experiment with adiabatic process (ADIABATIC run) is conducted to investigate the effect of the atmospheric response and the advection of large-scale atmospheric circulation. The intensification of the cold region is not reproduced by adiabatic run, although weak cold region is represented in this run. It means that the intensified cold region cannot be simulated by the atmospheric response and advection. Another sensitivity experiment with diabatic heating processes except for the surface heat fluxes (NO-SF run) is reproduced the intensified cold region. Form these results, it is speculated that the intensified cold region is caused by something of the diabatic heating process in the middle troposphere. Some typical events, which are strongly related to form the intensified climatic cold region, is investigated by the additional sensitivity experiment with diabatic heating process except for the radiation process (NO-RAD-R run). The intensification and maintaining of the cold vortex in the typical events cannot be simulated by NO-RAD-R run, although the NO-SF run can well simulate the features of the cold vortex. It is suggested that the radiation process in the middle troposphere is indispensable to intensify the cold region. From the satellite images, it is found that the cloud is formed in the cold vortex. Therefore, it is speculated that the infrared cooling from the cloud is also important to form the intensified cold region in December 2005.

Keywords: winter monsoon, cloud radiation, east siberia

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MS015 **Poster presentation** **5515**

Seasonal reconstruction of extreme events for central Spain from rogation ceremonies and historical floods.

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This work shows the evolution from 1500 to 1900 of two kinds of extreme climatic events very common in theIberian Peninsula: floods and droughts. The study was carried out in the southern Central Spanish Plateau on the basis of two documentary series: 1) The pro-pluvia rogations ceremonies (ceremonies to ask God for rain) celebrated inToledo. We analyze the duration of periods with continuous/overlapping ceremonies (Pro-pluvia Periods) to estimate the sign ificance of the drought. This methodology gives an objective criterion for the an alysis of th e drought periods, an d the poss ibility of w orking at season al scale. 2) The documented historic floods of the Tagus River at Aranjue z, Toledo and Talavera. T he combination of these three locations provides a complete record of historical floods into the study area. These floods are classified, on the basis of the flooded area and damages, as a) ordinary b) extraordinary and c) catastrophic.Despite it is uncommon that both phenomena took place during the same year, they use to alternate during periods of high frequency of events. Accordingly to the annual frequency and the magnitude of events, we differentiate six periods: 1500-1556. Few extreme events, droughts in spring and floods in winter (their usual season). 1557-1623. It is the period with the highest abundance of events. We identify two subperiods: 1557-1590, events took place in their usual season , and 1591-1623, events in all the seasons. 16 24-1716. Events are more frequent tha n in the first period but less frequent than in the second. Dr oughts an d floods appear in all th e season s but floods only appear with severity during the second half of the period , especially between 1700 an d 1715. 1717-1793. Increase d freque ncy of events. Droug hts were concentrated in s pring and fall b ut their lengt h decreased. Floods were mor e frequent in winter. This period shows th e highest num ber of years (7) with both dr ought and flood. 1794-1850. The number of droughts and floods decrease d drastically for all the seasons. 1850-1900. T his period is characterized by social changes, that led to the progressive abandonment of the rogation ceremonies, and an in creased ant hropic pressure on t he thalweg. A s consequence only some spring droughts are recorded up to 1875, when their record ce ases, but the flood record spreads to all the seasons. Thus, seasonal comparison of the frequency of events allows a better characterization of the annual series. On this basis, we can argue that the 1550 to 1800 episode was a period of high frequency of events during the Little Ice Age. Acknowledgements: This research is supported by the Spa nish Ministry of Science and Education (MEC) projects REN2002-04433-CO2 an d CGL2005-06458-CO2-01/HID. Fernando Domnguez-Castro work is supported by a MEC research gran t (BES-2003-0482).

Keywords: climatic variability, drought, historical floods

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MS015 **Poster presentation** **5516**

A rainfall-runoff models sensitivity to extreme events

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Extreme weather events can cause great damage to society and also endanger human health. Concerns of increased frequency of such extreme events in a future climate have driven research within this field in recent years. There are many difficulties in assessing the probability of increases in extremes, such as the inherently low number of observations and the poor representation of extremes in global climate models. This paper describes a methodology to investigate a hydrological models ability to model extreme events in a probabilistic way through sensitivity surfaces. The study was conducted within the project ENSEMBLES.Sensitivity surfaces are created by running a rainfall model for a drainage area with differentiated changes in the observed input data (e.g. temperature and precipitation). The probability for reaching an a priori determined threshold any given year is then calculated from the results. The threshold can be set generally, such as the probability of reaching the 50-year return period, or be more site-specific, relating to past observed events. The probability of the increased risk of a certain event in the future is then visualized by plotting the sensitivity surface and future projections from climate models in the same diagram. An advantage with this approach is that the future projections of weather variables from different models can be assessed in one diagram for each area and threshold. This assumes that the intra-annual variation in the modelled variables is similar for the models, or that the threshold is insensitive to intra-annual variations.Four areas were studied; Lake Vnern, Lake Mlaren and Lule River, and the runoff from the entire Baltic Sea basin. The hydrological model was the HBV model, a conceptual rainfall-runoff model which is widely applied in Swedish catchments. Specific thresholds were selected for Lake Vnern and Lake Mlaren. For Lake Vnern the threshold was set as maximum allowed release discharge during a period of 200 days or more, mimicking a critical event that occurred in the fall/winter of 2000-2001. For Lake Mlaren the threshold was set as water level below a certain level for more than 100 consecutive days. For the other case studies changes in the modelled runoff was compared. Preliminary resuls indicated that Lake Mlaren was most sensitive to differences in the intra-annual variations of the driving variables. The results for Lake Vnern indicated that only a slight increase in precipitation substantially increased the probability of reaching critical water levels in the lake, thus forcing a maximum outflow for a long time period. Thresholds for the other areas are not yet decided upon. The results can be used as decision support system to minimize the risks for future damage to societies and human health.

Keywords: runoff, modelling, sensitivity surface

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MS015 **Poster presentation** **5517**

Scenarios of subseasonal summer heatwaves over Europe

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Climate model studies indica te that summ er heatwa ves (such as in 2 003) over will become more frequent, more intense and lo nger lasting in the future. Most recent studies have ad dressed changes in seasonal mean temperatures, but most of the societal impacts of heatwaves occur on subseasonal time-scales. Thus, t he growing ris k of extreme heatwaves does not only depe nd upon the anticipated mean warming, but also upon changes in intraseasonal and interannual temperature variability in respo nse to greenhouse-gas forcing. The present stud y explor es the projected changes in d aily temperature variability from a set of regional climate model scen arios. We use the PR UDENCE multi-model scenario experiments to co nstruct scenario s fo r impact- related heatwave in dices and to investigate t he relationship between changes in daily, intraseaso nal a nd interann ual temperature variability o ver Europe. Chang es in heatwav e du ration, diurnal temperat ure range and threshold exceedances are analysed for different European land regions. The si mulated current climate co nditions in the different models are validated against daily temperature observatio ns (ECA dataset). Particular attention will be devoted to changes in the number of consecutive days with extraordinary high temperatures, which are known to have important impacts such as increases in mortality.

Keywords: heatwave, variability, extremes

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MS015 **Poster presentation** **5518**

On future heat waves in the Iberian Peninsula

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The aim of t his work is to obtain and analyse projections for th e occu rrence an d severity of su mmer heat waves to be observed in differen t lo cations (Madrid, Barcelon a, L a Coru a, ...) of th e Iberian Peninsula. Heat waves are defined as periods where the d aily maximum temperature, Tx, exceeds the threshold defin ed by the 95th percentile of daily Tx data, from June to August, for period 1971-2000. First, we analyse the outputs of the model CGCM3.1-T63 in the 20C3M e xperiment, for the model gri d points closer to the different observatories an d we c ompare their distributions with the ones corresponding to observed daily temperature values in 1951-2000. Corrections in variability and position are applied to makecompara ble the simula ted and t he o bserved trajectories. Second, the he at wave processes resulting from the GCM rescaled trajectories are comparatively analyse d with the observ ed ones, regarding both the occurrence an d severity characteristics. Alternatively, the GCM trajectories are used as input in the st atistical model proposed in Abau rrea et al. (2007), in order to obtain the "downscaled" heat wave process properties which we compare also with the observed ones. Using the best of both approaches we obtain a mediu m term projection, up to 2050, of the expected behaviour o f these extreme events in the scenario SRES-A2. References: Abaurre a, J., Asn, J., Cebrin, A. C., Centelles, A. (2007). Modeling a nd foreca sting ex treme hot events i n the central Ebro valley, a continental-Mediterranean ar ea. Glob. Planet. Change, doi:10.1016/j.g loplacha.2006.11.005 Beniston , M., Stephenso n, D.B. (2004). Extreme cl imatic even ts and their evol ution under c hanging climat ic conditions. Glob. Planet. Cha nge 44, 19. Meehl, G. A., Tebaldi, C. (2004). More intense, more frequen t and longer lasting heat waves in the 21st century. Science, 305, n. 5686, 994-997. DOI: 10.1126/science.1098704 Prieto, L., Garca Herrera, R ., Daz, J., Hernndez, E., del T eso, T. (2004). Minimum extreme temperatures over Peninsular Spain. Glob. Planet. Change, 44, 59-71.

Keywords: heat wave, projection

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MS015 **Poster presentation** **5519**

Analysis of extreme climate indices for the Carpathian Basin using observed and simulated temperature and precipitation data

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Several climate extreme indices are analyzed and compared for the Carpathian basin (located in Central/Eastern Europe) following the guidelines suggested by the joint WMO-CCl/CLIVAR Working Group on climate change detection. These climate extreme indices are determined on the basis of daily maximum, minimum and mean temperature values, and daily precipitation amounts. The statistical trend analysis includes the evaluation of 27 extreme indices, e.g., the numbers of severe cold days, winter days, frost days, cold days, warm days, summer days, hot days, extremely hot days, cold nights, warm nights, the intra-annual extreme temperature range, the heat wave duration, the growing season length, 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. In order to analyze the past trends, daily meteorological observations are used to calculate the time series of extreme temperature and precipitation indices for the 31 selected stations for the 20th century. Because of the lack of century-long meteorological time series, the analysis focuses mainly on the second half of the 20th century. However, the analysis is extended for the entire century in case of some stations, where sufficient data was available. The results suggest that similarly to the global and continental trends, regional temperature of Central/Eastern Europe got warmer during the second half of the 20th century. Furthermore, regional intensity and frequency of extreme precipitation increased, while the total precipitation decreased in the region and the mean climate became drier. In case of the future trends (2071-2100), daily values of meteorological variables are obtained from the outputs of various regional climate model (RCM) experiments accomplished in the frame of the completed EU-project PRUDENCE (the horizontal resolution of RCMs is 50 km). Both scenarios A2 and B2 are used to compare the past and future trends of the extreme climate indices for the Carpathian basin.

Keywords: extreme climate index, regional climate model, carpathian basin

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MS016 **5520 - 5589**

Symposium
Downscaling to Local and Regional Scales (ICCL)

Convener : Dr. Filippo Giorgi

This symposium invites papers on studies directed towards deriving fine-scale estimates of atmospheric and hydrologic conditions. Approaches based on both statistical and deterministic techniques, including especially fine-scale regional models, are invited. Topics to be covered will include techniques for downscaling and modeling, intercomparison projects, application of the approaches to particular regions and localities, and evaluation of the techniques and their transferability and uncertainties. Papers are also welcomed on the linking of regional atmospheric and climate models to models of other processes, including hydrologic and ecosystem models

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MS016 **Oral Presentation** **5520**

Comparison of Statistical and Dynamical Downscaling Results for Climate-Change Scenario Development in Southern Qubec

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Philippe Gachon

Global Climate Model (GCM) outputs are provided at a much larger spatial-scale than is usually needed in many impact studies. As a result, t wo downscaling approaches, namely statistical and dynamical downscaling te chniques, have emerged as a means to generate local or station-scale c limate change information based on the large scale GCM atmospheri c circulation data. This study m akes systematic evaluation of s tatistical and dynami cal downscaling outputs by construc ting climate scenarios at spatial scales more appropriate for impact studie s. Comp arison is made using observed pr ecipitation and temperature data from southern Quebec a nd downscaled data from two global climate models (CGCM2 and HadCM3) and the corresponding values from the latest Canadian Regional Climate Model (CRCM4). The downscaled results are validated over the 1961-1990 baseline period, and climate change scenarios are computed for the 2041-2 070 period. Preliminary resul ts, with particular emphasis t o the statistica l distribution and climate extremes, show that the downscaling performa nce over the r eference period significantly va ries between the downscaling techni ques and over the different seaso ns while both approaches produced comparable climate change sce narios for the fut ure. In general, the study helps identify the strength and weakness of the two downscaling approaches in reproducing the temperature and precipitation regimes for southern Qubec.

Keywords: downscaling, climate scenario, qubec

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MS016 **Oral Presentation** **5521**

Preliminary study and assessment of Weather Generator models with emphasis on LARS-WG model over Khorasan province

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Resolution of Global and Regional Circulation Models have been increasing, But none of these models can predict and determine the real climate in the local and micro scales . Microclimate of a specified region would be changed rapidly by a small displacement. So, here is a main question: How we can produce the weather data in the station-scale or microclimate? There are two main reasons for weather generating tools: lots of missing values in meteorological station around the world, somehow we need to synthetically reproduce these missing values. The second is resolution deficiency of the climate models needs to synthetic daily weather data will be remained. In this project, we have evaluated the skill of the one the famous weather generators named: LARS_WG over four selected synoptic stations of the Khorasan province, located in the North-East of I. R. of Iran. Stations are Mashed, Sabzvar, Birjand and Torbat heydarieh. Statistical results showed that the mean and standard deviation of synthetic data are acceptable in the confidence level of 0.05 and then we can use the model for climate change purpose in the stations under study.

Keywords: downscaling, weather generator, gcm models

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MS016 **Oral Presentation** **5522**

Construction of past and future climate change scenarios: a downscaling approach

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A study has been undertaken to investigate the climate change signal (if any) in the 20th century over the whole Indian region as well as over eastern part of India using CRU reanalysis and observed station data. A downscaled high-resolution future climate change scenarios have been constructed over eastern part of India as a special emphasis. A warming trend is detected from the fifties in case of the winter season while the eighties for the postmonsoon season where as a significant recent decreasing trend in the monsoon rainfall is also noticed. Future projection of climate change in the periods 2020s and 2050s using five GCMs namely HadCM2, CSIRO, GFDL, CGCM1 and ECHAM4 has been derived due to greenhouse gas forcing as well as sulphate aerosols forcing conditions. An amount of 0.3 - 0.6 0.2oC per oC global mean temperature change is noticed in the composite scenarios, with more warming in the northern India and less warming in the southern India. However, unlike mean temperature, pockets of positive as well as negative changes in rainfall are observed in different parts of the country. Downscaled scenarios using a statistical technique reveal a warming of 0.2-0.8 oC which is higher than that obtained from the all-India scenarios over the same region. The scenarios in the premonsoon seasons rainfall indicate a dipole structure with positive values of (2%) in inland and negative changes (-5%) in coastal belt. So the projection for 2010-2039 indicates a warming of about 0.5-2.0oC by introducing the global change of GCMs ('2.5oC) for green house gas forcing alone but slightly less when introducing sulphate aerosol forcing with it.

Keywords: downscale, climate change scenarios, global circulation models

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MS016 **Oral Presentation** **5523**

Projected change in mean and extreme climate over Korea from a double-nested regional climate model simulation

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Won-Tae Kwon, Filippo Giorgi

We present an analysis of a simulated climate projection covering the period 1971-2080 over the Korean Peninsula with a regional climate model (RegCM3) using a one-way double-nested system. The mean climate state as well as frequency and intensity of daily extreme events are investigated at various temporal and spatial scales, with a focus on surface air temperature and precipitation. Our analysis is primarily centered on the comparison of two 30-year climate periods between 2021-2050 and 2051-2080, in order to assess climatic changes at different time periods in response to anthropogenic forcings under the IPCC B2 emission scenario. Regarding the interdecadal variation of projected temperature and precipitation over whole integration period, we find that temperature change gradually increases by 3.2 C for the 2070s, with a persistently increasing trend. The projected precipitation in the future shows generally greater amounts than in the reference run and significant interdecadal variation which implies the need for carefully evaluating individual climate change simulations. From a composite analysis of 850 hPa winds and 500 hPa height fields, considerable differences between two periods of increasing and decreasing precipitation are found in the circulation pattern, especially in the summer season. During the period of increasing precipitation, the summer monsoon is intensified because the increased southeasterly flow is favorable for advection of lower level warm and moist air from the Pacific ocean. The spatial distribution of differences in temperature and precipitation between the future and reference scenarios well demonstrates the need for high resolution simulation in regions characterized by complex topography such as Korea. Although the general pattern between the mother and nested domain simulations shows similarity, more detailed structure over Korea is found in the nested domain simulation. The projected surface warming is more pronounced in higher latitudes and in the winter season, with a strong northward gradient. An increase of winter precipitation is also evident, with the maximum along the northeastern coastal ranges in response to orography. The change of summer precipitation is more complex. The southern parts of Korea during 2021-2050 will be expected to have dry conditions, whereas precipitation during 2051-2080 is projected to increase over the whole area, with a maximum in the northwest region. From the probability density function (PDF) of daily temperature fields, there is a tendency of shifting the mean value higher in the future climate than that during the reference period, suggesting the increase of milder conditions in the future climate. In addition, a substantial increase (decrease) of hot (frost) spells is found along with increasing (decreasing) of maximum (minimum) temperature. The frequency distribution of daily precipitation during 2051-2080 indicates heavy rainfall over 400 mm/day, suggesting the occurrence of flood-producing events. Wet spells of long periods tend to be more frequent, accompanying the increase of precipitation amounts. By comparison of the change between 2021-2050 and 2051-2080 periods, the climate change signal of both temperature and precipitation becomes more pronounced in the late 21st century as greenhouse gas (GHG) concentration is increased.

Keywords: regcm3, korea, double nesting

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MS016 **Oral Presentation** **5524**

The impact of lateral boundary data errors on the simulated climate of a nested regional climate model

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Ren Laprise

Climate-change projections at regional scale can be obtained by using a Regional Climate Model (RCM) nested by the large-scale data from a Coupled General Circulation Model (CGCM). Because these nesting data are not perfect, the RCM simulations can be affected by CGCM simulation errors. In this presentation we present the response of an RCM to errors in nesting data. The study uses a perfect-model framework nick-named the Big-Brother Experiment (BBE). The BBE permits to evaluate the errors due to the nesting process excluding other model errors; scale decomposition permits to analyse the impact of the large-scale nesting data on the small scales simulated by the RCM. It is found that the errors contained in the large scales of the driving model are transmitted to and reproduced with little changes by the RCM. In general, the RCM restores a great part of the driving-model small-scale errors, even if they do not take part in the nesting process. The RCM small scales are seen to improve slightly in regions with important orographic forcing due to its finer resolution. However, when the large scales of the driving model have errors, the small scales developed by RCM have errors as well, suggesting that the large scales precondition the small scales. In order to obtain correct small scales, it is necessary to provide the accurate large-scale circulation at the lateral boundary of the RCM.

Keywords: big brother experiment, lateral boundary errors, small scales

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MS016 **Oral Presentation** **5525**

Is there an added value for marine wind fields derived from two regional atmospheric models?

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The hindcast surface marine wind speed fields from the regional atmospheric model REMO in two configurations (with and without spectral nudging applied) and the regional atmospheric model CLM (with spectral nudging applied) are investigated with regard to their added value in comparison to the driving wind field from the NCEP/NCAR reanalysis (NRA). To do so wind speed measurements from buoys, light ships and platforms in the eastern North Atlantic are considered as truth. Added value from the regional models is obtained when correspondence with both the measured statistical distribution and instantaneous wind speeds is higher than that of the reanalysis. Wind speed fields from NRA, REMO and CLM are bilinearily interpolated to measurement locations and statistically compared. In the standard hindcast approach a regional model is initialized by a reanalysis. Furthermore the regional model is forced by the reanalysis at the lateral boundaries. Inside the model area the regional model can freely determine the prognostic variables according to the prognostic equations. While this is a wanted property for small scale processes, large scale fields that are reliably reproduced in the reanalysis by data assimilation are ignored within the integration area of the regional model. Thus cyclone tracks and the location of pressure systems or gradients may deviate from the observed ones, especially deep inside the modelled area far from the lateral boundaries. One mechanism to overcome this shortcoming in the standard regional modelling method is a dynamical downscaling approach called spectral nudging, in which the horizontal wind components inside the integration area are forced to accept the forcing reanalysis for large scales whereas smaller scales are left to be determined by the regional model (von Storch et al. 2000). The results show that for instantaneous wind speeds the regional models do not have an added value both in "open ocean" areas and the German Bight. However, in the English Channel, where local topography and associated local wind regimes become important, the regional model shows an added value for instantaneous wind speeds. Concerning the wind speed distribution there's a clear indication for an added value of the regional models in coastal regions, especially for higher wind speed percentiles, while in "open ocean" areas NRA is better reflecting observed distributions. These findings hold independently of the measurements' assimilation status, meaning whether the measurements are assimilated into the reanalyses or not. These results for the North Sea/North Atlantic are compared with similar investigations made by Sotillo et al. (2005) for the Mediterranean. Literature: von Storch, H., H. Langenberg, and F. Feser, 2000: A spectral nudging technique for dynamical downscaling purposes. Mon. Wea. Rev. (128), 36643673. Sotillo, M., A. Ratsimandresey, J. Carretero, A. Bentamy, F. Valero, and F. Gonzalez-Rouco, 2005: A high-resolution 44-year atmospheric hindcast for the Mediterranean Basin: Contribution to the regional improvement of global reanalysis. Climate Dyn. (25), 219236.

Keywords: downscaling, regional model, observations

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MS016 **Oral Presentation** **5526**

Reconstruction of the past 100-year weather variation in Europe

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We would rec onstruct the historical c limate in the aspects of temperature, precipitation, radiation, humidity, vapor pressure deficit, and so on, which wi ll be used to ecosys tem modeling as the climate forcing. The d aily variation is based on RE MO da ily datas et from 1971 t o 2000; the m onthly data is based on the CRU dataset from 1901 to 20 02. Canonical correlation analysis (CCA) is u sed for monthly data reconstruction; and the weather generator-like method is used for reproducing daily variability. The final daily variation results are the combi nation of monthly data a nd daily v ariability, with the characteristics that monthly data is consiste nt with CRU dataset and daily variability is consistent with REMO dataset. The auto-regression is employed for generating time series based on the time coefficient of principle component (PC) so that spatial relationship between spatial grids and different variables will be preserved through PC projection. One of the important steps in this work is to generate the random number which is expected to have the similar distri bution as the resi duals after t he auto-regression estimation. The whole reconstruction results are char acterized by the spatial consistence between grids and variables, which is obviously valuable for reconstruction of the past climate and making scenario in a spatial domain, and further valuable for spatial ecosystem modeling.

Keywords: weather, reconstruction, consistence

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MS016 **Oral Presentation** **5527**

Dynamical and statistical-dynamical downscaling with the regional climate model CLM

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We use the climate version of the Local Model (CLM) provided by the German Weather Service (DWD) to perform high resolution regional climate simulations. Because high resolution modelling with grid sizes lower than 20 km is very time expensive we have tested a statistical-dynamical downscaling based on the method of self-organizing maps (SOM) for regional climate simulations of the orographically structured region in South West Germany. The algorithm classifies the most important synoptic-scale weather patterns given from the global model and determines the frequency of each class. Only the different classes are simulated explicitly with the CLM and the results are multiplied by their frequency to get the statistics for the whole year. In the statistical-dynamical downscaling the initialisation of the soil moisture (and also soil temperature) profile is a very critical point because a wrong initialisation causes wrong latent and sensible heat fluxes and leads to wrong temperature and precipitation forecasts. Usually, the initial water content is taken from the driving model which has a coarser resolution and other soil types than the regional model. Therefore the soil moisture profile in the regional model may differ considerably from a realistic profile. For dynamical climate simulations that is not so important because the model is given some time for adaptation. But for statistical-dynamical climate simulations, where we simulate only time periods of some days, such an initialization may induce large errors. We therefore tried to produce soil moisture profiles for the initialisation day with a stand alone-version of the soil model. We start the soil model some years before the initialisation day and use ERA40 reanalysis data as driving data, together with a soil type and land use inventory. The computational effort is much smaller than to compute the period with the whole atmospheric part of the CLM and we get realistic soil moisture profiles for the initialisation day in a reasonable time. The soil model is driven with the same soil types and soil levels as we use in the CLM simulations. We compare the results of statistical-dynamical downscaling with the new soil initialisation and with the old initialisation and show a comparison between dynamical downscaling, statistical-dynamical downscaling and measurements to detect for which meteorological variables the statistical- dynamical downscaling method gives better results than the dynamical downscaling. The most critical variable is the precipitation. In summer the main part of the precipitation is caused by convection and we will indicate if the statistical-dynamical method with its restricted weather classes is able to reflect this precipitation.

Keywords: statistical dynamical, climate scale, initialisation

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MS016 **Oral Presentation** **5528**

Climate change scenarios for temperature and precipitation in Emilia Romagna (Italy) obtained using statistical downscaling models

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Climate changes of mean values and frequ ency of extreme temperature and precipit ation events in Emilia-Romagna region, over the period 2 070-2100 against 1960-1990, are evaluated. A statistica l downscaling method, applied to the HadAM3P experime nts (control-run, A2 and B 2 scenarios), is used to reach this objective. The method consists of a multivariate regression based on Canonical Correlation Analysis (CCA), using as possible predictor s mean sea le vel pressure (MSL P), geopotential height at 500hPa (Z500), temperature at 850 hPa (T8 50) and sp ecific humidity at 850 hPa. The predictands are the seasonal mean value s of minimum and maxim um surface tempe rature (Tmin and Tmax), 9 0th percentile of maximum temperature (Tma x90), 10t h percentile of minimum temperat ure (Tmin10), number of frost days (Tnfd), heat wave dur ation (HWD) a nd mean daily precipitation (p av). First, the statistical d ownscaling model is set-up for each se ason and index, using NC EP/NCAR re-analysis, in order to identify the large-scale predictors . The ob servational data set is composed by daily data collected at 30 stations for temperature and 90 stations for precipitation. The results of the optimisation procedure reve al that, as con cern the temp erature in dices, T850 is the best predictor in most cases. T850 combined with MSLP is an optimum predictor for winter Tmax90 and autumn Tmin10. MSLP is the best predictor for spring Tmin while Z500 is the best predictor for spring Tmax90 and heat wave duration index. As co ncern the precipitation, MSLP is the best predictor for winter, spring and summe r season, while T850 is the be st predictor for autumn mean daily precipitation. The HadAM3P ability to simulate the present day spatial and temporal variabili ty of the chosen p redictors is tested, using the control experiments. Finally, the do wnscaling model is app lied to all model output experiments so as t o obtain simulated present day and A2 and B2 scenario results at local scale. Results show that significant increases can be expected to occur under scen ario conditions in both maximum and minimum temperature, associated with a decrease in the numbe r of frost days an d with an increase in the hea t wave duration index. Significant changes are expect ed to occur in m ean daily precipitation durin g spring, summer and autum n. In spring and summer, the pattern of changes shows in generally a decreases of mean daily precipitation , whil e during autumn a significant increase has been obtaine d. The mag nitude of the changes is more significant for A2 scenario than for B2 scenario, for both, temperature and precipitation indices.

Keywords: statistical downscaling, extremes, scenarios

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MS016 **Oral Presentation** **5529**

The transferability of Regional Climate Models through an analyses of the diurnal cycle

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Five Regional Climate Models (RCMs) were implemented over seven different regions of the globe with the objective of assessing their "transferability". That is, the ability of RCMs to simulate the variability of continental scale climates over different regions of the world with minimal parameter changes. The models are: the Rossby Centre Regional Atmospheric Climate Model (RCA3) from Sweden; the Canadian Regional Climate Model (MRCC); the climate version of the operational forecast model of Environment Canada (GEM-LAM); the Climate Version of the Local Model (CLM) from Germany, and the Regional Spectral Model (RSM) from the United States. The RCMs were piloted by ERA-40 and NCEP boundary conditions for a five year period spanning from 2000 to 2004. Where useful, an analysis of the simulated surface energy budget (surface radiation and turbulent fluxes) is made using CEOP flux observations. This aids in understanding the cause of deviations in surface temperatures and humidity from those observed. To gauge the transferability of the 5 RCMs we have evaluated their performance separately for winter and summer seasons, using CEOP observations taken from: 1 mid-latitude coastal site, 2 mid-latitude continental sites, 2 Arctic sites, 2 sub-tropical land regions, 1 equatorial land station and 1 equatorial island. We present time-series, frequency distributions, bias estimates and mean diurnal cycle results for these stations, highlighting geographic areas and/or seasons when all the RCMs perform well or where there are systematic deviations. Most RCMs simulated the annual cycle of surface temperature close to the observations over mid-latitude regions of Europe and North America. The largest deviations were observed at high altitude station, arctic regions, and the tropics for different reasons. Analysis yields insight about how the RCMs simulate the timing of convection or frontal progression in different regions of the world. Where possible we use extra CEOP observations to determine the cause of a given model error and make recommendations for improvements for the individual modelling group concerned.

Keywords: transferability, rcms, diurnal cycle

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MS016 **Oral Presentation** **5530**

Winter rainfall in Southern Australia: past and future trends

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Significant rainfall declines have been observed across much of southern Australia over the last 30 years or so. Strong declines have occurred in the South-West of Australia (SWA) in the late 1960s and in the South-East of Australia (SEA) since the mid 1990s. These regions share a common winter rainfall regime with peak rainfall occurring from May through October. In both SWA and SEA, the reduction of rainfall has mainly occurred in the early part of the rainfall season (May-June-July), while rainfall in the latter half of the season (August-September-October) has remained close to the long-term average. Because of this decline, most cities in the southern half of the continent are facing some form of water shortage. The rainfall declines in SWA and SEA have been linked to large-scale circulation changes that bear resemblance to a shift towards the high phase of the Southern Annular Mode (SAM): surface pressure has increased across southern Australia and the extra-tropical jet has shifted poleward. Although, the largest trend in SAM has been observed in summer and does not coincide with the period of the rainfall decline. Climate models, when forced with observed and projected trends of anthropogenic atmospheric forcings, are readily able to simulate these large-scale changes. However, simulation of the accompanying rainfall changes is a challenge for the current generation of climate models. Rather than use rainfall simulated directly by climate models, we have developed a statistical method, based on the idea of analogous synoptic situations to exploit the ability of the model to simulate large-scale fields reasonably well and improve the simulation of the local rainfall spatial variability. This statistical downscaling technique relies on a combination of synoptic and moisture related atmospheric fields and is able to reproduce observed rainfall declines when applied to atmospheric re-analyses computed for the last 50 years. In a succession of studies, the technique was applied to a range of climate model simulations of both the past century and projection for the next century. It appears that external natural forcings (solar variability and volcanic eruptions) do not explain the rainfall decline in the SWA but anthropogenic large-scale atmospheric forcings and land clearance do. In terms of future projections, all the climate model projections used in these studies, across a range of IPCC emission scenarios, point toward a further rainfall decline over the coming century, consistent with an upward trend in SAM. However, the magnitude of the projected future rainfall decline varies considerably amongst models and across scenarios. Overall, it is of the order of magnitude of the past rainfall decline. However, while the recent observed decline is restricted to May to July, future projections suggest that future rainfall decline will not be limited to this period but will affect the entire southern wet season from May to October.

Keywords: rainfall, decline, past and future

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MS016 **Oral Presentation** **5531**

High resolution downscaling of temperature in complex terrain

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A new approach to high-resolution downscaling of temperature in mountainous terrain is presented. It is being developed using Austria's network of automatic surface stations which cover the elevation range from 150 to 3400 m. Starting with a regional-scale model prediction as a first guess, a three-dimensional correction field is constructed from differences at station locations between observed temperature and first guess. The spatial interpolation of the correction is based on distance weighting in the horizontal and 'distance' weighting in potential temperature in the vertical. With this method, the vertical range of influence of a station adapts in a physical way to variations in stratification. However, in situations where cold air pools are present in valleys and basins, potential temperature weighting by itself is not sufficient to adequately resolve the temperature distribution. In such cases the analysis can be further improved by including in the interpolation a topographic parameter which represents the degree to which the local topography supports the buildup of cold air. Analysis fields obtained by this method, which has been implemented into the operational analysis and nowcasting system INCA (Integrated Nowcasting through Comprehensive Analysis) are presented and verification results are shown. Implications for high-resolution downscaling of regional-scale temperature trends are discussed.

Keywords: downscaling, high resolution, temperature

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MS016 **Oral Presentation** **5532**

The Influences of NAO and the Hudson Bay sea-ice on the Climate of Eastern Canada

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Sea-ice cover over the Huds on Bay exhibits large variability in the fr eeze-up seaso n normally i n November and December. Its influence on t he climat e over Eastern Cana da has b een studied with the Canadian Regional Climate Model (CRCM) in three steps. First, a seven-ye ar continuous simulation from 1991 to 1997 was performed as a control r un to evaluate the simulated climate variability over Easter n Canada, assoc iated with the NAO (North Atlantic Oscillation). Eight additional experiments were performed with modified sea-surface conditions th at we re prescribed over the Hudson Bay. These integrations were used to esti mate the contribution of the Hudson Bay sea-ice on the climate variability of Eastern Canada. Finally, c limate variability related to sea-ice anomalies was compared to that related with the NAO. Results show that the NAO is the do minant factor controlling climate variability over Eastern Canada. The contribution of HB sea-ice anomalie s to climate variability is significant only in the immediate coa stal region. Under the influence of different phases of NAO, Hudson Bay sea-ice anomalies co-vary with temperature and pr ecipitation an omalies down stream of th e Hu dson Bay over Eastern Canad a. The ultimat e cause o f this relatio nship is NAO variability forcing on both Hudson Bay sea ice concentration and temperature/precipitation over Eastern Canada.

Keywords: nao, hudson bay, sea ice

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MS016 **Oral Presentation** **5533**

Generating probabilistic estimates of climate change impacts on a hydrological system

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This paper develops a method for linking probabilistic climate scenarios with downscaling methods for hydrological impact studies. Six Regional Climate Models from the PRUDENCE project, driven by boundary conditions from two different GCMs, are used to produce pdfs of change in temperature and precipitation for nine UK regions. The pdfs are produced using Bayesian statistics to weight climate model outputs based on bias and convergence criteria. An example application is then performed for the Eden catchment in the northwest England region. A weather generator approach is used to downscale the change pdfs to the catchment scale using change factors (CFs; the difference between the future and control simulations). These CFs (for Rainfall: mean, proportion dry days, variance, skewness, Lag 1 autocorrelation; and Temperature: mean, standard deviation) are applied to the weather generator, which incorporates a stochastic rainfall model based on the Neyman Scott Rectangular Pulses model and a regression-based temperature and potential evapotranspiration (PET) generator. Downscaled synthetic time series of precipitation and temperature/PET are then used as input to a calibrated rainfall-runoff model of the river Eden catchment. Simulations for different RCMs are weighted by using a random number generator combined with a resampling method, based on the weighting derived from the Bayesian scheme used to produce the regional change pdfs. This produces pdfs of change in various flow statistics (mean, Q5, Q95 etc). This method allows the uncertainty in the forecasts of different RCMs to be assessed, providing a probabilistic estimate of climate change impacts on a hydrological system. The sensitivity of the weighting procedure is also tested.

Keywords: probabilistic scenarios, bayesian statistics, weather generator

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MS016 **Oral Presentation** **5534**

Changes in European drought characteristics projected by the PRUDENCE regional climate models

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One of the key impacts of global climate change will be perturbations to the hydrological regime across Europe. To date, downscaled assessments of the impacts of future change have generally used results from only one climate model, underestimating the range of possible changes projected by different climate models. In this study six regional climate models (RCMs) are compared in their ability to reproduce mean precipitation and inter-annual variability for the 1961-90 period for six European catchments which are part of the EU FP6 AquaTerra project. Inter-comparisons of projections of future changes in mean precipitation are also made. A simple drought index based on monthly precipitation anomalies is also described and used to assess the models on a regional scale for each of the selected catchments. Projected changes in the frequency of short- and long-duration droughts are examined at timescales which reflect likely impacts on the water resource sectors in each region. The work will be placed in the context of a framework for the robust management of climate model uncertainty through the generation of probabilistic climate change impacts scenarios.

Keywords: drought, rcms, probabilistic

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MS016 **Oral Presentation** **5535**

Evaluation of the Rossby Centre regional Atmosphere-Ocean Model (RCAO) under different coupling schemes; A study in Arctic Region

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An atmosphere model and an ocean model usually have different parameterizations for their surface fluxes such as sensible heat, latent heat and momentum fluxes. This difference creates inconsistency of energy exchange at the interface of ocean and atmosphere when atmosphere and ocean models are coupled by exchanging scalar variables such as atmosphere surface wind, temperature, humidity, sea surface temperature and so on. However, the problem of inconsistency can be solved when atmosphere and ocean models are coupled by exchanging fluxes. In this study, Rossby Centre regional Atmosphere-Ocean Model (RCAO) is used to simulate Arctic ice using the two different coupling schemes. The results show that RCAO simulates better sea-ice condition in Arctic using flux coupling scheme.

Keywords: arctic, coupled, sea ice

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MS016 **Oral Presentation** **5536**

High resolution regional climate model simulations over Europe: Mean climate, interannual variability, and extremes

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We examine the results fro m high resolution clim ate change simulations performed f or the European domain as part of the Europe an ENSEMBLES project using the regional climate model RegCM3. Three simulations were performed: two contr ol s imulations (1961-2000) forced with the ERA40 Reanalysis with 50 and 25 km horizontal resolution, and a futu re scenario (IPCC A1 B scenario, 19 50-2100) driven with output from the European-Centre GCM, ECHAM. The future climate r un was performed at 25 km resolution only. For the c ontrol scenarios, we investigated the added value of the high r esolution (25 km) run compared to the lower resolution (50 km). Using monthly mean data, the large scale signal was filtered out in order to ana lyze the skill of the model in reproduc ing fine-scale st ructure in the precipitation a nd temperatur e fields. Such detail shou ld be better represented in the high resolution simulations compared with the low resolution simulations and observations. In addition, we evaluate the model's ability to simulate extreme events such as flood and droughts.

Keywords: downscaling, europe

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

MS016 **Oral Presentation** **5537**

Statistical Downscaling using Reforecasts

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With a long set of reforecasts (hindcasts) from a stable numerical weather prediction model, it is possible to perform a simple but effective statistical downscaling. In a local region, today's weather forecast is compared against past weather forecasts for similar times of the year. An ensemble of observed weather scenarios is then formed, the dates chosen where the past forecasts have the closest match with today's forecast. This procedure produces a calibrated probabilistic forecast, and if the observations are plentiful or if a time series of high-resolution analyses are used, then this procedure amounts to a statistical downscaling as well. This technique is demonstrated using a 25-year reforecast data set from the USA's Global Forecast System. The resulting probabilistic precipitation forecasts are shown to be much more reliable and skillful than those from direct model output. Time permitting, we may show results from an ECMWF reforecast data set and/or the results of ensemble streamflow predictions driven by these downscaled forecasts.

Keywords: reforecasting, ensemble, prediction

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

MS016 **Oral Presentation** **5538**

Do we still need statistical downscaling? Answers from STARDEX, ENSEMBLES and other European work

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One of the accepted shortcomings of dynamical down scaling is that it pr ovides grid-box information at coarser spatial scales than is required for many im pacts studies. In comp arison, statistical downscaling has the ability to provide station-scale information at relatively low co mputational expense. As the spatial resolution of RCMs in creases, from 50 km to 25 or 10 km, is th ere still a need for statistical downscaling? In part, the ans wer to this question relates t o the robu stness and reliability of statistical downscaling methods. This is demonstrated using results from the EU FP5 STARDEX pr oject. STARDEX also u ndertook an in tercomparison of stati stical and dynamical downscaling methods, and produced recommendations o n the us e o f the fo rmer metho ds. Within the EU FP6 ENSE MBLES pro ject, the statistical downscaling work developed in STARDEX, together with the dyna mical downscaling wor k developed in PRUDENCE, is being further developed and applied as part of the development of a n ensemble prediction system which will be used to produce an objective probabilist ic estimate of uncertainty in future climate at the seasonal, decada l and longer t ime scales. W ithin this probabilistic framework, the advantages of statistical downscaling become particular ly relevant. For example, larger ensembles can be run using statistical downscaling, spanning a larger r ange o f uncert ainty fro m the forcing AOGC M simulations. Statistical d ownscaling also has the pote ntial to be used to emulat e dynamically-downscaled results, thus furthe r increasing e nsemble size. Nonetheless, the ENSEMB LES work demonstrates that the re are consid erable me thodological an d tech nical issu es in volved in modifying exis ting statistical downscaling m ethods for a p robabilistic approach . Expl oratory work on developing model weighting schemes and ensemble averaging techniques for statistical downscaling will be described. The ENSEMBLES prediction system is being used to explore the impacts of climate change at seasonal to decadal a nd l onger (to 2100) timesc ales. Thu s the downscaling activities within the project are very much tailored to the needs of users. In order to best meet the needs of many of these users, a web-based service for statistical downscaling has been constructed. ENSEMBLES also offers the opportunity for an exchang e of expertis e betw een researchers working on seas onal-to-decadal timescales and longer timescales. The exte nt to wh ich it is possible to develop seam less statistical downscaling approaches across these different timescal es will be reviewed. Finally, a number o f users have a require ment fo r scen arios at very high tempo ral reso lution. For urban dr ainage studies, fo r example, information may b e requested at the 15 or e ven 5 minute r esolution. Exa mples from the UKCIP/EPSRC Building Know ledge for a Changing C limate programme il lustrate how t his problem is being addressed in the UK using a weather generator perturbed on the basis of RCM ou tput. Thus it is concluded that there is still a need for stati stical downscaling and that s uch methods c an be used in a complementary approach alongside dynamical downscaling.

Keywords: statistical downscaling, climate scenarios, europe

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

MS016 **Oral Presentation** **5539**

Climate change predictability and uncertainty involved in regionalization of GCM data using regional climate modeling

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Climate varies across a wide range of temporal and spatial scales. Yet, climate modeling has long been approached using global models that can resolve only the broader scales of atmospheric circulations and their interactions with convection , land, ocean surface, a nd sea ice. To observe the regional scales climate variation, regional climate modeling is pl aying a n important role by downscaling the global models inform ation at local scales for impact assessment. South Asia is a region with comp lex topography, land surface con ditions and coastlines. To study the climat e in such a re gion, the highly resolved Hadley Centre regional climate model PRECIS has been used. The performance of the model is demonstrated through its si mulation of th e observed pr esent-day clim ate over South Asia. Initia l a nd lateral bo undary co nditions were fro m the Euro pean Ce ntre for Medium -range Weathe r Forecasts re-analysis data set ERA-40 avail able at 1.25 1.875 spatial resolution. The model was integrated from Dec 1959 to Dec 1990 with a horizontal grid spa cing of approximately 50 km over the area covering 5 45N, 55 95E. The model simulated realistica lly not only the temporal evolution of the 30-year area-averaged temperature and precipitation pattern but also the da ily intensity distributio n. The mo nsoon circulation and its penetration from India into Pakistan were also fairly well reproduced. After having assessed the model performances for simulating the current climate, PRECIS was nested into HadAM3P GCM data set forced with the SRES A2-emission scenario for the time slice periods 1961-1990 and 2071-2100 in order to downscale the regional resp onse of th e GCM projecti on over South Asia. T emperature an d precipitation changes were analyzed over the whol e South Asia a nd Pakistan. The re alism of simulated changes for n ear-surface temperature an d precipit ation was investigated by first accounting the uncertainty of the large-scale driving model i.e. Ha dAM3P. Hence the ability of HadAM3P to simulate present-day climate patterns and circulations was analyzed. The results of the model evaluation process have indicated that the larg e-scale behavior of the RCM obeys the G CM, while the RCM is addin g information on small scales processes and extremes. After the validation of PRECIS and HadAM3P in the baseline period, a climate change scenario was then constructed by combining information from the two models. The future change i n temperature and prec ipitation were further analyzed for different sub regions over Pakistan . Th ese region s were selected accor ding to their i mportance for agriculture and water resources. The an alysis of the climate ch ange scenario has indicated that the greenhous e warming is affecting particularly the northern and the mountainous areas of Pakistan.

Keywords: precis rcm, regionalization, pakistan

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MS016 **Oral Presentation** **5540**

Downscaling climate variables to River Basin Scale in India for IPCC SRES scenarios using support vector machine

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Realistic assessments of the local impacts of natural climate variability and projected climate change in the future are important to make independent judgments about actions required to mitigate and manage natural disasters; manage the natural environment and their water resources in a sustainable manner. A river basin which integrates some of the important systems like ecological and socio-economic systems can be ideal to study the impact of climate change in the water cycle at a local scale. General circulation models (GCMs) are among the most advanced tools to simulate climatic conditions on earth hundreds of years into the future. The GCMs are run at global scale and as a result they are inherently unable to represent local scale features. Consequently, there is a continuing need for new and improved techniques for obtaining effective projections of hydrological and meteorological variables at the river basin scale. Downscaling is one such technique, which is gaining popularity in estimating these variables at regional and local scales by translating information simulated by GCMs at global scale. This paper emphasizes the importance of down scaling to a river basin scale and presents a methodology to downscale monthly climate output from GCM to this scale using Support Vector Machine (SVM). Implementation of the methodology is demonstrated by downscaling maximum temperature to Malaprabha reservoir catchment in India (which is considered to be a climatically sensitive region), using simulations from the third generation Canadian Global Climate Model (CGCM3) for IPCC SRES scenarios A1B, A2, B1 and COMMIT.

Keywords: supportvectormachine, ipcc sres scenarios, hydroclimatology

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MS016 **Oral Presentation** **5541**

Short-range downscaling hindcasts in South-East Asia with a Meso-scale model

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We perform a downscaling hindcast experiment in South-East Asia with a fine-mesh meso-scale regional model, MM5, under the assumption of the perfect forecast produced by a global numerical weather prediction model (NCEP final analysis). The experiment is done for July and August in the wet Southwest Monsoon period over Indochina region for several years. Validations of the downscaling hindcasts are done with surface station data of temperature and accumulated rainfall in Indochina Lao PDR and other countries. Some improvements in the downscaling hindcast are attained as a result of the better resolution of the surface topography. We also make a trial of ensemble forecasts using a simple lagged average method. Growth of small perturbations included in the initial conditions shows different behavior from those in medium- and extended-range NWPs with global models. Diurnal variation of the error growth is important in the meso-scale regional model.

Keywords: downscaling, south east asia, ensemble forecasts

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MS016 **Oral Presentation** **5542**

Weather types and rainfall in the Southern Amazon Basin

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K-means clustering techniqu e applied to daily ECMWF ERA40 Rean alysis fields (l ow level geopoten tial and wind in a first approach) are used to determine weather types. Daily rainfall data in the souther n Amazon basin are from th e S ervicio Nacion al de Meteorologia y Hidr ologia (Bolivia) an d from th e Agencia Nacional de Aguas (Brasil).

Keywords: amazon, rainfall, weathertype

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MS016 **Oral Presentation** **5543**

Effect of High Resolution Subscale Land Surface Scheme on the Simulation of Snow Cover and Surface Water Fluxes over the Alpine Region

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Herbert Formayer

Even RCMs with spatial resolution of 10km are not able to resolve big European mountain valleys (e.g Inn or V h V alley) in a realis tic way. The RCM su rface fields in mount ainous regions represent the situation at th e average altitude within the grid bo x. But especially snow accumulation and snow melt highly depend o n temperature and hence o n the surface altitude. Even the sensitivity of snow accumulation to temperature changes is in fluence by the altitude (Hantel et. al, 2000). As snow cover significantly influences the surface energ y fluxes, a r ealistic snow modeling is essential within mountainous regions.The main objective of this research is to investigate the effect of a very high resolution(1 km) S ubgrid-Scale T opography and Land Use Scheme (Sub-BATs) on the RCM-modeled snow accumulation and snow melt and the consequential changes in the surface water budget over the Alps. The introduction of sub-grid scheme (Giorgi et al 2003) in the Regi onal Climate Model (RegCM3) could result in better representation of the physic al processes in the surface layer i n regions with complex top ography. Two multi-seas onal simulations are compared: th e co ntrol uses standard B ATS surface schem e and the other employs sub-BATS sche me where the near surface variables (air temperature, water vapor and precipit ation) are disaggregated from coarse grid to fine grid. The effect of sub-BATS scheme on the surface water budget is mainly caused by more realistic simulation of snow cover due to a better representation of topography.Acknowledgment: This work is financially supported by the EU pr oject CECILIA (Central and Eastern Europe Climate Change Impact and Vulnerability Assessment) a nd through a scholarship of the first author by the Hig her Education Commission of Pakistan.

Keywords: regional climate models, alpine region, subgrid aggregation

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MS016 **Oral Presentation** **5544**

Impacts of land-use on monsoon climate: comparing results from a pair of regional and global model simulations

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Xuejie Gao

By comparing results from a pair of regional and gl obal model simu lations of lan d-use in on local and regional climate, this study ai ms at further enhancing o ur understanding of the do minant physical and dynamical processes resulting in the climate impact s of land-use in Asia n monsoon region. The sam e vegetation datasets, one p resenting the curren t vegetation covera ge in China and the other approximating potential vegetation coverage without human intervention , have bee n used in the ICTP RegCM3 experiments and in the Australian Bureau of M eteorology R esearch Cen tre (BM RC) g lobal model simulations. Comparin g the gl obal climate model r esults (with about 2.5o by 2.5o horizontal resolution) w ith the high res olution (50 km by 50 km) re gional climate model simulations reveals th e reason why ch anges in rainf all show a similar patte rn in northern winter, while the s ummer rainfall response to LUC shows op posite features between the model experiments. A reduction in winte r monsoon rainfall seen in bot h model experi ments is due to the enhance d low-level no rthly wind flo w, largely due to reduction in surface roughnes s, which impedes warm and humid air reachi ng the regio n in producing cold-front rainfall. In contrast, in the summer monsoon season, there is a cyclonic low-level circulation pattern o ver the So uth China S ea regio n in the global mod el, an unsatisf actory feature commonly seen in ma ny o ther glo bal climate mo dels. With the red uction in s urface ro ughness due to LUC, such a d eficiency beco mes more pr ominent an d further leading t o the reducti on in its summ er monsoon rainfall. In contrast, in the regio nal mo del, its so uth-southwestly summer m onsoon flo w is further e nhanced due to th e same mech anism o f the reduced surf ace ro ughness. The e nhanced monsoon flo w further pu shes the E. Asian monsoon rainfall belt mo re no rthward and produces mo re summer monsoon rainfall in theYangtze Riverregion. De spite of the di fferences in model-simulated summer rainfall responses, reduction in surface roughness is the outsta nding factor in both models in explaining ho w LUC can affect mo nsoon rainfall. Re sults in this study highlight t he importance of improving mod el capability in simu lation mo nsoon climate before on e can get reliable climate change projections in th e region . Ackn owledgement: P art of the s tudy is co nducted under an Australia-China climate change bilateral pr oject between BMRC and Ch ina Meteorological Administration and supported by the Australian Greenhouse Office.

Keywords: land use, monsoon

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MS016 **Oral Presentation** **5545**

Toward physically-based downscaling by a coupled landatmosphere satellite data assimilation system

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This study dev eloped a coupled land-atmosphere satelli te data assimilation system as a new physical downscaling approach, by combining a m esoscale at mospheric model with a land data assimilation system (LDAS). The LDAS consists of a land surface scheme as the model operator, a ra diative transfer model as the observation op erator, and the simulate d annealing method for minimizing the difference between the observed and simulated microwave brightness temperature. The atmo spheric mo del produces forcing data for the LDAS, and t he LDAS produces better initial surface co nditions for the modelling system. This coupled syst em can take into account land surface heterogeneities through assimilating satellite data for a better prec ipitation predictio n. 3- dimensional numerical experiments were carried out in a m esoscale area of t he Tibeta n Pla teau during the first week of July as a wet monsoon season. The results from the new system showed significant improvement compared with the ones from a regional atmospheric model simply nested from the global model. The surface soil moisture content and its distribution from the assimilation sy stem were more con sistent to in-sit u observations. These better surface conditions affect the land-atmosphere interactions through convection systems and lead to better atmospheric predictability as confirmed by satellite-based cloud observations and in situ sounding obse rvations. It also showed that larger scale atmospheric conditions can in some cases enhance the surface induced local circulations. Through the use of satellite brightness temperature, the developed coupled land-atmosphere assimilation system has shown potential ability t o provide accurate initial surface conditions and its inputs to the atmo sphere and to improve physical downscaling through regional models. Even thoug h, these result s can be considered as a ste p toward bett er atmospheric predictability by improved initial surface condition, one should consider that this target cant be reached without improving the initial atmospheric conditions as well.

Keywords: physical downscaling, data assimilation, remote sensing

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MS016 **Oral Presentation** **5546**

Projected climate change over China from a high resolution regional climate change simulation

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Results are presented from high resolution climate ch ange simulations ov er China by a r egional climate model, the ICTP RegCM3. The model is nested in one-way mode within an NASA/NCAR finite volume element AGCM (FvGCM). Two sets of multi-d ecadal simulations at 20-km grid re solution for present day (1961-1990) and future climate (2071- 2100, IPCC A2 e mission scenario) are conducted. Firstly the FvGCM and RegCM's simulation of present climate in China is analyzed. Comparing to the global model, results from R egCM simulations show that t he high resolution regiona l model impr oves the simulations of both surface air temperature and pre cipitation climatologies. It c an reprodu ce more detaile d structures of s urface temper ature distribution and reduce, in some extent, cold bias in the FvGCM simulations. Furthermore, it reveals that t he obse rved heavy precipitat ion center in south/southeast China is better simulated by RegCM. FvGCM give a wron g location of the high rainfall center with its heavy rainf all belt over the Yangtze River basin, and in southwest China. The improvement is mor e evident in the monsoon season. Simulated climate changes show difference between the FvGCM a nd RegCM over C hina. General warming is si mulated by both models, with more signific ant warming in Northeast and Northwest China, as well as the Tibetan Plateau. However, ove restimation of precipitation by FvGCM i n t hose significant warm ing a reas lead to a stronger snow-temperatur e feedback a nd consequently a greater warming when comparing to the RegCM simulations. A general increase o f annual mea n precipitatio n in China is simulated by FvGCM. Ho wever, reductio n of precipitation can be fo und in the RegCM simulatio ns in some areas, which shows consistency with th e observed trend in the late decades.

Keywords: climate change, regional climate model, china

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MS016 **Oral Presentation** **5547**

Spatio-Temporal Probabilistic Precipitation Forecast with Dynamical Bayesian Networks

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A Bayesian Ne twork (BN) is a directed acy clic gr aph in which no des rep resent rando m variables and edges indicate conditional de pendencies am ong them . Th e graph define s a factorization of the Joint Probability Distribution (JPD) which allows to efficiently perform probabilistic inferencer. Static BNs have been already applied as statistical downscaling methods; in this case, the nodes represent stations (local observations) and the links the spatial depend encies among them. Moreover, an extra node representing the atmospheric state (weather types) is included as an evidential variable (the futur e value is known). Therefore, the post erior di stribution of the stations can be directly co mputed from a predicted weather type using the BN. The standard analogue method is the simplest case where no spatial dependencies are con sidered (it cor responds to a Naive Bayes inverse classifier). In this pape r we study daily rainfall occurrence over the Iberian Peninsula and ERA-40 reanalysis. Different statistical learning methods allow to automatically obta in a graph and the corresponding JPD from data. We have applied different standard learning algorithms (K 2 and B) t o infer B Ns and to do wnscale rainfall occurrence obtaining a probabilistic forecast. In this case, no signif icant improvement over a standard analog method is achieved (the stations ten d to be independent given the atmospheric state variable). We show that this result is a consequence of the static character of BNs. Thus, we analyze the different extensions o f BNs to include tempo ral dependen cies. The most p opular dynamic ext ension of BNs considers a sequence of time slices corresponding to different snapshots in time of the same static BN, connected by t emporal links (Dynamical Bay esian Networks, DBN). Both spatial intra- slice and d ynamic inter-slice connections can be impo sed o r learnt fro m data according to different strategies. We have compared static and dynamic models consid ering three different approaches. The first method is a two step algorithm where we first learn a common structur e for the time slices (static model) and then the inter-slice connections. In t he second approach, both intra and inter -slice connections are learnt simultaneously. In the se two cases only a few inter- slice co nnections are establishe d, since spatia l relationships tend to be stronger than the temporal ones at daily basis. In order to favour dynamic relationships, in the last approach, we learn inter-slice connections before the intra-slice ones. This third approach obtained the best r esults in terms of ROC skill area.As a conc lusion we show that the an alog downscaling approach can b e naturally ext ended to include both spatial an d temporal relationships using the framework of DBNs . The validation result s show a small average improvement of the skill; however, for certain stations (those with poores t analog skill), a signifi cant improvement has been obtained.

Keywords: dynamic bayesian network, statistical downscaling, probabilistic forecast

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MS016 **Oral Presentation** **5548**

A Spatial Downscaling Model for Monsoon Rainfall over India

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G. Viswanathan

In this work, the focus is on the development of a spatial downscaling model using data from the TRMM (Tropical Rainf all Measurement Mission) sa tellite. Specifically, the 3B42 V6 data, which is available at0.25-deg X 0.25-deg (approximately 25 X 25 km) spat ial resolution , has been cons idered over the Indian region and scaling laws have been develo ped (f ollowing the work of P erica an d Fou foula-Georgiou,JGR-Atmospheres, 101(D21), 1996), which rela te the rainfall variability acr oss a range of spatial scales (25 km to 100 km). These relations, as we demonstrate, can be used to downscal e fromlarger-scale spatial rainfall pa tterns. The resulting downscaling mo del is applied to a new dataset provided by the India Meteorological Department wh ich is at a spatial resolution of 100 km X 100 km, and the downscaled fields are compared with the satellite snapshots to assess the validity and efficiency of the downscaling scheme in terms of being able to reproduce "small-scale" variability.

Keywords: spatial downscaling, scale invariance, trmm

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MS016 **Oral Presentation** **5549**

Statistical downscaling techniques for modelling projected changes in regional precipitation.

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C4I Met Eireann

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Statistical downscaling techniques are widely used for regional climate and impact modelling as they are faster and require less resources than dynamical downscaling from global climate models. Extremes and natural variability of precipitation have proven difficult to model accurately and both statistical and dynamical downscaling have strengths and weaknesses in this regard, as evidenced in the results of the EU Statistical and Regional Dynamical Downscaling of Extremes for European regions (STARDEX) project. In this study, a number of statistical downscaling models are used to generate climate change scenarios for the Irish region. The performance of the models to capture extremes of precipitation frequency and occurrence is evaluated against a network of observation stations. Results presented will include comparison of model performance and projected changes in precipitation between hindcast and future climate model runs.

Keywords: statistical, downscaling, precipitation

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MS016 **Oral Presentation** **5550**

Transferability assessment of regional climate models

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Transferability intercomparisons are providing a new approach for advancing the science of modeling the water cycle and energy budget on regional to global scales by using multiple limited-area models to simulate multiple domains. Under this approach, individual regional climate models perform simulations with all modeling choices held constant over a specific period on several prescribed domains representing different climatic regions. Transferability intercomparisons expose the limits of our current regional modeling capacity by examining model accuracy on a wide range of climate conditions and realizations, with special attention to challenging climate-system processes like the hydrologic cycle and extremes. Current transferability analyses are intended to complement the range of activity occurring under the emerging GEWEX Coordinated Energy and water-cycle Observations Project (CEOP), such as the Inter-Continental Transferability Study (ICTS), and the Worldwide Integrated Study of Extremes (WISE). In this presentation, we extend earlier testing of the hypothesis that regional models show performance on domain of origin that is similar to their performance in other regions. Previous study suggested a slight home-domain advantage. We focus on regions covered by the GEWEX Continental-Scale Experiment that provide a wealth of hydrologic-cycle observations for both climatic means and extremes. The analysis uses output from several regional models (RSM, RegCM3, CLM, RCA-3, and GEM-LAM) to assess their ability to capture climate variability and extreme events in precipitation and temperature. Further analysis attempts to link the extremes with governing circulation.

Keywords: regional climate modeling, climate model transferability

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MS016 **Oral Presentation** **5551**

Isolating the effects of climate on air pollutants concentrations during summertime in the Mediterranean

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Climate change impacts on a ir quality may affect lo ng-term air quality planning. However, the po licies aimed at improving air quality have not accounted for the variations in the climate (Steiner et al., 2006; Racherla and Adams, 2006). Furthermore, the coarse horizontal resolution of current global climate-chemistry simulations does n ot permit an estimate of th e effects of cl imate ch ange on troposph eric photooxidant distributions on the regional sc ale (Forkel and Knoche, 2006). The goal of this study is to determine ho w co ncentrations o f atmo spheric po llutants (mainly focusing on ozone and particulate matter) respon d to changes in climate over the Mediterranean by using t he regional mo delling system WRF-CMAQ-DREAM as implemented in the MareNostrum supercomputer. The domain of study covers an area of 4940 km x 2640 km with a horizontal reso lution of 20 km and a vertical resolution of 31 layers in the t roposphere. In order to is olate th e possible effects of climate change on the ground concentrations of ph otochemical pollutants in the Me diterranean, the assumptio n o f uncha nged anthropogenic emissions (derived from EMEP em issions) was im plemented. Three simulations (MareNostrum total simulation time of 108500 cpuh) corresponding to past climate variations under summertime conditions (August months of year s 19 60, 1980 an d 200 0 control year-) have been performed and compared. Also, two future s cenarios corresponding to the year 2030 SRES A1B and B1 Intergovernmental Panel on Climate Chang e scenarios following Unger et al. (2006) were investigated with the meteorology corresp onding to the control year. Meteorological conditions were driven by NCEP reanalysis. The metrics used include maximum 1- hr co ncentrations, mo nthly means and num ber o f exceedances of the threshold s established in the Euro pean legislation. The results for t he control year where evaluated against background stations data from EMEP network, depicting an accurate beha viour in the entire d omain of the study. The m aximum 1-hr ozone concentration variation ranges from -20 to 70 g m-3 in the August months of the period studie d depending on the region of the domain. The main increases are achieved in northern Italy, meanwhile the largest decreases in the ozone mixing ratios are found over Gr eece and the Aegean Sea. The rest of the domain depicts slight increments in the summertime m aximum 1- hr c oncentration. The s ummertime averag e concentration de picts a marked gradient from t he central Mediterranean (where increases i n the ground-level ozone mixing ratio reach 30 g m-3) t o the extremes of the domain, where no noticeable increases or even slight decreases are observed. The number of e xceedances of the ma ximum 1-hr ozone threshold (180 g m-3) has progressively increased in the months of Au gust of the years 196 0-1980-2000 in the central Mediterranean; meanwhile the number of exceedance s has decreased over the eastern coast and the Aegean Sea. A very similar p attern is obser ved for the summertime sulphate co ncentrations. Last, the response of air quality to a fu ture evolution of emissions has been studied by using the SRES A1B and B1 scenarios for the year 20 30. Present-day meteorol ogy has been used in both simula tions to isolate the effects of varying emissions. The 1-hr maximum concentrations in the Mediterrane an reduce in the whole domain for the B1 scenario; as a consequence, the number of hours when the 1-hour threshold is exceeded substantially decreases in the entire Medi terranean, but mostl y in the central part of the domain. For instance, in southern Italy the number of 1-hr ozone exceedances for the month of August is reduced (around 100 hours for the A1B sc enario and over 250 hours for the same period for the B1 scenario). Hen ce, the comple x topography of the Mediterranean causes pronounced regional patterns and differentiated behaviour of the Western, Central and Eastern basins. The assumption of unchanged

emissions leads to an increase of the mean concentrations of pollutants in most regions, which may be driven by an enhanced secondary production as a consequence of the temperature increase in the period of study and the higher pressures extending towards eastern regions observed for summertime 1960, 1980 and 2000. References Forkel, R., and R. Knoche (2006), Regional climate change and its impact on photooxidant concentrations in southern Germany: Simulations with a coupled regional climate-chemistry model, J. Geophys. Res., 111, D12302, doi:10.1029/2005JD006748. Racherla, P. N., and P. J. Adams (2006), Sensitivity of global tropospheric ozone and fine particulate matter concentrations to climate change, J. Geophys. Res., 111, D24103, doi:10.1029/2005JD006939. Steiner, A. L., S. Tonse, R. C. Cohen, A. H. Goldstein, and R. A. Harley (2006), Influence of future climate and emissions on regional air quality in California, J. Geophys. Res., 111, D18303, doi:10.1029/2005JD006935. Unger, N., D. T. Shindell, D. M. Koch, M. Amann, J. Cofala, and D. G. Streets (2006), Influences of man-made emissions and climate changes on tropospheric ozone, methane, and sulfate at 2030 from a broad range of possible futures, J. Geophys. Res., 111, D12313, doi:10.1029/2005JD006518.

Keywords: regional climate, mediterranean, climate change

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MS016 **Oral Presentation** **5552**

Variable horizontal resolution: the other numerical downscaling technique

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Regional scales are poorly rep resented by global coupled ocean-atmosphere models in use for climate change scenarios. Taking into account the complex distribution of topography, land-sea mask and other physiographic constraint is generally obtained by nesting a higher resolution model on a limited domain inside the global coarse resolution model. An alternative solution to get a high resolution over an area at a reasonable computation cost is to vary the horizo ntal resolution in a global model. The ARPEGE- IFS atmosphere model can be used in both ways: with a bi-Fourier representation of the fields it can be used as a limited area model forced at its lateral boundaries (it is known as A LADIN under such a geometry); with a Legendre-Fourier represe ntation it can be used as a global model with maximum resolution at the pole of the sphere. These two approaches with essentially the same equations (only the mapping of the fields is changed) will be compared in a 25- year climate simulation driven by a uniform high r esolution versio n of the model (perfect model approach). Mto -France is not the only climate center using variable resolution . The Stretched Grid Model Intercomparison Project (SGMIP) involves US, Canadian and Australian models as well, based on different numerical techniques to obtain high resolution over one part of the globe. Results from SGMIP-2 (present climate over the US) and preliminary results of SGMIP-3 (US and Europe, present climate and A2 scenario) will be shown.

Keywords: numerical, stretching, intercomparison

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MS016 **Oral Presentation** **5553**

Downscaling of precipitation in isolated islands

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Islands with significant topography are characterized by precipitation regimes which are highly influenced orographicprecipitation enhancement. In the analysis of climate change scenarios, and even in current climate hydrological analysis, the evaluation of spatially distributed precipitation is not possible without appropriate downscaling models. Statistical downscaling is often not feasible due to a lack of sufficient observations. In the present study we evaluate two simple downscaling models, the model recently proposed by Smith and Barstad (2003) and a modified version of a model proposed by Azevedo (1998). Results obtained by the two models are compared with observations in a network of 25 meteorological stations in theIslandofMadeira, and with results from simulations with two mesoscale models, MM5 and WRF, at horizontal resolutions down to 1 km. Results are first evaluated using 2 full years of simulation, one wet and one dry year, including a large number of sensitivity experiments with modified model setup and parameters.The two simple models are usedto simulateda 15 year period, with resultscompared with observations. The methodology is also applied to the downscaling of a current climate control simulation from the Hadley Centre Model, and for the corresponding climate change scenarios A2 and B2. The proposed methodology is easily extended to other Islands, as shown in an application to the Azores, with a rather different climate.

Keywords: downscaling, orographic precipitation, climate change

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MS016 **Oral Presentation** **5554**

Coupled Ocean/Atmosphere regional simulation of Coastal Jet off Central Chile: A case study for the October 2000 event

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The cool waters off central Chile (26S-36S) are principally maintained by coastal upwelling, which in turn is driven by persistent low-level alongshore southerly winds. Satellite data, marine reports, and coastal in situ observations off central Chile indicate that those alongshore winds intensify at intraseasonal timescale leading to Coastal Jets. The southerly jet events off central Chile occur year-round but are more frequent during the upwelling season in summer (over 60% of the time). The jet is characterized by an elongated maximum of surface wind speed (10m s-1) with its axis at about 150 km off the coast and a cross-shore scale of about 500 km. It is associated with a significant oceanic mesoscale variability that contributes to cross shore exchanges of heat, salt and biogeochemical material between the open and coastal oceans. High-resolution ocean (ROMS) and atmosphere (WRF) regional model simulations are used to document a typical Coastal Jet event which occurred in October 2000. At a first step, the sensitivity of the surface wind and air-sea heat fluxes to the horizontal resolution of the atmospheric model is evaluated. Near the coast, increased resolution improves the realism of the cross-shore variability of the wind stress. The atmospheric fields for different resolutions (54km, 18km and 6 km) are then used as boundary conditions for a regional ocean model. A heat balance is estimated in order to assess the relative contribution of the horizontal and vertical advection terms and to document the oceanic processes at stake during the Coastal Jet event. The results suggest that air-sea coupling at mesoscale is a significant contributor to the oceanic variability in this region.

Keywords: upwelling, coastal jet, heat budget

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MS016 **Oral Presentation** **5555**

RegClim: Addressing uncertainty in downscaled climate scenarios in Northern Europe

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In the Norwegian RegClim project (Reg ional Climate Develo pment under Global Warmin g), which no w has come to an end a fter almost 10 yea rs, one of the overall aims was to investigate sources of uncertaintyand the thus imp lied risks for the climat e in No rthern Euro pe. We have do ne this by dynamicallydownscaling climate projections for 2071-2100 from different global climate modelsusing the Norwegian version of the HIRHAM model with resolu tion 55 km. The e mission scenarios were A2, B2, A1B and CMIP 2, and the models were from UK Ha dley Centre, MPI Hamburg, Bergen Climate Mod el (BCM), and CAM- Oslo co upled to a slab o cean. The B CM wasused to study the influence ofunforcednatural variatio ns o f thephaseso f the At lantic Meridional Overtu rning Circ ulation on the climate change in the region.The scenario f rom CA M-Osloincluded adva nced treatment of the aerosol direct and indirect effects. The spread in the results for the region's climate is considerable, in particular because orography and coa stlines increase the impo rtance ofvariations inpreferred regional flow regimes. We have in particular studied thei nfluences on modeled probabilities of weather events. W e have also revisited the discussion of the size of integration domain in dynamical downscaling by applyinga deve loped version of the "big-brother - li ttle-brother" technique intro duced by Denisand co - workers (2002).Our HIRHAM-based results suggest, pe rhaps surprisingl y,that the do main should b e sufficiently large to enable improvements of regi onal flows and inclu de downwind adjustmentfrom inflow portions of the lateral boundaries.

Keywords: flow regimes, domain size, ocean influence

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

MS016 **Oral Presentation** **5556**

The North American Regional Cilmate Change Program (NARCCAP)

Dr. Linda Mearns
IAMAS

The Narccap Team

NARCCAP is an international program that will serve the climate scenario needs of the , and northern Mexico. We are systematically investigating the uncer tainties in region al scale proje ctions of fu ture climate and pr oducing high resoluti on climate change scenarios using multiple regi onal climate m odels (RCMs) and m ultiple global model responses to futu re emissions scenarios, by nesting the RCMs wit hin multiple atmosphere ocean general circulation mode ls (AOGCMs) forced with the A2 SRES scenario, over a do main co vering the conterminous US, no rthern Mexico, and most o f Canad a. Participtating RCMs include the CRCM, PRECIS, RegCM3, RSM, MM5, and WRF. The program also includes a validation aspect through nesting the participating RCMs within NCEP reanalyses (Phase I). The basic spatial resolution of t he RCM simu lations is 50 km. We pres ent results mainly f rom Phase I of the program, focusing on t emperature a nd precipitation across the entire domain in comparis on with several observational data sets. Early results from Phase II, which consists of driving the 6 RCMs with bo undary conditions from several AOGCM current and future (mid 21st century) simulatio ns (CCSM, GFDL , HADCM3, and the Canadian CGCM3) will also be presented.

Keywords: regional, climate, projections

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MS016 **Oral Presentation** **5557**

Seasonal Rainfall Predictions over the Southeast U.S. using the FSU Nested Regional Spectral Model

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COAPSMeteorology Florida Stste University

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We present s easonal rainf all predictions over theS outheast U.S. using the recently developed FSU nested regiona l spectral model(FSUNRSM). The FSUNRSM uses the spect ral method for computing the horizontalderivatives and so lving the semi-implic it time-stepping sche me. The spec traltechnique i s applied to perturbations, which need not be small, to a base fieldwhi ch may be from a coarser global model or re-analyses. For these experiments,the regiona l model is nested within the FSU global couple d model (i.e. theglobal model provides the base fields), which includes a version of the MaxPlank Institute HOPE ocean m odel. Simulations were done for 12 boreal winter seasons, from 1986 to 1997.Both the regional and gl obal models captured the ba sic large scale patterns ofprecipitation reasonably well when compared to observed station data. Theregional model was able to predict the se asonal anomaly pattern somew hat betterthan the global model. H owever, the regional m odel was consi derably more capableof predicting the frequency of significant rainfa ll events. There is also so meindication, in spite of limited number of simulated years, that the regionalclimate model may be able to predict the shift in the frequency of extremeprecipitation events associated with ENSO.

Keywords: downscaling, precipitation, seasonal

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

MS016 **Oral Presentation** **5558**

Impacts of Climate Change on Water Resources in North America

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Based on high resolution 25-km nested si mulations, we find substanti al modification s to the water budgets of many of the major river basins in North America in respo nse to anthropogenically enhanced greenhouse forcing. Most of the basins receive increased total annual runoff due to an overall increase in precipitation, despite increases in evapotranspiration. However,on aseasonal scale, in basins where a large fraction of the r unoff comes from sno wmelt, there is a shift to earlier runoff due to the less snow and earlier melting. This is li kely to strain existing water resources, particularly in the western United States, where little precip itation occurs during the summer season when water resources are in highest demand. Furthermore, whi le springtime soil moisture incr eases in many basins, it decreases during summer months, which could have detrimental impacts on agriculture.

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MS016 **Oral Presentation** **5559**

Regional climate change over the Northern Mediterranean and South Europe

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ČEdo Branković, Mirta PatarčIć

In order to analyse a possible climate change over the northern Mediterranean and south Europe area, the two sets of season-long integrations for present climate (1961-1990) and future climate scenario (2041-2070) have been performed using the regional climate model RegCM. The experiment design consists of thirty runs for each, winter and summer, season. The initial and boundary conditions were provided from the global circulation model EH5OM. For present climate, the RegCM results are verified against climatology of selected stations with the aim to assess possible (systematic) errors in the regional model and define confidence limits for scenario runs. Despite non-negligible biases, it was found that the RegCM and EH5OM representation of present climate is realistic. For both present and future climates, the RegCM results are also compared with those from EH5OM, thus defining the added value attained by dynamical downscaling. The climate change is studied by statistical analysis of the differences between present and future climate, focusing to 2m temperature and precipitation. Some implications for local climate are also discussed.

Keywords: regional climate change, dynamical downscaling, regcm

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MS016 **Oral Presentation** **5560**

A statistical-dynamical downscaling method based on weather type classification and mesoscale modelling to assess wind resources in France

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A statistical-dynamical downscaling method is presented to estimate 10m wind speed and direction distributions at high spatial and temporal resolutions using general circulation model output. Daily 850hPa wind fields (predictors) from ERA40 reanalysis and daily 10m wind speeds and directions (predictands) measured at 78 meteorological stations over France are used to build and validate the downscaling algorithm for a 28-year learning period from 1974 to 2002. The method is based on the assumption that a large enough sample of different atmospheric situations may be sufficient to reconstruct some local climate variable distributions. Thus the method consists in selecting a group of days (about 100) which is suitable for estimating the 10m wind distributions at each station. A bottom-up like approach is used to classify the daily wind fields into a few weather regimes. Those regimes are then subdivided into quantile classes according to the distances from days to the regime centroids. Finally one day is randomly chosen inside each class. Given the observed 10m winds for the selected days and the class occurrence frequencies, the 10m wind speed and direction distributions can be reconstructed at each station. A first evaluation of the method is carried out at this stage by comparing the reconstructed distributions with the observed ones. Different parameters of the method such as the similarity measure for the classification, the number of weather regimes, the number of selected days, the day selection method are thus tested. Simulations with a non-hydrostatic mesoscale atmospheric model are then performed for the selected days over three interactively nested domains over France, with finest horizontal mesh size of 3km over the Mediterranean area. The initial and coupling fields are extracted from the ERA40 reanalysis database. Evaluation of this step consists in comparing the model results with the observations for the simulated days. Finally, the wind distributions are reconstructed by weighting each simulation by the corresponding class frequency, and evaluation and uncertainty assessment of the whole procedure is performed. This method can then be applied for climate change impact studies by assessing changes in the class occurrence frequencies. As an example, an ensemble of experiments has been performed for the period 1950-2150 with the ARPEGE atmospheric general circulation model. Greenhouse gas and sulfate aerosol concentrations are derived from observations for 1950-1999 and from the IPCC SRES A1B scenario for 2000-2150. Sea surface temperature (SST) forcings are derived from a simulation with the CNRM-CM3 AOGCM model. Daily 850hPa wind fields are used to determine evolutions in the occurrence frequency of the wind classes and to assess potential evolution of the wind resources in France.

Keywords: downscaling, mesoscale, wind

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MS016 **Oral Presentation** **5561**

Stochastic Rainfall Downscaling for Hydrometeorological Purposes

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Nicola Rebora, Luca Ferraris, Jost Von Hardenberg, Antonello Provenzale

We present a spatio-temporal downscaling procedure for stochastic rainfall downscaling based on a non-linear transformation of a linearly correlated, Gaussian, field. The downscaled fields reproduce well the main statistical properties of observed rainfall patterns, while conserving the large scale structures of the forecast fields. The procedure, which we named Rain FARM (Rainfall Filtered AutoRegressive Model), can be easily applied to meteorological forecasts provided by Limited Area meteorological Models (LAMs). This model allows for taking into account the uncertainties in rainfall field predictions at the interface between meteorology and hydrology. A general description will be presented along with different hydrometeorological applications in the Mediterranean area.

Keywords: hydrometeorology, downscaling

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

MS016 **Oral Presentation** **5562**

Assessing the performance of RegCM3 in simulating snow for a mountainous region

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IAMAS

This study makes primarily use of the satellite-derived snow cover data to assess the performance of a regional climate model in simulating snow in the eastern parts of Europe and Turkey. It also addresses the sensitivity of snow simulations to snow-rain transition temperature, a threshold temperature that is used in the model to determine whether the precipitation is in the form of rain or snow. In addition, we compare the modeled temperature and precipitation with the observations from meteorological stations in Turkey. The regional climate model is the latest version of RegCM3, which was developed (based on NCARs RegCM2 model) at the International Center for Theoretical Physics located in Italy. The land surface scheme of RegCM3 is the Biosphere-Atmosphere Transfer Scheme. The models domain is centralized at Turkey, and covers an extensive area including Eastern Europe and most of the Middle East. The spatial resolution is chosen to be 24 km to make it consistent with the resolution of satellite snow cover data, which are obtained from the NOAA Interactive Multisensor Snow and Ice Mapping System. The model is continuously run for two 8-month periods: October 1, 2001 - June 1, 2002 and October 1, 2003 June 1, 2004. Subsequently, the simulations are repeated for different snow-rain transition temperatures including 1.8, 1.0, 0.2, and 0.6 oC. It is assumed that the modeled snow cover becomes comparable to the satellite snow cover when the modeled snow water equivalent is at least 5 mm at which the surface albedo is modified. In general, snow cover is well simulated by the model. Monthly spatial correlations between modeled and satellite snow cover for selected regions change between 0.5 and 0.8. The modeled snow is found to be slightly sensitive to snow-rain transition temperature. The model generally overestimates precipitation and underestimates maximum temperature for Turkey, however, the modeled minimum temperature matches well with the observations.

Keywords: regcm3, snow, performance

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

MS016 **Oral Presentation** **5563**

Sensitivity of regional climate studies over Kazakhstan to physical parameterizations

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The seasonal predictions of climate are very important for Kazakhstan. The climate of Kazakhstan is highly continental, with wide variations throughout the territory. There is a shortage of precipitation, and the cultivation of most of crops is only possible in the north, northeast and in a narrow foothill area in the southeast of the country. So, agriculture of Kazakhstan is considerably vulnerable to climate related stresses. Kazakhstan has a complex topography, the mountain regions occupy about 10% of its territory.High resolution regional climate model (RegCM3) was selected to carry out the regional simulations. The model offers a wide range of physical parameterizations which makes it a good candidate for this study. Different parameterizations lead to a wealth of options in the model design that affects the model results. The RegCM3 simulation domain includes the whole Kazakhstan and has 60km of horizontal resolution with 18 vertical sigma levels.A total of 24 simulations were carried out for the different seasons of the period 1991˜2000 by nesting the RegCM into the NCEP/NCAR Reanalysis. The experiments varied the parameterizations of convective precipitation (the Grell scheme with two closures (Fritsch-Chapell and Arakawa-Schubert) and the new Emanuel scheme).The main interest is to compare the RegCM results of precipitation and air temperature with observational data set (from CRU) on a monthly basis. The strengths and weakness of the parameterization schemes employed in the model were investigated for the flat and mountain regions of Kazakhstan.The results show that there is not a best combination of parameterizations for the whole Kazakhstan, for every season or even for every variable tested. But the study is useful to select a parameterization for a smaller area or for specific season.

Keywords: model, parameterizations

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MS016 **Oral Presentation** **5564**

Robustness in projected changes of the hydrological cycle over large European catchments as simulated by the MPI-M global and regional climate models

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Holger Gttel, Daniela Jacob, Philip Lorenz, Erich Roeckner

Recently, the new version of the coupled atmosphere/ocean general circulation model of the Max Planck Institute fo r Meteo rology has been used to co nduct an ensemble of climate simulations for the 4th assessment report of the I ntergovernmental Pane l on Climate Change (IPCC). These simulations comprise thre e control simu lations for the past century covering the period 1860-2000, and nin e simulations for the future climate (2001-2100). The co upled model was run without flux correction at T63 (about 1.9 or 200 km grid size) horizontal resolution and 31 vertic al levels in the atmosphere, and about 1.5 horizontal resolution and 40 vertical la yers in the ocean. For the past climate (1860-2000), observed concentrations of CO2, CH4, N2O , CFCs, O3 (tr opospheric and stratospheric), and sulphate aerosols (direct and first indi rect effect) were prescribed. For the fut ure climate (2001-2100) these concentrations were prescrib ed according t o the three IPCC scenarios B1, A1B and A2. Here, f or each scenario three simulations were pe rformed. Within the EU project EN SEMBLES these glo bal simulations were dynamically downscaled over Europe using th e regional climate model REMO at 0.44 horizonta l resolution (about 50 km). The re gional simulations comprise the 3 control simulations (1900-2000), the 3 A1B simulations and one simulation for B1 as well as for A2 (2001-2100).In our study we will focus on the 2m tempe rature and t he hydrological cycle in a control period repre senting current climate from 1961-1990, and in a future period representing a possi ble climate in the end of the 21st century from 2071-2100. First the simulate d hydrological cycle of the co ntrol period will be considered to get an idea of the internal variability of the models climate over large European catchments. Then the robustness of the climate change signal will be analysed by comparing the projected changes in the hydrological cycle for the three s imulations with in ea ch scenario and between the differe nt scenario simulations. Ideally regions and seasons will be identified where the cl imate change sign al in the hy drological cycle is robust, and where this signal has a larger uncertainty . Finally it wil l be analysed whether significant differences in t he robustness of the climate change signal occur between the global and the regiona l climate simulations.

Keywords: europe, climate change, water cycle

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

MS016 **Oral Presentation** **5565**

Validation of very high-resolution precipitation fields as simulated by the regional climate model REMO

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Holger Goettel, Sven Kotlarski, Susanne Pfeifer, Kevin Sieck, Daniela Jacob

A set of clima te simulations (validation run 1979-2006, control run 1950-2000, 3 different emission scenario runs 2001-2100) with the regional model REMO for Germany and parts of the surrounding area, including the European Alps, were performed at a high horizontal r esolution of 0.088 (~ 10km). The validation run has been carried out from 1979 until 2006, forced by ERA-15 and ECMWF analysis at the lateral boundaries. Focusing on the Rhine catchment the comparison of monthly mean precipitation shows a good agreement bet ween a dense network of station data and model output except for the Moselle sub-catchment and for high-altitude Alpine areas. For the entire model domain the comparison of simulated seasonal precipitation against obse rvation based d atasets shows ge nerally a good agreement with a slight unde restimation in autumn within the validation run. The area mean values for Germany are very well repr oduced. The accuracy of the simulated precipitation clearly depends on the altitude. In high altitudes the model underestim ates the precipitation rates wher eas they are overestimated in lower lying region s, especially in the summer season. Possible processes leading t o these deviations will be discussed. The bef ore mentioned analysis for p recipitation and additional the validation of some other meteorological key parameters will be presented.

Keywords: regional, high resolution, precipitation

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MS016 **Oral Presentation** **5566**

Analysis of extreme daily precipitation from observation and ERA-40 driven RCM simulations over the UK

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Richard Jones

The aim of this study is the detection of trends in the tail of the daily precipitation distribution for the period 1960-2000 over UK The distributions are those obtained from observed precipitation, aggregated over the RCM ENSEMBLES UK grid-boxes, and simulated by Hadley Centre RCM (HadRM3.0 and PRECIS) driven by ERA-40 reanalysis boundary conditions over the same area. An important aspect of the methodology is the strategy of spatial poolin g which can be used to improve the chances of detecting any trends. Trends from the observations and an assessment of the ability of the models to reproduce these trens will be presented at the conference.

Keywords: precipitation, extreme, downscaling

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MS016 **Oral Presentation** **5567**

Impact of Climate Change in the Po valley: downscaling high resolution RegCM output by coupling with ChYM hydrological model

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Xuejie Gao, Filippo Giorgi

The response of the Po River basin in northern Italy to anthropogenic greenhouse gas forcing is evaluated by means of hydrological model simulations coupled with regional climate model (RegCM3) output. Two RegCM3 simulations of 30 years in length for the past (1960-90) and future climate (2070-2100) are performed at a 20 km horizontal resolution for the European domain. The future simulations are performed according to the GHG emission scenario A2 as prescribed by the last IPCC report. A grid-based hydrological model ChYM is coupled off-line with the RegCM3 model. ChYM is run with a horizontal resolution of 1 km for the Po River basin forced with RegCM3 output. A preliminary hydrological model validation is performed using observed time series of Po River discharge. The change of water discharge for the basin in the future climate is evaluated by comparing the A2 scenario with the control simulation. Preliminary conclusions are drawn on the possible effect of future climate conditions on the basin water quantity.

Keywords: regcm, chym, po

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MS016 **Oral Presentation** **5568**

Soil-moisture temperature feedbacks in dynamical and statistical downscaling

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Regional climate change projections for Germany using different emission scenarios (A1B, B1 and A2) have been carried out for the 21th century using a dynamical and a statistical approach. Both methods performed a downscaling of the same global coupled atmosphere-ocean simulations carried out with the model system ECHAM5-MPI OM. The dynamical downscaling approach was done with the Regional Climate Model REMO on a very high horizontal resolution of 0.088 (~10 km), the statistical with the WETTREG model. Differences in the evolution of the projected mean 2m-temperature in both approaches, especially in the 2nd half of the 21th century, could be attributed to a dynamical feedback process in the dynamical downscaling procedure. Within REMO less precipitation during summer leads to lower soil moisture content, which in turns decreases evapotranspiration. This enhances the temperature increase and therefore leads to a stronger climate change signal. In the statistical downscaling method this feedback is not included, so that the temperature signal is less strong. More details will be presented at the conference.

Keywords: regional, high resolution, soil atmosphere feedback

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MS016 **Oral Presentation** **5569**

Bias correction of the meteorological variables from RCM for hydrological application

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Dynamic down scaling is an appropriate method when the density of surface station is not so high. Regional Climate Model (RCM) provides us the detailed spatial and temporal structure of meteorological field. By the way, it is usually very difficult to directly utilize the products of RCM to hydrological applications since the accuracy needed by hydrological side is usually higher than that achieved by RCM. In this study, the characteristics of model biases provided by RCM are investigated and the method for bias correction is developed making the best use of available meteorological data.Total precipitation is calculated to see the mean bias. Model bias varies from station by station, and it also varies each month. This nature requires the bias correction to vary both in space and time. Although the rain gauge density is not high enough, grid precipitation dataset is produced by spatial interpolation to calculate the monthly precipitation bias. Here, observation based grid precipitation dataset does not include the topographic dependency in its spatial interpolation process, and it should not be relied on too much (too much reliance of grid precipitation dataset might erase the structure of precipitation distribution well captured by RCM). That is why upper and lower limits are applied in bias calculation. Firstly, monthly mean biases were applied to get bias corrected radiation. And this simple method seemed to be successful on a monthly basis. The time series of daily mean radiation at Adana shows that there is high variability within short period. The simple correction method with monthly mean bias sometime gives unrealistic value if the original value is close to observation. Looking at this daily time series, it was found that the radiation bias has dependency on weather (sunny or cloudy) and season. Thus, model biases are calculated for each weather class which is classified by the ratio of RCM radiation to S0top (downward short-wave radiation at the top of atmosphere). Disaggregating all stations data into 120 (10 class times 12 month) categories, mean bias for each category was calculated.Daily mean temperature (Tave) is compared with observation. Regression coefficients were calculated at each station for each month. Regression coefficients are spatially interpolated to correct Tave at all grids. Diurnal temperature range (Tmax-Tmin) is compared with observation to adjust diurnal variation. Adjustment ratio is calculated at each station for 5 temperature range class. Available information is daily maximum and minimum relative humidity. Relative humidity is highly dependent upon air temperature, and it is not a good measure to know the humidity bias. Since the information on the time when the relative humidity had its maximum and minimum is not available, new index on water vapor pressure (Eave) which is calculated from mean temperature and mean humidity is defined.

Keywords: bias correction, rcm, diurnal range

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

MS016 **Oral Presentation** **5570**

Climate change in Estonia during the second half of the 20th century as simulated by the high-resolution regional climate model

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During the last 50 years, significant warming tren d in late winter (February and M arch) has been observed in Estonia. This trend is usually associated with the intensificatio n of westerly and so utherly airflow over the region. In thi s study, the modeling approach is used to estimate the climate change i n Estonia during the second half of the 20th century and to identify possible causes of this change at local and regional s cales. Two 27-year long climat e simulations (1948-1974 a nd 1975-2001) are carried ou t using the RegCM3 regional climate model a nd 25 km grid spacing. NCEP- NCAR reanalysis and Globa l Ocean Surface Temperature (GISST) data a re used fo r initial and bo undary co nditions. For calculating convective precipitatio n, the Emanuel sche me is us ed. The preliminary results of this experiment are presented here. The simulated values of surface air temperature, precipitation and other variables are evaluated against observations to identify major mo del biases. Monthly and seasonal statistics of two periods are compared to get estimates of regional climate change.

Keywords: climate change, high resolution modeling, local and regional scales

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

MS016 **Oral Presentation** **5571**

The hydrologic cycle in the eastern Mediterranean: using MM5 and WRF for dynamic downscaling

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Dorita Rostkier-Edelstein, Thomas T. Warner, Francois Vandenberghe, Yubao Liu, Scott Swerdlin

The Penn State/National Center for Atmospheric Research (NCAR) mesoscale model, version 5 (MM5), and the Weather Research and Forecast (WRF) model are being used to downscale the changes in the precipitation and other components of the water cycle that result from future climate change as predicted in a low-resolution atmospheric general circulation model. The geographic focus area is the eastern Mediterranean and the adjacent countries of the Middle East, where the water supply is critical and where the balance between supply and demand could change significantly for future climate scenarios.The first step in this study, which will be the focus of this presentation, is the use of the models to replicate the present-day hydro-climate of the area. To accomplish this, MM5 and WRF are run for several winter seasons using NCAR-NCEP (National Centers for Environmental Prediction) Reanalysis Project archived global analyzes for initial and lateral-boundary conditions. The control runs include data assimilation of surface and upper air observations. The comparison of the simulated and observed precipitation should help in establishing the veracity of the modeling system for use in simulating the water cycle for this geographic area. Several shorter experiments are run to aid in the selection of an optimal modeling set up (e.g., model physical parameterizations, cold start frequency, ingestion of boundary conditions, grid nudging) for subsequent coupling within the NCAR Community Atmospheric Model (CAM) and Climate System Model (CCSM), the ultimate goal of this project. The evaluation of the precipitation from the two simulations and the shorter sensitivity runs is performed in terms of total monthly amount, the geographic distribution in various rainfall areas, rainfall intensity, and the diurnal distribution of rainfall. Rain-gauge observations over land areas with good spatial coverage, and various satellite-derived precipitation estimates over oceans and data sparse areas, are used in the model validation.

Keywords: eastern mediterranean, precipitation, mm5 wrf

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MS016 **Oral Presentation** **5572**

A regional climate modeling study of the effect of desert dust on the West African monsoon

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We present a study of the effects of Saharan dust on the West African monsoon with the use of a regional climate model (RCM) interactively coupled with a dust module including production, transport, removal and radiative transfer terms. We simulated 32 summer monsoon seasons, from 1974 through 2005, over a large domain encompassing most of equatorial and northern Africa. This period includes the Sahel dust event as well as a number of El Nino and La Nina episodes. Two sets of simulations are conducted, one with and one without the radiative feedbacks associated with Saharan dust. Comparison of these sets of simulations allows us to identify the effect of dust. The simulated climate is validated by comparing to reanalysis and observed data sets. The model is able to reproduce realistic features of WAM during JJA. Mean precipitation and surface air temperature change indicate a decrease in precipitation over Sahel and a cooling of the surface over Sahara. This results show a weakening of the monsoon flow penetrating the continent, a weakening of the AEJ and an enhancement of the Tropical Easterly Jet (TEJ).

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MS016 **Oral Presentation** **5573**

A regional climate model coupled to a two-layer lake model

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Ekatherina Kourzeneva, Dmitrii Mironov

One of the most important issues in regional climate and weather prediction models is the interaction of the atmosphere with the underlying surface. For decades, the interaction with land and sea surface has gotten much attention, but lakes have many times been disregarded or treated in a very simplistic way. The reason for this is of course that land and sea surface dominate the surface of the earth while lakes are only regionally important. In regions where lakes represent a non-negligible fraction of the surface their large thermal inertia, when compared to the land surface, may cause them to have a substantial impact on the regional climate. This is particularly the case in Fennoscandia, Russia and in Canada. In RCM and NWP modelling the lower boundary condition for the atmosphere with respect to lakes must be described. The boundary condition is represented by the energy fluxes of radiation, heat and momentum. Thus, the lake interior is really not of importance per se. As long as the surface temperature (including ice) is well simulated the lake model can be made simple. For climate simulations, a computationally cheap model is also of high priority. A lake model that fulfils these criteria is FLake (http://nwpi.krc.karelia.ru/flake/index.htm), developed by Dmitrii Mironov. FLake is a two-layer model based on a self-similar representation (assumed shape) of the temperature profile in the mixed layer and in the thermocline. The model incorporates (i) a flexible parameterisation of the evolving temperature profile in the thermocline, (ii) an advanced formulation to compute the mixed-layer depth, including the equation of convective entrainment and a relaxation-type equation for the depth of a wind-mixed layer, (iii) an improved module to describe the vertical temperature structure of the thermally active layer of bottom sediments and the interaction of the water column with bottom sediments, and (iv) a snow-ice module. The ability of Flake to predict the temperature structure in lakes of various depths on diurnal and seasonal time scales has been successfully validated against data through single-column numerical experiments. Today FLake is implemented into the NWP model COSMO-LM (DWD) and into the regional climate models RCA (SMHI) and CLM (GKSS). It is also on its way into the NWP model HIRLAM. The Rossby Centre regional climate model RCA coupled to FLake has been successfully used for decadal simulations over Europe using ERA40 as lateral and SST boundary conditions. The simulated lake surface temperature and ice conditions are compared to observations and to corresponding RCA simulations where the multi-layer lake model PROBE has been used. Unfortunately, information on lake depth is not easily available over large regions. Results will be presented showing how sensitive the results are for lake depth. The results will also be compared to a simulation where lakes have been replaced by open land conditions, illustrating how important lakes are for the regional climate.

Keywords: rcm, lake model

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

MS016 **Oral Presentation** **5574**

On the Assessment of Climate Change Impacts in Central and Eastern Europe

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In the region of Central and Eastern Europe the need for high resolution studies is particularly important to asses the impacts of antropogenic clim ate change on regional and local scales. This region is characterized by small scale topographical p atterns that significantly affect the local climate conditions. A resolution sufficient to capt ure the effects of thes e topographical and associated land- use features is necessary, that is why 10 km resolution was introduced in project CECILIA accepted under the 4th call of EC FP 6 in last year. Based on region al climate modelling studies in targeted areas of Central and Eastern Europe with the res olution of 10 km local impact studies are planned in key sectors of the region like hy drology, water quality and manageme nt, air quality iss ues, agriculture and forestry. Climate change impacts on large urban and industri al areas modulated by topographical and land-us e effects which can be resolved at the 10 km scale, are investigated by CECILIA as well. Preliminary analysis of the first regional simulations will be presented.

Keywords: regional climate modelling, climate change, climate change impacts

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

MS016 **Oral Presentation** **5575**

Skill limits of regional climate model downscaling due to uncertainties in reanalysed lateral boundary conditions: case study for the West African Monsoon Region

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The one-way nesting of regional climate models (RCMs) within quasi-observed conditions from global reanalyses is now a widely used technique to assess the usefulness of regional climate modelling. The realism of RCMs depends on the quality of lateral boundary conditions (LBCs) and any systematic errors in the large-scale driving conditions will be added to the uncertainties of the RCM formulation. Although the use of quasi-observed LBCs limits biases inherited from driving data, it also introduces a source of uncertainty for RCMs in data sparse monsoon region where important disagreements exist between the different reanalyses data sets. Here, we provide a first attempt to quantify the impact of this source of uncertainty for regional climate predictions in the West African monsoon region. The Hadley Centre regional climate model PRECIS has been integrated with two sets of boundary conditions to form a pair of 22-year (1979-2002) simulation at approximately 50 km horizontal resolution. The two sets of driving conditions are the Reanalysis projects ECMWF-ERA40 and NCEP/DOD AMIIP2 (R2). The climatology and intra-seasonal variability of regional climate features are examined. This includes atmospheric circulations, precipitation, surface temperature, clouds and onset dates for the West African monsoon. The statistical significance of obtained correlations and differences is also estimated. The results suggest that, although PRECIS captures reasonably many features of the climate over West Africa, its performance depends strongly on the reanalyses used. This situation particularly notable over the Soudan-Sahel region where the differences between each surface temperature model bias reach up to 2-3 C at the peak of the rainy season in June-August. Further investigation into the skill of the ensemble mean indicates the advantage of combining outputs from regional climate model realizations driven separately with different reanalyses data sets. This gives a better evaluation of the predicting skill of the regional climate model.

Keywords: uncertainties, boundary conditions, reanalyses

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

MS016 **Poster presentation** **5576**

Sensitivity Analysis of Different Convection Schemes and Center Domains for Numerical Simulation of Seasonal Precipitation

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This paper qualifies the impact of different convective schemes and center-domains on the simulation of winter precipit ation over Ira n using a numerica l regional climate model, named R egCM3. It is compressible, finite differenc e with hydro static equ ilibrium in sigma coordinate with a semi-implici t algorithm for reduction of horizo ntal diffusion. During wint ers of 1997 and 2000, Iran experienced two wet and dry periods, respectively. In this paper se nsitivity of the RegCM3 regional clim ate model has been analyzed using dif ferent convective schemes including Grell-AS, Grell- FC, Emanuel and Kuo and different center domains including Himalay a, Mediterra nean sea, Ira n and Indian ocean (near Pakista n southern boundaries). NNRP 1 data with 5 degree resolution were used as initial and boundar y conditions. GLCC and GTOPO were used as land use and t opography data, respectively. We fo und that, there is an intelligency between model skill and center domain whic h means that, for example in the case of Siberia n high pressur e over Iran, the Hima laya center domain had better resul ts comparing to the o ther center do mains. Grell co nvective schemes ha ve minimum av erage erro rs a moung o ther convections schemes. In all experiments, Caspian sea precipitation had an eastward shift.

Keywords: numerical climate model, winter precipitation, sensitivityanalysis

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MS016 **Poster presentation** **5577**

Simulation of 1376 and 1379 winter precipitations using RegCM3 Regional Climate Model

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Regional climate models such as RegCM3 are capable of simulating different climate processes. Modeling the climate can detect differences between real climate and model- simulated climate in the area under study. Variety of simulations have been done for sensitivity investigation of the model to the physical computational processes and schemes such as radiation, convection, land use, resolution, domain size and center of domain. In this work, sensitivity of the RegCM3 has been measured to the different convective schemes including Grell, modified Kuo and Emanuel. Grell scheme itself has divided into two different schemes of Arakawa-Schubert (AS) and Fritch-Chapel (FC). Winters (started from Decembers up to February) of 1376 and 1379 were the period of Study. Skill of the model in producing the monthly amount of precipitation was calculated by comparing model output with observed precipitation of 151 synoptic stations of Iran and CRU reanalysis data. According to the results of this research, the regional appropriate schemes whit their errors are: Kuo whit -%24 error for southeast, Kuo whit %16.5 error for northeast, Emanuel with %85 error for central part of Iran, Kuo with %20 error for southwest, Emanuel with -%10 error for West, Grell-FC and Kuo with -%80 error for northeast and Kuo with -%16 for southwest of Caspian Sea. Simulation's errors for central and northwestern parts of Iran have been rejected statistically because of high amount of errors. But according to mean error analysis of two years simulations, Grell schemes with approximately %20 errors have good results for winter precipitation simulation of Iran.

Keywords: regcm3 convective scheme, grell fc scheme, emanuel scheme cru and observ

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MS016 **Poster presentation** **5578**

Evaluation and Adaptation of a Regional Climate Model for the Horn of Africa: Rainfall Climatology and Interannual Variability

Dr. Zewdu Segele

Lance M Leslie, Peter J. Lamb

Regional climate models (RCMs) increasingly are being applied to various parts of the world to examine regional climate patterns and processes This study evaluates the ability of the Abdus Salam International Center for Theoretical Physics (ICTP) version 3 RegCM (RegCM3) to reproduce the observed rainfall amounts and distribution over the mountainous region of the Horn of Africa. Simulations were performed for both dry (1984) and wet (1996) years using all of the deep moist convective schemes available on option in the RegCM3. It was found that for the Horn of Africa, the RegCM3 moist convective schemes produced wide-ranging precipitation distributions and amounts. An extensive program of comparative simulations of the RegCM3 moist convective schemes revealed that the Emanuel scheme best captured the rainfall patterns, interannual variability, and centers of precipitation maxima over continental Africa, despite having deficiencies over other regions of Africa not of interest in this study. Capitalizing on the positive aspects of the Emanuel scheme over the Horn of Africa, several model simulations were performed in which key parameters of the Emanuel scheme were modified to improve the simulated rainfall amounts and patterns over this region. The simulations show that for the 18-year period from 1982-99, the RegCM3 model using the modified Emanuel moist convective parameterization realistically reproduced the rainfall climatology and the interannual variability for the Horn of Africa. In particular, details of the 18-year average simulated rainfall pattern over much of Ethiopia closely follow the observed station rainfall analysis. Except for a slight overestimation, the main rainfall band over western Ethiopia is well captured. Furthermore, the simulations exhibit considerable skill in representing the important temporal variations of rainfall over Ethiopia. The RegCM3 also successfully captures the prominent deficient and excess Ethiopian rainfall seasons.

Keywords: ethiopia, monsoon rainfall simulation, regcm3

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MS016 **Poster presentation** **5579**

An evaluation study of the MM5 solar radiation estimates in a complex-topography area in Southeastern Spain

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The solar radiation plays a major role in the energy exchange process between the atmosphere and the earth surface and is, therefore, a key parameter in a wide range of studies related to agriculture, hydrology, ecosystem modelling or renewable energy. It is known that complex topography significantly modifies radiation fluxes at the earths surface. Nevertheless, terrain effects on radiation fluxes induced by aspect, slope, sky view factor and shadowing are normally neglected in numerical models when horizontal resolution is lower than 10 km. As spatial resolutions of mesoscales models increase (1-2 Km) the topographic effect on the solar radiation might be considerable, especially at low solar-height angles. Fine-scale non-hydrostatic numerical models, such as PSU/NCAR MM5, are able to include the effects of the slope and aspect on the solar radiation estimates. In this work we analyze the reliability of solar radiation estimates provided by the MM5 in complex topography. Particularly, hourly global solar radiation values for clear-sky days were obtained based on several MM5 simulations. The experiment was carried out for an area located within the Sierra-Magina Natural Park (Jan, Southeastern Spain). This area is characterized by a relatively complex topography, with elevations ranging from 600 to 2100 m. MM5 estimates were tested against field data measured at 12 radiometric station located in an area of 20 km x 20 km inside the Park. The location of these radiometric stations covers a wide range of elevations, aspects and slopes. The experiment was conducted for three winter and three summer clear-sky days collected along the year 2006. Two 1 km resolution simulations were carried out for each set of days: one including the MM5 topographic parameterization and one without including these effects. The comparative analysis of the results allows both knowing the effect of topography on MM5 high-resolution solar radiation estimates and how the slope and aspect parameterization of the MM5 deals with this problem. Finally, the results were analyzed on the light of the different topographic characteristics of the 12 stations. Results showed, firstly that, compared to observations, an important improvement is obtained both for temperature and radiation when including the topographic effects in the MM5 simulations. Additionally, the model tends to underestimate the solar radiation in morning day hours and to overestimate the values in the central day hours. Finally, results showed, that the difference between the estimated and measured solar radiation increases when the topographic complexity increases.

Keywords: mm5, solar radiation, complex topography

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MS016 **Poster presentation** **5580**

A regional climate study of Andalusia (southern-Spain) using MM5: results and comparison to observation

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The evaluation of regional models against observations is fundamental in climate studies since it can reveals misinterpretations in parameterization schemes leading to bias in the estimates of environmental properties and fluxes at variety of time and spatial scales. This work presents preliminary result about the performance of MM5 in simulating the daily-to-annual climate variability of the region of Andalusia (southern). Particularly, we evaluate the ability of different MM5 planetary boundary layer and explicit moisture parameterization to reproduce the daily-to-annual climate variability in high resolution (10 km) integrations. The area of study (100.000 km) is located in the transition region from middle latitudes to subtropical climates, with the Atlantic Ocean and the Mediterranean region in the southern bound. The western part of the region, covering around 30.000 km, is an almost homogeneous flat area, with about 100 m of mean elevation. On the other side, the eastern part the region presents a very complex topography, with several mountain ridges and elevation gradients of more 2000 metres in less than 20 km from the coast. As a consequence, the region presents a wide range of climatic characteristics. Particularly, precipitation presents a strong gradient, from above 600 in the western part to less than 200 mm in the eastern part. Given these special characteristics, the challenge is to know whether or not a single set of parameterizations is able to properly represent the climate of whole region. We base the evaluation on model-observation comparisons of three parameters: temperature, precipitation and shortwave downward solar radiation. Around 80 stations with daily values were available for evaluating the model outputs. The comparison is carried out during two years, 2003 and 2006, that displayed significantly different climates in the study region. The initial conditions and lateral boundary conditions are provided from 6-hourly European Center for Medium-Range Weather Forecasting (ECMWF) analysis. Preliminary results showed that the model output reasonable agrees with the observations and therefore provides an acceptable description of the regional climate. Nevertheless, not a single set of parameterizations perform best for all the evaluated variables and for all the time scales and sub-regions of this complex study area.

Keywords: mm5, andalusia spain, model evaluation

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MS016 **Poster presentation** **5581**

Model simulations of summer and winter precipitation over Bulgaria using REGCM3

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The geographical position of Bulgaria is very interesting from climate point of view as the temperate climate front system, following the Balkan mountain, passes through Bulgarian territory. It's annual averaged position could be identified approximately by the period with maximal precipitation in the year locations under Mediterranean influence show winter maximum, and the ones of temperate climate summer maximum. This paper is an attempt to study the variations of this climate boundary position over Balkan Peninsula using high resolution climate model (Regcm3). The above mentioned simple hypothesis is difficult to apply directly because of the Balkan divers landscapes, ranging from high mountains to flat planes, thus we need a model with finer resolution than the global circulation models to account for all orographic effects. The long-term monthly mean data for temperature and precipitation coming from CRU analysis and measurements in 135 stations in Bulgaria are used to identify the years with normal and anomalous climate conditions in regard to the precipitation seasonal cycle. Then the model is run for those years and the results are verified with the measurements. Conclusions regarding the adequacy of the results and the ability of model simulations to represent the global circulation effects at regional scales are given.

Keywords: climate, simulations

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MS016 **Poster presentation** **5582**

Comparison between Grell and Emanuel convective scheme in RegCM3 for a European domain

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Prodromos Zanis, Ioannis Kapsomenakis, Dimitrios Melas, Christos Repapis

Regional climate simulations have been performed with RegCM regional climate model with a horizontal resolution of 60 x 60 Km over the broad European and Mediterranean area for three individual 12-months periods using three convective parameterizations, a) the Grell scheme with Arakawa-Schubert (AS) closure, b) the Grell scheme with Fritsch-Chappell (FC) closure and c) the Emanuel scheme. Comparison of the model results with the Climatic Research Unit (CRU) 0.5 x 0.5 gridded surface temperature database indicates a significant cold bias with the Grell scheme (both with AS and with FC closure schemes) which is significantly reduced when the Emanuel scheme is used, especially in the summer when convection is known to be more often. The temperature differences between the two Grell and the Emanuel scheme dominate in the lower troposphere extending up to 700 hPa. As far as it concerns the total precipitation no systematical differences between Grell and Emanuel schemes are observed throughout the year for the European domain but the convective part of total precipitation is greater when Emanuel scheme is used. This difference in the behavior of the simulations due to the convective scheme choice indicate that the Emanuel convection scheme is invoked by the model more often than the Grell scheme and is more efficient in creating precipitation thus drying the atmosphere. The water vapour surplus in the two Grell simulations causes excessive non-convective precipitation which in turn balances the amount of total precipitation. The gratest differences occur in the comparison between the Emanuel and Grell AS convective schemes while the Grell FC scheme behavior lies between the Emanuel and Grell AS schemes. The warmer surface temperature in Emanuel compared to the two Grell schemes is attributed to the different effect they exert on the following cloud-radiation feedback mechanism: enhanced convective precipitation, more efficient drying of the atmosphere, less cloudiness, more incoming solar radiation, warmer surface temperature and again more convection.

Keywords: rcms, convection, feedback

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MS016 **Poster presentation** **5583**

Validation of an ensemble of regional climate model simulations for the area of Greece.

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The mean seasonal and inter-annual variability of surface temperature and precipitation simulated from an ensemble of 9 Regional Climate Models (RCMs) for the control period 1961-1990 is validated against respective gridded datasets interpolated from a network of about 57 stations covering Greece and the neighbouring countries. These Geek gridded temperature and precipitation data were compiled as yearly and seasonal means for the period 1961-1990 on the RCMs model grid and for clarity they have been also compared with the Climatic Research Unit (CRU) TS 2.0 data-set supplied on a 0.5 degree grid. The ensemble of 9 RCMs that took part in the European project PRUDENCE, have a common horizontal resolution of about 50 x 50 km and they have been forced with 6 hourly lateral boundary conditions provided by the same global model HadAM3H from the Hadley Center. In order to deal with the high spatial variability of the Greek climate was divided into 11 climatic sub-regions based on the most prevalent weather types. The comparison was done for the mean and the inter-annual standard deviation of temperature and precipitation of the reference period 1961-1990 for each individual season and the whole year for the 11 individual sub-regions of as well as for the integrated Greek domain. The majority of the RCMs reproduce well the annual mean of temperature while the inter-annual standard deviation is reproduced well for the maritime influenced sub-regions (except East Aegean) and it is overestimated for the continental sub-regions. The annual mean of precipitation is underestimated by most RCMs particularly in the southern maritime influenced regions and the inter-annual standard deviation is also underestimated for most of the models. The comparison of the seasonal means of both surface temperature and precipitation and their inter-annual standard deviation simulated from the 9 RCMs with the respective Greek gridded data varies with the season and the particular RCM. An interesting feature is that in all RCMs the mean temperature in the maritime sub-regions is underestimated during winter and overestimated during summer.

Keywords: rcms, validation, greece

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MS016 **Poster presentation** **5584**

Climate change hot-spots over East Asia

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The concept of climate change Hot-Spots can be approached from the viewpoint of vulnerability or from that of climate response. In t he form case a Hot-spot can be defined as a region for which potential climate change impacts on the environment or different activity sectors can be particularly pronounced. In the latter case, a Hot-Spot can be defined as a region whose climate is especially responsive to global change. In p articular, the characterization of climate response-based Hot-Spots can provide ke y information to identify and investigate primary pr ocesses of region al climate ch ange. From th ese premises here the response approach is adopted to investigate climate change Hot- Spots based on results from a multi-model ensemble of climate change simulations performed by modeling groups fro m around the world as contributions to the Fourth Assessment Report of the Intergovernmental Panel o n Climate Change (IPCC). Regional Climate Change Index (RCCI) developed by Giorgi (2006) is employed to study the re sponse of global warming in 2081-2100 over different area s of East Asia . The a nalyses are based on the latest set of climate change projections for IPCC AR4 by 14 climate m odels under the A1B, A2 and B1 IPCC emission scenarios. R CCI is defined based on four variables: change in grid mean surface air temperature relative to the global av erage temperature change, chang e in mean grid precipitation, change in grid surface air temper ature interannu al variability, and change in grid precipitation interannual variability. Results sho w th at North Eastern Asia, and Tibetan Plateau emerge as the primar y Hot- Spots, f ollow by Eastern Chin a, No rthern China, while So uthern China has a comparatively weaker response to global change. Di fferent factors hav e different contributions in the grid points to the magnitude of the RCCI. This is also discussed briefly in the paper.

Keywords: climate, change, hot spots

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MS016 **Poster presentation** **5585**

Deterministic skill of ECMWF experimental seasonal forecasts: comparison between global and regional model

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Cedo Brankovic

The Regional Climate Model (RegCM) has been used to dynamically downscale the nine-member seasonal ensemble forecasts from European Centre for Medium-Range Weather Forecasts (ECMWF) produced within the EU ENSEMBLES project. Downscaling has been performed for the winter (January-March) and summer (July-September) seasons from the 11-year period (1991-2001). The global model resolution was TL95, approximately corresponding to 1.875, and the RegCM domain covered central and western Europe and the northern Mediterranean with horizontal resolution of 50 km. The results for both global and regional models have been compared with ERA-40 data in terms of model bias and ensemble-mean skill scores. For both models, anomaly correlation coefficients for individual ensemble members have been calculated, in order to determine the spread of the skill within ensembles. It is expected that, in a limited domain, dynamical downscaling will improve the regional model skill over that from the global model.

Keywords: dynamical downscaling, seasonal ensemble prediction

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MS016 **Poster presentation** **5586**

Development of an atmosphere-biosphere-river coupling regional climate model for dynamical downscaling

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Carbon and hydrological cycles are essential regulator of the climate system. The responses of the climate system to increases in carbon dioxide concentrations and to changes inland use/land coverand the subsequent impacts of climatic variability on humans and natural ecosystems are of fundamental concern. Regional responses of surface hydrological and biogeochemical changes are particularly complex in climate systems such as the Asian monsoon. Even a hi-resolution global climate model (T106, approximately 100 km grid spacing) has not yet had enough capability to examine regional-scale feedbacks, in particular, between atmosphere and terrestrial ecosystems. It is necessary to add spatial resolution (less than 30 km grid spacing) to accurately assess critical interactions within this system. We are now developing and test an atmosphere-biosphere-river coupling regional climate model with vegetation dynamics which explicitly includes diverse aspects of the carbon cycle and pursue the key terrestrial feedback mechanisms and processes responsible for the maintenance and variability of regional carbon-water-energy cycles in the East Asian monsoon region.

Keywords: downscaling, carbon, river

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MS016 **Poster presentation** **5587**

Effects of topography and surface heat fluxes on the South Atlantic extratropical cyclones: regional climate simulations

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The importance of the topog raphy and surface heat turbulent fluxes on the extratropical cyclogenesis over the So uth Atlantic Oceanis investigated through regional climate simulations. The results from the integration of t he Regional Cli mate Model version 3 (RegCM3), driven in the lateral boundaries by t he National Centers for Environmental Prediction (NCEP) reanalysis, for one year are discussed here. Thr ee experiments were carried out: (1) control (ExpCTRL), which includes all the a vailable physics in t he model; (2) wi thout topograph y (ExpT opo); an d (3) with out sen sible and laten t h eat tu rbulent flu xes over the sea (ExpFlux). To identify and track the cyclones a numerical scheme that seeks relative vorticity minima (RV10) in the 10 m height wind is used. Assuming that 1990 represents a normal year, this algorithm was applied in the 1990 reanalysis data and in the three numerical experiments results to identify all the cyclones with RV 10<= -1,5x10-5s-1 and life cycle of 24 hours or more. As one would expect, the ExpCTRL cyclone climatology results are mo re similar to the reanalysis than the other two experiments. This experiment was able to si mulate the three cyclogenetic areas in the east coast of the South America (Argentine co ast near 48o S; the La Pl ata River discharge in (~35oS); and the south/southeast Brazilian coas t between 30o-25oS). Over the South Atlantic Oceanbasin, 275 and 297 cyclones were identified in the reanalysis and in the EXPCTRL, respectively, during 1990. The larg e impact in the annual climatology was found in the ExpFlux which had a reduction of 34% in the number of cyclones when compared to the ExpCTRL. The ExpTopo also presented a red uction in the cyclogenesis (11.8%) but it is lower than ExpFlux. The regions more a ffected by the fluxes turn off are the east of south and southeast Brazilian coast and east coast of . This result indicates that the energy transfer by the ocean is essential to atmosphere vertical coupling and future cyclone development in the two areas men tioned above. It is interesting to n otice that the ExpCTR L and ExpFlux showed sim ilar results in the cyclogenese density fields over sugge sting that other dynamic mechanis ms such as the baroclinicity and topography effects are more import ant in this area. On the o ther hand the ExpTo po showed a larg e reduction of cyclogenesis in the coast confirming the importance of the Andean mountains to these systems development.

Keywords: cyclogenesis, regcm3, south atlantic

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MS016 **Poster presentation** **5588**

Comparison of future climate scenarios for the Carpathian Basin using stochastical downscaling and regional climate model outputs

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Judit Bartholy, Gyorgyi Gelybo, Aniko Kern, Istvan Matyasovszky

The results from coarse resolution global climate models (GCM) can only be considered as a first-guess of regional climate change consequences of global warming. Stochastical and dynamical downscaling techniques can be both used to obtain better estimation of the future climate conditions of a given region. In order to estimate the regional climate change expected in the Carpathian basin (located in Central/Eastern Europe), these two different approaches have been used and compared: (i) stochastical downscaling technique nested in coupled ocean-atmosphere GCMs - developed at the Department of Meteorology, Eotvos Lorand University; (ii) regional dynamical climate modeling method - using regional climate model (RCM) outputs from the completed EU-project PRUDENCE. The stochastical downscaling method includes large-scale circulation of the atmosphere, and also, it is able to represent the linkage between the local surface variables and large-scale circulation. Seasonal and annual changes in temperature and precipitation have been determined for Hungarian stations in case of the 2xCO2 climate and compared to historical time series. The analyses cover the entire Carpathian basin with special focus on two Hungarian subregions: the Great Hungarian Plain, and the watershed of the Lake Balaton. Severe shortage of precipitation and unusual intense flood events occured in the last few decades in both areas, therefore, ecosystems must face to high risk of environmental change. Furthermore, the horizontal resolution of RCMs is much finer than the GCMs, therefore, a summary of the RCM outputs may lead to a better estimation of future climate in the European subregions. For the Carpathian basin, composite maps of expected change in temperature and precipitation are generated using the RCM simulations (with 50 km spatial resolution) for the periods of 2071-2100 (in case of A2 and B2 scenarios) and 1961-1990. Uncertainty of the regional climate change is represented by the standard deviation of the simulated changes.

Keywords: stochastic downscaling, regional climate model, carpathian basin

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MS016 **Poster presentation** **5589**

Climate change projection using a regional climate model and application to the evaluation of vulnerability to climate change impacts of the hydrological resources of the Nyong River.

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The RegCM model is be used to project climatic input variables for the evaluation of vulnerability to climate change of the water resources of a river catchments in southern Cameroon basin. As a first step control runs of the model are being made to ascertain its ability to model current climate and particularly important variables such as rainfall and temperature over West Africa. It was therefore integrated for the period of March to September 1993 using ERA40 reanalysis data as initial and boundary conditions. Results show that RegCM underestimate precipitation over West Africa and in particular on the coastal regions, irrespective of convective closure scheme or cumulus scheme. Temperature, humidity and wind fields look acceptable. Some modifications of model parameter have been done to improve rainfall and the result is now approaching observations in coastal region. We plan to continue to look at model parameter that could be adjusted to obtain the best rainfall simulation in the West Africa.

Keywords: regcm, west africa, rainfall

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MS017 **5590 - 5614**

Symposium
Climate Sensitivity and Climate Feedbacks: Progress and Remaining Questions (ICCL)

Convener : Dr. Natalia Andronova

Human economic activity is an important driving force for evolution of the climate system. Understanding and predicting changes in the climate system is a scientific goal for avoiding unwanted and abrupt changes. So far, in spite of uncertainties of its estimation, the climate sensitivity, defined as a change in the global near-surface temperature due to doubling carbon dioxide, still serves as an informative measure of climate change. It is widely used for climate model intercomparison and for evaluation of the climate system feedbacks. This symposium will be devoted to papers that further advance our knowledge of climate feedbacks, address uncertainties in climate sensitivity and use it to predict future climates

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MS017 **Oral Presentation** **5590**

Inferring climate sensitivity from volcanic events

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The possibility of estimating the equilibrium climate sensitivity of the earth-system from observations following explosive volcanic eruptions is assessed in perfect model experiments using the CCCma CGCM3 and the NCAR CCSM2 climate models. The two models, which have known but different equilibrium climate sensitivities, are perturbed with the same transient volcano-like forcing and their responses are analyzed to infer their climate sensitivity. Despite the models' differing climate sensitivities their global mean surface temperature responses are very similar, indicating that climate sensitivity cannot be inferred from temperature alone. Climate sensitivities can be determined if both the forcing and the change in heat storage in the system are known. Both must be known very accurately, however, and inferring climate sensitivity from volcanic events is a daunting prospect in the context of the earth's climate system.

Keywords: climate senitivity, volcano

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MS017 **Oral Presentation** **5591**

Some considerations of the concept of climate feedback

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A conceptual study of climate feedbacks has been carried out (Bates, 2007) using two simple linear two-zone models and the commonly used zero-dimensional model to which they reduce under simplifying assumptions. The term feedback is used in many different senses in the climate literature. Two prototype usages, stability-altering feedback (measured in terms of a systems asymptotic response to an impulsive forcing, negative when stability-enhancing) and sensitivity-altering feedback (measured in terms of the systems steady-state response to a step function forcing, negative when sensitivity-diminishing) have been isolated for study. These two climate feedback concepts are viewed against the background of control theory, which provides a generalized feedback perspective embracing all forms of forcing and which is often seen as providing the paradigm for feedback as used in climate. The relationship between the prototype climate feedbacks is simple in the context of the zero-dimensional model. Here, the stability-altering and sensitivity-altering feedbacks provided by a given interaction are of the same sign. Also, the sign of the stability-altering feedback as measured by initial tendencies always coincides with its sign as measured by the defining asymptotic tendencies. Even in this simple model, however, the sign of the prototype climate feedbacks can be opposite to the sign of the systems feedback as defined in control theory. In the two-zone models, the simplicity of the relationship between the prototype climate feedbacks as seen in the zero-dimensional model is lost. Here it is shown that, contrary to the common assumption that these feedbacks are always of the same sign, they can be of opposite sign. Also, the sign of the stability-altering feedback as measured by initial tendencies can be opposite to its sign as measured by asymptotic tendencies. In addition, it is shown that there is no simple relationship between the sign of either of the prototype climate feedbacks in the two-zone models and the sign of these models feedback as defined in control theory. These results point to the need for greater precision and explicitness in the definition and use of the term climate feedback, both to facilitate interdisciplinary dialogue in relation to feedback and to guard against erroneous inferences within the climate field. Explicit definitions of the two prototype categories of climate feedback studied here are proposed. Reference Bates, J. R. 2007. Some considerations of the concept of climate feedback. Quart. J. Roy. Met. Soc. , 133 (in press).

Keywords: stability, sensitivity, feedbacks

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MS017 **Oral Presentation** **5592**

Clear-sky radiative feedbacks in NCAR'S community atmospheric model

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Climate model s differ in the ir responses to impo sed for cings, such as increased greenhouse gas concentrations, due to different modeled climate feedback strengths. Using the method of Soden et al., 2007, we sep arate the clim ate feedbacks in NCAR's Co mmunity Atmospheric Model (CAM) into two components: the chang e in climate components in respo nse to an imp osed forcing and the radiativ e kernel, the effects that climate changes ha ve on the radi ative budget at the top -of-the-atmosphere (TOA). The usefulness o f thi s technique de pends o n the l inearity of the feedback processes. For the case of a dou bling of carbon dioxide, the sum of th e effects of individual clear-sky components (water vapor, temperature, and s urface albedo) on the TOA clear-sky change is simila r to the clear-sky flux changes directly calculated by CAM. When monthly averages are used rather than val ues from every time step, the global average TOA shortwav e change is underestimated by about a quarter as a result of intra-month correlations of surface albedo with the radiative kernel. Outside of these regions, though, the zonal average errors in TOA shortwave fluxes calculated using the kernel technique are a few tenths of a W/m/m. The TOA outgoing longwave flux changes do not depend on the averaging period, and the zonal-average clear-sky longwave flux calculations are within about 10% of the model-calculated values, while the global average differs by only 2%. We also examine the contribution of clear -sky components to the change in cloud radiative forcing (CRF), which is often used as a measure o f cloud feedback strength. Changes in these clear-sky variables make the change in shortwave cloud ra diative forcing more negative. The positive contribution of the wa ter vapor feedback partially cancels the negative contribution of the albedo fee dback. Longwave feedbacks also make the c hange in CRF more negative, with atmospheric temperature, water vapor, and arbo n dioxide all pr oviding negative c ontributions and surface temperature providing a positive contribution . The net effect of the clear-sky feedbacks on the change in CRF is -1.6 W/m/m, based on the kernel technique, while the total change in CRF from CAM is -1.3 W/m/m, indicating that clear-sky feedbacks contribute significantly to the CRF change and m ake it more negative. Assuming linearity of the CRF contributions, these re sults indicate that the net cloud feedback in CAM is positive.

Keywords: climate models, radiative transfer, clear sky feedbacks

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MS017 **Oral Presentation** **5593**

Climate feedback processes and their role in climate sensitivity: what progress since the TAR ?

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Climate sensitivity, commonly defined as the global mean surface temperature change caused by a doubling of atmospheric carbon dioxide, plays a central role in climate change studies. The range of climate sensitivity estimates from general circulation models remains large. This range stems primarily from intermodel differences in the treatment of climate feedbacks associated with the response of clouds, water vapor, lapse rate, snow and sea-ice. We will review the progress that there has been since the Third Assessment Report (TAR) of the IPCC in the interpretation of intermodel differences in climate feedbacks (the focus will be on climate models that have participated in the Fourth Assessment Report of the IPCC), and in the understanding of some physical climate feedback processes. Then we will show how observations of the current climate might be used to evaluate some components of these feedbacks. Finally, we will highlight some remaining questions, and will present projects or initiatives aiming at improving our understanding and our assessment of climate change feedback processes based on models and on observations.

Keywords: feedbacks, gcms, clouds

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MS017 **Oral Presentation** **5594**

Limits on climate sensitivity derived from satellite and surface observation

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The climate sensitivity parameter, lambda, that rela tes the top of the at mosphere radiative forcing to changes of the global air surf ace temperature, is de rived f rom analysis o f satellite obse rvation of the aerosol optical depth, changes in carbon dioxide concentration and the increase in global surface air temperature. Considering the time period from 2000 to 2006, when b oth decreasing aerosol optical depth and inc reasing carbon dioxide con centration are causing warming, we deduce the climate sensitivity to be lambda = 0.4 plus or minus 0.1 K/Wm-2. This corresponds to warming of about 1.6 plus or minus 0.4 deg C due to doubling of carbon dioxide from its pre-industrial level.

Keywords: climate, aerosols, co2

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MS017 **Oral Presentation** **5595**

Is water vapor and its feedback sensitive to cloud microphysics?

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It is shows using MLS a nd GPS water vapor data that the probability density of relative humidity in the free troposphere obeys an extremely simple scaling law. This law can be derived purely on the basis of an equally si mple advection- condensation mo del in whi ch cloud micr ophysical details play no rol e. Furthermore, a suite of experiments with successively more sophisticated models, culminating in runs of the CAM3 general circulation model, dem onstrate that microphysical sensitivity of rela tive humidity is significantly exaggerated by climate models that lack the degree of convective organization found in the real world. On the other hand, at least in pri nciple, subtle changes to dynamics can drastically alter the radiative impact of water vapor. Thus it is concluded that dynamical rather than microphysical issues are paramount in any remaining uncertainty co ncerning the behavior of water vapor in past and futur e climates.

Keywords: water vapor, feedbacks, cloud microphysics

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

MS017 **Oral Presentation** **5596**

Climate Sensitivity and Radiative Feedbacks in Simulations with Anthropogenic and Natural Forcings

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Masakazu Yoshimori

We examine the equilibrium response of an atmosphere-slab ocean model to a variety of natural and anthropogenic radiative forcing agents, including carbon dioxide, solar irradiance, tropospheric ozone, black carbon, organic carbon, and sulfate aerosols. Each of these forcing agents was applied individually. The experiments were designed such that the global mean radiative forcing from each radiative forcing agent has approximately the same magnitude. The climate sensitivity, defined as the ratio of the change in global mean surface air temperature to the radiative forcing at the tropopause, varies from 0.46-0.79 K W-1 m2 in these experiments. The sensitivity is largest for forcing by carbon dioxide and smallest for forcing by black carbon. Analysis of the radiative feedbacks in these experiments using the partial radiative perturbation method indicates that differences in cloud, water vapor, and lapse rate feedback all contribute to the differences in climate sensitivity.

Keywords: feedbacks, sensitivity, climate

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

MS017 **Oral Presentation** **5597**

Probabilistic estimates of climate sensitivity: where do we stand and where are we going?

Prof. Reto Knutti

Climate sensitivity, the equilibrium global average surface warming for a doubling of atmospheric carbon dioxide, might be the single most important number to quantify long-term climate change in response to anthropogenic greenhouse gas emissions. The range of climate sensitivity has been notoriously difficult to narrow down for more than twenty years. An attempt is made first to assess the large number of studies that have recently come up with constraints on climate sensitivity using the observed warming over the last century, climatological mean patterns, the Earths radiative imbalance, the temperature response to volcanic eruptions, temperature variations over the last 700 years, and proxy data of the last glacial maximum, or combinations thereof. There is increasing agreement for a best guess value of climate sensitivity of about three degrees Celsius. The lower bound of the range is well constrained, and provides a minimum estimate of climate change we have to adapt to if atmospheric greenhouse gas concentrations are stabilized at levels above preindustrial. The upper bound is more difficult to constrain, because observable quantities scale nonlinearly with climate sensitivity. More recent proposals that the combined constraint from several independent lines of evidence provides a tighter upper bound on climate sensitivity, new results from the climateprediction.net ensemble and remaining open questions are discussed in a second part.

Keywords: climate, sensitivity

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MS017 **Oral Presentation** **5598**

A climate sensitivity test using a global cloud resolving model NICAM.

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Yoko Tsushima, Hirofumi Tomita, Tomoe Nasuno, Hiroaki Miura, Akira Noda, Masaki Satoh

Conventional climate models exhibit a large range of sensitivities in response to increased greenhouse gases. One major factor of the variety of response is the cloud parameterization, which represents effects of sub-grid scale cloud convections. The cloud parameterization is widely known as one of the most uncertain components in AGCMs, because its formulation is based on an idealized statistical assumption. In order to avoid this ambiguity by resolving cumulus convection, we have been developing a global cloud resolving model (GCRM), named NICAM (Non hydrostatic ICosahedral Atmospheric Model). Using NICAM, we can calculate effectively super-high resolution simulations and treat the multi-scale and multi-physical interactions explicitly. We are now performing cloud resolving simulations under a condition proposed in CFMIP: perpetual July circumstances with two types of SST (July climatology and July climatology + 2K). At the meeting, focusing on the radiation budget, we talk about preliminary results such as how OLR and OSR are changed at the global warming. We found that the cloud-feedback in GCRM has different sense from those in conventional GCMs.

Keywords: cloud, feedback, nicam

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

MS017 **Oral Presentation** **5599**

Distinguishing forcing from feedback

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Tim Andrews

Energy balance analysis diagnostics and have been used on the data in the IPCC model data archive to help understa nd ho w carbo n dio xide radiative fo rcing gets translated into climate re sponse. These results suggest that there app ears to be a significant initial cloud response to the radiative forcing that can be thought of as a CO2 semi direct effect. Thes e analyses further suggest that much of the models' cloud feedback could be associated with such effect s, and the actual cloud feedback ex hibited by the models are generally rather weaker than expected.

Keywords: feedback, forcing, radiation

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

MS017 **Oral Presentation** **5600**

Estimating climate system properties from historical climate observations: progress and challenges

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Bruno Sanso, Andrei P. Sokolov, Peter H. Stone, Daniel Zantedeschi

Two major challenges in estimating climate system properties (e.g., climate sensitivity and rate of deep-ocean heat uptake) from climate observations are: (a) the uncertainty in the historical climate forcings and climate observations, and (b) the uncertainty in the unforced variability of the climate system. Each of these poses a major challenge due to both the limited data available from either observations or climate model output and the required accuracy for robust estimates of uncertainty from the statistical algorithms. In general, this is an underlying theme of this work. To address these issues, we have implemented a new algorithm based on Bayesian methods to estimate the probability density functions (PDFs) for climates system properties. This method is very similar to model calibration algorithms described in the statistics literature although here we use multi-variate patterns rather than scalar diagnostics. This method uses Markov Chain-Monte Carlo (MCMC) techniques to sample from the uncertain distributions for variables in the calibration algorithm. For example, the covariance matrices representing unforced variability are estimated from atmosphere-ocean general circulation models (AOGCMs) and thus, have uncertainty and must be treated as a stochastic variable. Likewise, the climate system properties are treated as a stochastic variable in the MCMC method as well. The present study has two major advances. First, we now include an uncertain distribution for the covariance matrices representing unforced variability while previous work used fixed estimates. Second, we estimate the parameter distributions for all variables simultaneously rather than treating each separately. We will also present new results obtained using updates to the climate change diagnostics used in the estimation. Specifically, we include the transient changes in sea-ice area for the recent 30 years as an additional diagnostic. Also, we explore the dependence of the posterior PDFs on the spatio-temporal patterns of climate change. We explore the use of long-term trends vs. changes in decadal means as well as using global averages vs. higher resolution spatial averaging. Each of these changes in spatio-temporal pattern will be discussed. In short, the major advances include: (1) Updates on unforced variability sampling via MCMC methods. (1a) Limits to information content from AOGCMs. (1b) Sensitivity to estimates from multiple AOGCMs. (2) Effect of updating climate observations to present-day (2a) Sensitivity to record length and spatial or temporal diagnostics (2b) Additional diagnostic using changes in sea-ice area.

Keywords: climate sensitivity, estimation, bayesian

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MS017 **Oral Presentation** **5601**

Detection and Assessment of the Dehydration-Greenhouse Feedback in the Arctic: A Status Review for the IPY

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Ric Girard, Colin Jones, Rodrigo Munoz-Alpizar, Patrick Grenier

The Arctic is one of the most sensitive region for climate change due to greenhouse gases. The rapid warming, mainly in the sub-Arctic, the retreat of sea ice and the extension of boreal forests at the southern edge confirm the general predicted warming trend. However, all climate models predict maximum warming during the cold season while many observations and analysis show broad regions with marked cooling trends in that season over recent decades. Clearly, other processes are also active in the Arctic, to the point of reversing the otherwise warming trend on regional and seasonal scales. As part of the International Polar Year activities, our research focuses on a feedback between aerosols, ice clouds, precipitation, radiation and atmospheric circulation likely to modulate profoundly the Arctic climate trend by reversing, at times, the water vapour greenhouse forcing, resulting in cold anomalies, retarding the potential Arctic warming and, very likely, influencing the winter storm activities in the mid-latitudes. In the research to investigate this process, called the dehydration-greenhouse feedback (DGF), we have to rely heavily on new satellites with active (CloudSat and CALIPSO) and passive instruments (AQUA), ground measurements (PEARL and ARM sites) together with sophisticated climate-circulation models accounting for aerosols and clouds in sufficient details. This presentation will summarise our research findings in this area, their climate implications and the strategy followed through the ongoing International Polar Year.

Keywords: arctic, climate, aerosol

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MS017 **Oral Presentation** **5602**

An Assessment of Climate Feedbacks in IPCC AR4 Models

Dr. Brian Soden
Meteorology RSMASMPO IAMAS

We compare the climate feedbacks in coupled ocean-atmosphere models using a coordinated set of 21st century climate change experiments. Water vapor is found to provide the largest positive feedback in all models and its strength is consistent with that expected from constant relative humidity changes in water vapor mixing ratio. The feedbacks from clouds and surface albedo are also found to be positive in all models, while the only stabilizing (negative) feedback comes from the temperature response. Large intermodel differences in the lapse-rate feedback are observed and shown to be associated with differing regional patterns of surface warming. Consistent with previous studies, we find the vertical changes in temperature and water vapor to be tightly coupled in all models and, importantly, demonstrate that intermodel differences in the sum of lapse-rate and water vapor feedbacks are small. In contrast, intermodel differences in cloud feedback are found to provide the largest source of uncertainty in current predictions of climate sensitivity. Although a surprising result is that cloud feedback is found to be positive in all models.

Keywords: climate

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MS017 **Oral Presentation** **5603**

A novel physically-based model for the water vapour feedback on climate change, with application to GCM diagnosis

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For 40 years it has been known that if, as expected, the distribution of relative humidity (RH) stays roughly the same as climate changes, then climate is more sensitive than it would be if instead the distribution of specific humidity (SH) were maintained. Since water vapour is the most important greenhouse gas in our atmosphere, and unchanging RH implies SH increasing rapidly with temperature, an effect in that direction must be expected. In fact, detailed calculations agree that about half the basic restoring "force" on climate from the increase in black-body radiation with temperature is cancelled by this "water vapour feedback", so doubling climate sensitivity. But this has been purely an "emergent constraint" - there has been no physical explanation why it should not cancel say 10%, or 90%, of the black-body term, which would give 10% or 900% increases in sensitivity. Also, conventional attempts to break down the thermal radiative response of GCMs into "lapse rate" and "water vapour" terms find so much cancellation between variation in these 2 terms that they provide no useful basis for understanding variation in climate sensitivity between GCMs. A very simple approximation - that as climate warms the component of OLR that is radiated by water vapour remains unchanged, while the rest increases like a black body - can be shown to be formally zeroth-order in a "small" parameter generally of size 1/10 to 1/4 in the troposphere away from inversions. This finally provides a physical explanation for the approximate size of the water vapour feedback - around half of OLR is emitted by water vapour. It also suggests a different way of breaking down the thermal radiative response of GCMs into components, which though more complex and perhaps less intuitive than the conventional method, does not suffer from such cancellations, and so has potential for understanding variation between GCMs in this important component of climate sensitivity.

Keywords: water vapour, gcm diagnosis, lapse rate

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

MS017 **Oral Presentation** **5604**

Distinguishing data from opinions on climate sensitivity

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David Frame, David Stainfort

Since Andronova and Schlesinger (2001), studies attempting to estimate a distribution of possible values of climate sensitivity can all be cast in the same generic form. Parameters are varied in a simple, intermediate-complexity or (more recently) full-complexity climate model, simulations are compared with observations in order to arrive at some measure of their relative likelihood, and a distribution for climate sensitivity is derived from the weighted distribution of the sensitivities of the individual models. The problem with this approach, as noted by Frame et al (2005), is that results are acutely sensitive to arbitrary decisions about how parameters are sampled in the experimental design. Frame et al proposedan approachto this problem that makes clear the relative roles of data constraints and prior opinion in a situation in which a single parameter dominates how sensitivity varies, along with the likelihood of the fit to the data, across the ensemble of models. While it will generally be possible in principle to generate a "super-parameter" of this nature through a comprehensive mapping of parameter-dependencies in the model, this may not be feasible in practice.Amore practical approach, equivalent to that of Frame et al in the single-relevant-parameter situation, is to map the relative likelihood of the most likely model as a function of the forecast variable of interest, which in this case is climate sensitivity. We will demonstrate this approach applied to simulations of recent transient climate change with a very simple climate model and applied to simulations of current climatology performed by the climatepredictionnet experiment. A further concern about climate sensitivity is the possibility that atmospheric feedbacks in a system undergoing transient climate change (either a secular trend, volcanic pulse or seasonal cycle) may be different from those that operate in a system that has regained equilibrium. This point is illustrated by the wide disparity in "effective climate sensitivities" (estimated from 1%/year increasing CO2 experiments) and "equilibrium climate sensitivities" (estimated, in general, from slab experiments) reported in the recent IPCC Fourth Assessment. We will show how such an effect can be incorporated into simple climate models, and the impact it has on our ability to constrain the long-term response to 550ppm stabilisation even if we can constrain the climate sensitivity that is effective today.

Keywords: climate sensitivity

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MS017 **Oral Presentation** **5605**

Cloud feedbacks and climate sensitivity in Hadley Centre climate models

Dr. Mark Ringer
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I will present an overview of the impact of model developments on the evolution of feedbacks and climate sensitivity in our models over the last decade or so, discuss new analysis methods and uses of satellite data, and finish with summary of our most recent work in this area.

Keywords: clouds, uncertainty, feedbacks

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MS017 **Poster presentation** **5606**

A new current warming trend estimation using wavelets

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Using a direct and inverse wavelet transform of the global and hemispheric mean as well as the interhemispheric difference time series of the near surface air temperature we demonstrate that the current climate change consists of a mix of a linear warming trend and a multidecadal oscillation. The trend is exactly the same for both hemispheres, and its increment is equal to 0.2oC/100 years only. This value is in discrepancy to the widely accepted value of about 0.4 0.6oC /100 year. The reason of this discrepancy is that a multidecadal temperature oscillation with the amplitude of about 0.2oC and a phase of such a value that this oscillation contribute appears to contribute to the current warming trend. In particular, a superposition of this oscillation maximum with the above linear warming trend seems to be the reason of the current warming peak during 1990s. It must be noted the maxima of this oscillation coincide well with some prominent events of the current climate dynamics such as the strongest El Ninos of 1941 and 1997, maxima of NAO, minima in the Sahel-precipitation, and strong changes in the Caspian sea level variations. Taking into consideration the current phase of the oscillation, we speculate that the global climate system has entered the stage of relative cooling. This stage can last two or three decades, similar to the preceding cooling stage during the 1940-1960s. This relative cooling stage is characterized by the mean temperature of the Southern Hemisphere higher as compared with the mean temperature of the Northern Hemisphere, prevalence of La Nino over El Nino, negative NAO, and high humidity in the Sahel zone. The Caspian sea level should be stabilized at its present-day level.

Keywords: current warming trend, multiscale climate variations, wavelet analysis

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MS017 **Poster presentation** **5607**

Constraining the range of climate sensitivity through the diagnosis of cloud regimes

Dr. Mark Ringer
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Keith Williams, George Tselioudis

The radiative feedback from clouds remains the largest source of variation in climate sensitivity between general circulation models (GCMs). This study aims to understand and evaluate the climate change response in an ensemble of structurally varying GCMs in the context of cloud regimes. It is found that the present-day characteristics of the cloud regimes contribute to the spread of the climate change response. By evaluating the simulated regimes against observational data, the variance of the global cloud radiative response, and hence the range of climate sensitivity, can be reduced. The method provides an observational metric with which to assess a climate model, which is demonstrated to be relevant for the model climate sensitivity.

Keywords: clouds, uncertainty, feedbacks

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MS017 **Poster presentation** **5608**

Responses of the Atmosphere to Ozone Changes

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While th e imp act of CO2 a nd oth er well kn own green house gases (GHGs) on c limate an d oz one evolution has been studied extensively in the past, th e response of the atmosphere to ozone changes is still a subject of much debate. Observational studie s have showed that t he climate has warmed over much o f the s outhern hemis phere in the p ast few decades, the role the oz one changes in both the troposphere and stratosphere plays in this warming trend is no t well understo od yet. Using a gener al circulation model (CAM3), a series o f the time- slice climate runs ha ve b een perfo rmed to investigate potential responses of the climate to ozone changes. The runs have been done with diff erent scenarios of oz one ch ange an d th e stratosph ere an d troposph ere interaction associated wi th su bscribed oz one change in both the troposphere and the stratopshere is analysed.

Keywords: ozone, stratosphere

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

MS017 **Poster presentation** **5609**

A study of the factors affecting air pollution and the Impacts on the environment: Case study of Tehran

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Mohammad Soleimani, Mina Gelim Forosh

As a con sequence of air pollu tion, poor qu ality cl imate is a global issue that a dversely affect s ecosystems and, thus, human society and the environm ent at local, re gional and global levels. It is imperative, hence to probe into the factors that influence this pro cess so as to co me up with scientificbased applied appr oaches or solutions n eeded to deal with the issue. This article is, accordingly, an attempt to study climatic an d weather conditions of Tehr an, capital of, as the selected area for this study. To do this, research analyses s ections have bee n dealt with: - Geographical structure and the environmental characteristics of the selected area. - The factors affecting air pollution. - The impacts of air pollution on the en vironment. - Conclusions a nd applied solutions to the environmental problems. - Recommendations

Keywords: environment, development, airpollution

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MS017 **Poster presentation** **5610**

Global Warming Diagnosis based on the Atmospheric Energy Conversion Diagram

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Yasushi Mochizuki, Chihiro Kodama

Impacts of global warming on the atmospheric en ergetics are studied by means o f the three-box cascade type of energy conversion diagram. Th e diagram is newly d eveloped for diagnosing the atmospheric general circulation based on wave-mean flow interactions and Lagrangian-mean meridional circulation. In contrast with the four-box energy cycle by Lorenz (1955), the m ass-weighted isentropic zonal means lead to a three-box cascade ty pe of energy conversion diagram composed of zonal mean available potential energy, PZ, zonal mean kineti c ene rgy, KZ and wave energy W. The energy conversion diagram is characterized by the only two dynamic conversion terms, C(PZ, KZ) and C(KZ,W). A diagnosis is made of the output of T42L45 atmospheric GCM (MRI/JMA-GCM). The atmospheric GCM is run with the prescribed SST and CO2 for 30 years. The global warming slightly decreases both energy conversion rates . As a result, PZ and KZ are increased but wave energy is decreased. The reduction of C(PZ, KZ) is due mainly to the suppression of mean- meridional cir culation in the extratropi cal troposphere, while th at of C(KZ, W) is due to the suppression of the Eliassen-Pa lm flux in the extratropics. Particularly in the boreal winter, the dynamic wave energy generation rates are increased for transient waves but decreased for stationary waves. References Iwasaki, 2001, JAS., 58, 3036-3052. Uno and Iwasaki, 2006, JAS., 63, 32773295.

Keywords: energetics, stationary wave, wave mean flow interaction

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MS017 **Poster presentation** **5611**

Observational Constraints on Climate Sensitivity from climateprediction.net

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Reto Knutti, William Ingram, Daithi Stone, Myles Allen, Claudio Piani

A very large ensemble of climate model simulations with perturbed atmospheric parameters has recently been performed under the distributed computing project climateprediction.net. The ensemble contains a significant number of simulations with a very high Climate Sensitivity. We seek to determine the comparative ability of different observations to constrain Sensitivity within the ensemble, by searching for models optimally close to observational fields.We use a neural network, a smoothed non-linear fitting procedure, trained to emulate model output from a set of model parameters. After training, the performance of a model version with specific parameters can therefore be estimated without actually running the simulation. The emulator is then used to propose an optimized ensemble of climate models which span a large range of climate sensitivity while remaining optimally close to observational datasets. The constraints on model response imposed by various observational fields are compared and used to produce separate estimates of real-world Climate Sensitivity. We investigate also how these constraints change when different observational fields are used in parallel. This proposed second generation ensemble of best performing models may be used in a new set of distributed experiments.

Keywords: climate sensitivity, constraints, neural network

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MS017 **Poster presentation** **5612**

Climate change in temperature anomaly fields

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Hisanori Itoh, Seiji Yukimoto

There have been many studies about climate change in time-mean fields. However, this describes only a part of climate change. Anomalies from time-mean fields (anomaly fields) also change, but they have hardly been studied. Climate change can be grasped in perspective by taking account of both time-mean fields and anomaly fields. Thus, this study considers climate change in anomaly fields. In particular, that associated with global warming is examined. Data are two climate change experiments (historical experiment: 1851~2000, SRES experiment: 1990~2100) performed by Meteorological Research Institute in Japan. They are monthly data (north of 20N) and ensembles of 3 members. Since the initial value in each ensemble of the SRES experiment is the value in 1990 in each ensemble of the historical experiment, these two experiments are combined in 1990. Thus, we can get 250 year data (1851~2100). The data are analyzed every season and ensemble. Anomalies are defined as deviations from trends and averaged for each season. Time variations in anomalies are expressed as time series of the root mean square (RMS) for 30 years. As to the anomaly of surface temperature, the RMS averaged in the high latitude (50N~90N) has negative trends in winter and especially autumn after the latter half of the 20th century. Since global warming appears clearly since 1960s in the historical experiment, this suggests the possibility that the negative trend and global warming are related. On the other hand, there are no long-term changes of the RMS in spring and summer. In addition, the RMS averaged in low latitude (20N~50N) also has no trends. Thus, we examined the process of decreasing temperature anomaly in the high latitude in autumn. Before global warming, temperature in the Arctic region is so low that the north-south difference in temperature is large. However, since global warming is stronger in the Arctic than in the mid-latitude, the north-south difference decreases. In addition, the east-west difference in temperature also decreases. That is, the temperature gradient in any directions is reduced. As a result, the exchange of cold and warm air weakens, therefore anomalies of temperature becomes small in the high latitude in autumn. In contrast to the general decrease of temperature anomaly in the high latitude, there are some regions where it increases locally even in high latitude. The reason may be that the temperature gradient there becomes large locally and the interannual variability of the sea ice increases there.

Keywords: global warming, anomaly, sea ice

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MS017 **Poster presentation** **5613**

Significance of the Arctic and Northern Hemisphere Air Surface Temperature Trends

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An analysis of observational records shows that the global surface air temperature (SAT) has increased by approximately 0.7oC for 100 years. During that period, the late 90s and 2000s were the warmest decade in the Northern Hemisphere. This warming is concurrent with variations of land- surface precipitation, a decrease in snow cover and sea-ice extent, sea level rise, and changes in the atmospheric and oceanic circulation patterns.Trends (especially linear trends) are frequently used as an indicator of climate change and variability. However, it is important to recognize that identification of long-term trends is complicated by strong low-frequency variability. In particular, the low-frequency variability in various climatically important parameters is evident in many instrumental and proxy records from the Northern Hemisphere and the Arctic. Because of this strong low-frequency variability, the climatic time series have a high level of serial correlation and tests of statistical significance of computed trends may be complicated substantially. For example, the sample correlation in the mean Northern Hemispheric SAT time series is 0.79 and 0.70 using one-year and two-year time lags, respectively. Traditional trend analysis approaches usually do not take into account this intrinsic serial correlation, and postulate the hypothesis of identically distributed independent random variables. Thus, they may lead to false conclusions, and special caution should be exercised interpreting these estimates by employing special methods of statistical trend analysis.Various statistical estimates like means, standard deviations, correlations, trends etc. may be described in terms of discrete approximations of generalized stochastic integrals (i.e. an integral of a product of a random function and a weight function).This approach has been broadly accepted and used for estimates of variance of statistical sample means (von Storch and Zwiers, 1999). However, the application of this equation to estimates of variance of trends seems to be questionable due to non-unit weight function. We propose a theoretical approach which allows calculations of variance of trends using an arbitrary weight function. This practicable algorithm has been used for estimates of statistical significance of climatic trends. Another important problem is connected to the random nature of the estimated sample variance. It meansan overestimation of statistical significance of observed trends. We suggest a special Student-type statistics for avoiding of that problem. The third and most complicated problem arises from the sufficient correlation of sample trend and sample trend variance. We have explored some ways for avoiding of that correlation.Using the suggestion about the Gaussian random distribution of the air surface temperature we have constructed the density distribution function of the coefficients of linear and parabolic regression. We have analysed some climatic air surface temperature time series. For the Arctic and Northern Hemisphere air surface temperature trends from 1900 to 2006 we have found that null hypothesis should be rejected at the 2 - 5% significance level. In the same time the trend significance level estimated on the base of routine procedure is less then 0.1%. Results of provided analysis support theanthropogenic induced global warming concept.

Keywords: climate, change, trends

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MS017 **Poster presentation** **5614**

Climate and hydrological sensitivity of specific economic sectors

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Silvia Kloster

Specific economic sectors or source regions emit a wide variety of air pollutants which influence climate and air quality. This includes emissions of greenhouse gases, chemical species which affect the oxidation capacity of the atmosphere and the concentrations of ozone and methane, and aerosol particles or aerosol precursors. Regional climate respectively weather controls transport and removal of pollutants, chemical transformation pathways, particle formation rate and sink processes as well as emissions from natural sources. Interactions between aerosols and trace gases modify their global and regional distributions. Thus, climatic and environmental impacts are not only controlled by amount and chemical composition of pollutant emissions but in addition also by their interactions, the local meteorological conditions in the source region and the feedbacks between the components of the climate system. For the development of mitigation strategies to minimize adverse conditions attributed to climate change and air pollution we need a better understanding of the role of source location, impact of interactions and feedbacks and of the influence of climate change on the chemical composition of the atmosphere. To demonstrate interactions and feedbacks between the cycles of gaseous and particulate atmospheric constituents, the water cycle, the biosphere and the changing climate we will present results of climate equilibrium simulations performed with the MPI Hamburg Earth system model and will discuss the question whether anthropogenic emissions from different source types and regions result in different climate and hydrological sensitivities.

Keywords: earth system modeling, climate sensitivity, hydrological sensitivity

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

MS018 **5615 - 5640**

Symposium
The Role of the Stratosphere in the Climate System (ICMA, IRC, ICCL)

Convener : Prof. Marvin Geller

Stratospheric processes play a significant role in the Earth's climate. The absorption of solar radiation in the stratosphere by ozone modulates the solar fo rcing of climate . The concentrations of some stratospheric gases, principally oz one, carbon dioxide and water vapo r, determine signif icant radiative forcing terms, and there is t wo-way interaction betw een stratospheric and tropospheric dynamics. This session will dis cuss observations, theories and models of the role of the stratosphere in the climat e changes that have been observed over the past several decades and those anticipated in the next century

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MS018 **Oral Presentation** **5615**

PArameter sweep experiments on remote influences of QBO and solar cycle in a stratosphere-troposphere coupled model

Prof. Shigeo Yoden
Department of Geophysics Kyoto University IAMAS

Kosuke Ito, Yoko Naito

The quasi-biennial oscillation (QBO) of the zonal mean zonal wind in the equatorial stratosphere affects global circulation mainly through the modulation of the propagation route of planetary waves. It has been shown that the stratospheric polar vortex is weaker, warmer, and more disturbed during winters in the easterly phase of the QBO (Holton and Tan 1980, 1982). The weaker polar vortex in the easterly phase is associated with a larger upward wave-activity flux in planetary scales from the troposphere to the stratosphere (Dunkerton and Baldwin 1991). An apparent signal of 11-year solar cycle can be identified in the interannual variations of the global-scale circulations, if the data are stratified according to the phase of the QBO (Labitzke, 1987; Labitzke and van Loon, 1988). The 11-year modulations of the temperature, wind, and ozone in the upper stratosphere are significant and attributable to a large variation (about 6-8%) of the solar UV radiation between solar maxima and minima. However, the dynamical mechanism that propagates such changes in the upper stratosphere down to the lower stratosphere and the troposphere is not well understood yet. Stratospheric sudden warming (SSW) is a major event to produce the interannual variations of winter stratospheric circulation in the Northern Hemisphere and also an important candidate to cause the vertical linkage between the upper stratosphere and the lower parts. We have performed numerical experiments on the effects of the equatorial QBO on SSWs with a simple global circulation model (Naito, et al., 2003; Naito and Yoden, 2006). Naito and Yoden (2006) obtained almost one thousand SSW events by long time integrations, and made a statistical analysis based on a large number of samples. An idealized zonal momentum forcing to mimic a phase of the QBO was imposed under a perpetual winter condition, and eight phases of the QBO-wind forcing were examined for each 10,800-day dataset. Some systematic dependence on the phase of the QBO-wind forcing is seen in the anomaly of the EliassenPalm (EP) flux in the composites for SSW events. Before SSW events, the upward EP flux in the troposphere and midlatitude lower stratosphere as well as the equatorward flux above the tropopause is larger in the westerly forcing runs than in the easterly forcing runs. After SSW events, the upward EP flux in the troposphere is still larger in the westerly forcing runs. Temperature anomalies around the stratopause that mimic the 11-year modulations are introduced in another series of numerical experiments. Some statistically significant relationship of the occurrence frequency of SSWs is obtained for the combination of the equatorial QBO and the stratopause temperature variations. Similarity to the observed relationship is discussed and possible explanation of the relationship will be given by the dynamics of planetary waves.

Keywords: qbo, solar cycle, ssw

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MS018 **Oral Presentation** **5616**

Wintervariability in the Stratosphere: Coupling between the Arctic and the Tropics

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Large effects of solar variability related to the 11-year sunspot cycle (SSC) are seen in the stratosphere, especially over the Arctic, but only if the data are grouped according to the phase of the QBO. New results based on an extended 65 year long data set fully confirm earlier findings and suggest a significant effect of the SSC on the occurrence of the Major Midwinter Warmings (MMWs) as well as on the strength of the stratospheric polar vortex and on the mean meridional circulation. By means of teleconnections the dynamical interaction between the Arctic and the Tropics in the stratosphere and in the troposphere is shown for the whole data set and compared with the anomalies of single events. The results suggest strongly that during the northern winter the teleconnections between the Arctic and the Tropics were determined by the MMWs and the COLD winters, respectively. These events in the stratosphere depend, however, on the 11-year SSC and on the QBO.

Keywords: teleconnections, sunspot cycle, qbo

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

MS018 **Oral Presentation** **5617**

Anthropogenic and natural influences in the evolution of the stratospheric temperatures

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M. D. Schwarzkopf

We will discuss the observed variations and changes in the climate of the stratosphere, as gathered from radiosonde and satellite observations. These observations reveal that stratospheric temperature trends have been substantial, with a pronounced cooling that, however, is not monotonic with time. In the global-mean, the magnitude of this cooling over the past 25 years exceeds the magnitude of warming that has occurred at the surface over the past century. We use the GFDL atmosphere-ocean coupled climate model, and knowledge of the known changes in atmospheric composition, to investigate the stratospheric impacts due to the different natural and anthropogenic forcing factors. Using an ensemble of model runs, we present an explanation of the observed global-mean evolution of the lower stratospheric temperature in terms of the forcing factors and unforced variations. Model simulations also reveal that a significant cooling of the global-mean middle stratosphere (~20-30 km) occurred by the first quarter of the 20th century, with the decline being mainly due to the human-influenced increases in the long-lived gases, chiefly carbon dioxide. Thus, the human impact on the climate of the stratosphere potentially occurred well before systematic instrumental observations were in place, and before carbon dioxide values had increased by less than 20% over pre-industrial values. Implications for the 21st century, particularly in the context of a possible ozone recovery over the next several decades but with continued increases in long-lived greenhouse gases, will also be presented.

Keywords: stratosphere, temperature, anthropogenic

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MS018 **Oral Presentation** **5618**

Role of the stratospheric process in the NH winter circulation trends

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Masatake Hori, Seiji Yukimoto, Michael Sigmond

Recent winter warming of the NH is attrib uted to increasing trends of the North Atlantic Oscillation (NAO) or th e Arctic Oscil lation (AO). Wh ether in creasing trends are due to a natur al variability or a greenhouse gas effect is under debate. Trend pattern in the NH winter are largely different according to the solar activity: trends in th e sea level pressure (SLP) during high so lar (HS) activity exhibit NAO/AO-like pattern connected to a s tronger stratos pheric po lar vortex, whereas during low s olar (LS) activity decreasing trends in the SLP appear over the north-eastern Pacific in association with warming trends in the tropical tr oposphere. The ses two types of trends are well compared with a separate response t o increased concentration of CO2 in the troposphere and i n the middle atmosphere. The result of the present study suggests that the cooling effect of the m iddle atmosphere due to increased CO2 can penetrate into the troposphere, in particular during HS winters. Underestimation of simulated trends in the NAO/AO w ithout strengthening of the st ratospheric po lar vortex c ould arise from m odels deficiency of the dynamical sensitivity to the stratospheric CO2 increase.

Keywords: stratosphere, trend, global warming

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

MS018 **Oral Presentation** **5619**

Solar Influence on Stratosphere-Troposphere Dynamical Coupling.

Mrs. Isla Simpson
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Mike Blackburn, Joanna D. Haigh

There is increasing evidence that changing solar activity over the 11-year solar cycle influences the Earths climate. However, as yet the mechanisms involved remain uncertain. One of the main problems is that the observed tropospheric response appears to be too large to be entirely explained by changes in the direct radiative forcing of the troposphere due to changes in total solar irradiance. The temperature changes observed in the troposphere over the solar cycle are non-uniform and these are accompanied by variations in tropospheric circulation. A weakening and poleward shift of the mid-latitude jets along with a weakening and expansion of the Hadley cells and a polewards shift of the Ferrell cells is found at solar maximum compared to solar minimum. These circulation changes along with the non-uniform temperature changes points towards a dynamical response rather than simply altered direct radiative forcing. With the now widely accepted view that there is a two way dynamical coupling between the stratosphere and troposphere a possible explanation for these tropospheric temperature and circulation changes is through a dynamical response to stratospheric heating by increased UV absorption by stratospheric ozone. Previous modelling results have demonstrated that similar tropospheric circulation and temperature changes to those seen over the solar cycle can be produced by a dynamical response to increased heating of the stratosphere primarily in the equatorial region. We present spin-up ensemble experiments using a simplified general circulation model to further investigate the mechanisms by which altered stratospheric heating could produce such a response in the troposphere. Results suggest that changes in eddy propagation are important in transmitting the effect of altered stratospheric heating to the troposphere below. This is further emphasized by the much weaker tropospheric response found in a zonally symmetric experiment in which the stratospheric temperature is altered but eddy fluxes remain fixed.

Keywords: stratosphere troposphere, solar variability, gcm

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MS018 **Oral Presentation** **5620**

Causes of stratospheric temperature change - revisited

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This paper re visits attributi on of stratos pheric temperature change to various mechanisms. It concentrates on explaining details of the vertical structure of the change, and focuses, i n particular, on the tropical lower stratosphere where some disagreement between models and observations remain

Keywords: ozone, temperature, trends

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MS018 **Oral Presentation** **5621**

Influence of the stratosphere on surface winter climate

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Jeff R. Knight, Chris K. Folland

Modelling experiments and observational datasets are used to estimate the influence of stratospheric variability on surface climate in winter. Stratospheric changes appear to be important for the very rapid warming of Europe in winter between the 1960s and 1990s and associated changes in the frequency of climate extremes. The winter of 2005/6 is used as a case study to illustrate how this influence occurs in individual years.

Keywords: winter, nao, stratosphere

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MS018 **Oral Presentation** **5622**

Can an improved stratosphere significantly change IPCC 2007 type simulations?

Dr. Mauro Dall'Amico
Meteorology Walker Institute for Climate System Research IAMAS

Prof Lesley J Gray, Prof Keith Shine, Dr Peter Stott, Dr Adam Scaife

Simulations for the IPCC 2007 4th Assessment Report were run with the new 38-level coupled ocean/atmosphere Hadley Centre Global Environmental Model (HadGEM1). In common with many other climate models, the atmospheric component of HadGEM1 has only a few levels in the middle stratosphere and its lid is at about 5 hPa. The simulations also do not contain a quasi-biennial oscillation (QBO) of equatorial stratospheric zonal wind. Moreover, the imposed zonally averaged ozone trends were approximate, with a constant trend up to 1990 and a linear relationship between equivalent effective stratospheric chlorine and ozone changes after 1990. These "all forcings" runs (including observed greenhouse gas increases, plus representations of natural variations such as volcanic eruptions and the solar cycle) have been re-run for the period 1979-2003 with the following modifications in order to test the influence of an improved treatment of the stratosphere: relaxing the equatorial stratospheric zonal wind to the observed QBO; using observed monthly time series of stratospheric ozone so that QBO, solar cycle and volcanic signals in ozone are present. The extent to which such improvements of the modelled stratosphere affect the near-surface climate trend is studied.

Keywords: ipcc, qbo, ozone

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MS018 **Oral Presentation** **5623**

Modeling the Response of the Middle Atmosphere to Natural and Anthropogenic Forcing

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The middle atmosphere (10-100 km) responds sensitively to changes in external forcing, as evidenced by observations of ozone depletion, long-term cooling trends, and decadal variability associated with the solar cycle. Attribution of these responses to different forcing agents can be difficult due to the relatively short length of global observations of the middle atmosphere, so comprehensive numerical models are necessary to help interpret the observations and elucidate the forcing mechanisms. In this paper, we review recent results obtained with the Whole Atmosphere Community Climate Model (WACCM), a fully interactive chemistry-climate model. We show that WACCM reproduces well observed changes in the last 20 years, and we present predictions of the expected state of the middle atmosphere in the 21st century under different scenarios. We also explore the response of the middle atmosphere to variable solar inputs and to variability in tropical sea-surface temperatures.

Keywords: middleatmosphere, climate, solar

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MS018 **Oral Presentation** **5624**

Introduction to the session

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To set the co ntext for the session, I briefly discu ss so me early work that s uggested stratospheric influences on tropospheric climate. These include suggestions of Hines about changes in planetary wave propagation, by Ramanat han of stratospheric wa rming effects on the polar radiation budget, and Ramanathan, Boville, and others, whose work either suggested or strongly hinted how seemingly small influences on the stratosphere could propagate downwards and eventually affect tropospheric climate.

Keywords: climate, stratosphere

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MS018 **Poster presentation** **5625**

Quasi-decadal oscillations in the total ozone, lower stratosphere temperature, wind and solar activity

Dr. Konstantin Visheratin
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Statistical analyses have bee n performed for mont hly zonal average total ozone from T OMS Version 8 data set and for temperature and zonal wind at 20 - 100 mb from NCEP/DOE reanalysis over the period 19792005 for detection of long-term oscilla tions and tren ds. Linear trends for latitude bands over the range of 65_S65N were found negative tha t is duri ng last decades Earth's ozone layer depletion and stratospheric cooling were accompanied by weakening of the lower stratospheric western winds. To find phase and amplitudes of quasi-decadal (9-12 yr) oscillations the modified Fourier and maximum entropy (Burg) analyses has been used. The latitudi nal distribution of th e phase of quasi-decadal oscillations in ozone, temper ature and zonal wind were compared w ith the phase of ba sic solar quasi-decadal oscillations ob tained by the same methods. The research was supporte d by Russian Foundation for Basic Research (Grant 06-05-64157).

Keywords: total ozone temperature wind, quasi decadal oscillations, solar activiy

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MS018 **Poster presentation** **5626**

The impact of lower stratospheric heating on zonal mean flow regimes in the troposphere.

Dr. Sarah Sparrow
Physics Imperial College London IAMAS

Michael Blackburn, Joanna Haigh, Andrew Williams

Idealised-forcing experiments have been performed previously using a simplified global circulation model with a spectral dynamical core. In each of these experiments changes to the stratospheric equilibrium temperature distribution leads to changes in the strength and position of the tropospheric subtropical jets, extent of the Hadley cells and mean meridional circulation. The work presented here investigates how the dominant pattern of variability is affected by these idealised stratospheric temperature changes and speculates how solar heating of the lower stratosphere could influence tropospheric variability.

Keywords: solar heating, tropospheric variability, stratosphere

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MS018 **Poster presentation** **5627**

Total ozone data base (1950-2004) for the UV radiation reconstruction over Europe

Prof. Janusz KrzyśCin
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The variations of UV irradiance during last decades are of special interests because of various detrimental biological effects related to the excessive UV radiation reaching the ground-surface. The routine UV measurements over Europe have been initiated in the beginning of 1990s. Thus, UV radiation in the past or present (over sites where the measurements are not available) can be only obtained using UV reconstruction models running with the confident input data. One of the input parameters is the total column amount of ozone (total ozone). Total ozone has been measured by the ground-based stations (rather limited number of stations since early 1960s) and satellite instruments (giving whole globe coverage since October 1978). We present a statistical model providing the total ozone field over Europe (25 W-35E, 30N-80N) since January 1950 with 1 deg (latitude) x 1.25 deg (longitude) resolution. The model, elaborated within the COST action 726, has been validated by comparisons with the total ozone measurements taken in Arosa, Oxford, Uppsala, and Lerwick (the time series since early 1950s). The accuracy of modeled daily total ozone values is +/- 5% and the long-term variations of total ozone are perfectly reproduced. Examples of the reconstructed UV time series (since January 1950) using COST 726 Total Ozone and NCAR/NOAA Reanalyses-1 data base (cloud field) are shown.

Keywords: atmospheric ozone, surface uvb, statistical models

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MS018 **Poster presentation** **5628**

Variations of the ozone trend

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In the present study an extension of the ozone trend analysis (Borkowski J. L. Trend determination in ozone series, Proc.XX Quadrennial Ozone Symposium, Kos, Greece, 300-302, 2004) is presented. The ground-based total ozone data from six stations (Arosa, Belsk, Bismarck, Hohenpeissenberg, Hradec-Kralove, Sapporo) with the longest records of measurements are used in order to determine trend in ozone time series. The traditional procedure used for trend determination is multivariate regression in which it is supposed that ozone series are composed additively of a linear trend, and several components accounting for a number of sources of variations in the ozone content. This procedure leads to a trend which is constant for a given period of time, does not reveal the dynamics of the ozone variability over this period, and depends on the length of the period. To avoid these shortcomings in the present study the trend is considered as a time derivative of the smooth component of the ozone time series. The smooth component of the series is extracted with the use of wavelet multiresolution decomposition technique. The change of the negative trend into positive one in the middle of ninethies can be observed for all stations, however the positive trend weakened in the recent years and is even negative if shorter time scale is considered.

Keywords: total ozone, ozone trend

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

MS018 **Poster presentation** **5629**

Tropospheric Quasi-Stationnary Wave Response to Anomalous Stratospheric Circulation

Dr. Grigory Nikulin
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The NCEP/NCAR reanalysis is used to analyse relationships between the state of the stratosphere and the tropospheric quasi-stationary (QS) wave variability during the Northern Hemisphere winter. First, a cross-spectral analysis reveals that the zonal-mean eddy heat fluxes through the top of the troposphere and the strength of the polar vortex are significantly related with each other, at periods longer than 50-60 days, for which downward propagation of the Arctic oscillation occurs. Consistent with the picture that the eddy heat flux drives the zonal mean flow changes in the stratosphere the time series measuring the eddy heat flux at 50 mb and the time series measuring the strength of the vortex at low frequencies are in lead-lag quadrature. As a consequence, if we select periods during which there is a weak polarstratospheric vortex, they are preceded by significant positive heat flux anomalies and followed by significant negative heat flux anomalies. However, the subsequent heat flux anomalies in the troposphere are always larger in comparison with the preceding ones. This difference found in the troposphere is related to QS waves with zonal wavenumbers 1-3 suggesting a tropospheric QS wave response to the earlier state of thestratosphere.

Keywords: arctic oscillation, eddy heat flux, tropospheric response

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MS018 **Poster presentation** **5630**

Assessing ozone along the subtropical tropopause: A model sensitivity study

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N.R.P. Harries, M.M. Hurwitz, O. Morgenstern, J.A. Pyle, M. Streibel, J.G. Levine

Tropopause definitions are crucial for our understanding of exchange processes between troposphere and stratosphere and subsequently trace gas budgets. Tropopause levels can be defined using different thermal, dynamical or tracer quantities. In ERA-40 data for 2001, the subtropical seasonal cycle of derived ozone distributions (PDFs) at 2 PV units (close to a vertical ozone gradient of 30 ppbv/km) shows larger means and modes during winter and spring with the largest difference between modes and means in NH winter. This seems to be in good agreement with seasonal variations revealed in trajectory transport studies (Levine et al., 2007). Model runs with the new stratospheric UK Chemistry Aerosol Community Model (UKCA) will be compared with this evidence. We will assess the impact of enhanced stratospheric chlorine and changing temperatures on the structure of ozone PDFs along the model tropopause, with respect to variations in stratosphere-troposphere exchange in subtropical latitudes.

Keywords: stratosphere, tropopause, ozone

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MS018 **Poster presentation** **5631**

Ozone and UT/LS interdecadal variability at southern midlatitudes 1980-2000

Dr. Pablo Canziani
PEPACG CONICET IAMAS

Eduardo A. Agosta, Fabio E. Malanca

Total ozone re lationships with selected UT/LS va riables, such as 400 hP a and 70 hPa temperatures, tropopause pressure and te mperature, 70hPa geopoten tial and potential vorticity at 340K, as well as between the variables, are analyzed on decadal scales over Southern Hemisphere mid latitudes (between 30 a nd 60S), for the period 1980-2000, duri ng early winter (June) and spring (October). TOMS V8 total ozone and ECMWF ERA-40 data pro ducts for the mo nths of June and October are used for the study. Multiple spatial correlation tec hniques are applied to infer the relationships between the mean fields as well as among decadal diff erence fields. Wave activitity Z and local EP-fluxes were calculated to further analyse the dynamics of the samples and their variability.The statistical studies show that observed latitudinal and longitudinal decadal variations of total ozone can be driven both by upper tropospheric and stratospheric variability, depe nding on latitude and seas on. When the sample is divided into subtropical and subpolar subreg ions, no rth and so uth o f 45S, differentiated relatio nships appear. Octob er ozone decadal variations during the 80s, particularly at the higher latitudes, i s attributed primarily to chemical ozone depletion, wh ile there appear to b e links betwee n tropospheric decadal chang e and some of the stratospheric variable s and tropopause beh aviour. In the 9 0s, tropospheric contributions decrease and the stratospheric quasi stationary wave 1 plays a major role, in winter and sp ring. In J une, tro pospheric change/v ariability appears to be more important tha n stratospheric driving, which however sti ll contri butes to change. Oz one change in the 90s has responded more to stratospheric dynamic change at higher latitudes, but despite reduced contributions, the troposphere remains a driver of variation at the lower latitudes of the sample.

Keywords: ut ls coupling, ozone, decadal variability

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MS018 **Poster presentation** **5632**

The interannual eastward motion of the Southern Hemisphere total ozone column horshoe: an indicator of tropospheric-stratospheric coupled dynamics

Dr. Pablo Canziani
PEPACG CONICET IAMAS

Eduardo A. Agosta, Elizabeth Castaeda

Several studies link the intr aseasonal-to-interannual variability in Total Oz one Column (T OC) observed over the So uthern Hemisp here to the atmospheric circulatio n co upling induced o n the lo wer stratosphere by the tropospheric/stratospheric Southern Annual Mode (SAM). An interesting, though not much studied feature, of the low-frewque ncy TOC variability is the slow eastward motion of th e enhanced TOC horseshoe structure at mid to high southern latitudes and the Atlantic Ocean TOC trough during winter and spring, o bserved in mo nthly fiel ds ove r the last 20 years. The TO C horseshoe is similar in shape to the atmos pheric circulation anomalies imposed by the SAM. However this eastward migrattion wou ld appear to suggst either a n eastward migration of the SAM mode or the existence of another source of variability in the lowers stratosphere during spring. The aim of the work is to examine whether: To explore potential tropospheric-stratos pheric mechanisms other than the SAM that could explain this low-pfrequency variability in the TOC mo nthly fields. The int erannual variability of the SA M in tro posphere sho ws a mo re co herent structure with the strato sphere during J anuary and J une. However, this variability is le ss li nked to the stratosphere's polar gr adient in spring (Sep-Oct). This suggests that different coupling mechanis ms are involved. The eastward ev olution of the TOC for October can be related to a quasi-wave 1 anomaly im posed on the pola r vortex variability, contr olled mainly by SAM, and could be related to a c ombination of tropospherically gener ated pl anetary wa ves and wave trains.. The analysis shows that the SAM has no eastward spatial evolution in the troposphere along the annual cycle and over the years sampled, with a barotropic structure at interanual scales; the horseshoe interannual-to-decadal variability can not be explained by the SAM alone. The results suggest significant con tribution from tropospheric anomaly pattern s over th e sou thern P acific an d Atlan tic Oceans.

Keywords: ut ls coupling, ozone, interannual variability

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MS018 **Poster presentation** **5633**

Changes in the stratospheric mean meridional circulation due to the increased CO2 - Radiation and SST induced effects

Mr. Chihiro Kodama
Department of Geophysics Tohoku University IAMAS

Toshiki Iwasaki, Kiyotaka Shibata, Seiji Yukimoto

Mechanisms of changes in the stratospheric Brewer-Dobson circulation (BDC) due to the increased CO2 are investigated through atmospheric GCM experiments. The total effects of increased CO2 on the BDC are separated into the radiation-induced effects (direct effects) and the SST-induced effects (indirect effects). During winter, both direct and indirect effects enhance the NH BDC in the upper stratosphere much more than the SH one, since stationary waves are more active in the NH upper stratosphere. In the NH during winter, tropospheric stationary waves are suppressed due to both the direct and indirect effects, implying that the wave generation in the troposphere is not directly related to the enhanced stationary waves in the upper stratosphere. In the summer stratosphere, the indirect effects mainly enhance the BDC in the stratosphere, consistent with the enhanced transient and stationary waves. The indirect effects enhance the mid-latitude westerlies in the summer hemispheres and probably affect the vertical wave propagation in the upper-troposphere and stratosphere.

Keywords: brewer dobson circulation, global warming, planetary wave

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MS018 **Poster presentation** **5634**

A plausible precursor of a stratospheric sudden warming event as inferred from hindcast AGCM experiments

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Hitoshi Mukougawa, Tomoko Ichimaru, Yuhji Kuroda

Recently the predictability of stratospheric sudden warming (SSW) events has attracted much attention by upsurging interests on stratosphere-troposphere dynamical coupling. In order to examine the initial-condition dependence of the prediction for a wavenumber-1 SSW event in December 2001, we conducts a series of hindcast experiments based on an atmospheric general circulation model (MRI/JMA-AGCM). During the onset period of the SSW, distinctive zonal mean zonal-wind anomalies with a barotropic tripole structure appeared throughout the region up to 10 hPa and are associated with a persistent blocking phenomenon over the Atlantic sector. A regression analysis on the AGCM experiments shows that such precursory anomalies play an important role to enhance upward propagation of wavenumber-1 planetary waves and lead to the SSW. Furthermore, it is revealed that the response of stratospheric circulation to the anomaly magnitude is nonlinear, which implies the existence of a threshold magnitude of the precursory anomalies for the occurrence of the SSW. Detailed investigation on the precursory event will enable us to reveal the dynamical relationship between tropospheric circulation anomalies and the subsequent SSW.

Keywords: predictability, stratospheric sudden warming, model experiments

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MS018 **Poster presentation** **5635**

Dependence of ozone depression in Antarctica on zonal circulation in the equatorial stratosphere

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Irina Gabis

It is well known that level of total ozone (TOZ) over Antarctica during ozone hole periods is subjected to significant inter-annual changes related to the Quasi-Biennial Oscillations (QBO) typical of the equatorial stratosphere zonal wind. Taking into account the ambiguity of these relations, several hypotheses have been put forward to explain the QBO-modulation of TOZ in the polar region by the equatorial circulation influence on meridional excha nge and strength of the antarctic winter -spring circumpolar vortex. The season regularities in the QBO-cycle evolution woul d be taken into consideration to examine co rrectly the QBO-circulation influence on ozone hole phenomenon. According to [1, 2], th e stagnation stage of descending ea sterlies always starts in so lstice (either in December- January o r in J une-July) and is complete by the equinox, b eing of quantized durati on in different QBO-cycles (about 3, 9, or 15 months). That is why the length o f the ful l QBO-cycle, d efined as a pe riod between t he consecutive stagnation stages beginnings, may be eq ual to 24, 30, or 36 mo nths. In our analysis w e compare the monthly mean October TOZ in Antarctica w ith the zo nal circulatio n determined by o f the height wind profiles in the equatorial stratosphere (between 100 and 10 hPa) for 1962-2005. TOZ-data are based on ground Dobson-spectrophotometer (1962-2 005) at station Amundsen- Scott (89 .98S; 24.8W) and satellite TOMS (Total Ozone Mapping Spectrometer) measurements (1978-2005). Our r esults show that two ozone h oles take place for th e 24- an d 30-mon ths QBO-cycles scenario starting in December-January. Three ozone holes a re observed during the 30-months QBO-cycles scenario starting in J une-July. 44 ozone holes were observed in Ant arctica for the period 1962-2005, and only 7 of them occur during the sta gnation stage. Fo r the mo st number of ozon e h oles th e formation of polar vortex an d ozone depressio n o ccur under co ndition of the var ying circulatio n in equato rial strato sphere. In overwhelming majority cases of the 24- and 30-mont hs QBO-cycles starting in December- January TOZ has a relative maximum during the first ozone hole and relative minimum during the second ozone hole. Nearly always TOZ shows a relative minimum during the third ozone hol e in the 30-months QBO-cycles starting in June-July. As a re sult, when series of the 24-months QBO-cycles are observed in equatorial stratosphere the course of TOZ demonstrates the true alternation of relative maxima and minima. When the 24-months series change s for the 30- months QBO-cycles series, the true alternation failures, since the relative TOZ maximum is followed by two mini ma in succession during the 30-months QBO-cycles starting in June-July. Minor d escending trend for TOZ obs erved before 1979 and after 1993 coincides with mixed 24- and 30-months QBO- cycles in the equatorial stratosphe re. However, t he very large descending trend of TOZ was typical of 19791993 when series of the 30-months QBO-cycles occurs. The tendency is displayed for less amplitud e of TO Z-variations during the 24- months QBO-cycles in comparison w ith the amplitude during the 30-mont hs Q BO-cycles.References:Gabis I.P., Troshichev O.A., Influence o f so lar UV irradiance o n quasi- biennial o scillations in the Earth 's atmosphere // Advances in Space Research, 2004, V. 34 (2), p. 355360.Gabis I.P., Troshi chev O.A., QBO cycle identified by changes in height profile of the zonal winds: new regularities // Journal of the Atmospheric and Solar-Terrestrial Physics, 2005, V. 67(1-2), p. 3344.

Keywords: ozone, depression

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

MS018 **Poster presentation** **5636**

Predictability of the Polar-night Jet Oscillation/Arctic Oscillation Numerical experiment in winter 2003/04-

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Polar-night Jet Oscillation (PJO) is a prominent variability in the stratosphere. It indicates slow poleward and downward propagation of anomalou s zonal- mean zonal wind, and the variability somet imes indicates very clear quasi-periodic nature througho ut the winter. As the PJO is lon g-lived cohere nt signal, it is interesting to examine how much the PJO can be predictable. If the PJO is well predictable, it is hoped that tropospheric signal similar to the Ar ctic Oscillation (AO) is also well predict able, because such signal is known to appear with the do wnward propagation of the PJO. To attack this problem, we had performed numerical experiments start from obse rvations in winter of 2003/04 whe n the signal of the PJO appeared very clearly. The results are also compared with the experiments in winter of 2002/03 when the PJO was not very clear. It is found that the occurrence of the PJO until the end of the winter can be well predictable if prediction is started after about 15 December, w hen the stratospheric sudden warming (SSW) is we ll predictable in winter of 2003/04. In this case, the occurrence of the AO associated with the downward propagation of the PJO is also well predicted more than 1-month prior to the occurrence. In contrast, the predictability of the AO associated with the SSW in winter of 2002/03 is found to be ve ry short. There results suggest that the AO associated with the SSW is well predictable with very larg e leading time only wh en th e activity of the PJO is very active or is pr edicted as very active.

Keywords: polar night jet oscillation, arctic oscillation, predictability

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

MS018 **Poster presentation** **5637**

Changing atmospheric composition: Fact or Fiction?

Prof. John Burrows
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The atmospheric composition is changing, as a result of natural phenomena and anthropogenic activity. Global knowledge of the changing atmospheric composition is required to test our current understanding of the atmosphere and to improve our ability to predict the response to and feedback between climate change and chemistry. SCIAMACHY and GOME are related passive remote sensing instruments, which observe from the ultraviolet to the show wave infrared red. GOME makes nadir measurements and has flown on the second European Research Satellite since 1995 and makes nadir measurements only. SCIAMACHY was launched on ENVISAT in 2002 and has now made over 5 years of measurements in alternate limb and nadir measurements. Both instruments provide unique insight into atmospheric composition. In particular the limb measurements of SCIAMACHY yield knowledge on atoms molecules and particles from the upper troposphere to the thermosphere. In this talk the observations of ozone and short lived stratospheric species and the observations of metals in the mesosphere and thermosphere will be discussed.

Keywords: stratosphere, mesosphere, thermosphere

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

MS018 **Poster presentation** **5638**

QBO modulation of tropical deep convection

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Stefan Liess, Ryan O'Neil

Some previous modeling and data investigations suggest that the stratospheric quasi-biennial oscillation plays a modulating role for deep convection in the tropics. We have investigated this using a new data product - the weather states derived from ISCCP two-dimensional histograms. In particular, Weather State 1 (WS1), is an unambiguous indicator of deep convective systems in the tropics. We have preformed Student t-tests to see how the population of WS1 is related to the phase of the QBO. We find that WS1 in enhanced during the easterly phase of the QBO in regions in which deep convection frequently occurs, while it is simultaneously suppressed in surrounding regions. We show that this is a significant effect in which the enhancements in WS1 can be 20-30% of its mean occurrence. We show that the signature of this QBO influence on deep convection is very different than the tropical biennal oscillation. We believe that the stratospheric QBO can significantly affect the climate by modulating deep conection, with its associated latent heating and large-scale circulations.

Keywords: qbo, convection, tropics

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

MS018 **Poster presentation** **5639**

Stratospheric chemistry in the UKCA model

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Peter Braesicke, John A. Pyle, Fiona M. O'Connor, Colin E. Johnson

The U.K. Chemistry and Aerosols (UKCA) project aims to provide a new chemistry and aerosol module for the MetOffice's Unified Model (UM). The chemistry component contains a coupled tropospheric andstratospheric chemistry. Here we evaluate stratospheric gas phase chemistry in UKCA against climatological datasets within HadGEM1, a climate version of the UM. Ozone and long-lived tracers are in good agreement; we discuss the remaining deficiencies. We juxtapose two time-slice experiments representative of present-day and 2050 conditions, and assess the main effects on ozone chemistry associated with expected changes in long-lived tracers and greenhouse gases.

Keywords: ozone, stratosphere, recovery

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MS018 **Poster presentation** **5640**

Measurements Of Humidity in the Atmosphere: Validation Experiments (MOHAVE): Results overview and implications for the long-term lidar monitoring of water vapor in the UT/LS

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I. Stuart Mcdermid, Holger Voemel, Thomas G. Mcgee, David Whiteman, Belay Demoz, Larry Miloshevich

In October 2006, a major atmospheric water vapor measurement campaign took place at the JPL-Table Mountain Facility in So uthern Califo rnia. The MOHA VE campaign (Measurements Of Humidity in th e Atmosphere: Validation Exper iments) aimed at eval uating the perfo rmance o f several high capability water vapor R aman lidars. In particular, the JPL Raman Lidar permane ntly located at Table Mountai n was designed to measure water vapor mixing rati os with accuracy better than 5% above 12 km, allowing for the long-term measurements of lower stratospheric water v apor and possible detection of its long-term trends. The ca mpaign was v ery successful as 250 hours of lidar measurements wer e compared to measurements from about 50 Vaisala RS9 2 radiosondes and 10 Cryogenic Frost- Point hygrometers (CFH). The comparisons with the CFH allo wed the identific ation a systematic wet bias i n the UT/LS part of the profiles measured by all thr ee Raman lidars involved in the campaign. The bias was found to be caused by the presence of residual fluorescence in the lidar receivers. I t revealed the necessity for a major reconfiguration/redesign of Raman lidars dedicated to the measure ments of water vapor in the UT/LS. The results from MOHAVE also showed that once the fluorescence is suppressed the lidar measurements agree very well with the CFH measurements, indicating that the Raman lidar remains a promising instrument for the future long-term monitoring of water vapor in the UT/LS.

Keywords: water vapor, ut ls, lidar

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

MS019 **5641 - 5730**

Symposium
Middle Atmosphere Science (ICMA)

Convener : Prof. Kevin Hamilton

Papers related to any aspect of the dynamics, chemistry, or physics of the atmosphere from near the tropopause to the lower thermosphere are appropriate for this session. Observational, modeling and theoretical papers are all solicited. Particularly welcome are contributions relating to a number of recent satellite missions that have the potential to greatly increase our knowledge of the middle atmosphere, including TIMED, ENVISAT, EOS-AURA and COSMIC

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

MS019 **Oral Presentation** **5641**

Interannual Changes of Arctic Ozone: Contributions from Transport and Photochemical Destruction

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Springtime ozone over the Arctic changes significantly between years, through anomalous transport and chemical destruction, two mechanisms that control the wintertime increase of ozone. Previous attempts to disentangle those contributions to anomalous ozone rest upon the isolation of air over the Arctic. Here, observed changes between warm and cold winters are investigated in the reprocessed record from SBUV-V8, which provides the 3D structure of ozone mixing ratio. Observed changes of ozone structure are then related to contemporaneous changes of dynamical structure in the record from ECMWF. Relative to warm winters, springtime ozone over the Arctic is anomalously lean - by some 60 DU. Reflecting the rms change between years, this deficit is comparable to ozone changes that have been ascribed to chemical depletion. A major contributor, however, appears conspicuously in the 3D structure of March ozone. Mixing ratio surfaces have been driven into coincidence with theta surfaces following warm winters but remain deflected across the mf following cold winters. The difference in ozone structure reflects isentropic mixing by planetary waves, which transports ozone-rich air into the Arctic. In concert with anomalous downwelling of ozone-rich air, such mixing accounts for at least 2/3 of the observed deficit of springtime ozone over the Arctic following cold winters. Of the deficit present during March, about half is erased during April, when the vortex eventually weakens following cold winters. The Arctic is then opened to isentropic mixing by planetary waves. Although delayed, the ensuing transport reduces the ozone anomaly relative to warm winters from that present a month earlier. The observed reduction is consistent with the contribution to anomalous Arctic ozone from isentropic mixing. A 3D model of dynamics and photochemistry is then used to explore interannual changes of stratospheric dynamical and chemical structure through their dependence on tropospheric planetary waves and on the QBO. The integrations reproduce the salient features of anomalous temperature and ozone, which have been composited from the observed records of ECMWF and TOMS. Characterized by a strong anomaly of one sign at polar latitudes and a comparatively-weak anomaly of opposite sign at subpolar latitudes, each bears the signature of the residual mean circulation. The structure is very similar to that associated with the Arctic Oscillation. nomalous upward EP flux from the troposphere, representative of that observed, eads to an omalous downwelling of ozone-rich air. In concert with isentropic mixing by planetary waves, the resulting enrichment/leaning at extratropical latitudes sharply modifies total ozone over the Arctic. Integrations distinguished by the omission of heterogeneous processes indicate that chemical destruction accounts for ~20% of the anomaly in Arctic ozone between warm and cold winters. Comparable to estimates derived from the observed record, the remaining ~80% follows from anomalous transport.

Keywords: arctic, ozone, interannual

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

MS019 **Oral Presentation** **5642**

Past and future trends in the upper stratosphere and mesosphere from the Canadian Middle Atmosphere Model

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Andreas I. Jonsson

The Canadian Middle Atmosphere Model is a general circulation model which extends from the surface up to about 95 km. It contains an interactive photochemical module and includes realistic parameterizations of the major physical processes necessary to represent the complexity of interactions throughout the model domain. The model has been run from 1960 to 2100 to investigate the atmospheric response to transient forcings in sea surface temperatures, CFCs and greenhouse gases, including CO2, CH4 and N2O. Our focus is on processes in the upper stratosphere and mesosphere. In particular, we analyze simulated trends in temperature, ozone and water vapor, and changes in shortwave and longwave heating rates. The middle atmosphere temperature decreases in response to CO2 increases but past and future trends are different due to the modulation of ozone changes on heating rates. Ozone depletion in the past leads to additional cooling whereas ozone recovery in the future reduces the CO2 effect. Comparison with available long-term observations of the recent past shows good agreement.

Keywords: middle atmosphere, climate change, modelling

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

MS019 **Oral Presentation** **5643**

Stratospheric ozone trend analysis: Challenges to attribute ozone trends to ozone depleting substances

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The ozone hole reported for austral spring 2006 was one of the largest ever observed despite the large decrease in tropospheric concentrations of ozone depleting substances (ODS, chloroflurocarbons as halons) attributable to the Montreal Protocol (1987) and its amendments. The documentation and scientific interpretation of the temporal evolution of the ozone shield is a challenging task which requires reliable and high quality ozone measurements. This topic will be briefly addressed in the presentation. Another challenge is the concept of data analysis requiring an appropriate scientific understanding of the processes that influence the global ozone shield. They include natural variability (such as caused by Quasi-Biennial Oscillation (QBO) and the eleven year solar cycle), violent volcanic eruptions, polar ozone depletion as well as influences related to climate variability and long-term climate change. These complex interactions make the attribution of the ozone changes to the effect of the Montreal protocol a difficult task. Different concepts of data analysis (using multiple regression analysis) will be illustrated and discussed using recent results.

Keywords: ozone, trends, ozonedepletion

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

MS019 **Oral Presentation** **5644**

MIPAS global observations of the atmosphere from the upper troposphere to the lower thermosphere

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Thomas Von Clarmann, Norbert Glatthor, Michael Hoepfner, Mathias Milz, Joerg Steinwagner, Swaroop Chauhan, Bernd Funke, Udo Grabowski, Sylvia Kellmann, Michael Kiefer, Mariliza Koukouli, Andrea Linden, Manuel Lopez-Puertas, Tilman Steck, Stefan Versick, H

MIPAS is a Fourier-transform infra-red limb emission spectrometer launched on ENVISAT in March 2002. Since then it has provided ob servations of more than 20 atmospheric c onstituents, te mperature, and cloud properties in the altitude range from the upper troposphere to the lower thermosphere, with pole-to-pole coverage during day and nigh t. A scientific data pr ocessor has be en run at IMK/IAA to re trieve trace constitue nt distributions and further paramete rs from MIPAS spec tral data. During its mission, MIPAS has covered several Arctic and Antarctic po lar wint ers, among them the unprec edented major warming event in the A ustral vortex in Se ptember 2002, the solar storm in Oct/Nov 2003 with its unexpected impact on the stratospheric chlorine chemistry, the evolution of a belt of polar stratosph eric clouds (PSCs) consisting of NAT (nitric acid tri-hydrate) particles in Antar ctic winter 2003, and a huge biomass burni ng plume i n t he Souther n hemisphere upp er troposphere in fall 200 3. Besides these events, MIPAS is n ow on th e cu sp of providin g lon g-term time series of trace constituents like water vapor, HDO, methane, CFCs , ozone and SF6, releva nt fo r studying anthropogenic climate change, its relation to natural variability like the solar c ycle, and its f eed-back to d ynamics and chemistry in the troposphere and stratosphere. The talk will give an overview on our work with MIPAS data.

Keywords: mipas envisat, atmospheric chemistry, remote sensing

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

MS019 **Oral Presentation** **5645**

The wave origin of a temperature fluctuations observed in the radio occultation measurements and the method of determination of the intrinsic frequency of internal long-period gravity waves propagating in stratosphere of the Earth

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Andreev, V.E, Pavelyev, A.G.

In order to examine internal low-frequency gravity wave characteristics we have analyzed small-scale fluctuations of normalized temperature in stratosphere of the Earth using radio occultation data. It is known that a low-frequency wave may propagate upward with an amplitude saturation, so that it remains always near the dynamical instability condition [Fritts, D.C. and Rastogi, P.K., 1985, Radio. Sci. 20, 1247]. An analysis technique to identify the wave origin of observed temperature (or density) fluctuations, assuming a gravity wave saturation, is proposed. This technique is based upon a comparison of the experimental and theoretical values of the relative amplitude threshold. The theoretical amplitude threshold for dynamical instability, assuming a minimum Richardson number of 1/4, is a function of the ratio inertial to intrinsic frequencies [Fritts, D.C., 1989, PAGEOPH. 130, 343]. The theoretical threshold values are confined from 0 to 1. In case, when this criterion is satisfied for its experimental counterpart and the wave origin of the analyzed fluctuations is positively identified, then the intrinsic frequency of the monochromatic gravity wave can be determined from only a single, occultation. For the experimental examination of the efficiency of the analysis technique proposed, we used the results of the simultaneous temperature and wind velocity measurements obtained in high-resolution balloon experiment [Cot, C. and Barat, J., 1986, J. Geophys. Res. 91, 2749], where a nearly monochromatic and long-period wave propagating in the stratosphere upward was identified. By using the temperature data only, we reconstructed the ratio inertial frequency to intrinsic frequency and other wave parameters with the accuracy of 20%. The results of determination of the intrinsic frequency and other characteristics of internal gravity waves, propagating in stratosphere of the Earth are presented and discussed.

Keywords: gravitywave, radiooccultation, intrinsicfrequency

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

MS019 **Oral Presentation** **5646**

The importance of the Montreal Protocol in protecting climate

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Stephen Andersen, John Daniel, David Fahey, Mack McFarland

The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer is a landmark agreement that has successfully reduced the global production, consumption and emissions of ozone-depleting substances (ODSs). ODSs are also greenhouse gases that contribute to the radiative forcing of climate change. Comprehensive time-dependent scenarios of ozone-depleting substances (ODSs) in the atmosphere and their radiative forcing of climate are formulated. Using historical ODSs emissions and scenarios of potential emissions, we show that the ODS contribution to radiative forcing most likely would have been much larger if the ODS link to stratospheric ozone depletion had not been recognized in 1974 by Molina and Rowland and followed by a series of regulations. The climate protection already achieved by the Montreal Protocol and subsequent amendments and adjustments alone is far larger than the reduction target of the first commitment period (2008-2012) of the Kyoto Protocol. Additional climate benefits that are significant compared to the Kyoto Protocol reduction target could be achieved by actions under the Montreal Protocol, by managing the emissions of substitute fluorocarbon gases and/or implementing alternative gases with lower global warming potentials. The results provide a needed quantitative perspective of the unique coupling of the Montreal Protocol and climate protection.

Keywords: gwp, cfc, ozone

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

MS019 **Oral Presentation** **5647**

Energetic particle precipitation effects on the polar winter stratosphere as observed by MIPAS/Envisat

Dr. Bernd Funke
IAMAS

Manuel Lpez-Puertas, Gabriele Stiller, Thomas Von Clarmann, Norbert Glatthor, Udo Grabowski, Michael Hpfner, Sylvia Kellmann, Andrea Linden, Mathias Milz, Herbert Fischer

Energetic particle precipitati on (EPP) in the po lar atmosphere has important implications o n stratospheric ozone chemistry. Solar protons or highly energetic electrons generated during solar storms cause sporadicly in situ produ ction of strat ospheric NOx and HOx radicals invo lved in catalytic ozon e destruction. Further, NO produced continuously in the meso sphere and lower thermosphere by medium energy electron precipitation descends to the strato sphere during the polar winter, where it represent s an additional, though variable source of NOx. Th e capability of MIPAS to measure all important NO y species, as well as ClO and HOCl with global co verage including the p olar night regions make this instrument an ideal candidate to study EPP effects on stratospheric chemistry. We present a quantitative assessment of EPP-induced stratospheric composition changes as observed by MIPAS during 2002-2004, including the unusually strong solar proton event in October/November 2003.

Keywords: mipas, particle precipitation, nox

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

MS019 **Oral Presentation** **5648**

Comparative gravity wave contributions to middle atmosphere dynamics on Earth and Mars

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We compare here what can be inferred about gravity wave (GW) sources, propagation, amplitudes, saturation, momentum fluxes, and induced mean flows from aero-braking densities and other measurements on Mars with what we know from measurements in Earth's middle atmosphere. Compared to Earth, GW forcing by topography and other sources on Mars appears to be very strong, resulting in 1) GWs of large amplitudes extending, on average, to much lower altitudes than on Earth, 2) the attainment of very large amplitudes and momentum fluxes, and 3) mean forcing attaining much larger magnitudes and extending to much lower altitudes on Mars. These responses appear to maximize in the winter polar jets, but also exhib it significant modulation by large r-scale motions, primarily the large-amplitude non-migrating tides on Mars.

Keywords: middle atmosphere, gravity waves, mars

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

MS019 **Oral Presentation** **5649**

Observations of the stratospheric diurnal tide with cosmic satellite and radiosonde data

Dr. Simon Alexander
Research Institute for Sustainable Humanosphere (R Kyoto University IAMAS

Toshitaka Tsuda

The importance of atmospheric diurnal tides on the energy budget in the upper atmosphere (~100km) is well known. Many of the tides have sources in the lower atmosphere, such as tropospheric water vapour and stratospheric ozone, as well as longitudinal inhomogeneities in topography and water vapour concentration. Diurnal tides have been previously studied using satellites and ground based systems. The recent launch of the COSMIC GPS radio occultation satellite constellation allows high resolution observations of temperature and water vapour on a global scale up to a height of 30km. This means that the temporal variability of the temperature's tidal amplitude and phase can be studied with COSMIC concurrently with changes in tropospheric water vapour. Results from the first year of COSMIC observations will be presented, detailing the tidal amplitude and its relation to regional scale variability of water vapour. The COSMIC observations will also be compared with historic records of regional-scale tidal data obtained with radiosondes launched during intensive campaigns between 2001 and 2006 in Indonesia and Northern Australia.

Keywords: diurnal tide, cosmic, radiosonde

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

MS019 **Oral Presentation** **5650**

Seasonal variations of the stratospheric gravity waves in the polar region analyzed with GPS radio occultation data

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Hayato Hei

We have analyzed the potential energy (Ep) of the atmospheric gravity waves in the stratosphere by using temperature data observed with GPS radio occultation (RO) measurements. Ep is estimated from the temperature fluctuation with vertical scales shorter than 7 km at 12-19 km, 19-26 km and 26-33 km, by using the GPS RO data obtained with the German CHAMP satellite from June 2001 to December 2006. We have determined monthly mean values of Ep in a longitude and latitude cell of 20x10 degrees, and studied the climatological behavior of the gravity waves in the polar region in both northern and southern hemispheres. The seasonal variation of Ep in the Arctic region is characterized by an annual cycle with the maximum from November to March and the minimum in summer. Over the Antarctica the Ep variation also shows enhancement in winter months, but, in addition, a sharp peak of Ep appears in spring, coinciding with a rapid decay of the polar vortex. The Ep variations in the Arctic and Antarctic regions are compared with various parameters that can be related to the wave generation mechanism, such as the intensity of the polar night jet, surface winds, topography, planetary wave activity and so on.

Keywords: gravity waves, gps radio occultation, polar region

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

MS019 **Oral Presentation** **5651**

Morphology and forcing of nonmigrating tides in the middle atmosphere: What did we learn from TIMED?

Dr. Jens Oberheide
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Qian Wu, Maura E. Hagan, Raymond G. Roble, William E. Ward, Jeffrey M. Forbes

The instrum ents on board NASA's Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite, since its successful launch in December 2001, have pr ovided invalua ble insight into the dynamics of the MLT regi on and its cou pling with the atmosphere below. The non-Sun-synchronous (nonmigrating) tides play a key role in this context and considerable progress has bee n made by the TIMED instruments in resolving thei r spatio-temporal structure over a range of MLT altitudes. With the data that is now available, it is possible to elucidate th e morphology, pr opagation and forcing of nonmigrating t ides in a muc h more quantitative way than before. This is particularly interesting fo r general circulation modeling because tidal waves are cl osely linked to the parameterizations of radiative heating, co nvection, clouds and latent heat. As su ch, com parisons between models and observed tidal signatures provide a means of evaluating a nd valida ting these paramete rizations. The paper presents nonmigrating tidal winds derived fro m T IMED Do ppler Interferometer (TIDI) mea surements a nd examines their internal consi stency with te mperature tides fro m the Sounding the At mosphere using Broadband Emission Radiome try (S ABER) in strument. A comparison of t he observed tidal fields with models of differing characte r (GSWM, TIME-GCM, extended CMA M) gives insight into the relative importance of latent heat an d wave- wave interact ion forcing of the standi ng, and the westward and eastward propagating tidal components. This and a discussion of model/observation dis crepancies may help to further improve our current understanding of nonmigrating tides.

Keywords: nonmigrating, tides, timed

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

MS019 **Oral Presentation** **5652**

Three-Dimensional Satellite Observations of Atmospheric Gravity Waves

Dr. Joan Alexander
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Gravity waves drive large scale circulations in the atmosphere, and are treated via parameterization in most modern general circulation models. The effects of mountain wave drag are parameterized in most climate models, and the effects of non-stationary waves are important in models seeking a realistic middle atmosphere circulation, including chemistry-climate models that forecast future ozone changes. Gravity wave parameterizations require detailed information on the spectrum of vertical flux of horizontal momentum carried by gravity waves from their sources globally. The known sources for gravity waves include topography, convection, and unbalanced winds, all of which are known to exhibit both geographical and temporal variations. Satellite observations offer the best hope of quantifying the needed information on a global scale. Progressive advances in satellite-borne instrument resolution have allowed observation of smaller scale gravity waves and their global properties. Gravity waves are generally detected in satellite observations as temperature fluctuations. The conversion of measured wave temperature amplitude to momentum flux requires simultaneous observation of the vertical and horizontal wavelengths and wave propagation direction. Techniques for estimating momentum flux from space-borne temperature profile data have suffered from large uncertainty, primarily due to the limited horizontal sampling of the measurements. Recent advances in horizontal sampling of instruments on the AQUA and EOS-AURA satellites have not only reduced this uncertainty, but in some cases are now providing a fully resolved three-dimensional view of gravity waves from space. Examples from the Atmospheric Infrared Sounder (AIRS) and the High Resolution Dynamics Limb Sounder (HIRDLS) will be presented.

Keywords: gravity wave, satellite, observations

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MS019 **Oral Presentation** **5653**

A sensitivity study of the middle atmosphere to changes in the parameterized momentum drag of gravity waves

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J.H. Richter, R. R. Garcia

We investigate the sensitivity of the mean climate and its variability to a variety of assumptions in the parameterization of non-stationary gravity waves used in Whole Atmosphere Community Climate Model, version 3 (WACCM3). Typically, WACCM3 uses a Lindzens type parameterization with waves uniformly distributed from -80 m/s to +80 m/s and a source spectrum defined to produce an acceptable climatology in the reference simulation. This reference simulation is compared to other experiments where the source spectrum is modified, the spectral resolution is made nonuniform, or the launching level is changed. We also investigate the effect of linking the source spectrum to typical tropospheric sources of gravity waves: convective sources are introduced by using the Beres (2002) scheme; frontogenesis is accounted for by using the Charon and Manzini (2002) scheme. Our results show that the middle atmosphere climate can be significantly impacted by changes in the gravity wave parameterization: the summer mesopause temperature is very sensitive to such assumptions, its height and minimum temperature can change significantly; the lower stratosphere cold pole bias can be improved at the expenses of the summer mesopause temperature; the occurrence of wintertime stratospheric warmings, while in general deficient compared to observations, can be improved. These results illustrate the difficulty of tuning the climate system using solely the gravity wave parameterization.

Keywords: gravity waves, middle atmosphere

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MS019 **Oral Presentation** **5654**

Gravity wave studies in the lower stratosphere using superpressure balloons

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Albert Hertzog, Gillian Boccara, Francois Vial

Superpressure balloons (SPB) that float at a constant density level provide a powerful means of studying atmospheric gravity waves at heights near 20 km. Here we describe techniques to derive important wave parameters including momentum flux and phase speed. The techniques are applied to observations made in SPB campaigns in both the Arctic and Antarctic, including the STRATEOLE-VOCORE campaign in the Antarctic spring of 2005. Results will be discussed in terms of geographic and temporal variability, including links to sources. Plans for future campaigns in the equatorial regions will also be discussed.

Keywords: gravity waves, stratosphere

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MS019 **Oral Presentation** **5655**

An instability of the polar lowermost stratosphere ?

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Sarah Kew, M.Sprenger

Attention is drawn to a salient feature of the polar lowermost stratosphere - the occurrence of isolated vortex-like anomalies of potential vorticity (PV). Consideration is given to the dynamics and origin of these features by examining both their climatology and that of the ambient environment. It is suggested that the background ambient flow has a structure that is potentiallyunstable, and the implications and repurcssions are explored from both a theoretical and numerical modelling standpoint.

Keywords: lowermost stratosphere, instability

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MS019 **Oral Presentation** **5656**

Sensitivity of the Stratosphere Resolving Metoffice Model to Changes in Horizontal Resolution

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Lesley Gray, Neal Butchart, Reddy Shekar, Andrew Bushell

Compared to the troposphere, the stratosphere exhibits its own distinctively unique variability. In the context of climate change, the response of the stratosphere is quite different compared to the lower atmosphere in that it is thought to cool with increasing Greenhouse gas concentrations. The future recovery of the ozone hole is also thought to be in some way influenced by the future trend of stratospheric cooling. However, in forecasting trends in stratospheric temperature and ozone, one must understand the nature and response of stratospheric internal variability. This necessarily includes an understanding of the internal variability within our models. An investigation of the internal variability of the 60-level stratosphere resolving Metoffice Unified Model has been carried out with different horizontal resolutions. Initial condition ensembles of multi-annual simulations at 2.5deg x 3.75deg and 1.25deg x 1.875deg resolutions were compiled under otherwise identical conditions. We report on systematic differences seen in the tropical variability (Quasi-biennial Oscillation) and extratropical variability as expressed by the frequency and nature of sudden stratospheric warmings.

Keywords: sudden stratospheric warmings, variability, qbo

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MS019 **Oral Presentation** **5657**

Multi-model projections of ozone recovery in the 21st century

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Darryn W. Waugh, Ccmval Team

Simulations of the recent past from thirteen coupled chemistry-climate models (CCMs) participating in the CCM Validation Activity for SPARC (CCMVal) are evaluated to provide guidance for the interpretation of ozone projections made by the same CCMs. Several different diagnostics are used to evaluate temperature, trace species and ozone in the models. The core period of the evaluation is from 1980 to 1999 but long-term trends are compared for an extended period (1960-2004). Most CCMs show reasonable agreement with observed total ozone trends and variability on a global scale, but a greater spread in the ozone trends in polar regions in spring. Global long-term stratospheric temperature trends are in reasonable agreement with satellite and radiosonde observations. The simulated ozone evolution in the 21st century in the CCMs is mainly determined by decreases in halogen concentrations and continued cooling of the global stratosphere due to increases in greenhouse gases. Differences in stratospheric inorganic chlorine (Cly) among the models are key to diagnosing the inter-model differences in simulated ozone hole recovery. It is found that there are substantial quantitative differences in the simulated Cly, with the October mean Antarctic Cly peak value varying from less than 2 ppb to over 3.5 ppb in the CCMs, and the date at which the Cly returns to 1980 values varying from before 2030 to after 2050. There is a corresponding large range in the timing of recovery of Antarctic ozone back to 1980 values.

Keywords: chemistry climate modeling, ozone, stratosphere

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MS019 **Oral Presentation** **5658**

HIRDLS measurements of temperature, water vapor and ozone at the tropical and mid-latitude tropopause

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John Barnett, Craig Hartsough, Charles Cavanaugh, Chris Hepplewhite, Hyunah Lee, Bruno Nardi

The High Resolution Dynamics Limb Sounder (HIRDLS) instrument is a 21 channel infrared limb sounder designed to obtain observations of temperature, 10 trace species and aerosols from the upper troposphere to the upper mesosphere with high (~1 km) vertical resolution. An unforeseen incident during launch created a blockage in the optics such that only a fraction of the beam width was clear. After much effort, corrections have been developed to allow exploitation of the clear area that remains. Fortunately, none of these corrections affects the small vertical scales that were originally targeted for study. Here we present results showing the small scale vertical structure of temperature, ozone and water vapor at the tropical tropopause. Seasonal and latitudinal variations are explored, with special emphasis on the Asian monsoon and its relationship to maintaining the distribution of stratospheric water vapor. We also explore the distribution of double tropopause structures, and the associated distributions of water vapor and ozone in mid-latitudes.

Keywords: hirdls, tropopause, highresolution

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

MS019 **Oral Presentation** **5659**

Thermal Structure in the Arctic middle atmosphere above ALOMAR (69N)

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Armin Schch, Jens Fiedler

The ALOMAR Rayleigh/Mie/Raman lidar, located in Northern Norway at 69 N, measures relative density profles and aerosol particle s and derives temperatures in the strat osphere and mesosphere. It is operated year-round whenever permitted by the weat her during both nighttime and d aytime. The lidar signal consists of backscattered laser light and is separated during dayti me from scattered sunlight b y using spectral filters opt imized to the highly stabilized lase rs and a small f eld of view of the receivin g telescopes. This technical design together with a dedi cated crew of operators allow us to col lect up to 1100 h of lidar observations per year, on average one prof le every fourth day. Ass uming hydrostatic equilibrium, temperature pro f les are derive d in the aerosol-free part of the middle at mosphere abov e 30km. The mean season al th ermal structure of the middle atmosphere is obtained by combining the dataset of all observations from 1997 to 200 5. After deriving the mean thermal structure we can easil y identify remar kable variations of the ther mal st ructure like stratospheric warmings / mesospheric coolings and mesospheric inversion layer s. By co mbining the lidar observations with temperature soundings by meteorological ro ckets, launched fro m the nearby rocketrange, we will present the first extensive investigation of th e mesospheric co oling during stratospheric warmings and of mesospheric inversion layers at our Arctic lidar site.

Keywords: lidar, temperature, mesospheric inversion layers

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

MS019 **Oral Presentation** **5660**

Calipso observations of stratospheric aerosols: a preliminary assessment

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We have examined the 532-nm aerosol backscatter coefficient measurements by the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) for their use in the observation of stratospheric aerosol. CALIPSO makes observations that span from 82S to 82N each day and, for each profile, backscatter coefficient values reported up to ~40 km. The possibility of using CALIPSO for stratospheric aerosol observations was demonstrated by the observation of the 20 May 2006 eruption of Montserrat in the earliest CALIPSO data in early June as well as by observations showing the 7 October 2006 eruption of Tavurvur (Rabaul). However, the very low aerosol loading within the stratosphere makes routine observations of the stratospheric aerosol far more difficult than episodic volcanic events. Nonetheless, we found that averaging a complete days worth of nighttime only data into 5-deg latitude by 1-km vertical bins reveals the main stratospheric aerosol data centered near an altitude of 20 km though the values are clearly too small and often negative in much of the stratosphere. In addition, distinctive features of the stratospheric aerosol including the clean wintertime polar vortices and the small maximum in the lower tropical stratosphere appear in the averaged data. The data can be significantly improved by increasing the measured backscatter (molecular and aerosol) by approximately 5% suggesting that the current method of calibrating to a pure molecular atmosphere at 30 km is most likely the source of the low values.

Keywords: calipso, aerosol, volcano

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

MS019 **Oral Presentation** **5661**

The sensitivity of the QBO to variations in the lower and upper boundary conditions by El Nino and the 11-year solar cycle

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Hauke Schmidt, Natalia Calvo

The quasi-biennial oscillation (QBO) is the leading mode of variability in the tropical stratosphere with effects in dynamics, transport and chemistry in the tropical and extratropical middle atmosphere. It is recognized that the QBO contributes to the interannual variability of the high latitude winter circulation. Further it was found that the high latitude circulation, especially discussed for the Northern hemisphere, is also sensitive to the solar cycle and to the ENSO cycle. Solar cycle signals seem to interfere with QBO signals so that signal detection studies found strongest signals for specific combinations of the solar cycle and the QBO phase. It is not yet understood to which degree this is a problem of signal separation, or if this is a necessary consequence arising from non-linaerity of the system. A further factor complicating the analysis of high latitude middle atmosphere variability is the influence of El Nino on the polar Northern vortex. In this study we use two sets of experiments in order (1) to compare QBO effects on the high latitude circulation under upper boundary conditions for solar minimum and solar maximum, respectively, and (2) to compare QBO effects under lower boundary conditions representative for El-Nino or neutral years, respectively. The models employed here allow the simulation of the QBO by internal wave forcing. Therefore this work adresses two major questions: What is the sensitivity of the QBO to the modified boundary conditions? And is there a significant non-linearity in the high latitude response to the combined QBO and solar cycle or QBO and El Nino conditions. This presentation will focus on the first question.

Keywords: quasi biennial oscillation, el nino, solar cycle

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MS019 **Oral Presentation** **5662**

Tropical waves in the LMDz stratospheric model and in the ERA40 reanalysis

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Francois Vial, Jayan Kuttipurath

The stratospheric dynamical variability is in part driven by planetary waves issued from the tropical troposphere. A reasonable representation of these tropical waves in models is essential for a good simulation of the stratospheric dynamics. In this presentation, the tropical waves are analyzed using a method that uses reanalysis or model data and that mixes spectral analyses techniques and the equatorial waves theory. More specifically, for the gravest Kelvin Waves, we use the theoretical fact that it yields to zonal wind anomalies that are almost uniform in latitude and over the Equatorial band. Hence, an horizontal wavenumber versus frequency Spectral Analysis of the zonal wind averaged over the tropics reveals the dominant frequencies and horizontal wavenumbers associated with these waves in our datasets.These spectral analysis permits to build space-time band pass filters that retains the zonal wavenumbers and frequencies of interest. A compositeanalysis of the filtered data, keyed to the upper troposphere zonal wind anomalies that are uniform in latitude and over the Equatorial band, permits to extract the characteristic life cycle of the Kelvin Waves that enter in the tropical stratosphere. For the Rossby Gravity waves , the same method is used but using the meridional wind anomalies that are almost uniform in latitude and over the Equatorial band. In this presentation,the equatorial waves extracted in a 20 year integration with the LMDz model are compared with those extracted from the ERA40 reanalysis during the 1980-2000 period. A special emphasis is given to the waves with zonal wave numbers s=1 (Kelvin waves and Rossby waves), and s=4 (Rossby Gravity wave).

Keywords: tropical waves, lmdz gcm, era40 reanalysis

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MS019 **Oral Presentation** **5663**

Measurements of Atomic Oxygen, Hydrogen, and Chemical Heating Rates

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C. Lehmann, L. Hoffmann, M. Riese, C. V. Savigny, M. Lopez-Puertas, B. Funke, D. R. Marsh

This talk deals with the derivation of atomic oxygen and atomic hydrogen in the mesopause region from various instruments on the european Envisat satellite. The core are SCIAMACHY/Envisat limb observations of vibrationally excited OH and a non-LTE model. Since the SCIAMACHY instrument can observe emissions from all vibrational states of OH up to v=9, it allows to constrain OH non-LTE model parameter errors and to retrieve chemical heating rates and atomic oxygen densities with excellent quality. In combination with GOMOS/Envisat star occultation observations of mesospheric ozone we are able derive atomic hydrogen densities in the upper mesosphere / lower thermosphere. The derived quantities will be compared with simulations of the NCAR ROSE model.

Keywords: mesosphere, oh, non lte

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

MS019 **Oral Presentation** **5664**

A study of daily total column ozone forecasting based on TOMS data and meteorology

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Sema Topcu, Bulent Aksoy, Ceyhan Kahya, Selahattin Incecik, Yilmaz Acar, Mustafa Ozunlu, Mithat Ekici

Ozone is one of the important atmospheric gases that absorb incoming solar radiation near ultraviolet. Therefore the prediction of daily total column ozone is a critical issue in assessing the maximum level of harmful UV radiation. The global trend in total column ozone is found to decline at the mid-latitudes of the Northern Hemisphere during the last two decades. This result is now well established. The strongest decline over northern mid-latitudes is observed during winter-spring seasons. Variations in total column ozone in the mid latitudes are mainly caused by changes in the amount of ozone in the lower stratosphere. The total ozone over Ankara in for 1984-2006 gives the seasonal cycle. The seasonal variability of ozone above Ankara is characterized by a maximum in spring and a minimum in fall. The highest total ozone (361 DU) is in March and the lowest (285 DU) in October. The ozone decreases in all seasons. The annual rate of decrease is 2.1% per decade. The maximum decrease is found in winter and the minimum in summer and fall. This ratio is 1.7% and 1.6% for winter and spring seasons respectively. In 22 years (1984-2006) the total 16 DU ozone is depleted above Ankara. The existence of significant statistical relations between total column ozone and a number of meteorological variables has long been known. The total column ozone has been forecasted on operational basis since recent decade in the world based on TOMS or ground based measurements as well as Brewer. In this work, in order to forecast the total column ozone over Ankara in, we have examined several linear multiple regressions with different predictors based on the ozone-meteorology relationships with previous days ozone value. The meteorological predictors consist of temperatures and geopotential heights at standard levels from 700 hPa to 50 hPa with temperature differences. The upper-air data were used in this regression model in order to forecast the Wt total ozone on the current day from temperature and geopotential heights together with the total ozone on the previous day. The temperature and dynamic heights were obtained from daily balloon observations from Ankara radiosounding station and the total ozone values were obtained from TOMS and recently a ground-based Brewer MKIII ozone spectrophotometer installed in November 2006 measurements made at Ankara (39o 58' N; 32 52' E). The accuracy of the predicted total column ozone is found with the acceptable levels. The most informative predictor is previous days ozone.This study is a part of the Turkish Scientific and Technical Research Council, under contract no: 105G032.

Keywords: total ozone, brewer

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

MS019 **Oral Presentation** **5665**

Non-migrating tides above Antarctica and their variation on short and long time scales

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T. Aso, M. Tsutsumi, D. C. Fritts, D. M. Riggin, M. J. Jarvis, A. J. Mcdonald, S. E. Palo, H. Iimura, R. A. Vincent

A high-latitude tide basis function that describes the major migratingand non-migrating components of the semidiurnal and diurnal tide can be fitted to wind data using linear least-squares fitting techniques. MF radars at Davis (69S, 78E), Syowa (69S, 40E), Rothera (68S, 68W) and Scott Base (78S, 167E) in Antarctica that are operating concurrently allow real-time application of this tidal analysis technique. After consideration of the potential for spatial aliasing, time series of tidal amplitudes and times of maximum are calculated. A 10-day fitting window provides insight into tidal variations at sub-monthly time scales. Using Davis meteor radar echo heights and width distributions to define equivalent heights, the westward zonal wavenumber one results are compared to those obtained concurrently by the COBRA meteor radar at South Pole and are found to agree. The seasonal and short-term variation of the tides are then considered, as are possible source mechanisms. It is found that non-migrating components of both the diurnal and the semidiurnal tide are present in high southern latitude MLT winds.

Keywords: tides, antarctica, mlt

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MS019 **Oral Presentation** **5666**

Radiosonde temperature trend during 1958-2005 in China

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In this work, we examine the upper-air te mperature trends derived fro m the radiosonde temperature timeseries (RTT) of all stations in Chines e radi osonde network. In order to elimin ate error and discontinuity in o riginal dat a, we co nduct qualit y co ntrol (QC) and ho mogenization to RTTs. The identified breakpoint and adjustment reveal s significant effect of the homogenization to orig inal RTT. The impact of homogenization to the trend was contrary corresponding to pre- and satellite era. During 1958-1978, removal detected breakpoints from original series (ORI) efficiently weaken the cooling trend in upper- a nd middle troposphere. Over the satellite era, the cooling trends from ORI of stratospher e enhanced by homogenization, while the war ming trends at 400 a nd 500 hPa were wea ken. The trend, averaged from full Chinese r adiosonde network du ring 1 958-2005, reveals cont rariety of cooling in stratosphere and upper troposphere, while warmin g trend has s ubstantiated in mid- and lower-troposphere. However, such inconsistent ha s been attested to be occurr ed just since 1980s by a nalysis with various temporal scales. Furthermore, seasonal structure of trend exp ounds the warming of lower free-atmosphere inconsistence is determined by wi nter but summer cooling in upper. To address the diurnal range between day- and nighttime launches, we computed the mean trend profile of 00UTC, 12UTC and th e diurnal rang e averaged ov er select ed 116 stations. 12UTC time series shows smaller cooling trend a nd larger war ming trend than that of 00 UTC with ex ception of lower tr oposphere. The trend of diurn al range decrea sing versus al titude from 40 0 to 100 hPa and near a constant for othe r level. The tre nd averaged over all stations is a ffected by sampling frequency in network as w ell. Decreasing sampling number of the stations enhance warming trend but weaken co oling trend at leve l of 300-850 hPa, and weaken cooling trend at top troposphere and in lower stratosphere.

Keywords: radiosonde, temperature, china

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

MS019 **Oral Presentation** **5667**

Jets and fronts as sources of inertia-gravity waves

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Chris Snyder

Among the tropospheric sour ces of inertia-gravity waves, jets an d fron ts remain poor ly u nderstood, despite their importance. In recent years, the prob lem of gen eration of grav ity waves from balance d motions such as jets and fronts has r ecieved renewed interests, and differe nt mechanisms o r interpretations have been proposed for their generation (geostrophic adjustement, instabilities, Lighthill radiation). In o rder to investigate the mechanisms o f this 'spo ntaneous' genera tion, numerical simulations of i dealized baroclinic life cycles were carried o ut with the Weather Research and Forecast Model. Different life cycles a re obtained by varying the strength of the initial jet and t he shear at t he surface, leading to different nonlinear developments of the instability, and different types of generation of gravity waves, both from th e surface fronts and the jets. These simul ations provide a framework t o investigate fundamental issues on the generation of gravity waves from jets and fronts: what aspects of the large-scale flow deter mine the characterist ics of the emitted waves? Among the different mechanisms p roposed for thegeneration of these wa ves (geostrophic adjustment, Lighthill radiation, ageostrophic instabilities) wh ich one(s) are relevant inthese life cycles, and which one(s) help us t o predict quantitatively the generation from k nowledge of th e large-scale flow? One of th e ou tcomes of these simulations is to highlight the role of propagation in jet exit regions: the strong deformation of the large-scale flow leads t o 'wave-capture', which largely determines the intrinsic frequency of the inert ia-gravity waves from knowledge of the large- scale fl ow. Consideration of a simpler flow, a steadily propagating di pole, allows to better unders tand this aspect and its impl ications for wave-mean flow interactions.

Keywords: inertia gravity waves, jets, wave mean flow interaction

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

MS019 **Oral Presentation** **5668**

Determination of catalytic ozone production and destruction cycles in the stratosphere and mesosphere

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An algorithm for the automatic determinati on of reac tion pathways, e.g. cata lytic cycles, in compl ex chemical reaction systems is presented. Using reaction rates as input, it calculates rates ("fluxes") of the pathways determined. The algorithm was applied to analyse output from a chemical box model that had been initialised by a three-di mensional chemistry-c limate model. It was used to dete rmine catalytic production and destruction cycles of oz one in the stratosphere and meso sphere. The ozone production was dominated by the photolysis of oxygen, as expected. In the lower stratosphere a small contribution from the "ozone smog cycle", known from tropospheric chemistry, was observed. The analysis algorithm was augmented by a procedure to group catalytic cycles into families (Ox, HOx, NOx, ClOx, BrOx). The dominant o zone destructio n cycles at different alti tudes in the atmosphere be longed to the follow ing families: HOx (lower stratos phere: tropics, mid lati tudes), ClOx and Br Ox (lower stra tosphere: pola r spring), NOx and ClOx (upper stratosphere), HOx (mesosphere).

Keywords: catalytic ozone destruction, stratosphere, mesosphere

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MS019 **Oral Presentation** **5669**

Vertical distributions of Temperature, Water, Ozone and Nitric Acid from MARSCHALS measurements during the SCOUT-O3 campaign in Darwin (Nov-Dec 2005)

Dr. Bianca Maria Dinelli
ISAC

B. M. Dinelli, E. Castelli, M. Gai, L. Santurri, B. Carli

MARSCHALS is a FIR heterodyne spectrometer that measures the atmospheric thermal emission with the limb sounding technique.It operates on board the M55-Geophysica stratospheric aircraft. MARC is a retrieval code designed for the analysis of MARSCHALS spectra. The MARC code and the MARSCHALS instrument were developed under an ESA contract to test the performances of limb measurements in the FIR. The results of the measurements acquired by MARSCHALS during the SCOUT-O3 campaign in Darwin (Nov-Dec 2005) analysed with the MARC code will be presented. Vertical distributions of Temperature, Water, Ozone and Nitric Acid in the UTLS region have been obtained. The results have been validated with the measurements of other instruments on board the Geophysica and with model data

Keywords: stratosphere, chemistry, obsevation

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MS019 **Oral Presentation** **5670**

Mesospheric winds study in southern Brazil with an all-sky interferometric meteor radar

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Nelson Jorge Schuch, Cassio Espindola Antunes, Thiago Brum Pretto, Czar Augusto Daroit, Natanael Rodrigues Gomes, Barclay Robert Clemesha, Paulo Prado Batista

Of all the available techniques for winds measurement in the middle atmosphere, only radars allow continuous measurements for long periods of time, making possible the evaluation of the diurnal and seasonal mesospheric wind variations at a given location. A meteor radar system - "All-Sky Interferometric Meteor Radar - SKiYMET", has been installed in Santa Maria, RS, (29.7 S, 53.7W), and has been in operation since December, 2004, making it possible to study mesopause region tidal winds in the South of Brazil. A comparative study between the data collected in southern , in Santa Maria, by the SKiYMET System and the GSWM - Global Scale Wave Model developed at HAO (High Altitude Observatory), NCAR (National Center for Atmospheric Research) by Dr. Maura Hagan will be presented.

Keywords: mesosphere, winds, meteoric trails radar

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

MS019 **Oral Presentation** **5671**

Comparison of satellite gravity wave measurements with a global ray tracing experiment

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Standard techniques for extracting gravity wave (GW) temperature variances from infrared limb sounding satellite data (Preusse et al., 2002) were applied to a four-year series of temperature acquired by the SABER instrument. Prominent structures in the global distribution of monthly mean wave activity appear similarly in all years. Apart from strongly localized forcing by orographic and convective sources, many of these overall structures can be reproduced by a global ray-tracing experiment based on a homogeneous and isotropic launch distribution employing the GROGRAT ray tracer (Marks and Eckermann, 1995). Such measurement-tuned global GW modeling could be used for testing quantitatively some of the crude assumptions made in GW parameterization schemes in global models, such as (for instance) assuming wave propagation in a purely vertical column. Ambiguities in the measurement interpretation will, however, remain unless future limb-imaging instruments measuring at fine horizontal and vertical resolution can directly measure the magnitude and sign of the wave momentum flux.

Keywords: gravity wave, ray tracing, satellite measurements

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

MS019 **Oral Presentation** **5672**

Vertical distribution of temperature fluctuations in mesosphere measurements from SABER and modeling

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Atmospheric temperature fluc tuations are quantified by th eir standard d eviations S from zonal mean temperatures. Four years of SABER data (2 002--2005)show regular structures in the d ependence of S on altitude,latitude, and seas on. Ve rtical pr ofiles of S typi cally sh ow a kin k in th e u pper mesosph ere which is interpreted as a 'wave turbopause', i.e. it is believed to indicate increased wave damping below and decreased damping a bove this level. Middle at mosphere results of the HAMMONIA GCM have been analyzed for s uch fe atures, and very similar structur es are found in spac e and time. Especially a wav e turbopause can be derived from the mod el data as well, and its al titude is similar to that of the measurements. The turbopause altitude shows strong latitudinal and sea sonal variation s in the SABER data. Very similar variations are seen in the model data, though less pronounced. To bet ter understand the vertical S profiles with their kinks, climatolog ies of planetary wa ves, gravity wa ves, and tides (GSWM) have been analyzed. They all show profile kinks somewhere in the mesosphere. The interaction of gravity waves and planeta ry waves was studied by a special HAMMONIA run in which the gravit y waves hav e b een omitted. The resulting ve rtical si gma profiles are quite peculiar in two respects: 1. Omission of the gravity wave s increases(!) the stand ard deviation sigma considerably at all altitudes in the mesosphere. 2. The relative shape of t he vertic al profile of S very much resembl es th at of th e standing plane tary wave SP W 1 as shown by the SP W climatol ogy of J. Forbes. T his su ggests th at omission of the gravity wa ves has strongly reduced the damping of the planetary waves. This reduction could have be en achieved b y shifting t he zero wind line and lo w wind regimes in th e meso sphere. Indeed, the HAMMONIA run without gravity waves shows a wind field with no zero wind line at all in the mesosphere at thelatitudes studied.

Keywords: wave turbopause, saber, hammonia

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MS019 **Oral Presentation** **5673**

First results on mesospheric rotational temperatures using ground-based multi-wavelength photometer from Tirunelveli (8.7N), India

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S.Gurubaran

Night time mesospheric OH (8, 3) rotational temperatures have been estimated from the measurements of the relative intensities of therotational lines [P1(2) (7 31.62nm) and P1(5) (740.2nm)], using the multi-wavelength filter photometer recently installed at Tirunelveli (8.7oN, 77.8oE), an equatorial station in India.The OH airglow photometer has been operated during a few nights of clear sky conditions. Few data sets that show gravity signatures have been isol ated from the rotati onal te mperature data. Comparisons are also made with simultaneous meas urements o f ho rizontal wind parameters aro und mesopause altitudes obtained from the co-located MF radar in order to examine any possible association of dynamical parameters with the mesopause temperat ure variabilities. The detailed results will be presented during the meeting.

Keywords: rotational temperature, gravitywaves, nightglow

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MS019 **Oral Presentation** **5674**

Interannual variability in mesospheric wintertime descent: implications for thermosphere-stratosphere coupling

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Observations from the Sounding of the Atmosphere with Broadband Emission Radiometry (SABER) experiment on the NASA/Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) satellite show an unusual vertical displacement of the winter stratopause in 2006 with zonal mean temperatures at 0.01 hPa (80 km) exceeding 250 K. By contrast, at the conventional stratopause location near 50 km, temperatures were unusually cold. Simulations with the NOGAPS- ALPHA model suggest that these are coupled to an unusually warm and disturbed lower stratosphere that filtered out many of the gravity waves that normally break at and above 50 km. The model also shows that downward transport in the 2006 Arctic vortex was enhanced relative to 2005. These results might explain observations of enhanced upper atmospheric NO descending to the upper stratosphere in 2006 and highlights the importance of gravity waves in modulating the coupling of the upper atmosphere with the stratosphere.

Keywords: mesosphere, waves, vortex

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

MS019 **Oral Presentation** **5675**

Chemical ozone loss from models and measurements deduced using ozone-tracer relations

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We show that chemical ozone loss in the Arctic and Antarctic may be deduced ina reliable manner using ozone-tracer relations. Mixing across the vortex edge,when it occurs, may only lead to an underestimate of ozone loss; differen tialdescent followed by mixing within the vortex and intrusions of mesospheric airinto the stratospheric vortex have only a minor impact on ozone tracerrelations. The methodology is also applicable to the analysis of model re sults,we demonstrate that chemical ozone loss may be significantly underestimated inchemistry climate models. Measurements by HALOE were used to deduce amulti-year time series of chemical ozone loss in both the Arctic and theAntarctic which is reliable also during years when HALOE measurements areinfluenced by the stratospheric aerosol cloud from the eruption ofMt. Pinatubo. We find that ozone loss during the time period of maximum chlorine is saturated in the Antarctic but that a potential for increasingozone loss exists in the Arctic, in case of a cooler polar vortex in thefuture.

Keywords: polar ozone loss, ozone tracer relations, chemistry climate models

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

MS019 **Oral Presentation** **5676**

O3-N2O correlations: Revisiting a diagnostic of transport and chemistry in the stratosphere

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We revisit a widely used diagnostic of transport and chemistry in the stratosphere the O3-N2O correlation with newly obtained data from the Atmospheric Chemistry Experiment (ACE) satellite instrument. ACE provides the first comprehensive data set for the investigation of inter-hemispheric, inter-seasonal, and height-resolved differences of the O3-N2O structure. Our knowledge of stratospheric O3-N2O correlations is thereby extended and their potential for model-measurement comparison assessed. By sub-sampling fields from the Canadian Middle Atmosphere Model (CMAM), we show that the representativeness of the ACE data is somewhat restricted and therefore may lead to biases in the interpretation of the O3-N2O structure. However, area- and measurement-weighted joint probability density functions (PDFs) can drastically improve the evaluation, especially in the middle stratosphere where the correlations are not compact and therefore mainly reflect data sampling. It is shown that PDFs provide a detailed picture of key aspects of transport and mixing such as the tropical pipe, surf zone and polar vortex, but also trace polar ozone loss. Below about 20 km, the ACE data confirm the compactness of the correlations as found in previous aircraft measurements and also the existence of distinct polar and midlatitude branches, especially in the SH. The compactness allows a quantitative comparison of the correlation slopes in the lower and lowermost stratosphere, which exhibit pronounced and distinct seasonal cycles. We discuss observed differences found in the seasonal cycles in the Northern and the Southern Hemispheres and evaluate the capability of the model to represent these cycles.

Keywords: stratosphere, correlations, validation

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

MS019 **Oral Presentation** **5677**

Variability of ozone in the upper mesosphere and its relationship with temperature and dynamics

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Measurements of global ozone in the mesosphere by the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) indicate the ozone in the upper mesosphere is highly vari able. Ozone at these altitudes is close to photochemical eq uilibrium during both day and night. The variability reflects changes in the equilibrium due to changing temperat ure and background density as well as changes in the concentrations of atomic oxygen and re active hydrogen species. We also compare the mean and variations of ozone with simulations from the Whole Atmosphere Community Climate Model (WACCM) to aid in diagnosing the causes for the variability.

Keywords: ozone, saber, mesosphere

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

MS019 **Oral Presentation** **5678**

A numerical study of mesospheric gravity waves forced by cumulus convection

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Characteristics of mesospheric gravity waves forced by cumulus convection are investigated using a two-dimensional ARPS model that extends to z = 105 km. The basic-state wind used in the simulation is the July mean zonal-mean zonal wind at 35 N from the CIRA climatology data, which represents best for the background condition of July 18, 2001 airglow observation at Mt. Bohyun, Korea. It is found that the convectively forced internal gravity waves amplify with height as they propagate upward and are broken near z = 75 km within 1 hour. The area of wave breaking widens and extends downstream with time, and consequently, the flow near the breaking region is dramatically changed. The drag forcing due to the gravity wave momentum flux is a few m/s/day below about 70 km but is more than 50 m/s/day above 80 km. The spectral analyses of the vertical velocity show that the characteristics of gravity waves below and above 75 km are different significantly: waves with longer (shorter) horizontal wavelength (than 50 km) and longer (shorter) period (than 20 min) are dominant below (above). Especially, above z = 85 km, horizontal wavelength and period spectra are nearly homogeneous for all components, since the flow is almost completely mixed by the wave-breaking process.Instability due to the breaking of gravity waves above z = 75 km is likely the secondary source of gravity waves, which has a wide spectral range. Decomposition of upward and downward propagating waves demonstrates clearly that the waves below about 70 km are the superposition of the upward propagating waves from the troposphere and downward propagating waves from the secondary source in the mesosphere, and their spectral shape is determined largely by the basic-state wind through the critical-level filtering process, along with wave reflection at the boundaries of different vertical wavenumber. This result implicates that the waves generated by the secondary source are important not only in the upper mesosphere but also in the mid-mesosphere and stratosphere.

Keywords: gravity waves, secondary source, momentum flux

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

MS019 **Oral Presentation** **5679**

Past and future influence of changes in stratospheric climate on the evolution of Antarctic ozone trends

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Long-term changes in climate will affect both stratospheric temperatures and transport which in turn are likely to affect the chemical processes driving ozone depletion over Antarctica. Recent studies have shown that temperatures close to the vortex edge exhibit strong control over the size of the Antarcticozone hole while the mean meridional temperature gradient affects the strength of the polar night jet and hence the dynamical isolation of the Antarctic vortex. An overview of recent changes in Antarctic stratospheric temperature fields and their effect on the severity of ozone depletion within the polar vortex will be presented. To provide a quantitative basis for investigating this dependence, a semi-empirical model relating the annual conversion of total inorganic halogens in the Antarctic stratosphere (Equivalent Effective Antarctic Stratospheric Chlorine - EEASC) to activated forms, as a function of the area of polar stratospheric clouds exposed to sunlight, has been developed. This model, trained on MLS observations of ClO, can be used to calculate the total mass of activated EEASC through a given season when provided with stratospheric temperature fields and a definition of the vortex edge. A second semi-empirical model, relating the time rate of change in Antarctic ozone mass deficit (OMD) to the mass of activated equivalent chlorine and to mid-latitude planetary wave activity has also been developed. The OMD is a robust measure of the severity of Antarctic ozone depletion and these two semi-empirical models are able to explain much of the intra- and inter-annual variability observed in daily OMD time series. Furthermore, assuming that the key sensitivities of EEASC activation on polar stratospheric clouds exposed to sunlight and OMD tendency on EEASC activation will remain unchanged in the future, these simple models can be used to estimate how future changes in stratospheric climate (both in temperature and in wave activity) may affect the future evolution of the severity of Antarctic ozone depletion. Application of these models to such projections will be presented.

Keywords: ozone, dynamics, climate

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

MS019 **Oral Presentation** **5680**

H2O densities in the mesosphere and lower thermosphere measured by TIMED/SABER

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The SABER instrument on board the TIMED Satellite is a limb scanning infrared radiometer designed to measure temperatures, minor constituent densities and energetics in the mesosphere and lower thermosphere (MLT). The broadband 6.3 micron channel radiances are measured in order to retrieve H2O densities. During daytime adequate interpretation of these radiances requires application of a detailed non-LTE model of H2O in the MLT that accounts for various processes of radiative and collisional excitation and quenching of vibrational levels. Pumping of H2O vibrations by absorption of the solar near infrared radiation and vibrational-vibrational energy exchange with the excited O2(v) molecules also must be included. In this study we utilized the daytime extended H2O non-LTE model of Manuilova et al, 2001 coupled with the novel model of the electronic-vibrational kinetics of the O2 and O3 photolysis products suggested by Yankovsky & Manuilova, 2006. Both models were updated using the newest collisional and radiative rates available and optimized for massive data processing. The sensitivity of retrieved H2O densities to the model parameters is discussed. The retrieved densities for various seasons and locations are compared to those obtained in other satellite experiments.

Keywords: water, retrieval, non lte

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

MS019 **Oral Presentation** **5681**

Ozone variation in the years 1980-2100 calculated by the CCSR/NIES CCM in the CCMVAL-REF2 scenario

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Global ozone variation in the REF2 scenario of CCMVal was calculated by the Center for Climate System Research, University of Tokyo / National Institute for Environmental Studies (CCSR/NIES) chemistry-climate model (CCM) in the years 1980-2100 using the Ab scenario (WMO 2003, Table 4B-2) for the halogen concentration and the IPCC A1B scenario (IPCC, 2000) for the greenhouse gas concentration. Table 1-16 in WMO (2003) is used for the halogen concentration after 2050. The sea surface temperatures for the past and future are prescribed by the outputs of an atmosphere-ocean coupled general circulation model (CGCM) calculation for climate change, which uses the same greenhouse gas scenario. The CGCM was developed by CCSR, NIES, and the Frontier Research Center for Global Change of the Japan Agency for Marine-Earth Science and Technology (FRCGC). The results of the REF2 run suggest that the ozone hole will disappear around 2050-2065. A sensitivity run was performed, in which the concentration of the global warming gases was fixed to the values at 1975 and the sea surface temperature was fixed to the 1970s mean. The results show that the global warming effect accelerates the disappearance of the ozone hole by 10-20 years owing to ozone production in the colder stratosphere of the future atmosphere. Tropopause height elevation in the future atmosphere of the REF2 scenario and its effects on the ozone profile are analyzed and discussed. A small ozone hole in a given year in high planetary wave activity with high equivalent effective stratospheric chlorine (EESC) concentration in the REF2 run is also analyzed, discussed, and compared with the observed 2002 ozone hole.

Keywords: ccm, ozone, prediction

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MS019 **Oral Presentation** **5682**

Current challenges in middle atmosphere science

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The past 15 years have seen a golden age of middle atmosphere measurements, driven in large part by the problem of stratosph eric ozone depletio n. Unfortunately, this is not li kely to continue. However in the last few years, data assimilation syste ms have begun to encompass the middle atmosphere, while Chemistry Climate Models have finally emerged as useful tools for the attribution and prediction of long-term changes. In light of this developing shift from a measurement-driven to a model-driven field, a perspective is offered on some current challenges in middle atmosphere science.

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MS019 **Oral Presentation** **5683**

Analysis of Short-term Variation of Stratospheric Ozone Connected Dynamical Variations over Rikubetsu, Japan

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In order to understand d ynamical effects to short- term variations of the stratospheric ozone, w e investigated the altitudinal dependence o f rela tionships between the oz one mixing ratio and the dynamical par ameters. In this work , we u sed th e data of vertical oz one distribu tion obtain ed from November 199 9 to Decembe r 2001 with a ground-bas ed millimeter-wa ve radiometer at Rikub etsu, Japan (43.5N, 143.8E) operated by National Institute for Environmental Studies (NIES) since November 1999. Potential temperature and potential vorticity as indices of the horizontal transport and the vertical displacement, respectively were calculated from NCEP Reanalysis data. We applied a multiple regression model in order to evaluate the contribution of these tw o dynamical p rocesses to th e short-term variations of o zone. We fou nd th at about 80% of th e sh ort-term variatio ns of oz one at fou r altitu des (20, 22, 24, 26 km) can be explained by the two dyna mical processes. At 20km, vertical displacement is the major fact or, while the role of horizontal tr ansport becomes important and its contribution is comparable with that of vertical displacement at 26km. Moreover, when we used equivalent latitude as an index of th e horizontal transpor t instead of potential vorticity, we found that the contribution of horizontal transport has increased more than that in case of potential vorticity. We will present details of the results and will discuss about the difference be tween the results by using potential vorticity and equivalent latitude.

Keywords: stratospheric ozone, dynamical effects, short term variations

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MS019 **Oral Presentation** **5684**

Predictability of stratospheric sudden warmings in the Northern Hemisphere as inferred from ensemble forecast data

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Stratospheric sudden warmings are caused by enhanced planetary waves propagating from the troposphere. In some sudden warmings, only planetary waves with zonal wavenumber 1 essentially contribute to their occurrence, while wavenumber 2 and/or 3 components play an important role in the development of other sudden warmings, which are often accompanied with split polar vortices. Such a difference in the course of time evolution would make a difference in predictable periods of the sudden warmings. In this study, we examine 4 warming events occurring in recent five Northern Hemisphere winters using the Japan Meteorological Agency (JMA) ensemble one-month forecast data. Each predictable period is carefully estimated on the basis of the prediction of zonal mean temperatures in the polar stratosphere. Furthermore plausible factors giving rise to different time evolution of each event is discussed. It is found that predictable periods are fairly different depending on the time evolution of the warmings; the lead time for the prediction of the wavenumber-1 warmings is relatively long, say, 2-3 weeks in advance, compared with that of the warmings contributed to by wavenumber-2 and/or 3, say, 7-10 days. The short predictability of the latter might be connected to the difficulty in the prediction of wavenumber-2 and 3 evolution compared with that of wavenumber-1 evolution. Even if the time change of zonal mean temperatures is successfully predicted, that of zonal-mean zonal winds is often difficult to predict; this may be due partly to the failure in precise prediction of the wavenumber-2 and 3 evolution.

Keywords: predictability, stratospheric sudden warming, ensemble forecasts

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MS019 **Oral Presentation** **5685**

Latitudinal Extent of Solar Proton Forcing from Hydroxyl Observations and Modelling

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Solar forcing affects the neut ral chemistry of the middle atmosphere, also in the form of energetic particle precip itation (EPP). T he ionisation caused by the precipitating p articles leads t o productio n of odd hydrogen and odd nitr ogen species. Subseque ntly, substantial loss of oz one may occu r in the mesosphere a nd upper strat osphere thus affecting the t hermal balanc e and dy namics of the middle atmosphere. The direct effec ts of EPP are confined in the polar regions by th e Ea rth's dy namically changing magnetic field. We utilise hydrox yl observ ations from the MLS/Aura satellite instrument to study the latitudinal extent of particle forcing in the northern polar region during the January 2005 solar proton event. We also predict the hydroxyl change s with respect to the magnetic latitude by the Sodankyl Ion and Neutral Chemistry model, estimating the variable magnetic cutoff energies for protons using a parameterisation based on magnetosph ere modelling and the Kp magnetic index. The observations s how th e bou ndary of th e pr oton for cing w ith th e tran sition region , fro m n one to "fu ll" effect, ranging from about 57 to 64 degrees of ma gnetic latitude. The model predictions are in reasonable ag reement with the measurem ents, alth ough the transition region seems to be more poleward than in the data.

Keywords: odd hydrogen, solar proton event, magnetic cutoff

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MS019 **Oral Presentation** **5686**

Zonal Asymmetry of Methane Distributions in the Equatorial Lower Stratosphere Associated with the Quasi-Biennial Oscillation

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Hyesun Choi

Relationships between the quasi-biennial oscillati on (QBO) in the equato rial zo nal wind and the zonal distributions of observed methane are examined by using satellite data. Zonal wind at 10 hPa during the wintertime based on ECMWF ERA-40 data shows differe nt levels of zonal asymmetry dependent on the phase of the QBO. The met hane mixing ratios for the pe riod 1993-200 2 were obtaine d from Hal ogen Occultation Experiment onboard Upper At mosphere Research Satellite. Observed m ethane s hows different levels of zonal asymmetry in the m ethane distribution dependent on both QBO phase and the observing latitude. Among methane distributions at 10S, 10N and the equator, the zonal asymmetry i s the strongest at 10N. The zonal variations of the ob served methane at 10N from Januar y to March are large when the equatorial zonal wind is westerly, but those are fairly small when zonal wind is easterly. The correlation between zonal asymmetries of the eq uatorial and 10S met hane and the equatorial QBO phase seems to be small. Possible mechanis ms for th eses correlations between the zonal asymmetry of methane distributions and the equatorial QBO are discussed.

Keywords: qbo, asymmetry, methane

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MS019 **Oral Presentation** **5687**

Variability of mesospheric gravity wave activity at high and mid-latitudes

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The seasonal variation and interannual variability of gravity wave activity in the mesosphere/lower thermosphere (MLT) region at high and mid-latitudes is investigated for periods of low and high solar activity. Variations of the gravity wave activity are examined in relation to the filtering processes due to the changes of the background winds, tides and planetary waves. Our studies are basing on MF radar wind measurements at Andenes (69N, 16E) and Juliusruh (55N, 13E) as well as on meteor radar observations of winds and temperatures at Andenes (69N, 16E), and Khlungsborn (54N, 12E). Furthermore, the variability of mesospheric temperatures is derived from continuous radar observations of meteor decay times. Additionally, turbulent energy dissipation rates have been estimated from spectral width measurements using a 3-MHz Doppler radar near Andenes. Particular attention is directed to the changes of winds, turbulence, and gravity wave activity in the mesosphere during winter with its strong variability due to enhanced planetary wave activity and related sudden stratospheric warming (SSW) events. In a case study, increased turbulent energy dissipation rates are observed during a period of intensified westerly winds following a SSW related wind reversal. At the same time, enhanced activity of gravity waves with periods between 3 and 9 hours is observed in the altitude range 70 - 85 km together with reduced amplitudes of stratospheric planetary waves. During summer, the thermal state of the polar mesosphere is characterized by the lowest temperatures of the Earths atmosphere allowing the formation of ice clouds, which can be observed by VHF radars as polar mesosphere summer echoes (PMSE). Here, the interannual variability of their occurrence rates is studied with respect to variations of the gravity wave activity due to changes of the background circulation.

Keywords: gravity waves, vertical coupling, mesosphere

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MS019 **Oral Presentation** **5688**

A revised ozone parameterisation scheme: COPCAT coefficients within SLIMCAT simulations

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For computational cost reasons, operational NWP models do not implement a complete ozone chemistry but use simplified ozone photochemical parameterisations instead. The most widely used ozone parameterisation is the Cariolle and Dquu scheme (CD scheme) [Cariolle and Dquu, 1986], which is a linearization of ozone sources and sinks in terms of temperature, local ozone and ozone column above the considered grid point. The coefficients for the CD gas-phase scheme can be provided by off-line photochemical models [Cariolle and Dquu, 1986; McLinden et al., 2000; McCormack et al., 2004; 2006]. Up until now, the effects of the heterogeneous chemistry on ozone have been considered apart by adding a heterogeneous term to the CD scheme. In this work a new set of coefficients (COPCAT) has been derived for the CD scheme using the off-line SLIMCAT chemical transport model (CTM). The SLIMCAT stratospheric chemistry includes reactions occurring on liquid aerosols, solid NAT and ice particles. In the present version of the coefficients the effects of chlorine activation and polar ozone loss are therefore included implicitly. 3D SLIMCAT simulations have been run to test the new set of coefficients and a comparison with other existing sets is presented. Testing the coefficients within the same CTM that has been used to obtain them provides an excellent framework to assess the performance of the CD linear scheme and identify regions where this scheme may be less suitable. Results using the new COPCAT coefficients are in very good agreement with observations over the Southern Hemisphere, where a realistic simulation of the spring ozone hole is accomplished with the new coefficients. However, the COPCAT coefficients produce too low values over the tropics, and too high values over northern high latitudes, problems that are common to all previous sets of coefficients, and are much less obvious in full-chemistry runs of SLIMCAT. Also the effect of using different analysed winds to run the CTM is investigated, as well as the possibility of deriving a stratospheric water vapour parameterisation through the ozone scheme obtained from SLIMCAT.

Keywords: ozone parameterisation, ctms, nwps

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MS019 **Oral Presentation** **5689**

Ground-based millimeter-wave measurements of stratospheric H218O in a subtropical region in the southern hemisphere, Atacama highland in Chile

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Stratospheric water vapor pl ays an important role in chemistry and ra diative energy balance in the middle atmosp here, and it a ttracts attention becaus e of its long-term increasing trend over a few decades until the end of 1990s (e.g., Oltm ans et al . 200 0). The major sources of stra tospheric wate r vapor are considered to be transport from the troposphere and in-situ production by oxidation of CH4 in the stratosphere, but the detailed mechanism of the long-t erm trend is not yet complet ely understood. Water vapor i sotopic ratio i s influenced by vari ous fractionating mechanisms that depend on the transportation path and the c hemical environment, and therefore, meas urements of tim e variations of the isotopic ra tio may lead us to better understand ing of the major causes of the long-term trend of stratospheric water vapor. In order to observe is otopic water vapor , installed a millimeter-wave spectroscopic radiometer in the Atacama highla nd (23 .0S, 67.7W, 4 ,800m Alt.). We carried out continuous observations of an H218O rotational emission line at 204.41GHz (J=3-2, K-1=1-2, K+1=3-0) from 27 Augu st to 30 December, 2006. The radiomet er is equipped with a superconductive mixer receiver with a double-side-band receiver temperat ure of ~ 200K and an acou sto-optical spectrometer (AOS) covering 1GHz bandwidth at 1MHz fre quency resolution. We retriev ed vertical profile of H218O f volume mixing ratio (VMR) fr om 30km to 6 0km by using a weighted-damped least sq uare algorithm (Nagahama et al. 1999) based on the Rodg erss optimal estimation meth od (Rodgers, 1976). Through the four months, the volume mixung ratios (VMRs) of H218O at 50km an d 60km are al most constant, whereas the VMR at 40km increases by ~ 4%/month from spring to summer above Atacama. These tendencies are consistent with our pilot observation of H218O at Las Camp anas Observatory in in 2003. We compared the H218O VMRs with those of the most ab undant H216O and derived the enrichment factor of 18O t o 16O, delta-18O, by usin g AURA-MLS data (Ver. 1.5) at t he location of Atacama. The H216O VMRs at 50km and 60km show a similar trend to H218O, i.e., those are almost constant through the four months. However, a t 40km, the H216O VMR decreases from spring to summer in contrast to H218O, indicating that the enrichment, delta-18O of water vapor varies by ~17% within the four months at 40km. We will pr esent the details of th e resul ts and discuss the implicatio n of the time variation of the VMRs and the 18O enrichment.

Keywords: water vapor, stratosphere, ground based observation

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MS019 **Oral Presentation** **5690**

The Mystery of Calcium in the Upper Atmosphere

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About 50 tonnes of interplanetary dust enters the earths atmosphere every day at speeds ranging from 11 to 72 km s-1. Impact with the atmosphere causes most of the dust to vaporize completely. The metals which ablate from meteoroids are the source of the layers of metal atoms such as Na, Fe and Ca that occur globally in the upper mesosphere and lower thermosphere (MLT). A long-running problem has been the depletion of atomic Ca in the MLT, by more than 2 orders of magnitude with respect to Na. There are two likely explanations for this. Firstly, Ca may ablate much less efficiently from meteoroids. This theory will be examined using a new kinetic and thermodynamic model of meteoric ablation, which includes sputtering and impact ionization of evaporating atoms. Application of this model to the calcium problem places constraints on the meteoroid geocentric velocity distribution. This distribution is currently the subject of intense debate in the radar community. The second explanation for the depletion of atomic Ca is that the atmospheric chemistry of calcium is radically different from other metals. This possibility is being examined through a laboratory study of the kinetics of the pertinent ion-molecule and neutral reactions of calcium species with atmospheric constituents such as O3, O2, O and H. The results of this study, together with the meteoric ablation model, will be combined into a new model of calcium in the upper atmosphere.

Keywords: meteor ablation, calcium layers, upper mesosphere

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

MS019 **Oral Presentation** **5691**

Lidar observations of potassium densities and atmospheric temperatures at Spitsbergen (78N)

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Lidar measure ments of potassium temperatures and number densities were performedin the uppe r mesosphere/lower thermosphere at Spitsbergen (78N) in 2001-2003. A total of 667 hours of hig h precision measurements wer performed covering the season from March until Septemb er and altitudes from 80-110km. The seasonal variation of K densit ies s hows a maxim um from early May until late August, opposite to other metals at low er latitu des. Temperatures a re derived from the Dopple r broadened D1 line of potassiu m with a typical resoluti on of 1km and 1hour, respectively. Ch aracteristic systematic and statistical tem perature uncer tainties are 3K and 0.5-3K, where the latter is valid fo r integration times of 1 day to 1hour, respectively. The K-lidar temperatures are generally consistent with simultaneous and co-located insitu measure ments by falling spheres. Temperatur es show variability on all detectable scales. The magnitude of the fluctuat ions varies little wi th season and is remarkably similar to analog observation s at lower latit udes (54N). The summer m esopause is located at ~90k m and is as cold as ~120K. In winter the mesopause is significantly higher (~100-105km), warmer (~180-190K), and less pronounced.Lowest temperatures are detected at the mesopause around July 4which is approximately 2 weeks after astronomical mid summe r. Large differe nces of more than 20K occur between mean K temperatures and empirical climatol ogies. The lower thermosphere is significantly colder compared to global circulation models.

Keywords: high latitudes, mesosphere, temperatures

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

MS019 **Oral Presentation** **5692**

Mid-latitude temperature soundings by lidar from 1 - 100 km: Annual variation and variability

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Optical Soundings Leibniz-Institute of Atmospheric Physics IAGA

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Temperature profiles from the troposphere to the lower thermosphere are measured at night at the mid-latitude station of Khlungsborn (54N, 12E) by combination of a Rayleigh- Mie-Raman lidar and a potassium resonance lidar. Since autumn 2002 about 240 observations have been performed between 1 and ~100 km altitude, each of 3 - 15 h length. From this data set comprehensive information on the seasonal variation of temperatures has been derived. Additionally, harmonic fits of the seasonal temperature variation are calculated in each particular altitude, allowing for annual, semi-annual, and quarter-annual variation. This method provides information of amplitudes and phases of the individual components. The amplitude of the quarter-annual variation is less than 3 K at all altitudes, while the annual variation dominates throughout the whole range with amplitudes of up to about 30 K (85 km). Around 65 km the amplitude of the annual variation minimizes (less than 3 K) and is about as strong as the semi-annual component. The fitted temperatures nicely represent the observed data even though there is a high night-to-night variability in the winter season between October and March. This variability will be examined further and the dependence of the seasonal fits on the wintertime data with incidental sudden stratospheric warmings will be discussed. In summer the mesopause and stratopause are observed at an altitude of about 87 km (~145 K) and 48 km (~275 K), respectively. In winter the mesopause is located slightly above 100 km (~170 K). For the winter stratopause observations with and without disturbed stratospheric conditions have to be separated. We will compare our data with reference atmospheres like CIRA-86 and NRLMSISE-00, showing some discrepancies especially around the summer mesopause.

Keywords: temperature, mesosphere, lidar

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MS019 **Oral Presentation** **5693**

Mechanisms for coupling the mesosphere and lower atmosphere in data assimilation systems

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Recently, the lids of weather forecast models have been moved into the mesosphere, primarily to better simulate satellite radiances from nadir sounders whose sensitivies extend into this region. While higher lids raise the prospect of assimilating mesospheric data, they also permit the transfer of information through vertical wave propagation. This can occur both through vertical propagation of resolved planetary and gravity waves, and through the parameterized impact of unresolved gravity waves. Since the mesosphere is largely driven by the atmosphere below, analysing the lower atmosphere may then lead to a reasonable analysis of the mesosphere even before mesospheric data is assimilated. In this work, the Canadian Middle Atmosphere Model and 3D-Var data assimilation system (CMAM-DAS) is used to study the mechanisms through which the mesosphere is driven by the lower atmosphere. The impact of vertically propagating resolved gravity waves is demonstrated by the impact of gravity wave filtering schemes on the diurnal tide, and on the global mean temperature in the mesopause. The impact of unresolved gravity waves is demonstrated during stratospheric sudden warmings when the mean flow rapidly evolves, impacting its gravity wave filtering properties.

Keywords: data assimilation, mesosphere, information propagation

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MS019 **Oral Presentation** **5694**

Conditions for the Formation of Mesospheric Undular Bores

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Instances of traveling wave trains observed in the airglow have been identified as mesospheric internal undular bores. They have been observed to occur in association with traveling airglow walls, inversions and strong wind shears. The bores are thought to be associated with some generation mechanism within a duct, as for tropospheric bores, notably the Morning Glory phenomenon, where ducting is the result of trapping due to inversions and background winds. Troposphere bores are generally associated with the lowest mode the system can support. In the mesosphere the ducting can be more complex, since in addition to the inversion in the mesopause vicinity observed in association with bores, there is also under typical conditions a higher ducting layer in the lower thermosphere. This talk reports on a numerical study of ducted waves in the upper mesosphere and focuses on conditions (e.g., inversion thickness and strength, wind shear) that give ducting in altitude regions where the airglow layers in the upper mesospheric and lower thermospheric are found. We find ducted modes that agree with observed phase speeds and wavelengths. These modes include but are not confined to the stable layer associated with the inversion in the mesopause region. The wave in the upper stable layer can be the stronger and more vertically extensive part of the total eigenfunction. However, with a mesospheric inversion and winds similar to those described by Smith et al., (JGR, doi:10.1029/2002JA009500, 2003) the part of the wave in the lower stable layer is much stronger that the wave in the upper layer, and exhibits stronger more nearly resonantamplification than for climatologicalwinds.

Keywords: bores, mesophere, ducting

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MS019 **Oral Presentation** **5695**

Gravity waves generation around the polar vortex in the stratosphere

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It is considered that gra vity waves are e xcited mo stly in the troposphere. However, results of a hodograph an alysis for small vertical- scale wind an d te mperature fluctuations obser ved in the pola r stratosphere by radiosondes indicate that severa l tens percent of gra vity waves pr opagate energ y downward. This means that there exist grav ity wave sources in the polar winter st ratosphere (Yoshiki and Sato, 1999). We made intensive radiosonde observ ations with time intervals of 3 hours over ten days of each season at Syowa Station in the Anta rctic in 2002. Moreover, we performe d a simulation using an aq ua-planet mo del with sufficient high reso lution to reso lve gravity waves explicitly . Through the analysis of these observatoin and model data in detail, the mechanism of gravity wave generation around the polar vortex in the stratosphere is discussed.

Keywords: gravity, waves

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

MS019 **Oral Presentation** **5696**

Geographical Distribution of Potential and Kinetic Energy of Internal Waves in the Atmosphere found from CHAMP and FORMOSAT3 Radio Occultation Data

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The radio occultation (RO) method, which employs the high-precision global positioning system (GPS) signals, allows one to determine the vertical gradients of refractivity and monitoring wave structures in the atmosphere on a global scale in the altitude range from 10 to 40 km. The results of analysis of data corresponding to Challenging Minisatellite Payload (CHAMP) and FORMOSAT3 RO events are presented. We introduce a new technique based on simultaneous analysis of the phase and amplitude variations of RO signal. This technique allows one to reveal contribution of the layered structures corresponding to internal atmospheric waves and separate it from the turbulence effect on the phase and amplitude variations in the RO signal. We found wave clusters in the amplitude and phase variations of RO signal with interior vertical periods from 0.8 to 4 km in the tropopause and lower stratosphere at the heights from 15-40 km (low latitudes) to 10-25 km (moderate latitudes). We demonstrate that the amplitude and phase variations of RO signal can be considered as a radio-holographic image of wave structures in the atmosphere. For internal gravity waves (GW). We show that the GW dispersion and polarization relationships allow one to estimate the vertical profile of the horizontal wind perturbations, its gradient and the GW intrinsic phase speed. Then the geographical distribution of the potential and kinetic energy of IGW has been obtained with a global coverage. In general case, when the origin and type of internal waves are not known, the height dependence of the vertical gradient of refractivity can be applied for monitoring the seasonal and geographical distributions of wave activity at different levels in the atmosphere.

Keywords: radiooccultation, gravitywave, stratosphere

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MS019 **Oral Presentation** **5697**

Comparison of model predictions with data from the OMI SO2 measurements and the CALIPSO backscatter measurements

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The Soufriere Hills volcano (Montserrat) erupted on May 20, 2006. The eruption injected a plume of ash and sulfur dioxide into the lower stratosphere. The SO2 was observed by the Dutch/Finnish Ozone Monitoring Instrument (OMI) on the Aura spacecraft for a period of 23 days (May 20 to June 11). On June 7 the backscatter from stratospheric aerosols was sighted by the CALIOP (Cloud-Aerosol LIdar with Orthogonal Polarization) instrument on board the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) satellite. The two spacecraft are part of a constellation of satellites (the A-Train) that fly in formation and simultaneously observe the same region of the atmosphere. Using data from the two satellite-borne instruments and a microphysical model, we carried out a study of the formation and growth of aerosol particles and found that the theoretically predicted aerosol backscatter at 532 nm agreed extremely well with the measured value. Our work illustrates the use of such models in obtaining closure for instruments making different but coincident observations of atmospheric phenomena.

Keywords: aerosols, model, measurements

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MS019 **Oral Presentation** **5698**

Variations of the residual circulation in northern hemispheric winter and their impact on Arctic ozone

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Due to variability in the tropospheric wave activity th e strength of the residual circulation has a distinct seasonal cycle and significant year to year v ariability. We u se a reverse domain filling tr ajectory model based on ECMWF ERA-40 data and the EC MWF operational data to compil e a multiannual time series of the strength and spatial structure of the polar br anch of the resid ual circulation. Two differen t approaches ar e used in the trajectory rou tine to calculate the vertical movement of air. The first approach is based on the vertical velocity given by E CMWF, a quantity that is derived from the divergence of t he ho rizontal winds and t hat tends to be noisy. Therefore, in the second approach we use a radiation transfer model to calculate t he diabatic heating rates from the divergence of the ne t radiation flux. We compare the derived descent from both methods with measured tracer distributions from satellite data and Arctic field campaigns. The comparison shows that the second approach results in a much more realistic vertical transport. Therefor e the method based on the diabatic heating rates is used to compile a climatolog y of the diabatic descen t averaged within the polar vorte x for the Arcti c winters 1957/58-2003/04. Furthermore the climatology co ntains information of the spatial structure of the diabatic descent. The influence of the di abatic descent in the Arctic polar vortex on the total ozone column is calculated for the recent winters since 1990. We show that th e interannual variability of the Arctic t otal ozone column is in equal shares caused by the dynamical tr ansport proces sses and by the chemical ozone depletion.

Keywords: transport, ozone, stratosphere

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

MS019 **Oral Presentation** **5699**

Tropical oscillations in the middle and upper atmosphere simulated by the HAMMONIA model

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Hauke Schmidt, Marco A Giorgetta

The tropical m iddle and upper atmosphere is characte rized by a range of oscillations in zonal mean zonal wind: The Quasi- Biennial Oscillatio n in the statosphere, the Se mi-Annual Osclillatio ns at the startopause an d at the mesopause, and th e mesosphe ric Quasi- Biennial Oscillation. Results from the Hammonia whole atmosphere model are a nalyzed in or der to evaluate how the vertical evo lution from the troposphere to the therm osphere of the tropical oscillations is simulated. The aims of the evalaution are to pr ovide a comprehensive assessment of how the tropical oscillations are modelled and a context for investigating the impact of the tropical o scillations on transport and chemistry. The manifestation of these oscillations in zonal mean fields as well as in atmospheric waves are reported, to demonstrate the dynamical coupling to the upper atmosphere.

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MS019 **Oral Presentation** **5700**

Stereoscopic imaging of gravity waves in the mesosphere at -mid and low latitudes

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Faivre Michal, Clairemidi Jacques, Meriwether John, Lehmacher Gerald, Chau Jorge, Vidal Erick, Mougin-Sisini Davy

A program of stereo-imaging of the mesospheric near-infrared emissive layer has recently been initiated using two CCD cameras operating in a vis--vis observation mode at a separation distance of ~550 km. These images are analyzed using a stereo-correlation method suitable for low contrast objects without discrete contours. This approach consists of calculating a normalized cross-correlation parameter for the intensities of matched points. Initially, the altitude of the layer is chosen to be between 82 and 92 km. The computer code calculates the altitude of the centroid of the emissive layer for each observed point and produces surface maps of the layer for 50x 50 km2 areas. A first program of simultaneous observations was conducted in September 2000 at the Pic du Midi (42 56 ' N, 8 32' E, altitude 2862m, Pyrnes) and the Chteau-Renard (44 41' N, 6 54'E, altitude 2989m, Alpes) observatories. The calculated surface maps are compared with coded maps of the emission intensity. Both types of maps show significant comparable wave structures. The mean altitude and thickness of the emissive layer are 87 and 7 km. The vertical amplitude of the waves is found to be typically between 1 and 2 km. The Fourier characteristics are measured using a Morlet type wavelet generator function. The horizontal wavelengths in the meridional and zonal directions are ~20-40 km and 100-150 km, and the temporal periods are ~15-30 minutes. The same observational program was conducted in the Peruvian Andes in July 2006. The sites were the Cosmos Observatory (12 04' S, 75 34' W, altitude 4620m) and the Cerro Verde Tellolo mountain (16 33' S, 71 40 ' W, altitude 2272m). Preliminary results including a video sequence that shows the propagation of gravity waves will be presented. 1. MS019 2. Middle Atmosphere Science (ICMA) 3. mesospheric emissive layer, gravity waves, stereoscopic imaging 4. Moreels Guy, Observatoire de Besanon, 41 bis Avenue de l'Observatoire, BP 1615, 25010 Besanon Cedex, France Tl : 33 3 81 66 69 18, Fax 33 3 81 66 69 44, e-mail: guy.moreels@obs-besancon.fr 5. O 6. PC 7. NO

Keywords: mesospheric emissive layer, gravity waves, stereoscopic imaging

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MS019 **Oral Presentation** **5701**

Changing atmospheric composition: Fact or Fiction?

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The atmospheric composition is changing, as a result of natural phenomena and anthropogenic activity. Global knowledge of the changing atmospheric composition is required to test our current understanding of the atmosphere and to improve our ability to predict the response to and feedback between climate change and chemistry. SCIAMACHY and GOME are related passive remote sensing instruments, which observe from the ultraviolet to the show wave infrared red. GOME makes nadir measurements and has flown on the second European Research Satellite since 1995 and makes nadir measurements only. SCIAMACHY was launched on ENVISAT in 2002 and has now made over 5 years of measurements in alternate limb and nadir measurements. Both instruments provide unique insight into atmospheric composition. In particular the limb measurements of SCIAMACHY yield knowledge on atoms molecules and particles from the upper troposphere to the thermosphere. In this talk the observations of ozone and short lived stratospheric species and the observations of metals in the mesosphere and thermosphere will be discussed.

Keywords: stratopshere, mesosphere, ozone

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MS019 **Oral Presentation** **5702**

Empirical master equations applied to stratospheric QBO, solar cycle and northern annular mode

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Prof Joseph Egger, Prof Martin Dameris, Prof Lesley Gray

Time series of climate variables are used to deri ve master equations in the discretized phase space spanned by three variables. The empirical m aster equation (EME) predicts the probability density in this phase space. The EME is formally equivalent to an (empirical) first-order Markov chain descrip_tion. The time series consist of standardized and de-s easonalized quantities obtained from the ERA-40 re-analysis and observations. A first EME is derived fr om time series of the quasi-bienni al oscillation (QBO) of stratospheric equatorial zonal wind at two pressure le vels and from a time series of the temperature of the Arctic middle stratosphere. This EME captures the c limatological f eatures of the QBO and the probabilistic ch aracter of its phase tran sitions. Al so, the Arctic stratosp here at 10 hPa is about 2 K warmer during the easterly phase of the QBO than during the westerly phase. A second EME including a time series of the solar radio flux at 10.7 cm hi nts that t he relationship between the QBO and the temperature in the Arctic stratosphere is shifted to wards warmer or colder states by about 1 K during periods of h igh or lo w so lar activity, resp ectively. In a third EME, the variables chosen are highly correlated with the no rthern annular mo de (NAM). This EME sho ws that NAM ano malies in the middle stratosphere propagate into the lower stratos phere and then in the lower troposphere with a time scale of abou t two and fou rs weeks, respectively. T he in fluence of stron g tr opospheric NA M an omalies is confined to the lower stratosphere.

Keywords: qbo, solar cycle, nam

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MS019 **Oral Presentation** **5703**

Short-period waves in the mesosphere and lower thermosphere observed by SABER

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Ruth Lieberman

The SABER instrument onboard NASAs TIMED satellite has been making global observations of temperature in the stratosphere, as well as in the mesosphere and lower thermosphere (MLT), from January 2002 to date. The measurements have been made almost continuously, on both ascending and descending orbits, except for short breaks during spacecraft yaw maneuvers. This sampling pattern makes SABER observations especially well suited for mapping by Salbys Fast Fourier Synoptic Method (FFSM). Although the FFSM has usually been applied to observations taken during a single yaw cycle of polar-orbiting satellites, we show that it is straightforward to generalize it to data segments of arbitrary length by interpolating the observations to a common Salby s-coordinate. This is useful because, given that the orbit of TIMED precesses in local time, it allows resolution of the diurnal tide when at least two yaw cycles are mapped as a single data segment. We have used this generalization of FFSM mapping to construct a continuous climatology of traveling waves in the MLT, with emphasis on tropical oscillations. We show that, in addition to the migrating tides, variability in the tropical MLT is strongly influenced by the presence of fast, planetary-scale waves, among them the 2-day and 5-day waves, Kelvin and inertia-gravity waves, and non-migrating tides. We illustrate seasonal and interannual changes in the amplitude of these waves and attempt to identify the factors that produce such changes.

Keywords: saber, waves, mlt

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MS019 **Oral Presentation** **5704**

Evidence for diurnal tide and planetary waves coupling from meteor winds at So Joo Do Cariri (7.4 S), Brazil

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Horizontal wind fields in upper mesosphere and lower thermosphere (MLT) region obtained during 2005 by meteor rad ar at So Joo do Cariri-PB, Brazil (7 .4S, 36. 5W), were used to study the diurn al an d planetary waves coupling. The spectral analysis of th e hourly winds, besides presenting strong diurnal and semidiurnal power, also shows distinct power sp ectrum with peaks associated with low-frequency oscillations. Se ries of amplitu des of the diurnal ti des wer e also obtaine d. The diurnal tide amplitud e series also revealed periodic variability associated with planetary wave occurrence, som etimes with the same periods as the wind amplitudes at the 2, 5, 6.5 and 16-day periods. These relationships have been investigated using bispectral analysis and t he results are interpreted in terms of nonlinear interactions between diurnal tides and planetary wave components.

Keywords: tidal, planetay waves, coupling

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MS019 **Poster presentation** **5705**

Stratosphere Troposphere Interactions during the passage of cyclones using Indian MST radar

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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 momentum flux and mass flux transport during the cyclones are also studied. The major outcome of the study will be presented in detail.

Keywords: tropicalcyclone, stratosphere, troposphere

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MS019 **Poster presentation** **5706**

Characteristics of stratospheric gravity waves in the tropics Analyzed by using GPS RO data in 2001-2006

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Using a long-term observations of the stratospheric temperature proflies with the GPS radio occultation (RO) by the German CHAMP satellite, we have studied the clomatological beahvior of the atmospheric gravity waves and Kelvin waves in the tropics. We calculated the wave potential energy, Ep=1/2(g/N)^2(T/T0)^2, where T is the temperature fluctuations with vertical scales shorter than 7 km, g is acceleration of gravity, N is Brunt-Vaisala frequency, and T0 is background temperature. Ep is estimated in a longitude and latitude cell of 20ox10o at 19-26 km and 19-33 km. We analyzed the mean value of Ep in the equatorial region every three months (Jun/Jul/Aug, Sep/Oct/Nov, Dec/Jan/Feb, Mar/Apr/May) from June 2001 to May 2006. The Ep distribution is compared with the cloud parameters, i.e., cloud top height from OLR, convective rain rate and storm height from TRMM-PR (precipitation radar). The Ep distribution in the western Pacific shows a clear seasonal variation. Ep becomes the maximum in Dec/Jan/Feb, and it is considerably enhanced in Mar/Apr/May and Sep/Oct/Nov. Ep becomes minimum in Jun/Jul/Aug, and its center moves toward north. Localized enhancement of Ep seems to be mainly contributed by gravity waves. In addition, longitudinally elongated portion of Ep is partially affected by Kelvin wave-like disturbances with short horizontal scales. This is evident in Dec/Jan/Feb, when the convective heat source is located over the equator. The longitude distribution and seasonal variations of Ep are closely related to the cloud convection. However, in addition to the wave generation (convection), wave propagation characteristics, such as wave-mean flow (QBO) interaction, must be considered.

Keywords: gravity waves, equatorial region, gps radio occultation

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MS019 **Poster presentation** **5707**

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 earth's 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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MS019 **Poster presentation** **5708**

Long term trends in tides in the lower thermosphere above Antarctica

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Radar observations of the winds above the Antarctic coast have been underway since 1968 using meteor (Molodezhnaya, 45.9 E, 67.7S) and MF (Mawson 62.9E 67.6S, Davis 78.0E, 68.6S) radars. Comparisons between concurrent observations from Moldezhnaya and Mawson, and with other meteor radar systems aid the process of cross calibration of the measurements. Monthly tidal amplitudes and phases that have been extracted from these winds will be presented along with information on long-term trends.

Keywords: tides, trends, antarctica

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MS019 **Poster presentation** **5709**

A model for interpretation of space-based optical data containing information about gravity waves in the mesosphere.

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Quantitative characterization of a role of gravity waves in the mesosphere is still insufficient although our understanding of one has improved considerably. Significant advances could be made by systematic survey of gravity waves which can be accomplished by spacecraft based imaging only. Nadir viewing from International Space Station (ISS) would permit the observation of the short wavelength (down to $\lambda x \approx 10$ km) gravity waves which are most significant in controlling the MLT energy and momentum balance. This paper presents a model for interpreting space-based optical data which contain information about gravity waves. In a model is considered a situation of observation of the O2 Atmospheric (0,0) dayglow emission from ISS under twilight conditions, i.e. when tropospheric and stratospheric domains are in the Earth's shadow, and the MLT region are illuminated by rising or setting Sun. In the frames of this theoretical model the complete set of functions has been created as a basis functions for spectral decomposition of an observed brightness field. It is shown that spectrum obtained in this case may be interpreted as a spatial Fourier spectrum of wave induced temperature fluctuations. The special methods for image processing and comparing experimental data with simulated data have been developed. The results of a treatment of the images obtained onboard ISS are shown. Merits and demerits of a proposed method are discussed.

Keywords: gravity waves, dayglow, space based observations

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MS019 **Poster presentation** **5710**

A modeling study of O2 Atmospheric (0,0) nightglow wave perturbations observed from space

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Alpatov Victor

A three-dimensional model is used to investigate the relations between parameters of atmospheric gravity waves (GW) and spatial structure of O2 Atmospheric (0,0) nightglow wave perturbations observed from space. The observed amplitudes of the airglow perturbations induced by GWs are calculated for different slanting lines of view. It is shown that observed perturbations may be divided into the linear and nonlinear parts. The linear perturbations appear as a wave signature observed at certain view directions. The nonlinear part of perturbations causes an increasing of all sky brightness of the O2 Atmospheric (0,0) nightglow. The model calculations show that at the certain view directions the cancellation effect for waves passing through emission layer is disappeared, i.e. the waves whose vertical wavelength is smaller than thickness of the emission layer may be successfully registered. The latter gives opportunity to create the complete set of functions which may be used for spectral decomposition of observed brightness field. The obtained spectrum may be interpreted in terms of Fourier coefficients of 3D-decomposition of the temperature fluctuations induced by gravity waves. The model simulations have shown that nonlinear addition caused by the GWs passing through the O2 Atmospheric (0,0) emission layer results to the noticeable modulations of all sky brightness of O2 nightglow. The magnitude of these modulations can achieve value of 10% of the background brightness.

Keywords: gravity waves, nightglow, space based observation

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MS019 **Poster presentation** **5711**

Simulation of Semidiurnal Tide in an Ultrafine Resolution Global Model

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Wataru Ohfuchi

wave that is forced mainly by solar heati ng in the ozo ne layer. The semidiurnal surface barometric oscillation, denoted S2(p), has been determined at very large numbers of stations throughout the world. This talk considers how well the semidiurnal tide and particularly its expression at the surface as S2(p) can be mo delled by co mprehensive atm ospheric general circulatio n mo dels (AGCMs). First th e simulation of the semidiurnal tide in previous AGCMs is reviewed, starting with the early work of Zwiers and Hamilton (1987) and Tokioka and Yagai (1989). Arguments will be presented showing that, perhaps paradoxically given the global scale forcing of the tide, there are advantages to analyzing S2(p) in very-fine resolution GCMs. Then recent results fo r S2(p) from a T1279 version of the AFES (AGCM for the Earth Simulator) will be presented. The an alysis of these results will sh ow ho w fine-resolution glo bal model simulati ons together with observati onal anal yses can be used to determine t he topographic effects on S2(p).

Keywords: tides, agcm

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

MS019 **Poster presentation** **5712**

Longterm behavior of sporadic sodium layers at 23 S

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Barclay Clemesha, Paulo Prado Batista

The INPE lidar has been measuring atmospheric sodium since 1972, and the first observation of a sporadic layer was reported in 1978. In this paper we look at the occurrence and characteristics of these layers, measured with a height resolution of 0.25 km, for the period 1987 to 2006 (the data from 1972 to 1987 was presented in Batista, et al. [1989]). The diurnal variation for the number of layers per hour of data evaluated in one hour intervals for the period shows a broad peak for the night time period with a maximum of 0.62 layers/hr at 0100 hrs. This behavior is substantially different from that reported in Batista et al. where the maximum was also broad going from 2300 to 0400 hrs but very flat. This study shows a preferred height for the layers (evaluated at 1 Km. Intervals) of 94 Km, little different from the value of 95 km obtained by Batista et al. The shape of the height distribution is quite similar also. The height of the peak for the sporadic layers evaluated in one hour intervals shows more variation than the peak height of the normal layers which shows a diurnal variation descending from a peak at 22 hr. to a minimum at 15 hrs. While the period 15-23 has a similar behavior, but with a peak ~2 Km. higher, there appears to be a secondary peak around 12 hrs. The distribution of layer width s peaks at 1.25 Km. FWHM and then falls roughly exponentially out to 4.5 km. In Batista et al. the lowest value was 1.2 Km., the peak around 2 Km. and the largest was 4 Km. The strength factor (ratio of the peak value to the average determined background value) distribution also shows an exponential behavior with a maximum occurrence at 2 (smallest considered sporadic layer) extending out to 10 (largest layer considered). In Batista et al. the peak was also at 2 but the largest was 5 (except for 1 point at 7). Dividing the data into seasons centered on the solstices and equinoxes only gave meaningful results for the strength factor and layer width, mainly because our data acquisition is very seasonally dependent, with winter having the most and best data and summer having the least and worst. The layer width shows no appreciable seasonal variation out to a width of 3.5. The strength factor has a definite annual variation with winter having the broadest distribution and summer the narrowest. The data show that there were more low strength layers (68%) and substantially less high strength layers (20%) in winter as compared to summer. A preliminary year- to-year analysis of the occurrence rate of sporadic layers does not show an appreciable variation over the period analyzed.

Batista, P. P., B. R. Clemesha, I. S. Batista and D. M. Simonich, Characteristics of the sporadic sodium layers observed at 23 degrees S, J. Geophys. Res., 94, 15349-15358, (1989).

Keywords: sporadic, sodium, lidar

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MS019 **Poster presentation** **5713**

A correlation between tidal wind shear and gravity waves in the low latitude MLT region.

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Meteor radar measurements of winds in the MLT region show that the amplitudes of short period fluctuating winds are closely related to the vertical shear of the tidal winds. The radar data, obtained by Skiymet radars located at So Joo do Cariri (7.4 S, 36.5 W), Cachoeira Paulista (22.7 S, 45.0 W) and Santa Maria (29.7 S, 53.7 W), were analyzed in 3-hour/3-km bins in such a way as to provide estimates of the mean zonal and meridional wind and the corresponding fluctuating components with periods of 3 hours or less. A comparison between the rms fluctuating wind components and the vertical shear of the horizontal winds shows that there is a high degree of correlation between them. This correlation is apparent for the short period variations between sample intervals and can also be seen over longer periods, including the mainly semi-annual seasonal variation. Our results suggest that the short period wind fluctuations, assumed to correspond to gravity waves and turbulence, might be largely generated by tidal wind shear. This being the case, gravity waves propagating up from the troposphere and generally believed to make a major contribution to the energy and momentum budgets of the MLT, may be less important than the tidal winds.

Keywords: gw, wind shear, meteor radar

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MS019 **Poster presentation** **5714**

COSMIC temperature and humidity profiles - A validation study

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Pangaluru Kishore, Kiyoshi Igarashi

This paper addresses the validation of temperature and humidity profiles derivedby the recently launched COSMIC satellite. GPS radio occultation technique has been applied to derive high resolution datasets of temperature, pressure, and refractivity profiles. COSMIC-RO provides about 1000-1200 vertical profiles of atmospheric parameters per day within the height interval of 0-40 km. Typical vertical resolution of the profiles ranges from 30-40 m in the lower troposphere to 100-200 m inthe stratosphere. For the validation studies, we have used other data sets including CHAMP, NCEP reanalysis, and radiosondes. Comparison of COSMIC temperature profiles with the nearest radiosonde observations reveals good agreement. We found certain differences in the CHAMP and COSMIC measurements, especially for the polar regions. COSMIC humidity profiles derived by the direct water vapor pressure (DWVP) technique are compared with the CHAMP measurements. We see reasonably good agreement between the two measurements. The paper will describe the global temperature trends in the lower atmosphere.

Keywords: cosmic, temperature, humidity

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MS019 **Poster presentation** **5715**

The vertical structure of the winter stratospheric warming on lidar data

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Valery Marichev, Semyen Titov

A height temperature profile measurements were made with Rayleigh backscatter lidar near Yakutsk (61 N, 129.7 E). A n Nd:YAG laser on 532 nm was operatin g as source sounding impulses with rate 20 Hz, pulse energy is 195 mJ. A Newton system telescope with 60 cm diameter and 200 cm focal length used as receiving antenna. The calibration on lower heights was made on balloon sounding data on Yakutsk meteorological observatory. A win ter strato spheric warmi ngs in DecemberMa rch in the main occurre d above Far- East and Eastern Siberia. This is due to orographical features given region. On the height profiles obtain ed during lida r soundings in 20052006 wi nter season t he vertical de veloping of the stratospheric warming is seen, and during this is observed a strato pause height decrea sing on 10 km. Taken place t he respectively increasing t he tropop ause height in thi s time. A stra topause heigh t decreasing (a mesosphere lower) is accompanied by temperature decreasing in the me sosphere and, it seems, coupled with blocking by warmed region the planetary wave subsequent lifting what responsible for the mesosphere heating.

Keywords: stratosphere, warming, lidar

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MS019 **Poster presentation** **5716**

Monthly averaged ozone and nitrous oxide derived from ILAS/ILAS-II and Odin/SMR measurements for the Northern and Southern Hemispheric polar regions: A method for the validation of atmospheric photochemical models

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Northern and Southern hemispheric monthly averages of ozone (O3) and nitrous oxide (N2O) have been suggested as a tool for validating atmospheric photochemical models. An adequate data set for such a validation study can be derived from measurements made by satellites which in general have a high spatial and temporal resolution. Here, we use measurements made by the Improved Limb Atmospheric Spectrometers (ILAS and ILAS-II) which use the solar occultation technique and by the Odin- Sub Millimetre Radiometer (Odin/SMR) which passively observes the thermal emissions from the Earth's limb. Using correlations of N2O and O3, the data are organized monthly in both hemispheres by partitioning these data into equal bins of altitude or potential temperature. The resulting families of curves help to differentiate between O3 changes due to photochemistry from those due to transport. From ILAS/ILAS-II and Odin/SMR observations 1- year climatologies of monthly averaged O3 and N2O were derived for the altitude range between 60 to 90 and -60 to -90, respectively. A comparison between both climatologies shows a good agreement and verifies that limited sampling from satellite occultation experiments does not constitute a problem for deriving such a climatology. Since Odin/SMR provides measurements for the entire Hemisphere, a 1-year climatology is reported here for the entire Northern and Southern Hemisphere from these measurements. Further, the 1-year climatologies derived from Odin/SMR is separated into climatologies for the low latitudes, midlatitudes, and high latitudes. The 1-year climatologies from Odin/SMR and ILAS/ILAS-II as well as the climatologies for the specific latitude regions from Odin/SMR provide a potentially important tool for the validation of atmospheric photochemical models.

Keywords: stratophere, ozone, satellite data

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MS019 **Poster presentation** **5717**

A dipole type of zonal wind variation in the upper troposphere and lower stratosphere during weak and strong years of indian summer monsoon

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K. Mohankumar

The upper troposphere and lower stratosphere regions over India has been studied in relation to the Indian Summer Monsoon Rainfall (ISMR) for the period 1960-1998. In this study we have made an attempt to understand the characteristic features of zonal winds in the tropical Upper Troposphere and Lower Stratosphere (UT/LS) region during DRY and WET years of summer monsoon season (June to September) over the Indian longitude belt (65o E 90o E) and its relation to Indian Summer Monsoon Rainfall (ISMR). It is found that in monsoons giving deficient (excess) ISMR called DRY (WET) years equatorial upper tro posphere zonal winds have westerly (easterly) anomalies and equatorial lower stratosphere opposite anomalies. Thus there is an upper troposphere/lower stratosphere dipole. Its intensity is correlated significantly with ISMR. It is also found that the June to September upper troposphere zonal winds averaged between 15o N and 15o S latitudes have a long-term trend during 1960 to 1998. Over this period the tropical easterlies and the tropical jet stream have weakened with time.

Keywords: utls, monsoon, ste

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

MS019 **Poster presentation** **5718**

Instabilities of an atmospheric front that couple balanced and unbalanced motions

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It is known that at large Rossby numbers geostrophically balanced flows develop specific ageostrophic instabilities. These can couple balanced and unbalanced motions, hence providing a possible source for gavity waves from jets and fronts. An example of such ageostrophic instability is the Rossby-Kelvin instability, obtained by Sakai (1989) for fronts in a two-layer fluid. The configuration considered by Sakai was symmetric (two layers of equal mean depth). Using a collocation method, we confirm his results and extend the analysis to configurations having layers of unequal depth and to configurations where the front intersects the surface. A crucial question is to determine whether these instabilities are still present in more realistic flows, with a continous stratification. Idealized simulations with the Weather Research and Forecast model were carried out to examine the stability of an intense front in a periodic channel on the f-plane. The simulations demonstrate that the same modes of instability as in the two-layer model exist, with comparable growth rates. The simulations are then used to analyse the nonlinear development of the instability and to discuss its relevance for the radiation of gravity waves from frontal regions in the atmosphere.

Keywords: fronts, gravity waves, instabilities

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MS019 **Poster presentation** **5719**

Semidiurnal tides from the Extended Canadian Middle Atmosphere Model (CMAM) and comparisons with TIMED Doppler Interferometer (TIDI) and meteor radar observations

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William. E. Ward, Jens Oberheide, Takuji Nakamura

The Extended Canadian Middle Atmosphere Model (extended CMAM) is a general circulation model which extends from the surface to about 210 km. This high upper boundary allows dynamical processes to be studied from the ground to the lower thermosphere without the influence of sponge layers, which are often inserted in the mesosphere. The extended CMAM includes realistic tidal forcing due to radiative heating, convective adjustment and latent heat release and uses the gravity wave breaking parameterization of Hines.In this paper, spatial complex spectral analysis is applied to horizontal winds simulated by the extended CMAM to obtain semidiurnal tidal amplitudes and phases (from e5 to w5) in the mesosphere and lower thermosphere (MLT) region. The dominant w2 migrating component and the presence of nonmigrating tides (w3, e1, e2) in the mid-latitudes are identified. The migrating semidiurnal tide (w2) has amplitudes reaching 20 m/s for both zonal and meridional winds in mid-latitude region. The amplitudes of non-migrating semidiurnal tides are also non-negligible compared to the migrating semidiurnal tides, the amplitudes for w3 exceeds 12 m/s and e2 reaches 8 m/s.Comparisons are made with the TIMED Doppler Interferometer (TIDI) wind measurements, which are analyzed to obtain 6 nonmigrating tidal components (w4, w3, w1, s0, e1, e2) between 85 km and 105 km altitude and between 45oS and 45oN latitude. Overall, the modeled semidiurnal components agree very well with TIDI observations. The 11 semidiurnal components from the model are then superimposed to get the total semidiurnal winds which are compared to two equatorial MWR radar stations (Jakarta and Kototabang). The comparisons between CMAM and two radar stations show that the amplitudes and phases have generally good agreement for semidiurnal tide, with Jakarta station agreeing much better than Kototabang station.

Keywords: semidiurnaltides, extended cmam, observations

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MS019 **Poster presentation** **5720**

The Terdiurnal Tide Simulated by the Extended Canadian Middle Atmospheric Model (CMAM)

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William E, Ward

The diurnal (24-hour) tide, which is dominated in the subtropics, and the semidiurnal (12-hour) tide, which is larger at high latitudes, have been extensively studied from the observations and models. However, our understanding of the terdiurnal (8-hour) tide remains limited, partly because of it being the third harmonic in the wind decomposition. Horizotal winds simulated from the extended Canadian Middle Atmosphere Model (CMAM) are analyzed to delineate diurnal, semidiurnal and terdiurnal tidal structures and stationary planetary waves. Each frequency component is then subjected to Fast Fourier Transform (FFT) to perform the zonal wavenumber decomposition for s = -5 to s = 5. In this paper, the seasonal-latitudinal and height structures of these 11 terdiurnal tide components are now revealed. The migrating terdiurnal component is dominated over other components at middle latitudes with significant amplitudes (wind speed over 15 m/s) in the lower thermosphere (90 -110 km). Theamplitudes vary strongly with season below 95 km and are maximum during winter; however above 95 km, the seasonal variation is not as obvious. Other components tend to peak at polar regions with amplitudes between 2 - 6 m/s. There is uncertainty about the origin of the terdiurnal tides. Solar heating, convective heating and latent heat release in the model at March and June for terdiurnal tidal components are utilized to aid in interpreting their behaviors and ascertaining their origins.

Keywords: terdiurnaltides, extended cmam

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MS019 **Poster presentation** **5721**

Persistence and decay of anomalies in the vertical ozone distribution

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Vitali Fioletov

The persistence and decay of anomalies in the vertical ozone distribution is analyzed over different latitudes using ozonesonde and satellite (e.g., Solar Backscatter Ultraviolet (SBUV), Stratospheric Aerosol and Gas Experiment (SAGE)) data. The persistence of anomalies is studied for different latitude and altitude regions including possible applications for long-range ozone and UV forecasting. We show the contribution of polar ozone depletion in spring to midlatitude ozone decline in summer for partial column ozone data below 19 km for the northern and southern hemisphere. The estimation of dynamical and chemical contributions to midlatitude ozone trends at different altitudes will be estimated from observations and model outputs.

Keywords: ozone, anomaly, trend

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MS019 **Poster presentation** **5722**

Searching for Gravity Waves Sources in the Brazilian Equatorial Region During CAWSES Campaign

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Hisao Takahashi, Joaquim Fechine, Amauri Fragoso Medeiros, Luis Fernando Guarnieri, Luis Eduardo Antunes Vieira

Gravity waves in the mesopause region were observed by airglow all-sky imaging technique at So Joo do Cariri (7S, 36W), in the equatorial region. A reverse ray tracing method was used to find out wave source region and to study propagation process through the middle atmosphere. Meteorological satellite image data and troposphere-stratosphere wind data by NCEP were used to identify the tropospheric disturbances. Ray tracing results showed that the wave source region in the troposphere are located 250 km radius away from the observation site mainly in south, Some ray paths stopped at the mesospheric heights and the wave source could not be identified. The tropospheric deep convection in the equatorial region should be the most important gravity wave source.

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MS019 **Poster presentation** **5723**

Observations of waves and coupling at the Polar Environment Atmospheric Research Laboratory (PEARL) In Eureka, Canada

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Alan Manson, Young-Min Cho, Tatyana Chshyolkova, Dragan Veselinovic, Ding Yi Wang, Tom Duck, Gordon Shepherd, Marianna Shepherd, Robert J. Sica, Kimberly Strong, Jim Whiteway

The Polar Environment Atmospheric Research Laboratory (PEARL) is a sophisticated observatory in the Canadian Arctic at Eureka (80N, 86W). It houses a suite of instruments including radars, lidars, spectrometers, radiometers and imagers which allow measurements of Arctic conditions from the ground to the lower thermosphere. One scientific theme being investigated at the observatory is the wave environment in this region and the coupling of the dynamics between atmospheric layers and locations. Instrumentation pertinent to these investigations include the E-Region Wind Interferometer,the meteor radar, the Spectral Airglow Temperature Imager, the PEARL All-Sky Imager, the ozone and Rayleigh/Mie/Raman lidar, the VHF and cloud radar, the Fourier Transform Spectrometer and the Atmospheric Emitted Radiance Interferometer. Together these instruments provide the means to determine the mean fields, and wave signatures associated with tides, planetary waves and gravity waves from the stratosphere to the mesopause region. Interpretation of these results will be supported with satellite observations, model results and analyses from data assimilation. Collaborations are being developed with other polar observatories so that a global view of these processes in the Arctic middle atmosphere can be developed. This effort will peak during International Polar Year. In this paper the capabilities of the observatory will be described and some early results presented.

Keywords: polar, observatory, couping

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MS019 **Poster presentation** **5724**

Low- frequency oscillations observed from meteor winds and timed/saber temperatures in the equatorial region

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Horizontal wind measuremen ts o btained from So Joo do Cariri-PB (7.4 S , 36.5 W), Br azil, associated with equatorial MLT temperature data acquired by the TIMED/SABER satellite, have been used t o investigate the presence of p lanetary-scale oscillations. The data were obtained from August/2004 t o December/2005, which were subjected to the spectr al analysis and t he results reve aled the quasi - simultaneous presence of distinct power spectrum with peaks associated with low-frequency oscillations. In this time, our focus is the range period from 12 to 20 days, whose activities were r evealed mainly during time-intervals from December/2004 to Marth/2005 and from June to October/2005. The characteristics observed suggest that the perturba tions were due to presence of 16-day planetary waves.

Keywords: planetay, waves, winds

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MS019 **Poster presentation** **5725**

The CO2 15 micron band additional cooling of the MLT due to the diurnal tide in a doubled CO2 atmosphere

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Radiative cooling of the mesosphere and lower thermosphere (MLT) in the 15 m CO2 band depends nonlinearly on the kinetic temperature. The temperature perturbations due to the migrating diurnal tide (DT) result in that the values of heat influx in the 15 m CO2 band, averaged over wave period, differs from those corresponding to unperturbed atmospheric temperature profiles. Thus for the modern CO2 volume mixing ratio (VMR), the DT provides mostly an additional cooling of the MLT region with two local maximums of 0.9 K/day and of 0.2 K/day (i.e. 6% and 12% in comparison to the unperturbed cooling rate values) near the equator at the altitudes 100 km and 75 km, respectively (Ogibalov et al., doi:10.1134/S0001433806010087). Recently, the impact of doubled CO2 on the DT in the mesosphere has been studied (McLanders and Fomichev, doi: 10.1029/2005GL025345), and the tidal temperature amplitude increase (of up to 2K, i.e. about 20%, at the altitude 85 km) in the equatorial upper mesosphere was found. In this study, the additional 15 m CO2 band cooling rates in a doubled CO2 atmosphere have been estimated using the model for solving the problem of radiative transfer in the CO2 bands taking account of both the line overlapping over frequency and the local thermodynamic equilibrium breakdown (non-LTE) in the middle and upper atmosphere of Earth. The main conclusions are as follows. (a) Both doubling the VMR of CO2 and the temperature amplitude increase of DT result in an increase of the additional 15 m CO2 band cooling rate above 70 km. (b) The local maximum of the additional cooling at 75 km rises almost twice, i.e. up to 0.43 K/day (15%), but the one at 100 km rises slightly up to 1.16 K/day (2.5%). (c) A new local maximum of the tidal additional cooling of about 1.2 K/day (about 15%) appears at the altitude 90km. Its reason consists in a combined nonlinear action both of increased CO2 VMR and of increased temperature perturbations due to DT.

Keywords: co2 cooling rate, diurnal tides, non lte

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MS019 **Poster presentation** **5726**

Gravity Wave Momentum Fluxes infered from OH and O2 Airglow Image Observations

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The calculation of gravity waves momentum fluxes and their forcing on the atmosphere mean state, using airglow image observation, depends critically on the amplitude of the brightness fluctuations and the amplitude of the major gas kinetic temperature fluctuations. In this sense, the Cancellation Factor (CF) was introduced by the Swenson and Gardner (1998) [J. Geophys. Res., 103, 6271] with the purpose to be helpful in the optical studies. It essentially depends on the intrinsic wave parameters and major gas densities. In this report, a numerical model was developed by introducing CF as a complex quantity, |CF| e-i, including atmospheric viscosity effects and a realistic photochemistry for OH and O2 emissions. The present model was applied for calculating the gravity wave momentum fluxes from the OH NIR and O2 (A) all-sky imaging observation at Cachoeira Paulista (23o S, 45o W) in 2005. The observed amplitudes flutuations of OH and O2 airglow brightness range from 3 - 15 % and 1 - 8%, respectively; the infered momentum fluxes were 2 - 10 m2 s-2 and 1 - 15 m2 s-2, respectively, mostly due to high frequency gravity waves. The discussion will be focused to what atmospheric parameters are more sensitive in calculating the momentum fluxes by this CF numerical model.

Keywords: momentum flux, cancellation factor

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MS019 **Poster presentation** **5727**

Mesospheric bore observations during CAWSES 2005 campaign in Brazil

Mr. Joaquim Fechine
DAE INPE IAGA

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During the Spread F Experiment campaign carried out in , from Septemb er 22 to November 8, 2005, several mesospheric bores were observed under distin ct propagation conditions. These wave structure s were recorded by an all- sky imager installed at Cariri (7.4S, 36.5 W) . Mesospheric wind and temperature observed by m eteor radar and the TI MED/SABER satellit e, respectively, were used t o analyze the ba ckground co ndition of the wave pro pagation. Large meso spheric inversion layers and a strong wind shear were observed at the airglow laye r altit ude. In the m ost interesting events, it was observed a wa ve front dissip ating, an evid ence of bore generation and a bore propagating within a Doppler duct. These obser vations contribute to our knowledge of the atmospheric background conditions during the singular events of mesospheric bore observed over the equatorial region.

Keywords: mesospheric bore, gravity wave, airglow

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MS019 **Poster presentation** **5728**

Comparison in Vortex-Based Coordinates of Stratospheric Ozone Measured by the JPL lidars at Table Mountain Facility, CA and Mauna Loa Observatory, HI and by the Aura-MLS

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I. Stuart Mcdermid, Lucien Froidevaux

The Jet Propulsion Laborator y has been operating Differential Absorpti on Lidars for the long term monitoring of ozone since 1989 at Table Mountain Facility, CA (34.4N) a nd 1993 at the NOAA Mau na Loa Observatory, HI (19.5N). The the EOS-Microwave Limb Sound er (EOS -MLS) on board th e Au ra satellite was launched in August 2004. Stratospheric ozone measured by the JPL lidars and by EOS-MLS will be compared in vortex-b ased coordinates over the th ree-year period August 2004 - June 2007. In traditional geographic(Lon-Lat) coordinatesthe agremeent between lidar and MLS v1.5 and v2.2 remains within the rep orted uncertainties, not exceeding 5-10% in the mid s tratopshere.This agreement i s expected to increase as vortex-based coordin ates are used in the coincidence criteria. Besides individual comparisons, seasonal and interranual variations and meridional transport even ts will also be investigated.

Keywords: ozone, lidar, mls

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MS019 **Poster presentation** **5729**

Thermospheric temperatures derived from atomic oxygen densities.

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K.-U. Grossmann, H. Gerstner

CRyogenic Infrared Spectrometers and Tele scopes for the Atmosphere (CRISTA-2) satellite measured the limb radiances of atomic oxygen at 63 m in August 1997. A retrieval method for deriving the kinetic temperature between 130 and 180 km is presented. The poster shows processed data between 72S and 72N, comparisons with the NRL-MSIS empirical model and TIME-GCM model runs.

Keywords: temperature, lower thermosphere, atomic oxygen

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MS019 **Poster presentation** **5730**

Testing Lagrangian theories of internal wave spectra

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Len Sonmor

Our incomplete understanding of physical dissipation processes within an internal gravity wave field impacts on q uestions of m ixing in both the at mosphere and ocean, with enor mous dynamical ramifications in the case of the middle atmosphere . Efforts to solve the puzzle ha ve centered o n nonlinear interactions among intern al waves, but the inherent complexity has hindered progress. There is a growing b ody of literature which maintains that this complexity can be circumvented by using a Lagrangian,rather than Eulerian, formulation. We have investigated this proposition with a L agrangian wave model; the results have important implications for certain Lagrangi an theories of wave spectra, specifically those advanced by Hines and Allen and Joseph.

Keywords: gravity waves, middle atmosphere

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MS020 **5731 - 5769**

Symposium
Solar Activity and its Influences on the Earth's Weather and Climate (IRC)

Convener : Prof. Werner Schmutz

There is increasingly strong evidence that there is a link between variations in solar activity and the terrestrial climate. Changes in the solar output are present in total solar irradiance but also in spectral irradiance (particularly in the UV), solar wind and high energy particles. These can influence the state of the terrestrial atmosphere by both direct and indirect means, potentially having an influence on weather and climate. This symposium invites papers on topics relating to the nature and consequences of changes in solar activity on the geosphere. It addresses issues of the SCOSTEP research program "Climate and Weather of the Sun-Earth System (CAWSES)" with its emphases on variations of the solar irradiance and its influence down to the troposphere.

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MS020 **Oral Presentation** **5731**

Influences of ozone depletion, solar variability and the QBO on the Southern Annular Mode

Dr. Howard Roscoe
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Joanna D. Haigh

We consider the impacts of solar activity, stratospheric volcanic aerosol, the QBO, ENSO and several trend-like indices on the Southern Annular Mode (SAM). SAM is the leading mode of atmospheric variability at southern high latitudes and is represented here by the meridional gradient in sea-level pressure from station data spanning 1957 to 2005. Our analysis uses a multiple linear regression approach which takes account of autocorrelation in the time series. We find a signal of ENSO and a strong signal of volcanic aerosol, but almost no signal of either solar forcing or the QBO. When the product of the solar and QBO indices is used in place of the two factors individually, a strong signal appears. Using this mixed solar-QBO index, together with ENSO and volcanic aerosol, we explore three different representations of the long-term change in SAM: a linear trend (to represent the increase in greenhouse gas concentrations), effective equivalent stratospheric chlorine (EESC, that depletes polar ozone) and the ozone mass deficit (OMD) measured in the Antarctic vortex. We find a significant linear trend in SAM, but there is a major increase in significance when the linear term is replaced by EESC2, and a further increase when it is replaced by OMD. Although we make no direct attempt to identify cause and effect, we conclude that stratospheric ozone loss is a much more likely cause of the recent increase in surface SAM than greenhouse gases. Monthly and seasonal regressions show a maximum correlation with OMD in summer and autumn, consistent with earlier work describing the effect of stratospheric change on tropospheric climate in Antarctica.

Keywords: solar, ozone loss, sam

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MS020 **Oral Presentation** **5732**

Coupled chemistry climate model simulations of the solar cycle in ozone and temperature

Dr. John Austin
Some Department (No idea What) No Idea IAMAS

Klairie Tourpali, Eugene Rozanov

The results from new simulations of coupled chemistry climate models are examined for the presence of the 11-year solar cycle in ozone and temperature. In contrast to most previously published simulations, the new simul ations are in b etter agreement with sate llite observations of the vertica l profile of the ozone respon se, particu larly in low latitudes wh ere the observational signal can be more firml y established. It is found that this improved agreement occurs by incorporating variability only in the solar fluxes in the models and that the upper atm ospheric effects of energetic particles are not impor tant for the low latitude ozone signal. The results also suggest that the presence of the quasi bie nnial oscillation is not necessary to simulate the observed low lati tude minimum in lower stratospheric ozone response . Comparisons are also made b etween model simulations and total column ozone. As in previous studies, the model sim ulations agree well w ith obse rvations. Howe ver, a substant ial difference exists between the observed signal for the p eriod 1960-1980 and for the period 1980-2000. This is sim ulated by those models which cover the full temporal range, and it is shown that the difference between the solar cycles is due almost entirely to ozone changes below 50 hPa. Possible reasons for the tropical ozone minimum, and for t he di fference in oz one response for different s olar cycles are discussed in addition to the impacts of the solar response on the troposphere.

Keywords: solar, ozone, temperature

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MS020 **Oral Presentation** **5733**

The atmospheric response to solar cycle variability in northern hemisphere winter

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A number of observational and numerical studies have provided evidence for the influence of 11-year solar cycle radiation variability on composition and dynamics of the middle and lower atmosphere. However, discrepancies between observed and simulated features of the atmospheric response still exist. It is attempted to improve numerical simulations by using complex models coupling atmospheric dynamics and chemistry and extending over a large altitude range. In this paper, we present simulations with the HAMMONIA chemistry climate model that seems particularly suited for studying the stratospheric solar cycle response as it internally produces a realistic quasi-biennial oscillation (QBO) of equatorial winds that is believed to interact with the 11-year solar signal. The focus of our study is on the northern hemisphere winter. For this time of the year, mechanisms have been suggested for a downward propagation of the solar signal from the stratopause region to the lower stratosphere and even the troposphere. We will present model results with respect to possible solar cycle-QBO interactions and the role of stratospheric sudden warmings, and show that a number of observed stratospheric and tropospheric signals is well reproduced by the model.

Keywords: solar cycle, middle atmosphere

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MS020 **Oral Presentation** **5734**

Signatures of the Solar Cycle in the Circulation of the Tropical Stratosphere and Troposphere

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An analysis of low-frequency variability in the NCEP record reveals a decadal variation inside the tropical troposphere, one that operates coherently and in phase with the 11-yr variation of solar irradiance. The variation represents a robust signature of solar variability, achieving higher levels of significance than have been relied upon previously. Characterized by symmetric latitudinal structure, the decadal variation involves anomalous temperature that maximizes over the equator and anomalous zonal wind that maximizes in the tropics of each hemisphere. Its deep vertical structure, in concert with the horizontal distribution of anomalous temperature, suggests the involvement of organized convection, as well as a direct radiative influence at upper levels, inside the tropical tropopause layer. Perhaps related is a decadal modulation of the stratospheric QBO. Involving high-frequency variability (periods shorter than 5 yrs), it too varies with the 11-yr cycle of UV irradiance. The cyclic modulation of the QBO makes possible a relationship to the tropical troposphere that may cancel and, hence, be invisible in the long-term average (upon which prior studies have focussed). An analysis that accounts for a cyclic variation in their relationship reveals coherent changes in the tropical stratosphere and troposphere. Involving interannual varibility, their relationship manifests itself in major properties associated with the QBO and the Hadley circulation. It operates on the same periods as the so-called Tropospheric Biennial Oscillation (TBO). Like the QBO's relationship to the polar stratosphere, its relationship to the the tropical troposphere reverses on the time scale of a decade. The systematic swing in the relationship between the QBO and the Hadley circulation mirrors the cyclic variation of ozone heating in the upper stratosphere, where the phase of the QBO is set. The QBO, in turn, interacts with the tropical troposphere, directly, through the tropical tropopause, and indirectly, through the Brewer-Dobson circulation, which couples the stratosphere and troposphere through transfers of mass.

Keywords: solar, stratosphere, tropics

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MS020 **Oral Presentation** **5735**

Solar irradiance variability results from NASA's SORCE mission

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The total solar irradiance (TSI) and solar spectral irradiance (SSI) from 0.1 nm to 34 nm and from 115 nm to 2400 nm have been measured by NASA's Solar Radiation and Climate Experiment (SORCE), which was launched in January 2003. The Sun is the only external forcing for climate changes, thus the solar irradiance and its variability are important input for studies of the energetics of Earth's atmosphere, surface, and oceans. This talk will provide an overview of the solar irradiance and its variability as a function of time and wavelength during the SORCE mission, starting with the high solar activity in 2003 and progressing to the low solar activity in 2007. The dominant temporal variations are due to flares (minutes-hours), active region evolution and solar rotation (days), and solar cycle magnetic evolution (months-years). The variations in wavelength are dependent on where the emissions arise. The photospheric emissions, which dominatein the near infrared, visible, and near ultraviolet ranges, vary by about 0.1% over the 11-year solar cycle and are characterized by dark sunspots and bright faculae. The emissions from the solar chromosphere and transition region are easily identified in the extreme ultraviolet and far ultraviolet ranges, and their solar cycle variations of 20% to a factor of 3 are associated with the evolution of the bright plage and active network features on the Sun. Finally, the coronal emissions, which dominate in the X-ray and the lower part of the extreme ultraviolet range, vary by factors of 5 to 1000 over the solar cycle.

Keywords: solar irradiance, solar variability, solar cycle

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MS020 **Oral Presentation** **5736**

Response of the atmosphere to the 11-year solar forcing: role of the dynamic

Dr. Philippe Keckhut
MS020 IAMAS IAMAS

C. Claud, M. Marchand, S. Bekki, B. Duchiron, C. Cagnazzo, A. Hauchecorne, G. Thuillier

Three independent datasets covering the upper stratosphere and the mesosphere, where the direct photochemical effect is expected, will be first described. The analysis of the different datasets, which is based on the same regression linear model, will be presented. An overall good agreement among the datasets has been obtained, providing the global picture of the solar impact in the upper stratosphere and lower mesosphere that suggests a strong contribution of the dynamics. Results from mechanistic model simulations have also been analyzed and confirm that the level of planetary wave activity modulates the response of the stratosphere to the solar cycle. The model is a stratosphere and mesosphere model with detailed chemical, radiative and dynamical schemes. Simulations illustrate the crucial role played by the planetary wave forcing in the solar cycle temperature signal. It suggests a mechanism by which a small change induced by the solar forcing can generate a large atmospheric response. This work has recently been extended to the low stratosphere. This issue is of primary importance, since the response of the tropospheric circulation to solar changes depends on the precise distribution of the low stratospheric perturbations. Solar maximum conditions are associated with a stronger vortex, except in February. Numerical simulations show that Eliassen-Palm fluxes are the largest at this time of the year, which indicates an increased probability of sudden stratospheric warmings. Finally, associations between the 11-year solar cycle and the troposphere have been investigated using long series of surface observations. They suggest a statistically significant change of the circulation, which is also observed when restricting the analysis to the last 40 years. CCM simulations are presently underway to understand the complex interactions between the solar cycle and the climate.

Keywords: temperature, sun, synamics

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MS020 **Oral Presentation** **5737**

Is there evidence for sunsport forcing of climate at multi-year and decadal periods?

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It has been proposed that solar cycle irradiance variations may affect the whole planets climate via the stratosphere, the Quasi-Biennial Oscillation (QBO) and Arctic Oscillation (AO). We test this hypothesis by examining causal links between time series of sunspot number and indices of QBO, AO and ENSO activity. We use various methods: wavelet coherence, average mutual information, and mean phase coherence to study the phase dynamics of weakly interacting oscillating systems. All methods clearly show a cause and effect link between Southern Oscillation Index (SOI) and AO, but no link between AO and QBO or solar cycle over all scales from biannual to decadal. We conclude that the 11-year cycle sometimes seen in climate proxy records is unlikely to be driven by solar forcing, and most likely reflects other natural cycles of the climate system such as the 14-year cycle, or a harmonic combination of multi-year cycles.

Keywords: sunsport, climate, variability

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MS020 **Oral Presentation** **5738**

The Response in the Troposphere over the Pacific Ocean and in the Equatorial Stratosphere to the Sun's DecadalOscillation

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The re-constructed and observed sea-level pressures and sea-surface temperatures allow us to study 14 decadal solar oscillations (DSO) sinc e the m id-1800s. In the northern wi nter, in the peaks of the DSO, the atmo spheric co nvergence zo nes in the Pacific re gion (that is, the Int ertropical C onvergence Zone north of the equato r and the So uth Pacific Convergence Zone) strenghthen and extend po leward. The rainfall increases in the co nvergence zo nes, the SE- trades strenghthe n, upwelling o f co oler water increases on the equator, and the cold tongue in the water and drought reach farther westward. These effects are acc ompanied by a nomalies in the tropical Hadley and Walker circulations, a nd the resulting Rossby wave response in the atmosphere is associated with positive sea-level pressure anomalies in the Gulf of Alaska. T he anomalies look like th ose in Cold Extremes in the Southern Oscillation but are weaker. Rather, the pattern is an enhanc ement of the climatological mean. Cold Extremes in th e Southern Oscillatio n can o ccur at any time during a DSO, but the descr ibed enhanced mean is the preferred pattern at peaks in the DSO. When the oscillatio n is not at its peak, the atmosphere-ocean system is unco nstrained and both Wam and Cold Extr emes in the Southern Oscillation can occur. The mean anomaly pattern of sea-level pressure at the solar peaks is similar but weaker in the year leading into and in the year exiting the peaks; a nd the concurrent negative mea n anomalies in the sea- surface temperature d evelop during the year befor e and wane i n the year a fter the peak. I n the northern summer before the solar peak s the Walker C ell expands and the cooler eq uatorial water develops. And, as in winter, the zonal wind anomalies in the stratosphere are westerly below and easterly above.

Keywords: sun, troposphere, stratosphere

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MS020 **Oral Presentation** **5739**

Solar irradiance influence on ozone and climate during the first half of the 20th century

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It was hypothesized that duri ng the first hal f of th e 20th century the v ariability of the so lar irradiance consisted of the steady increase modulated by th e decadal scale fluctuatio ns. Numerous experiments with General Circulation models driven by the changes in total solar irradiance showed that the obtained climate response have bee n underestimated in compar ison with observations. To estim ate the role of the spectral so lar irradiance variability in c limate and ozone changes during the first h alf of the 20th century we ha ve carried o ut transient ense mble run with the Chemistry- Climate Model SOCOL covering 1900-1960 driven by time e volving solar s pectral irra diance, sea surface temperature, sea ice , land properties, sulfate aerosol loading, greenhouse gase s and ozone destroying subst ances. In the paper we present the solar signal in the atmosphere ex tracted from these transient runs using multiple regression analysis technique. We also defin e the contribution of the imp osed solar irradiance change s to the time evolution of the simulated quantities and esti mate their sensitivity to the long-term and decadal scale solar irradiance variability. The model results are compared with the solar signal obtained from the transient simulation covering 1975-2004 an d with the solar signal in the land surfac e temperature extracted from the observational records.

Keywords: solar irradiance, climate, ozone

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MS020 **Oral Presentation** **5740**

Atmospheric Temperature Responses to Solar Irradiance and Geomagnetic Activity

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IAMAS

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Climate change occurs on various time scales due to natural variability and anthropogenic causes. One major source of natural variability is the Sun where changes in solar irradiance and the solar wind can both influence atmospheric circulation by changing heating and cooling rates which may subsequently affect weather systems and climate patterns. Solar irradiance heats the atmosphere directly and follows a quasi-11-year cycle, while the solar wind affects the atmosphere indirectly via the Earths magnetic field causing changes in atmospheric chemistry. This study examines the relative effects of solar irradiance and geomagnetic activity on the atmospheric temperature from the monthly to inter-decadal time scales. Geomagnetic Ap (Ap) signals are found primarily in the stratosphere, while the solar F10.7-cm radio flux (Fs) signals are found in both the stratosphere and troposphere. In the troposphere, 0.1-0.4 K increases in temperature anomalies are associated with Fs. Enhanced Fs signals are found when the stratospheric quasi- biennial oscillation (QBO) is westerly. In the extra-polar region of the stratosphere, comparable increases in temperature (up to 1 K) are associated with solar irradiance and with geomagnetic activity. In these regions, Fs signals are strengthened when either the QBO is easterly, or geomagnetic activity is high, while Ap signals are strengthened when either the QBO is westerly, or solar irradiance is high. High solar irradiance and geomagnetic activity tend to enhance each others signatures either making the signals stronger and symmetric about the equator or extending the signals to broader areas, or both. Positive Ap signals dominate the middle Arctic stratosphere and are 2-5 times larger than those of Fs. When solar irradiance is low, the signature of Ap in Ta is asymmetric about the equator, with positive signals in the Arctic stratosphere and negative signals at mid-latitudes of the NH stratosphere. Weaker stratospheric QBO signals are associated with high Ap and Fs, suggesting possible disturbances on the QBO. The signals of Ap and Fs are distinct from the positive temperature anomalies resulting from volcanic eruptions. These results will help to address a key question of atmospheric research: to what extent solar activity has contributed to the temperature rise in comparison to greenhouse gases?

Keywords: solar activity, atmospheric temperature, geomagnetic activity

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MS020 **Oral Presentation** **5741**

Solar cycle influences on the stratosphere, the NAO and tropospheric circulation over Europe

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The 11-year solar cycle influence on stratospheric dynamics and its effects on the North Atlantic Oscillation are investigated with a coupled Chemistry-Climate Model. A structural modulation is found with its main features being an eastward shift of the surface Atlantic center of action into Europe and a vertical extension into the stratosphere during solar maximum conditions. These results are in good agreement with observation analysis of the ERA-40 and NCEP-Reanalysis data sets. As the above results suggest a solar effect in the tropospheric circulation, the solar cycle modulation of the northern hemisphere atmospheric blocking is examined, showing an influence particularly in the Euro-Atlantic Region.

Keywords: solar cycle, nao, atmospheric blocking

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MS020 **Oral Presentation** **5742**

Modelling solar total and spectral irradiance

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Solar total irradiance and its spectral distribution vary with time. Measurements and models suggest that these variations occur at all time scales ranging from seconds to billions of years. Whereas variations on time scales of minutes to days are due to solar oscillations and granulation, variations on longer time scales are driven by the evolution of the solar surface magnetic field. Here a review of recent models of the solar irradiance variations on time scales of relevance for climate studies will be given.

Keywords: solar irradiance, uv radiation

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MS020 **Oral Presentation** **5743**

Reconstructing Historical Total Solar Irradiance from Lunar Borehole Temperatures

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Satellite observations revealed total solar irradiance (TSI) varies due to solar activity. Variations in TSI are evident in 11-year cycle of solar activity as well as sunspot passage. Accurate observations of both TSI and spectral solar irradiance (SSI) from SORCE satellite are useful for sun-earth climate study. The sun had experienced a very low inactive time period - Maunder Minimum, and may have caused a change in Earths climate. To reconstruct TSI in centennial time scale is very important in understanding the solar variation and its impact on Earths climate. The Moon, a coevolving natural satellite of the Earth, without atmosphere, biosphere, hydrosphere, and human activities is an ideal place for reconstructing TSI variations in centennial time scale. The Moon is covered by regolith layer with very lower thermal conductivity and diffusivity. With undisturbed lunar surface albedo, changes in solar input lead to changes in lunar surface temperature that diffuse downward to be recorded in the temperature profile. Here we present a feasibility study of recovering TSI from lunar borehole temperature profiles back to Galileo's time.

Keywords: totalsolarirradiance, lunarborehole, regolith

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

MS020 **Oral Presentation** **5744**

The 11-year solar signal in tropospheric variability- a model study

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We present a model study to show the tropospheric response to the 11-year 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 be tter represent UV changes associated wit h the solar c ycle. Spectral irradi ance and solar cycle indu ced oz one ch anges were prescribed. The model was used in t he T42L39 reso lution to perform a 25-year solar minimum a nd maximum equi librium simulation, respectivel y. The model simulates an i mproved poleward-downwar d movement of zonal wind anomalies during northern winter. We will discuss the tropospheric response to solar variability in terms of changes in the dominant modes of variability, such as the Arctic Os cillation (AO) and the North Atlantic Oscillation (NAO). In the 25-year simulation we find an AO-like response pattern in January which extends from the stratosp here to the tr oposphere leading to near-surface changes in temperature and circulation during northern winter. To test the robustness of the results the simulations were extended to 50 years each.

Keywords: solar cycle, troposphere, variability

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MS020 **Oral Presentation** **5745**

Atmospheric measurements of the infra-red absorption caused by cosmic ray ionisation

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Laboratory measurements have shown that charged molecular clusters, formed throughout the atmosphere by cosmic rays and natural radioactivity, absorb infra-red (IR) radiation. The existence of an appreciable IR absorption signal from the cluster ions continually generated by cosmic ray ionisation in the atmosphere could influence the energy balance. Infra-red absorption by ions might also ultimately provide a method for remote sensing of the global electric circuit and detection of fair weather electrical activity in planetary atmospheres. These important applications have motivated experiments to study the IR absorption of atmospheric ions. Measurements have been carried out at two contrasting sites, Snowdon Summit Weather Station, an unpolluted mountain site, and the highly instrumented, urban site of Reading University Atmospheric Observatory (RUAO). At Snowdon, a simple solar-powered system comprising a pyrgeometer to detect broadband IR absorption (5-50micron) was deployed alongside a Geiger counter coincidence detector, to estimate cosmic ray ion production in the atmospheric column above the mountain summit. For use at RUAO, a narrowband detector tuned to the 9.1micron cluster-ion absorption band, the Infrared Absorption Radiometer (IAR), has been developed using thermopile sensors. RUAO is a highly instrumented meteorological site with a unique array of atmospheric electrical sensors against which the radiative data can be compared.

Keywords: charge, cluster, climate

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MS020 **Oral Presentation** **5746**

Particle electrification on cloud and aerosol boundaries

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Maarten H. P. Ambaum

Molecular cluster ions are produced throughout the atmosphere by cosmic rays, and, over continental regions, radon isotopes provide additional cluster ions. Because of solar modulation of galactic cosmic rays and the direct solar generation of energetic particles which can occasionally reach the surface, cluster ions may be important elements in any physical mechanism by which solar changes influence cloud processes in the lower troposphere. Atmospheric cluster ions cause charging of aerosol and water droplets. Electrification is known to modify the physical behaviour of aerosol particles, such as by increasing the aerosol removal rate to cloud droplets, and, at extreme levels of charge, physical disruption of the water droplets. In the atmosphere a vertical flow of charge (the conduction current density) continually occurs as a result of the global atmospheric electrical circuit. For a layer (stratiform) cloud, this can lead to enhanced particle electrification on the upper and lower cloud-air boundaries. Possible consequences of this electrification on stratiform clouds will be discussed, together with a new methodology for their investigation through combining meteorological and atmospheric electricity measurements.

Keywords: charge, droplet, scavenging

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MS020 **Oral Presentation** **5747**

On the Analysis of Spectral Composition of Solar Irradiation and Changes with Solar Activity, Connections to Circulation Patterns

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The detailed analysis of spectral composition of solar irradiation reconstructed by Lean et al. (1995) is presented. Beside of systematic increase of total irradiation as well as the increase in most of the spectrum, especially significant in UV part, opposite behaviour can be seen in spectral band of near infrared (1525-1825 nm). The relations of individual spectral bands to solar flux F10.7 is analyzed as well as to long-term behaviour of global circulation spectral structures in terms of spherical harmonics coefficients of expansions for selected variables (potential vorticity, sea level pressure, geopotential) based on NCEP/NCAR database of reanalyses for period 1948-2005. Temporal analyses of significant spherical harmonics are introduced as well as the relations between them, connections of the relations to selected circulation indices and some sets of solar and geomagnetic activity parameters are analyzed. The systematic review of the appropriate correlations and linear regression analysis are presented, long-term trends are studied for some of wave numbers as well.

Keywords: solar activity, solar terrestrial connections

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MS020 **Oral Presentation** **5748**

Solar Irradiance Variations and Modeling

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Solar irradiance, both bolometric and at various wavelengths, has been measured for three solar cycles. These measurements show that solar irradiance changes on time scales of minutes to the 11-year solar cycle. Although considerable efforts have been put forward to investigate the nature and origin of irradiance variations, no real physical understanding is available at this time. Thus, most of the irradiance models are still quasi-empirical models, assuming that the major causes of the observed changes are surface magnetic structures. In addition, the lifetime of single experiments is not sufficient to study long-term changes, thus irradiance composites must be compiled to move the various observations to the same scale. In this paper we address the questions: how reliable the current surrogates used in irradiance modeling are; how well we can describe irradiance changes on time scales when no observations exist; how reliable are the current modeling techniques; and what efforts are needed to better account for the underlying mechanisms of irradiance changes.

Keywords: solar irradiance, bolometric, wavelengths

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MS020 **Poster presentation** **5749**

Near-space influences on the meteorological parameters in Istanbul area

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G. S. Pekmezci

The surro unding space aro und the plane t Earth ha s a very big sig nificance for influencing the meteorological conditi ons. It is thought that the main sprung-from-this-region factor affecting the climate is the Suns own, and the rest co nsists of cosmic rays, planetary and interplanet ary magnetic fields which exhibit a correlat ed or anti-corr elated way of behaviour with sola r cycles. T he coherencies between space indices and some meteorolog ical phenomena which have not been studied commonly in the case like wind velocity and atmosphe ric pressu re a nd usual factors like precip itation and air temperature are investigated. The meteorological data are supplied from the Meteorology Laboratory of Kandilli Observatory, Istanbul, TR; thus the study is valid for the surrounding location.

Keywords: solar activity, cosmic ray, climate

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MS020 **Poster presentation** **5750**

Precipitation on Greater Cairo area and its Correlations with Variations of Solar Activity during Cycle23

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The relationship between sol ar activity variations during solar cycle 23 a nd daily, monthly and an nual penetration in the Greater Cairo area is studied analytically. The solar data of sunspot numbers, sunspot area, radio flux, solar prot on, electron and neutron fluencies, x-ray backgro und flux a nd optical flares are analyzed and compared with the influencing of precipitation on the land. Th ese results indicate that the rate of precipitation is closely related to the variation of solar activity data.

Keywords: solarcycle23, precipitationongreatercairo, solarprotonsflares

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MS020 **Poster presentation** **5751**

On the problem of connection between the solar activity and the Earths climate

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It becomes clear during the last years that the solar activity includes not only solar UV irradiance but also energy of the solar particles and the solar wind. This Session is an example of such approach to the problem. Long term variations of the solar wind parameters were analyzed in this report. We used data of the satellites observations for period of the last 40 years. Temporal variations of such parameters as density and velocity of the solar wind, full vector of the interplanetary magnetic field, vector of magnetic field, connected with sector structure of solar wind and determined by large-scale weak magnetic field of the Sun were considered. It was found out that parameters of the solar wind have different periodicity of the variations. Full vector of the interplanetary magnetic field is demonstrated strong 11 - 12 cycle activity. Maximum of velocity of the solar wind is observed usually 2-3 years later after the maximum of the Sun spot activity. The vector of magnetic field connected with large-scale weak magnetic field of the Sun has period of changes equal to ~ 40 years. The same period is observed in variations of the solar wind density. Energy of the solar wind determines amount of electromagnetic energy, which can be transmitted into the near-Earth space. It means that different periodicity of geoeffective parameters of the solar wind will determine variety of climatic effects on the Earth. However it must be taken into account that transmission of the energy of the solar wind into geospace depends on state of the atmosphere and ground surface. Local ground surface electric conductivity is an important parameter of this mechanism. It is not reasonable to look for periodicity of atmospheric parameters in global scale, which is typical for changes in the solar wind. However, long term changes of temperature in the Arctic basin demonstrated a definite variability equal to ~40 years, which is character for large weak magnetic field of the Sun. These results allow one to hope that such approach to solar-terrestrial relations could discover other ways of coupling between the Earths climate and weather and the solar activity in its different forms.

Keywords: solaractivity, solarwind, earthclimate

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MS020 **Poster presentation** **5752**

Solar activity during Maunder Minimum and the Beveridge Wheat Price Index

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The yearly Beveridge wheat prices index (BWPI) is likely the longest time series reflecting meteorological changes in the Central and Western Europe from 1500 to 1869, which coincides with reduced solar activity during Maunder Minimum (16451715), and Dalton Minimum (1790-1820). Fourier and wavelet transforms were used to compare spectral characteristics of the BWPI and solar activity using Zurich (from 1700), Group (from 1610) and Pulkovo (from 1500) sunspot number indexes. The wavelet analysis showed that during Maunder minimum (MM) quasidecadal oscillations of the BWPI were shifted from 9-12 yr to 15-17 yr and their amplitudes at the beginning and the end of MM simultaneously were raised about twice. The quasidecadal oscillations were in phase with Suns 11 yr cycle for time of Maunder period and for 1720-1850, but in opposite phase at the end of MM (1700-1705). In little extent, the similar pattern is seen for Dalton minimum. The fine structure of quasifive (4.6-6 yr) and quasidecadal oscillations obtained by means of the Fourier analysis showed the close coincidence for periods of these oscillations for WPBI and Pulkovo index. There is some evidence that quasifive oscillations are overtones of the basic quasidecadal oscillations as for BWPI so for sunspot number indexes. The results obtained confirm conclusions that during preanthropogenic (pre-1850) period the decline in solar activity may have been the cause of the climate severity that reflected in the wheat-prices fluctuation. This research is sponsored RFBR under Grant 06-05-64157.

Keywords: maunder minimum, beveridge wheat prices index, fourier wavelet analysis

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

MS020 **Poster presentation** **5753**

Strong / Weak Solar Activity and Climate Anomaly

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The climate and its variation should be related with solar activity because the fundamental energy to drive the atmospheric and oceanic motions is from the solar radiation. Some analyses have shown that there is obvious correlation between strong / weak solar activity and the climate variation. There are evident different anomalous patterns of the geopotential height, temperature and ozone in the stratosphere corresponding to strong / weak solar irradiance. The summer Meiyu in China is also related to solar activity, especially for the variation with interdecadal timescale. Based on the previous studies, we will discuss possible influence ways of the solar activity on the Earth climate. The direct impacts through the solar irradiance, the solar UV and the solar proton, will lead to atmospheric circulation and climate anomalies. The indirect impacts through geomagnetic field anomaly caused by the solar activity, which can lead to geomagnetic energy anomaly and the Earth rotation speed, then atmospheric circulation and the Earth climate will be affected.

Keywords: solar, climate, atmosphere

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MS020 **Poster presentation** **5754**

Variation of the eleven-year solar cycle during the last 1200 years and its effect on terrestrial climate

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Radiocarbon is mainly produced by the incoming galactic cosmic rays modulated by solar wind and the interplanetary magnetic field, and thus its production rate and its content in the atmosphere and in the tree-rings reflect the state of solar magnetic activity. By measuring the radiocarbon contents in annual tree-rings, we can trace back the characteristics of the eleven-year solar cycles during the pre-historical periods. The Sun holds several long-term cyclic variations in addition to the 11-year sunspot activity cycle and the 22-year cycle in the polarity reversals. The 88-year and the 208-year quasi cyclic variations of the Sun have caused several long-lasting sunspot minima such as the Maunder Minimum (1645-1715 AD), and have brought cold spells as referred as the Little Ice Age. However, not only the mechanisms of such long-term solar variations but also the mechanisms of solar influence on climate are not clarified yet. In order to clarify the transitions of solar cycle in the past and their effect on climate, we investigated the change of the characteristics of the eleven-year solar cycle during the last 1200 years, including the grand solar activity maxima around the 9-10th century, the Spoerer Minimum (1415-1534 AD) and the Maunder Minimum by measuring the radiocarbon content in tree-rings with annual time resolution. The spectral analyses of the radiocarbon data have revealed the suppression of the eleven-year variations and the slight stretching of the cycle lengths during the grand activity minima. On the contrary, slight shortening of the eleven-year cycle was found for the grand solar activity maxima. The 22-year polarity reversal cycle was also modulated in association with the change of the 11-year cycle. We compared these results with the reconstructed temperatures for the last 1200 years, and found that the significance of the 22-year cycle is much larger than that of the 11-year cycle especially around the grand solar minima periods. It suggests that the polarity change of the Sun is taking important role in the multi-decadal climate variations, and that the electromagnetic forcing is more important to climate rather than the irradiative outputs of the Sun such as UV radiation.

Keywords: solar cycle, tree ring, radiocarbon

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MS020 **Poster presentation** **5755**

Solar and geomagnetic forcing of aerosol optical depth

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One of the possible mechanisms that relay solar variability and optical atmospheric changes is studied. This link can bring great importance for the overall solar-terrestrial relationship. Even a small deviation in the optical properties of the atmosphere can shift the balance between absorption, transparency and albedo. This gives a physically motivated scenario for an enhanced triggering effect of solar activity in the Earth atmosphere. The objective of our investigation is analysis of the effect of short- (some days) term variations of solar activity and cosmic rays on the optical properties of aerosol and atmospheric optical depth. It is taking into account effect of solar cosmic rays, ground level effects of solar protons and Forbush decreases of galactic cosmic rays. The results of our investigations explain how strong the optical atmospheric parameters response to the solar signal, how stable are these relationships (both spatially and temporarily) and whether they are affected by other external forces.

Keywords: solar activity, cosmic rays, atmosphere of the earth

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MS020 **Poster presentation** **5756**

Seasonal variation of biologically-effective solar radiation at so Martinho da Serra (29.5 S), Kiyotake (31.9N), Brussels (50.9N), Punta Arenas (53.2 S) and Padang (0.9S).

Mr. Pabulo Rampelotto
IAMAS

Andr Passaglia Schuch, Ana Paula Soares De Lima, Marcelo Barcellos Da Rosa, Damaris Kirsch Pinheiro, Nobuo Munakata

The use of microorganisms a s biosensors for solar ra diation measurements is imp ortant, because it is possible to es timate the real action of the s olar ra diation on live systems. In this work , the seasonal variation of biologically-effective solar radiation in low, middle and high latitudes, using spore dosimetry as sensor of UV radiation is reported. Data from Punta Arenas - Chile (53.2 S), So Martinho da Serra - Brazil (29.5 S), Padan g In donesia (0.9S), Brussels Belgium (50.9N) and Kiyota ke Japan (31.9N) from 1999 to 2004 are compared. Seasonal variations of SID were observed p resenting the higher values in summer (973˜73 for Punta Arenas and 4, 369˜202 for So Martinho da Serra, as well 1,402˜170 an d 3,400 ˜1,674 for Brussels an d Kiyotake, respectively). The lower SID values were observed in winter (33˜8, 332˜149, 44˜21 and 163˜63 for P unta Arenas, So Martinho da Serra, Brussels and Kiyotake, respectively). The maximal se asonal ratio between SIDMAX and SIDMIN was obtained for Punta Aren as (24) and for Brussels (29), where these presents the higher latitudes and consequently lowers radiation intensities. At Padang is observed the highe r SID values (> 6,000, no en countered in other station). A n exponential correlation between the hemispheres had been observed.

Keywords: seasonal variation, solar radiation, spore dosimetry

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MS020 **Poster presentation** **5757**

Solar cycle signal in the seasonal moisture field over the peninsular Indian region

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The total precipitable water or moisture integrated vertically from surface to 300 hPa (VIM) over the peninsular India for various seasons have been studied using NCEP/ NCAR monthly specific humidity datasets. The time series analysis of the winter-time (December-February) VIM over the peninsular India showed decadal mode of variability for the analysis period of 1950-2004. To understand the spatial extend of this mode of variability, Fast Fourier Transform FFT of the VIM was carried out for the region 20 S-50 N and 50-110 E. The spatial patterns of spectral power corresponding to 10 and 11 years show high values over the peninsular India and extending over Bay of Bengal to Singapore. This also has a northeastward spread towards east China region. In order to study the percentage variability of 10-11 year mode, Empirical Orthogonal Function (EOF) analysis over the same region was carried out. The first EOF shows the similar anomaly patterns as that of the FFT power corresponding to 11 years. The second EOF shows similar patterns as that of the spectral power over the southern peninsular India region. The first EOF gives 21.2% of the total moisture variability over the study area, which corresponds to 11-year mode, and the second EOF gives 12%, which corresponds to the 10-year mode. To suggest a causal mechanism for this kind of moisture variability, the correlation of 10.7 monthly solar radio flux and tropospheric air temperature (NCEP) was studied along vertical sections along 80 E and 10 N. The meridional cross-section along 800 E shows that in the northern hemisphere the correlation extends down to about 850 hPa up to 15 N and is significant at 99% level. Though not statistically significant, high correlation extends further north to 25 N and down to 950-hPa level. The zonal cross section at 10 N shows that the correlations are significant down to 800 hPa in the eastern hemisphere. The tropical atmospheric moisture is dependant on tropospheric temperature. It is suggested that the influence of solar flux on the tropospheric temperature, though feeble but statistically significant, may be driving force behind the principal modes of variability.

Keywords: empirical orthogonal function, fast fourier transform, solar flux

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MS020 **Poster presentation** **5758**

On solar and geomagnetic activity signatures in climatic variations in Romania

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Many recent studies revealed the correlation between solar parameters (sunspot number, solar irradiance), cosmic rays, and the climatic parameters, especially temperature. We analyze the relationship between solar and geomagnetic activities and the climatic variations in Romania. Long-term trends in solar and geomagnetic activities inferred from the sunspot number and aa index time-series are compared to the long-term variations of mean temperature and precipitation over Romania, in the context of European and global data. The discussion is based on yearly means of the temperature and precipitation recorded at 14 stations in Romania in the last 150 years. The comparison at interdecadal and centennial time-scales of solar and geomagnetic parameters with the mean temperature shows positive correlation coefficients, while the comparison with the mean precipitation shows negative correlation coefficients. The correlation of climatic parameters seems to be stronger in case of geomagnetic activity than in case of solar activity. The relationship with the Atlantic Multidecadal Oscillation (AMO) and the North Atlantic Oscillation (NAO), the most important sources of climatic variability over Romania, is investigated as well.

Keywords: sunspot number, aa geomagnetic index, climatic parameters

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MS020 **Poster presentation** **5759**

Solar and geomagnetic activity effects on the occurrence of synoptic types in Europe

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Winter months (winter = December to March) in 1949-2003 are divided into three classes according to the mean monthly solar F10.7 flux, corresponding to the minima of the 11-year solar cycle, a moderate solar activity, and solar maxima. Within each class, frequencies of occurrence of groups of the Hess-Brezowsky synoptic types (which characterize atmospheric circulation over central and western Europe) are calculated. Differences in the occurrence of individual groups of types between solar activity classes indicate the presence of a solar activity effect on atmospheric circulation over Europe. Statistical significance of these differences is estimated by a block resampling method. Several statistically significant results are obtained: 1. Westerly types are more frequent under high than low solar activity. 2. Northerly types are more frequent under low than high activity. 3. Easterly and anticyclonic types are more frequent under low than moderate solar activity; the opposite holds for cyclonic types. Analogous analysis was conducted for geomagnetic activity. Its results are, however, considerably less significant and more erratic.

Keywords: solar activity, synoptic types, tropospheric circulation

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MS020 **Poster presentation** **5760**

The effect of strong geomagnetic storms on the troposphere of the Northern Hemisphere in winter

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The effect of strong geomagnetic storms (Ap≥60; Dst≤-100 nT) occurring in winter (January-March) periods of 1970-2004 on the troposphere in the Northern Hemisphere was investigated. There were 32 such cases. The analysis of pressure, temperature and windfield maps, plotted at geopotential height 500 hPa, the analysis of pressure and temperature vertical sections (850 hPa-100 hPa) along the profile Atlantic-polar region-eastern Asia, as well as the analysis of course of pressure and temperature at particular gridpoints pointed out, that: a) a decrease in pressure and temperature over the North Atlantic occurs 5-8 days after strong geomagnetic storm. b) The effect lasts by isolated geomagnetic storms only (3-4 days). c) More persistent effect is associated with prolonged high geomagnetic activity. d) The geopotential height over the North Atlantic is subnormal in months in which the average of daily sum Kp is higher than 23. Such situations occurred predominantly in February. e) The effect of geomagnetic activity on the value of geopotential height averages over the North Atlantic is amplified by the level of solar activity. One must bear in mind that the fluctuations of pressure, temperature and windfield are autonomous processes. The geomagnetic and solar activity just modulate them.

Keywords: geomagnetic activity, solar activity, winter troposphere

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MS020 **Poster presentation** **5761**

The 11-year solar cycle affects teleconnectivity of atmospheric circulation

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We examine whether the teleco nnectivity o f atmo spheric circulatio n in the No rthern Hemisphere depends on t he phase of the solar cycle. The tele connectivity is characterized here by one-point correlation maps and effects of modes of low-frequency variability on surface climate (t emperature and precipitation), both in 500 hPa heights. Winter mo nths (December to March) are divided into thre e classes by the level of solar activity, measured by F10.7 solar flux. Within each class, co rrelation maps are calculated at each gridpoint with the 500 hPa height field in the Northern Hemisphere north of 20N. At each gridpoint, the area with remote negative correlations lower than a neg ative threshold is calculated in each solar activi ty class separa tely. Also, at e ach gr idpoint, the agreement between the correlation patterns for diffe rent solar activity cla sses is qua ntified by pattern correlations. Results indicate that at the majority of gridpoints, the teleconnections are more spatially extensive under a high solar activity. The difference in correlati on patterns between solar minima and maxima is largest in the midlatitudes over the Atlantic and Pacific oceans where large responses to solar activity in the variability modes have been detected recently. In the Euro -Atlantic do main, four mo des o f low-frequency variability are calculated in mont hly mean 500 hPa heig hts. We demo nstrate that t heir effects on surface tempe rature and pre cipitation at a bout 100 stations across wh ole Euro pe sig nificantly differ between a high and low solar activity.

Keywords: solar activity, teleconnections, tropospheric circulation

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MS020 **Poster presentation** **5762**

Solar maximum epochs imprints in tree-ring width from Passo Fundo, Brazil (1741-2004).

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Prestes, A, Nordemann, D.J. R., Da Silva, H. E., Souza Echer, M. P., Echer, E.

Tree-ring width data (1741- 2004) from Passo Fundo, Southern Brazil (lat: 27o 15S, long: 52o 54W), were studied by spectral analysis and cross-wavelet analysis technique, which permits the identification of non-stationary features in tree ring data and sunspot number. Evidences of the 11, 22, 54, 80 and 208-yr. solar cycle periods were found. The 11 yr solar cycle in the tree-ring width data is present only during the epochs of maximum solar activity, during 1764-1804, 1824-1884 and 1924-1984 intervals. The Hale solar cycle in the tree-ring width data is present only during 1764-1864 and 1904-2004 intervals. The Gleissberg solar cycle in the tree-ring width data is present in the 1844-1994 intervals. The cross-wavelet map between tree-ring widths and sunspot numbers show identical results for the 11, 22 and 80-yr. solar cycles found in tree-ring width wavelet map.

Keywords: tree ringwidth, spectralanalysis, waveletanalysis

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MS020 **Poster presentation** **5763**

Global lightning on the 11-year solar cycle

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Gabriella Stori, Jzsef Br

Schumann resonances (SR) are electromagnetic eigen-modes of the Earth-ionosphere cavity excited by ELF (extremely lo w frequency) radiatio n o f lightning discharges. Lo ng-term SR freque ncy reco rds at Nagycenk (NCK), Hungary h ave been used to determin e areal variations of global lightning on the 11 - year solar cycle.The daily frequency range (DFR) of Schumann resonances (SR) is the band in which the resonance freq uency shifts u p and do wn during a da y. The DFR is rela ted to the size of the region where the random lightning discharges are distribute d. The wider, the region is, the smaller the DF R becomes, and vice versa. The mean size (diameter) of thunderstorm regions can be o btained from the DFR using a c alibration curve characteristic of the SR sta tion at Nagycenk (NCK), Hun gary. Mo nthly means of source diameter were determined fr om May 1993 up to December 2006. The ann ual an d semiannual areal variations known already ex hibit clear 11-year solar cycle modulation. The magnitude of the mo dulation o f the annual are al v ariation in creases with increasing so lar activity while th e semiannual areal variation shows an opposite behaviour on the same time scale, its mo dulation follows rather the variation of galactic co smic rays on the 11-year solar cycle. The opposite modulation of the annual and se mi-annual are al variatio ns on the so lar cycle can be explained by the no rth-south asymmetry of the land-covered areas between the two hemispheres. The thunderstorm areas extended up to the 60-65N latitude i n the Norther n Hemisp here summer and practically there is no lightning below 40S latitudes in the Southern Hem isphere su mmer. Lightning activity in hig h-mid no rthern latitudes can be influenced by the variation of solar activity. The semiannual areal variation origins from lower latitudes. It is attributed to the tropical land surface temperature variations and increased thermal instability in the transition seasons (spring, fall). Lightning activity of this lower lat itudinal range seems to be m odulated by the variations of galactic cosm ic rays on the 11- year solar cycle. Homogeneous data sets of sa tellite lightning observations are available only for shorter period than the 11-year solar cycle but they show similar interannual trends as disclosed by Schumann resonances.

Keywords: global lightning, areal variation, 11 year solar cycle

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MS020 **Poster presentation** **5764**

Connection of variation of thunderstorm intensity with variation of solar wind parameters

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Investigation of connection variations of VLF-noise intensity of the thunderstorm origin with solar wind parameters variations is carried out. The data of the continuous analogue registration of the VLF-noises intensity at frequency 8,7 kHz since 1979 year were used. The VLF-noises intensity at st. Yakutsk characterizes thunderstorm activity in Eastern Siberia, and activity of the African global thunderstorm centre. It is obtained, that there is a significant connection between a thunderstorm activity and solar wind parameters variation. The obtained result can be explained by the physical mechanism in that solar and cosmophysical factors acts on the global atmospheric circuit, and therefore on a thunderstorm activity.

Keywords: thunderstorm, vlf noises, solar wind

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MS020 **Poster presentation** **5765**

Effect of ENSO on the possible relationship between cloud cover and solar activity

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There is increasing evidence showing a correlation between different solar proxies (cosmic rays, solar irradiance, magnetospheric activity) and cloud cover variations, suggesting a solar effect on the occurrence of clouds. On the other hand, regular or sporadic terrestrial effects as ENSO and/or major volcanic eruptions, which do affect the cloud formation, may affect the results of statistical studies of the Sun-cloud relation and produce spurious correlations. Based on a thorough statistical analysis of the sun-cloud relation, we show here that removing periods of strong ENSO and volcanic events does not alter the conclusions of the full set analysis over the majority of the Earth surface (except for the equatorial Pacific clearly dominated by ENSO). Moreover, removing the ENSO/volcanic events improves the correlation between clouds and solar proxies. This supports the idea that the solar signal does affect clouds directly.

Keywords: sun climate relationship, sun climate enso cloud

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MS020 **Poster presentation** **5766**

Climate Response to External Forcing

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Air surface temperature time-series, volcanic and solar activity in the past are analyzed in order to investigate the possible external source of regional and global climate variability. Using cross-wavelet and EMD techniques we have found periods and regions of significant phase coherence between long-term modes, demonstrating nonlinear influence of solar and volcanic forcing of climate changes.

Keywords: climate changes, solar activity, volcanic activity

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MS020 **Poster presentation** **5767**

Multi-resolution analysis of the global surface air temperature and solar activity relationships

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Daniel Jean Roger Nordemann, Ezequiel. Echer, Nivaor Rodolfo Rigozo

The surface air temperature is a basic meteorological parameter and its variation is a primary measure of global climate change. In this work the relationship between global and latitudinal averaged surface air temperature and solar activity over several timescales is studied by wavelet multi-resolution analysis. The temperature anomaly and sunspot number (Rz) in the period 1880-2000 are show to investigate of the global, hemispheric and zonal surface temperature on solar activity.

Keywords: global surface air tempera, sunspot number, wavelet analysis

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

MS020 **Poster presentation** **5768**

The solar activity influence on the high latitude troposphere of Earth

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The complex analysis of temperature a nd pressure f ield reaction in troposphere to individual heliogeophysical disturbance s was carried out. It is detected that t he regular changes of the temperature and pressure fields accompany these disturbances. It is determined that the significant (up to 15 Ko) temp erature increasing in separate high latitude regions of the lower and middle troposphere is observed after the helio geophysical disturbances. But in upper troposphere is observe d the decrease of temperature. It was fou nd the chang es of typi cal zonal transfer are to be observed after the heliogeophysical disturbances, which become appa rent as stopping of the same earlier moving structures. The analysis o f influence o f solar activity level variations on t he Earth climate system wa s carried out. It is shown that by the solar ac tivity increase take place the decrease of energy losses by the climate system of the Ear th, generally, in high-l atitude regions in win ter periods. Th e ascertained regularities have full explanation in framework of the mechanism and model of heliogeophysical factors influence on the climate ch aracteristics of tr oposphere, that was proposed in paper (G.A. Zherebtsov, V.A. Kovalenko, S.I. Mo lodykh, Advances in Space Researc h, 2005, 35, 1472). The key concept of the model – is the influence of heliogeophysical distur bances on the parame ters of Earth climate system regulating the energy flux rad iated from the Earth in to the space at high-latitude regions. The model i s based on t he physical mechanism of heliogeophysical factors influence on the climate characteristics and atmo sphere circulatio n in the high- latitude troposphere through the atmosphere electricity. According to t his mechanism, on th e one hand, the atmosphere electricity parameters at high latitudes are under the significant influence of sola r activi ty; o n the o ther han d, it greatly influences the distribution acc ording to the height in tropospher e of char ged condensation cores and, consequently, the formation of cloudiness and radi ation balance. This mechanism effectively works in high-latitude regions, leading to the additional formation of cloudiness in the regions where ther e is a needed concentration of the water vapor.

Keywords: sun, influence, climate

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

MS020 **Poster presentation** **5769**

Solar variation & climate: correlation & causation

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Many correlations have been found between variables representing aspects of solar activity & those representing aspects of Earth's climate, but how much do they mean? Some novel examples for the 20th century, the only one for which we have good observational coverage, will be presented, which emphasize the importance of reliable uncertainty ranges - without them, after all, all we can say about a best guess is that it has zero likelihood of being correct. GCM examples which show the importance of the difference between the patterns (in space & time) of climate forcing & those of climate response will also be presented. This sort of material is familiar within the GCM community, but less appreciated outside it. Some comments will also be made about the use of Fourier filtering, & on evidence for "solar amplification" from GCM simulations.

Keywords: climate, change, solar

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