Perugia, Italy July 2-13, 2007

IAPSO

INTERNATIONAL ASSOCIATION FOR THE PHYSICAL SCIENCES OF THE OCEANS

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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.

JPS001 Symposium (1577 - 1680)

Convener : Dr. Michael McPhaden
Co-Convener : Dr. Neil Holbrook

Interannual and Interdecadal Climate Variability

JPS002 Symposium (1681 - 1701)

Convener : Dr. Hans Renssen

Abrupt Climate Change

JPS003 Symposium (1702 - 1715)

Convener : Dr. Denise Smythe-Wright

Environmental Controls on Marine Biota

(P) - IAPSO - *International Association for the Physical Sciences of the Oceans*

JPS001 **1577 - 1680**

Symposium
Interannual and Interdecadal Climate Variability

Convener : Dr. Michael McPhaden
Co-Convener : Dr. Neil Holbrook

This symposium will address the causes and consequences of climate variability on interannual to interdecadal time scales from theoretical, numerical, and observational perspectives. Phenomena of interest include ENSO, NAO, Northern and Southern Annular Modes, Pacific Decadal Oscillation and the related Interdecadal Pacific Oscillation, the Indian Ocean Dipole, Atlantic and Benguela Nios, the Atlantic Interhemispheric Gradient Mode, and other dominant modes of variability. Papers dealing with climate dynamics, environmental and societal impacts, paleoclimate reconstructions, and the relationship between dominant modes of natural climate variability and anthropogenic climate change are encouraged.

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JPS001 **Oral Presentation** **1577**

How ENSO impacts precipitation in Southwest and Central Asia

Dr. Annarita Mariotti
ESSIC UMD IAMAS

Hydroclimatological variability in parts of Southwest and Central Asia is very large. For instance, a very severe drought was experienced in a broad region centered around Iran, Afghanistan and Pakistan during the period 1998-2002, which has been associated with the exceptionally prolonged La Nina-like conditions. Several studies have investigated the broader role of ENSO (El Nino Southern Oscillation) events in precipitation variability in this region. A late summer-early winter ENSO precipitation signal has consistently been reported by various authors, however the underlying cause has not been established. In other seasons the precipitation signal is unclear. In this talk, the impact of ENSO events on interannual precipitation variability in parts of Southwest and Central Asia throughout the seasonal cycle is described using state-of-the-art precipitation datasets and re-analyses. Decadal changes in this teleconnection are addressed. The mechanisms behind this teleconnection are investigated in numerical AMIP-type simulations. In particular, we will discuss the roles played by various oceanic regions in producing the observed signal.

Keywords: enso, precipitation, southwest asia

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JPS001 **Oral Presentation** **1578**

The enhanced PNA-like climate response to Pacific interannual and decadal variability

Dr. Bin Yu
Environment Canada Climate Research Division IAPSO

Francis W. Zwiers, Amir Shabbar

The observational record and a 1000-year climate modelling analysis provide further evidence of the impacts of Tropical Pacific interannual (ENSO) and Northern Pacific decadal-interdecadal (PDO or NPI) variability on the Pacific-North American (PNA) sector. Both the tropospheric circulation and the North American temperature suggest an enhanced PNA-like climate response and impacts on North America when ENSO and PDO variability are in phase. In association with the stationary wave anomalies, large stationary wave activity fluxes appear in the mid-high latitudes originating from the North Pacific and flowing downstream toward North America. There are significant Rossby wave source anomalies in the extratropical North Pacific and in the subtropical North Pacific. In addition, the axis of the Pacific storm track shifts southward with the positive PNA. Atmospheric heating anomalies of the same sign appear in both the Tropical Pacific and the North Pacific in association with this variability. Both sources of variability provide energy transports towards North America, which tends to favor the occurrence of stationary wave anomalies and would lead to a PNA-like wave anomaly structure.

Keywords: pacific variability, pna like climate response, physical processes

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JPS001 **Oral Presentation** **1579**

Climate variability analysis for temperature and precipitation based on REMO datasets

Dr. Youmin Chen
Ecosystem Group Max-Planck Institute for Biogeochemistry IAMAS

Environment change is currently one of the great challenges that humans are facing. Most of the environment changes are closely related to climate change. It is either the result of climate change or the factor causing climate change, or both. Climate data are used in ecosystem modeling as the forcing for environment change research. The REMO data were used as one of the forcing for ecosystem modeling within the CarboEurope-IP project. We managed to derive the climate signals represented by REMO data, in order to explore how the climate change is happening, and what influence could be made on environment. The climate change can be characterized by appearance of the trend in climate variables and changes in their variability. Our work here is focusing on the climate variability. Through the statistical analysis such as EOF, rotated EOF, CCA and wavelet analysis as well, we have found some interesting points. In year 2003 the temperature in Europe mostly has the negative anomaly in the months from Jan to Apr and Oct; but positive anomaly in the other months. The positive anomalies are much stronger in summer time (especially in June and August) in the middle and Western Europe. The CCA analysis between temperature and precipitation shows that the temperature anomaly is mostly opposite to precipitation anomaly. Therefore, in 2003 the extreme heat in summer corresponds to less precipitation, which leads to relatively serious drought in that year. None of EOF or REOF patterns are similar to the anomaly pattern of 2003 for temperature. It could be concluded that the extreme climate in 2003 is not a typical case, but an exceptional climatic event. The further cluster analysis based on REOF space will be carried out soon for making sub-region, with which the more detailed analysis can be made, focusing on a specific coherent region.

Keywords: remo, reof, varibility

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JPS001 **Oral Presentation** **1580**

Dynamics of Decadal Variability in the Northeast Pacific

Dr. Antonietta Capotondi

The Gulf of Alaska (GoA) is a complex environment where variations in the physics and biogeochemistry impact the marine ecosystem with important implications for the fishery industry. Biological processes in the Gulf of Alaska are strongly influenced by mixed layer depth in conjunction with light availability and micronutrients in the center of the gulf, and by eddies, which influence the nutrient supply near the coast. The GoA has an upper-ocean structure characterized by a thick layer of low-salinity near the surface. Since at high-latitudes salinity has a controlling influence upon density, the halocline, the depth with the largest salinity gradients, determines the pycnocline. In winter, the mixed layer reaches to the top of the pycnocline, and horizontal gradients of pycnocline depth determine the strength and direction of the geostrophic currents. Thus, understanding pycnocline variations is very important for biological processes. The pycnocline depth in the GoA exhibits large decadal variations. In particular, large changes in the upper ocean density structure of the GoA are found in conjunction with the 1976-1977 climate regime shift. They include a shoaling of the pycnocline in the center of the GoA and a deepening of the pycnocline in a broad band along the coast. These changes lead to more pronounced horizontal density gradients and intensification of the currents, especially the Alaskan Stream. In this study we use numerical model simulations to examine the dynamical processes responsible for the low-frequency pycnocline depth changes. It is found that at decadal timescales most of the pycnocline changes can be primarily explained by local Ekman pumping forcing and along-coast advection and wave propagation. Westward propagation of Rossby waves seems to play a secondary role, and the Sverdrup balance does not appear to hold.

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JPS001 **Oral Presentation** **1581**

Arctic Oscillation and Dipole Anomaly and their contribution to sea ice export from the Arctic in the 20th century

Prof. Jia Wang
International Arctic Research Center University of Alaska Fairbanks IAPSO

Eiji Watanabe

The winter Arctic Oscillation (AO) and Dipole Anomaly (DA) in the Arctic atmosphere and their contribution to sea ice export are investigated by using a high-resolution coupled general circulation model and NCEP/NCAR reanalysis. The spatial distributions of the first two leading EOF modes of winter mean sea level pressure and geopotential height at 500 hPa north of 70oN obtained by the long-term simulation (1900-2010) are highly similar to them derived from the NCEP/NCAR reanalysis datasets (1948-2004). The first leading mode corresponds to the Arctic Oscillation (AO). The DA is defined as the second-leading mode. The AO and DA account for 66 % and 13 % of the variance, respectively. Composite spatial patterns of sea level pressure, sea ice thickness and velocity in the extreme years when both the absolute values of PC1 and PC2 exceed 1.0 indicate that the DA plays a great important role in sea ice export from the Arctic Ocean to the Greenland Sea due to its strong meridionality. Sea ice export is highly promoted (restricted) in the positive (negative) DA phase. The dependence of sea ice export on the DA is comparable to or rather larger than that on the AO. However, whether the DA is physically independent of the AO or not has been unknown yet. Composite SLP fields suggest that the location of the most dominant anomaly in the Arctic seems to be characterized by the DA, while the sign of the anomaly is represented by the AO. The mechanism for existence of the DA and its relationship with the AO are open for further studies.

Keywords: arctic oscillation, dipole anomaly, sea ice export

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JPS001 **Oral Presentation** **1582**

Global SST Variability and Drought over North America

Dr. Siegfried Schubert
Global Modeling and Assmilation Office NASA GSFC IAPSO

Max Suarez, Philip Pegion, Randy Koster, Julio Bacmeister

In this study we examine the role of SST variations in the development of multi-year drought over North America. Specifically we carry out a number of atmospheric general circulation model experiments in which the model is forced with the leading patterns of annual SST variability consisting of a global warming pattern, a pan-Pacific pattern, the Atlantic multi-decadal oscillation, and various combinations of the three patterns. We will highlight the role of each pattern in producing drought, the dynamical mechanisms linking the SST anomalies to regional drought, and the role of soil moisture feedbacks in amplifying or maintaining the drought conditions.

Keywords: drought, sea surface temperatures, climate variability

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JPS001 **Oral Presentation** **1583**

Southern African climate variability: subleties and challenges

Prof. Chris Reason
Oceanography University of Cape Town IAPSO

The climate of southern Africa is characterised by substantial variability on a range of temporal and spatial scales. Due to its close proximity to three major oceans and its remoteness from the main centres of ENSO interactions, diagnosing the impacts of various large-scale modes is difficult. In addition to ENSO, the Southern Annular Mode, the Benguela Nio, the Indian Ocean Zonal Dipole Mode and subtropical modes have all been shown to impact the region The task is further complicated by the strong gradients in sea surface temperature (SST), ocean currents, topography, vegetation and soil moisture existing in the region that interact with the regional circulation anomalies imposed by these modes in subtle and not well understood ways. The relationships between these gradients, the base climate of the southern African region, and the main patterns of variability over the region forms part of the SAGRADEX research programme being developed by the CLIVAR Variability in the African Climate System panel that seeks to determine how well these gradients need to be represented in models for climate prediction and what constraints do they impose on regional climate predictability. This talk will review southern African climate variability, its sensitivity to various large-scale climate modes and efforts for regional climate prediction.

Keywords: africa, oceans, interactions

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JPS001 **Oral Presentation** **1584**

Variabilty of mean wind speed in large cities over Iran

Dr. Fatemeh Rahimzadeh
climatology ASMERC IAG

Nooshin Mohammadian, Abdolah Sedaghatkerdar

It is necessary to study the trends and variability of wind speed in large and small scales, although some features make study of wind variability difficult. In this paper, we study variability of mean wind speed using some statistical methods, in some synoptic stations of Islamic Republic of Iran that are located near large cities and their wind records affected by urbanization and landuse changes. The results indicate that annual mean wind speeds in large cities mostly decreased during the latter half of the 20th century over Iran. The changes in wind speed distribution in stations like Tehran and Esfahan strongly linked to changes in increasing of their populations. These changes over the latter portion of the 20th century has potentially caused increasing of air pollution in these cities

Keywords: climatic variability, wind speed, iran

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JPS001 **Oral Presentation** **1585**

Decadal variability of stratification and biological impacts in the California Current with CalCOFI and ROMS

Mrs. Hey-Jin Kim
Climate Research Division Scripps Institution of Oceanography

Arthur J. Miller

The 55-year CalCOFI (California Cooperative Oceanic Fisheries Investigations) dataset in the southern California Current reveals a significant surface-intensified warming and increased stratification (buoyancy frequency) across the 1976-77 climate regime shift. How did these physical changes alter coastal circulation and nutrient supply into the euphotic zone? To quantify stratification structure changes, thermocline depth and thermocline temperature were calculated using CalCOFI data. Thermocline depth was defined as a depth with maximum vertical gradient of temperature profile. Thermocline temperature increased after the shift by the surface-intensified warming, however, the average depth of the thermocline did not change significantly across the regime shift. As the surface heating strengthened stratification, cross-shelf momentum flux at the interior of the water column by Ekman transport is getting more important than bottom boundary return flow (Lentz and Chapman, 2004). This affects nutrient supply for new production in euphotic zone because major nutrients increased with depth in the ocean. Thus the quality of upwelled water may have been fundamentally altered. Three dimensional numerical modeling study using ROMS (Regional Ocean Model System) was conducted to address details of coastal circulation pattern changes according to different surface SST forcings.

Keywords: pdo, californiacurrent, calcofi

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JPS001 **Oral Presentation** **1586**

Climate change in Turkey: temporal and spatial variability

Dr. Mete Tayan
Dept. of Environmental Engineering Lecturer

Ulas Im, Murat Dogruel, Mehmet Karaca

Climate change and its urban-induced bias in selected Turkish cities is studied with a quality controlled temperature and precipitation data of Turkish stations in the period of 1950-2004. These stations are classified into two groups according to their populations; S1, including rural and suburban stations and S2, including large urban stations. 365-day moving average signals and their digital low pass filtered versions are produced to eliminate the short term fluctuations and examine the possible trends or anomalies in climate data. Furthermore, relative difference signals are introduced and applied to temperature and precipitation series to observe the actual local changes in the climate data independent from large-scale effects. Mann-Kendall test statistics are calculated for maximum, minimum, mean temperature and precipitation series and plotted on maps to determine any spatial trend patterns. Signal analysis show a cool period extending from early 1960s till 1993, generally with the lowest temperature values on 1992-93 owing to the eruption of Mt. Pinatubo. A last decade significant warming trend is observed in both of the series, S1 and S2, leading to 2000-2002 temperatures to be recorded as maximums in record history. The variability of urban precipitation series is generally larger than the rural ones, suggesting that urban stations can experience more frequent and severe droughts and floods. Though not significant, an increase in the urban precipitation compared to the rural one is also found. Spatial analysis resulted in significant warmings in southern and southeastern parts of the country. Particularly, minimum temperature series show significant warming in almost all of the regions indicating the effect of urbanization. Significant decreases of precipitation amounts in the western parts of Turkey, such as Aegean and Trachea regions, are found. On the other hand, some Turkish northern stations show increases in precipitation of which some are significant.

Keywords: climate, temperature, precipitation

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JPS001 **Oral Presentation** **1587**

Anti-persistence in global temperature anomaly field

Dr. Leila Carvalho
Atmospheric Sciences University of Sao Paulo, Brazil IAMAS

Anastasios Antonios Tsonis, Charles Jones, Humberto Ribeiro Da Rocha, Paulo Simionato Polito

The Earths average surface temperature has increased by 0.6 -0.2C since the late 19th century with significant global impacts. However, uncertainties about the details of the natural variability as well as the response of the climate system to the rapid increase of greenhouse gases still remain (IPCC 2001). Understanding natural variability of the climate system is crucial to predict non-linear climate forcings. The objective of this study is to improve our understanding of climate variability by providing new insights about the spatiotemporal variability of temperature anomalies. Here, low-frequency variations in temperature anomaly are investigated by mapping temperature anomaly records onto random walks. Anti-persistence scaling properties of temperature anomalies are investigated. We show evidence that global overturns in trends of temperature anomalies occur on decadal time-scales as part of the natural variability of the climate system. Paleoclimatic summer records in Europe and New-Zealand provide further support for these findings as they indicate that anti-persistence of temperature anomalies on decadal time-scale have occurred in the last 256 yrs. Atmospheric processes in the subtropics and mid-latitudes of the SH and interactions with the Southern Oceans seem to play an important role to moderate global variations of temperature on decadal time-scales.

Keywords: decadal, anti persistence, random walks

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JPS001 **Oral Presentation** **1588**

ENSO and Mean Flow Energetics over the Western North Pacific during Typhoon Season

Mrs. Pang-Chi Hsu
Department of Earth Science National Taiwan Normal University IAMAS

Chih-Hua Tsou

The interannual variations of SST over the Central-Eastern Pacific during typhoon season are closely related to the interannual variability of tropical storm (TS) occurrence over the tropical western North Pacific (WNP). Accompanying with the warm SST anomalies shift eastward in the equatorial Central-Eastern Pacific, the westerly jet, monsoon trough, anomalous upward motion and diabatic heating all extend southeastward. The large-scale circulations modulated by summertime ENSO provide a favorable environment for TS occurrence. The maintenance of these large-scale anomalous circulations is investigated by the mean flow energetics in this study. Composites of mean flow energy reveal that both the mean available potential energy (MAPE) and mean kinetic energy (MKE) increase over the WNP. The increment of MAPE in the tropics is mainly contributed by the generation of MAPE associated with the heightened diabatic heating over warm region. As the upward motion intensified, the MAPE converts to MKE to maintain the anomalous circulations. The enhancement of these anomalous circulations plays an important role for transient eddies growth because it provides a suitable condition for eddy baroclinic and barotropic conversions.

Keywords: enso, typhoon, energetics

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JPS001 **Oral Presentation** **1589**

Changes in Atmospheric Circulation over the Last Century

Prof. Nikolay Sidorenkov
Hydrometcentr of Russia Hydrometcentr of Russia IAG

The kernel of the global climate change is the change in the atmospheric circulation. Variations in the frequency of the atmospheric circulation forms W, E, and C (by Vangengeim's classification) are studied for the period from 1891 to the present time (Girs, 1971). These forms characterize the climatic conditions over a large part of the Northern Hemisphere. It is shown that the frequency of form W has continuously decreased, while that of form E has increased. This fact indicates to a considerable secular change in the atmospheric circulation over the Northern Hemisphere. The form C frequency features variations of the decade time scale. There is a correlation between the anomalies of frequency of the atmospheric circulation forms (C and W + E) and the decade variations in the Earth rotation. This relationship can be used to diagnose the fluctuations in the frequency of form C and the combined form (W + E) and thus, to define the climatic variations over the Northern Hemisphere. Close correlations are found between the decade variations in the length of day, variations in the rate of the westward drift of the geomagnetic eccentric dipole, and variations in the climate characteristics (anomalies of the atmospheric circulation forms, the hemisphere-averaged air temperature, and the increments of the Antarctic and Greenland ice sheet masses). The nature of these relationships is discussed.

Keywords: atmospheric circulation forms;, variations in earth rotation;, interdecadal climate change

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JPS001 **Oral Presentation** **1590**

Reconstruction of global monthly upper-level fields back to 1870

Mr. Thomas Griesser
Institute for Atmospheric and Climate Science ETH Zurich, CH-8092 Zurich, Switzerland

Prof. Dr. Stefan Brnnimann

The study of upper-level fields is an important tool in climate research and is particularly important for understanding the mechanisms leading to long-range teleconnections. However, global 3-dimensional datasets are only available for the second half of the 20th century. For the investigation of teleconnections, especially with respect to interannual-to-decadal oscillations, it is of interest to have upper-level fields prior to 1948. Upper-air data from the early 20th century can still be found on paper in various archives. We have digitized large amounts of data from radiosondes, kites, and aircraft and have compiled radiosonde and pilot balloon data from existing data bases. After an extensive quality control the data is used for statistical reconstructions of global monthly mean fields of temperature and geopotential height back to 1870 for the 850 to 100 hPa levels. A principal component regression model is fitted in a recent calibration period (1957-2004) using the ERA40 reanalysis as predictand and applied in the reconstruction period (1870-1957). The regression models are extensively validated using long simulations with coupled ocean-atmosphere climate models. The reconstructed fields are presented for selected months and are analyzed with a main focus on large-scale circulation variability.

Keywords: reconstruction, 3 dimensional dataset, 1870 1957

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JPS001 **Oral Presentation** **1591**

Changes in high frequency (2-14 yr) variability in sea level records since 1807

Dr. Svetlana Jevrejeva
POL Proudman Oceanographic Laboratory IAPSO

A. Grinsted, J. C. Moore, S. Holgate

We analyze 1023 sea level records from the Permanent Service for Mean Sea Level (PSMSL) database. Using advanced statistical methods we separate nonlinear trends and statistically significance oscillations for 13 large ocean basins. We demonstrate that signals in the 2.2-13.9 year band contribute from 5 to 20 % of variability in time series, however, contributions from particular oscillations (2.2, 3.5, 5.2- 5.8, 7.8 and 13.9 yr) considerably change in time. We also show that variability in sea level records over periods 2-14 years has increased during the past 50 years for the most of the ocean basins. We provide evidence that this increase in 2.2-13.9 year variability is associated with the greater influence of the large scale atmospheric circulation represented by the Southern Oscillation, North Atlantic Oscillation, Arctic Oscillation and Pacific Decadal Oscillation indices.

Keywords: sea, level, variability

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JPS001 **Oral Presentation** **1592**

A diagnostic study of the Indian Ocean dipole mode in El Nino and non-El Nino years

Dr. Hae-Kyung Drbohlav
NA Center for Ocean-Land-Atmosphere Studies IAPSO

Silvio Gualdi, Antonio Navarra

The Indian Ocean Dipole Mode (IODM) is examined by comparing the characteristics of oceanic and atmospheric circulations, heat budgets, and possible mechanisms of IODM between El Nino and non-El Nino years. ERA-40 reanalysis data, Reynolds SST, and ocean assimilation data from Modular Ocean Model are used to form composites of IODM that occur during El Nino (72, 82, 97) and non-El Nino (61, 67, 94) years. In El Nino years, two off-equatorial, anti-cyclonic circulations develop, associated with the increased pressure over the eastern Indian Ocean. The anti-cyclonic circulation over the northern hemisphere enhances the easterly component of winds in the northwestern Indian Ocean. This enhanced easterly component increases the mixed layer temperature by inducing an anomalous westward ocean current that advects the warm mean mixed layer from the central to the western Indian Ocean. Meanwhile, the anti-cyclonic circulation over the southeastern Indian Ocean strengthens southeasterlies, thereby causing oceanic meridional and vertical advection of the cold mean temperature. Consequently, the IODM in El Nino years is characterized by the warming in the northwestern and the cooling in the southeastern Indian Ocean. In non-El Nino years, a monsoon-like wind flow increases the westerly and southeasterly component of winds over the northwestern and southeastern Indian Ocean, respectively. Oceanic currents induced by these winds result in anomalous cold advection in both of these regions. In addition, the monsoon-like wind flow over the southeastern Indian Ocean enhances the anomalous latent and sensible heat fluxes in non-El Nino years. Hence, the cooling of the eastern tropical Indian Ocean, rather than the warming of western Indian Ocean, becomes the major feature of the IODM during non-El Nino years.

Keywords: indian ocean dipole mode, indian ocean zonal mode

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JPS001 **Oral Presentation** **1593**

Variability of global sea surface temperature from 1982 to 2005: low-frequency and Enso contributions

Dr. Susana Barbosa
Applied Mathematics Faculdade Ciencias, Universidade Porto

Sea surface temperature (SST) is a key parameter in climate variability at inter-annual and inter-decadal time scales. In this study, low frequency variability of global SST is investigated from the NOAA Optimum Interpolation SST dataset. Monthly SST time series on a regular 2 degree grid and covering a period of 24 years, since January 1982, are analysed. A non-linear rank-based extension to traditional EOF analysis is applied for the extraction of low-frequency space-time modes from the SST dataset. The first mode reflects a systematic decrease of SST during the 24-years period in the equatorial Pacific and an increase in most of the global ocean, particularly in the Japan Sea and North Pacific, in the western south Pacific, in the Labrador Sea and in the North-East Atlantic. The second low-frequency mode reflects ENSO variability in the Pacific Ocean. The examination of the contribution of the two derived low-frequency modes to the globally-averaged SST fluctuations indicates that these modes modes are able to account for most of the variability observed in global mean SST.

Keywords: sst, enso, low frequency

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JPS001 **Oral Presentation** **1594**

Why does reemergence of winter sea surface temperature anomalies not occur in North Pacific eastern subtropical mode water area?

Dr. Shusaku Sugimoto
Department of Geophysics Graduate School of Science, Tohoku University IAPSO

Kimio Hanawa

It is known that in some area, winter sea surface temperature (SST) anomalies can reemerge in the next winter. This phenomenon is called reemergence of winter SST anomalies, and the reemergence phenomenon can be expected as the oceanic phenomenon to generate SST variation with long-term timescale. Previously, seven reemergence areas were detected in the worlds oceans and it was found that the reemergence areas correspond to major mode water formation areas. However, the North Pacific eastern subtropical mode water (NPESTMW) has never been detected as a reemergence area. The purpose of this study is to elucidate the reason why reemergence of winter SST anomalies does not occur in the NPESTMW area in spite of occurrence in the North Pacific subtropical mode water and North Pacific central mode water areas. We use vertically temperature and salinity profiles of the World Ocean Circulation Experiment Hydrographic Program and Argo floats with vertically and temporally high resolution, together with heat flux data through the sea surface. We point out first that one of the causes for non-occurrence of reemergence that thickness of NPESTMW is very thin. In addition to this basic cause, major two reasons are found: a vigorous mixing in the lower portion of NPESTMW and less heat input from the atmosphere in the warming season. Since, in the lower portion of NPESTMW and deeper, the stratification is favorable for salt-finger type convection to occur compared with the other mode water areas, vigorous mixing take place. This is confirmed by both large Turner Angle there and existence of staircase structures in vertical temperature and salinity profiles. From the viewpoint of heat input, NPESTMW area gradually gets heat in the warming season compared with other mode water areas. As a result, NPESTMW cannot be capped so quickly by the shallow summer mixed layer, and water properties of NPESTMW are to be gradually modified even in the upper portion.

Keywords: mode water, reemergence mechanism, north pacific

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JPS001 **Oral Presentation** **1595**

Increases in Net Precipitation and Recent Freshening of the North Atlantic Subpolar Gyre

Dr. Simon Josey
OOC National Oceanography Centre, Southampton, UK IAPSO

Robert Marsh, Paul G. Myers

The role that increases in the air-sea freshwater flux (precipitation-evaporation, P-E) have played in causing freshening of the North Atlantic subpolar gyre since 1960 is investigated using atmospheric model reanalyses and observational data. Both the NCEP/NCAR and ERA40 reanalyses show a major increase in P-E (primarily due to increased precipitation) in the mid-1970s, from 0.10 m yr-1 to 0.27 m yr-1 in the eastern gyre. This increase is supported by independent rain gauge observations from Iceland, the Faeroes and Ireland. The eastern gyre air-sea freshwater flux for 1975-89 is 4 x10^12 m3 greater than in 1960-74. This increase is about twice as large as the freshwater excess associated with the Great Salinity Anomaly. Potential links between the P-E increase and the two major modes of atmospheric variability, the North Atlantic Oscillation (NAO) and the East Atlantic Pattern (EAP), are investigated. The EAP is found to be the dominant cause of the increase in the eastern gyre with the NAO only playing a minor role. The impact of increased net precipitation on sea surface salinity is examined using hydrographic measurements at 60o N which show freshening since the mid-1970s that can be largely explained as a direct response to changes in P-E. The freshening of the eastern gyre will be placed in the context of other recent work which shows a major increase in the net precipitation, by 0.09 m yr-1, in the mid-1970s in the Labrador Sea.

Keywords: freshwaterflux, northatlantic

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JPS001 **Oral Presentation** **1596**

A statistical downscaling method to force an ocean model over the North Atlantic region for climate change studies

Mrs. Marie Minvielle
Climate Modeling and Global Change Team CERFACS-CNRS IAPSO

Julien Boe, Julien Najac, Christophe Cassou, Laurent Terray

The impact of a modification of the North Atlantic atmospheric circulation on the thermohaline circulation is investigated in the framework of climate change. Most CGCMs suggest a weakening of the thermohaline circulation for the next century. However, uncertainties about the amplitude of this reduction are important. Part of those uncertainties may be due to the coarse resolution of the oceans models and to the air-sea fluxes biases of the atmospheric models. In this study, a statistical method is carried out, in order to obtain the atmospheric forcing for the high resolution North Atlantic oceanic model NATL4 (0.25) developed by the MERCATOR project. The statistical downscaling method is based on weather regimes for the North Atlantic region. This method allows to establish a link between the atmospheric large scale circulation, and the atmospheric variables at the surface. The ERA40 re-analysis is used to carry out and validate the method. The obtained surface variables are required to compute the air-sea fluxes with bulk formulae. Different bulk parameterizations are tested and compared. The ocean model is forced by fluxes obtained with the downscaling method for present climate, and to validate this experiment, it is compared with a simulation performed with the re-analyzed fluxes. Next, this methodology is also applied to the next century where the atmospheric modification will be represented by a change of the North Atlantic weather regimes occurrence. The ARPEGE coupled model will be used to predict the atmospheric circulation changes for climate change scenarios.

Keywords: thc, regimes, downscaling

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JPS001 **Oral Presentation** **1597**

Variability of the Deep Western Boundary Current-Gulf Stream system in the North Atlantic

Mrs. Beatriz Pena-Molino
Physical Oceanography WHOI-MIT

Terry M. Joyce

Sea Surface Temperature (SST) and Sea Surface Height (SSH) data are combined with in situ velocity and hydrographic measurements to analyze the variability of the Deep Western Boundary Current (DWBC) and the Gulf Stream in the Western North Atlantic. The mean monthly path of the Gulf Stream between 65W and 75W, estimated from the SSH, is found to be significantly correlated with the SST north of the Gulf Stream. The lags at which the correlation is maximum suggest that the correlated part of the field is advected by a flow of a few centimeters a second. This advection is consistent with typical values of the DWBC in the region. In situ data, from both a series of hydrographic surveys and a mooring array located at 69W, are used to relate this observed surface variability to processes occurring throghout the water column. Means and fluctuations of the velocity field in the DWBC are found to be barotropic. The relation between the variability of the velocity field and other important dynamical properties is presented.

Keywords: dwbc, gulf stream, variability

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JPS001 **Oral Presentation** **1598**

Understanding the anatomy and drivers of low frequency variability in the South Pacific gyre

Mrs. Katy Hill

CSIRO.UTas Quantitative Marine Sciences program CSIRO Marine and Atmospheric Research, Hobart IAVCEI

Stephen R. Rintoul, Richard Coleman, Ken Ridgway

The Maria Island coast station (42 36S 14814E) has been operating since 1944. Observations of temperature and salinity show that the waters of the east coast of Tasmania have become gradually warmer and saltier over 60 years. Increases in SST and Salinity are equivalent to 2.28C and 0.36psu per century. A southward expansion in the range of observed species down the east coast of Australia, across a broad range of Taxa, has also been documented. We can demonstrate that the temperature and salinity signal observed at Maria Island is linked to a strengthening in the westerlies in the South Pacific, which has modified the wind stress curl field, driving a stronger South Pacific Gyre, and hence a stronger East Australian Current. The Maria Island time series also shows significant decadal variability. However, very little is known about the low frequency variability in the South Pacific. The advent of 40-50 year ocean and atmospheric reanalysis products has allowed low frequency climate variability to be explored in significant detail for the first time. We present an analysis of variability in the South Pacific gyre using the Simple Ocean Data Assimilation (SODA) velocities to understand the relationship between the variability of regional currents and the timescales of response to variations in wind forcing. We also assess the usefulness of SODA for understanding low frequency climate variability by comparing with in situ data from coast stations and XBTs. The interplay between the two dominant modes of influence in the region, the Southern Annular Mode (SAM) and ENSO, is discussed and regression techniques used to establish their role in gyre scale variability in the South Pacific. SAM appears to have a stronger influence on the strength of the gyre than ENSO, although they have much in common in terms of the spatial pattern of their influence. With SODA, we can explore the ocean response to these forcings on long timescales. SODA appears to reproduce decadal variability reasonably well since the mid- late 1970s, Prior to this, the low frequency component in SODA falls away.

Keywords: gyre, sam, enso

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JPS001 **Oral Presentation** **1599**

Interannual Variability of SST in the East Pacific Warm Pool

Mr. Kristopher Karnauskas
Earth System Science Interdisciplinary Center University of Maryland

Antonio J. Busalacchi

In recent decades, a great deal of research has been directed toward understanding the coupled ocean-atmosphere system in the western and equatorial Pacific Ocean, notably the west Pacific warm pool (WPWP). In contrast, relatively little is known about the east Pacific warm pool (EPWP). Numerous prior studies explicitly state that further understanding of the interannual variability of precipitation in the Inter-Americas region depends on an improved understanding of what governs SST in the EPWP. The results of a series of interannually-forced OGCM experiments are presented, with the goal of separating the relative roles of momentum flux, heat flux, freshwater flux, and remote forcing (e.g. ENSO). Term-by-term heat budget calculations are presented to reveal the dominant physical mechanisms that act upon the ocean mixed layer to ultimately drive SST variability. Differences between the EPWP and its western counterpart, as well as differences among subregions within the EPWP (e.g. the Costa Rica Dome) are discussed. The resolution of the model also permits reasonable representation of ocean mesoscale eddies. Since the north eastern tropical Pacific is a region of high eddy activity, we address the role of eddies in the temporal variability of SST in the EPWP.

Keywords: sst, interannual, model

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JPS001 **Oral Presentation** **1600**

Interannual variations of intraseasonal Kelvin waves in the equatorial Indian Ocean

Mr. Iskhaq Iskandar
Earth and Planetary Science Graduate School of Science, The University of Toky

Tomoki Tozuka, Yukio Masumoto, Toshio Yamagata

Interannual variations of intraseasonal Kelvin waves in the equatorial Indian Ocean are evaluated in this study. A normal mode analysis and a neural network pattern recognition approach, so called self-organizing map (SOM), are applied to fourteen-year output fields from a high-resolution ocean general circulation developed for the Earth Simulator (OFES). The time series span the interval January 1990 December 2003, which capture prolonged El Nio event in 19911993, pure Indian Ocean Dipole (IOD) event in 1994, strong IOD/El Nio event in 1997/98, and two La Nia events in 1995/96 and 19981999. The analyses identified change in dominant mode of variability associated with the IOD/ENSO events. During positive IOD/El Nio events, the intraseasonal Kelvin waves are mostly dominated by higher modes, while the first mode becomes more dominant during negative IOD/La Nia events. One potential contribution factor to these interannual variations is an apparent shoaling of pycnocline in the eastern equatorial Indian Ocean during the positive IOD/El Nio events, allowing the wind-forcing to project more onto the higher modes. The mechanism by which the dominant mode of variability changes during the IOD/ENSO periods will be discussed in detail.

Keywords: intraseasonal kelvin wave, indian ocean dipole, enso

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JPS001 **Oral Presentation** **1601**

Decadal variability in the monsoon and post monsoon Total Precipitable Water over Peninsular India region

Mr. Rajesh J
Department of Atmospheric Sciences Cochin University of Science and Technology

K. Mohankumar

Kerala, the southwestern meteorological subdivision of India considered as the gateway of Asian summer monsoon, situated between the geographic region 74-78E and 7-14N shows unique interannual and intraseasonal variability in rainfall compared to All India Summer Monsoon Rainfall (AISMR). The data used for the present study was monthly specific humidity obtained from NCEP/NCAR for a time period of 55 years from 1950-2004. Total precipitable water (TPW) was computed between selected levels in the atmosphere, viz. 1000 to 850, 850 to 700, 700 to 600 and 600 to 500 hPa. TPW was then averaged spatially between 74-78E and 7-14N and temporally for monsoon (June, July, August) and post monsoon (September, October, November) seasons. These were subjected to wavelet analysis. The mother wavelet used was Morlet. During the monsoon season TPW in the layer 850-700 hPa shows 10 to 12 year oscillations, which is significant at 95% level. The significance has weakened after mid seventies at the time of climate shift and significant periods increases in the later part of the study. Similarly, for post monsoon season also the wavelet spectra showed 10-12 year variability significant at 95% level for integration between 1000-850, 850-700 and 700-600. The spectrum for 600-500 hPa TPW shows 10-12 year mode at 90% significance only.

Keywords: total precipitable water, wavele analysis, statistical significance

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JPS001 **Oral Presentation** **1602**

Long wave dynamics of the Indian Ocean Dipole events

Dr. Dongliang Yuan
KLOCAWS Physical Oceanography IAPSO

Long wave dynamics of the interannual variations of the equatorial Indian Ocean circulation are studied using an Ocean General Circulation Model (OGCM) forced by the assimilated surface winds and heat flux of the European Center for Medium-range Weather Forecast. The simulation has reproduced the sea level anomalies of the Topex/Poseidon altimeter observations well. The equatorial Kelvin and Rossby waves decomposed from the model simulation show that the western boundary reflection provides important negative feedback to the interannual variations of the equatorial Indian Ocean circulation. The elevated (depressed) sea level in the western (eastern) equatorial Indian Ocean during the Indian Ocean Dipole (IOD) events is produced through the propagation of the downwelling (upwelling) equatorial Rossby (Kelvin) waves to the western (eastern) boundary, which establishes a sea level dipole. Two downwelling Kelvin waves are generated at the western boundary during the IOD events: The first is reflected from the equatorial Rossby waves and the second from the off-equatorial Rossby waves in the southern Indian Ocean. The 1997-1998 IOD event is found to be weakened by the first Kelvin wave and terminated by the second. The duration between the peak and disappearance of the 1997-1998 sea level dipole is thus determined by the difference between the equatorial and off-equatorial Rossby wave speeds, which generates a time lag of the second Kelvin wave from the first at the western boundary. In comparison, the 1994 IOD event is found to be terminated by the first Kelvin wave, hence the abrupt ending of that IOD event. The dynamics of the two IOD events are compared and the difference of the southeasterly winds off the Java coast is noted. In addition, the atmospheric intraseasonal forcing is also found to be important to the phase and amplitude of the interannual equatorial waves associated with the IOD events.

Keywords: indian, ocean, dipole

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JPS001 **Oral Presentation** **1603**

Southwest Pacific Subtropical Mode Water: a climatology

Dr. Neil Holbrook
Physical Geography Macquarie University IAMAS

Angela M Maharaj

The large scale distribution and changes in southwest Pacific Subtropical Mode Water (STMW) are investigated and discussed. The paper presents for the first time geographic maps showing the spatial distribution of STMW thicknesses, with a vertical temperature gradient <2.0oC/100m occupying the 14o-20oC range below the mixed layer depth, across the entire southwest Pacific region. STMW changes in areal thickness extent, vertical cross-sectional area along selected transects, and total volume, are examined on seasonal and interannual time scales between 1973 and 1988. We find that STMW extends across the entire width of the Tasman Sea in a very broad swath between the Tropical Convergence in the north (just to the south of New Caledonia), the southeast Australian coast in the west to as far south as 39oS (likely due to the southward extension of the EAC), and eastwards along the southern STMW boundary in a meandering pathway that broadly follows the Tasman Front. The total STMW volume across the region (i.e., west of 180o) varies seasonally by a factor of more than three between the estimated maximum of 6.6 (+/-0.5) x 10^14 m^3 in October and minimum of 1.9 (+/-0.4) x 10^14 m^3 in May. Interannual variations O(+/-0.5 x 10^14 m^3) are also observed in the spatial extent of the thick Mode Water and its total volume. El Nio composite maps show an anomalous thickening of the STMW during the El Nio year with October positive thickness anomalies in excess of +20m (total volume anomaly of +0.6 x 10^14 m^3) manifested throughout the subtropical gyre interior as far north as New Caledonia. Total volume anomalies tend to be positive from January of the El Nio year through to the July following (18 months). The maximum correlation coefficient r = -0.3 between three-monthly STMW volume anomalies and the Southern Oscillation index is statistically significant at the 95% confidence level. We conclude that during the anomalous cooling of the upper southwest Pacific Ocean in the El Nio year, winter-time convection and STMW formation is enhanced across the region resulting in an El Nio Southern Oscillation climate signal that is identifiable below the mixed layer by the increased STMW volume which persists through to the following winter.

Keywords: subtropical mode water, southwest pacific ocean, enso

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JPS001 **Oral Presentation** **1604**

Mechanisms of interannual-decadal variability of the Atlantic Meridional Overturning Circulation

Dr. Arne Biastoch
TM IFM-GEOMAR IAPSO

The potential threat to the MOC and its related northward transport of heat due to anthropogenic climate change has led to major efforts in designing a monitoring system able to detect MOC changes in the subtropical North Atlantic (NA). The characteristics and mechanisms of interannual to decadal MOC variations in the NA are investigated here using a suite of basin-scale to global models, varying in resolution from 1/2-deg to 1/12-deg. The focus is on the role of different forcing mechanisms in the generation of low-frequency transport variability, and their implication for the detectability of a potential (multi-)decadal MOC signal. The model experiments suggest that part of the transport changes in the subtropical and mid-latitude NA can be related to the variability in subarctic deep water formation, and a fast propagation of the corresponding dynamical signals to the tropics. This thermohaline signal is, however, effectively masked by intraseasonal to interannual variations in wind-driven transports: for all latitudes, the amplitude of wind-driven MOC anomalies exceeds the thermohaline variability. The model analysis suggests, however, that mid-latitude MOC signals of subarctic origin can be traced back to changes in the deep western boundary current of the subpolar NA, suggesting the potential of a subpolar transport index as an element of a MOC monitoring system.

Keywords: overturning, model

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JPS001 **Oral Presentation** **1605**

Decadal to centennial climate variability in a model of the coupled ocean-atmosphere system

Dr. Riccardo Farneti
GFDLAOS Program Princeton University

Geoffrey K. Vallis

We investigate the mechanisms and predictability of climate variability on the decadal to centennial timescales using an idealized coupled ocean-atmosphere model. The ocean component is a coarse resolution (i.e., non eddy resolving) hydrostatic, primitive-equations model with greatly simplified geometry (specifically, a version of MOM), while the atmospheric component is a moist primitive-equations model with simplified parameterizations of atmospheric processes such as radiation and boundary layer transfer. Multi-century climate simulations have been carried out both with the interactive, dynamical ocean and with a slab mixed-layer ocean model. The long-term variability of the two systems is analyzed in an attempt to identify the mechanisms and dynamics that might lead to natural climate variability at interannual to interdecadal timescales. Specifically, we investigate the timescales on which can the system be considered as truly coupled; what, if any, the role of ocean dynamics is on redenning the atmospheric response; and whether 'weather' variability in the atmosphere plays an essential role in longer term variability. The sensitivity to the poorly known parameterizations - such as the oceanic horizontal and isopycnal diffusivity - and to the effect of the ocean geometry will also be considered.

Keywords: interdecadal, ocean atmosphere, climate

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JPS001 **Oral Presentation** **1606**

Mechanisms of interdecadal variability of the East Asian Summer Monsoon

Mrs. Yonghui Lei
Department of Meteorology University of Reading

Brian Hoskins, Julia Slingo

Two patterns of interdecadal variability of the East Asian summer monsoon (EASM) precipitation have been determined from observation in Chinafrom 1958 to 2002. One pattern describes an increase in precipitation in the south of China during the last 20 years. The other pattern has precipitation anomalies of opposite sign in the Yangtze and Yellow River valleys, with a reversal in the sign of the pattern occurring in the 1970s. Global Historical Climatology Network (GHCN) data since 1900 suggests that the interdecadal variability of EASM occurring in the past 45 years did not occur in the previous period. This raises the possibility that interdecadal modes may be influenced by some contemporaneous factors. The link between two patterns in monsoon precipitation and the large-scale circulation and moisture transport has been investigated using ERA-40 data. Associated with the increase in precipitation in the south of China, there is a low-level anti-cyclonic anomaly in the South China Sea and an increased moisture flux from the tropical west Pacific. The precipitation anomaly pattern for the Yangtze and Yellow River valleys has associated low-level cyclonic anomalies in the Bay of Bengal and the northwest Pacific. The possible relationship of these circulation anomalies with sea surface temperature anomalies and land surface warming will be discussed.

Keywords: easm, interdecadal variability, teleconnection

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JPS001 **Oral Presentation** **1607**

Exploring decadal time scale predictability in the GFDL CM2.1 global climate model

Mr. Keith Dixon

Thomas Delworth, William Hurlin

A series of perfect predictability type model simulations performed using the NOAA/GFDL CM2.1 coupled global climate model are examined. This climate model previously has been used to study decadal-to-centennial time scale issues (including multi-century control experiments and IPCC-class climate change projections), as well for seasonal-to-interannual climate variability experiments focusing on the ENSO phenomenon. For this study, six ensembles ten members each of twenty year long model integrations were generated initially. The six sets were drawn from a control model integration with successive sets initial conditions being separated in time by 100 years. The ten members of each of these six ensembles shared the same ocean, sea ice, and land model initial conditions, but used atmospheric initial conditions drawn from dates between five and 25 days distant. Even a casual visual inspection of the modeled North Atlantic meridional overturning circulation (MOC) strength reveals that for some of the six ensembles, the different members' MOC time history evolved in a generally similar manner for eight to ten years. However, for other ensembles, the individual members MOC strength diverged more rapidly. These initial results prompted additional experiments and more detailed analyses designed to further explore the extent to which multi-year to decadal time scale predictability exists in the GFDL CM2.1 model simulations, including why the apparent level of MOC predictability is greater for some time periods than others. Predictability of climate variables other than the MOC also are considered. Additional ensembles of model simulations were conducted in which the initialization techniques were varied drawing atmospheric initial conditions from more wide-ranging time periods and grouping the land model components initial conditions with the atmosphere rather than the ocean. All told,approximately 2000 model years of GFDL CM2.1 simulations are included in this study.

Keywords: predictabilty, climate variability, global climate model

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JPS001 **Oral Presentation** **1608**

THE indonesian throughflow and the climate shift of 1976/77

Prof. Gary Meyers
CSIRO Marine and Atmospheric Research IAPSO

Lana Wainwright, Susan Wijffels

Quantitative Marine Science PhD Program, University of Tasmania, Hobart Tasmania 7005.

A sharp increase in global surface temperatures was seen in 1976, and related changes detected throughout the worlds oceans. The climate shift was identified in the tropicalPacific Ocean as a change in the background state of the El Nino Southern Oscillation phenomenon, toward more El Nino-like conditions. The associated weakening of easterly trade winds across the Pacific led to a hypothesis that the Pacific to Indian Ocean Indonesian Throughflow (ITF) had weakened. Since the ITF is a critical choke point in the global distribution of heat, it is important to know if the weakening has in fact occurred since 1976 and its magnitude. The change in geostrophic volume transport of ITF before and after 1975 was estimated using subsurface temperature data on the IX1 line, which has been used to monitor ITF in recent decades. The data set comprised all the available, historical mechanical (MBT) andexpendable (XBT) bathythermographic data as well as hydrographic station data in the vicinity of IX1. The profiles were quality controlled to the high standards set during WOCE, as far as possible for the older profiles. Then the average temperature profile was calculated before and after 1975 in fixed spatial bins, with approximately 1-degree latitude resolution. By using the mean temperature profiles and the Temperature/Salinity relationship in conjunction with salinity from the CSIRO Atlas of Regional Seas, it was possible to calculate the change in temperature, current velocities and volume transport relative to 800 db before and after 1975. Statistically significant changes in temperature were observed. Sea surface temperature (SST) rose by 1-2C off the coasts of Indonesia and Australia, which could be due to a combination of factors such as increased air-sea heat flux and/or a change in regional circulation. There was also a subsurface cooling in the main thermocline along IX1, intensified on the Australian side, which has been attributed to a weakening of the Pacific trade winds. The South Equatorial Current (SEC) was found to have diminished in size and weakened in strength. The net westward geostrophic volume transport (in Sverdrups, 106 m3/s) from continental shelf to shelf between Australia and Indonesia was found to be ~ 11 Sv before 1975 and ~8.5 Sv after 1975 showing a decrease of ~2.5 Sv, or 25%. These results are consistent with other studies showing the equatorial Pacific winds have weakened. The temperature transports and transports calculated using the Island Rule are also presented.

Keywords: throughflow, ocean current, climate change

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JPS001 **Oral Presentation** **1609**

The role of equatorial/off-equatorial wind stress forcing on interdecadal sea surface temperature variability in the equatorial Pacific Ocean

Dr. Neil Holbrook
Physical Geography Macquarie University IAMAS

Shayne Mcgregor, Scott B. Power

Many modelling studies have been carried out to investigate the role of oceanic Rossby waves linking the off-equatorial and equatorial Pacific Ocean. Although the equatorial ocean response to off-equatorial wind stress forcing alone tends to be relatively small, it is clear that off-equatorial oceanic Rossby waves affect equatorial Pacific Ocean variability on interdecadal time scales. In the present study, a hybrid coupled model (HCM) of the equatorial Pacific (between +/- 12.5° latitude) was developed and used to determine if the relatively small equatorial ocean response to off-equatorial (polewards of 12.5° latitude) wind stress forcing is enough to initiate an atmospheric feedback response that will significantly alter the original equatorial region variance. The HCM utilises a reduced-gravity ocean shallow-water model (SWM) and a statistical atmosphere derived from monthly outputs from a 100-yr BMRC coupled general circulation model (CGCM) integration. Results from the series of HCM experiments show that the interannual and interdecadal sea surface temperature (SST) variability of the equatorial Pacific Ocean is due to the sum of both equatorial region and off-equatorial region wind stress forcing. We note that the equatorial region wind stress forcing dominates both the interannual and interdecadal SST variability and that, even with ocean-atmosphere coupling in the equatorial Pacific, the equatorial response to off-equatorial wind stress forcing alone is insufficient to initiate an atmospheric feedback that significantly amplifies the original equatorial region variability. Consequently, the predictability of equatorial region SST variability could be limited to ~1-yr (the maximum time it takes an oceanic Rossby to cross the Pacific Ocean basin in the equatorial region). However, our results suggest that the addition of off-equatorial wind stress forcing to the HCM introduces a small but significant equatorial Pacific Ocean response. This response is potentially predictable with lead times of up to three years, which may prove to be important during extreme ENSO events.

Keywords: rossby waves, interdecadal variability, hybrid coupled model

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JPS001 **Oral Presentation** **1610**

Large Scale Dynamics and High Frequency Forcing of ENSO Variability

Dr. Michael McPhaden
NOAA Pacific Marine Environmental Laboratory IAPSO

Xuebin Zhang, Harry Hendon, Matthew Wheeler

Year-to-year variability associated with the El Nio/Southern Oscillation (ENSO) is governed by large-scale ocean dynamics and coupled ocean-atmosphere interactions. However, the cycle between warm and cold phase ENSO conditions exhibits considerable irregularity in terms of amplitude, duration, and spatial and temporal patterns of development. One factor contributing to this irregularity is stochastic forcing in the form of weather noise, a prominent source of which is the Madden-Julian Oscillation (MJO). A simple two-predictor regression model is developed to estimate the relative influence of large-scale low frequency deterministic ocean-atmosphere dynamics and stochastic forcing on peak sea surface temperature (SST) anomalies associated with ENSO for the period 1980-2005. One predictor is equatorial warm water volume, which is an index for the role that upper ocean heat content plays in regulating ENSO variability. The other predictor characterizes stochastic forcing in the western Pacific in the form of an MJO activity index. The two-predictor model accounts for about 65% of peak Nino3.4 SST anomaly variance at 2-3 season lead times and suggests about equal influence (on average) of stochastic and deterministic processes affecting peak ENSO SST anomalies over the past 25 years. The implications of these results for ENSO prediction are discussed.

Keywords: enso

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JPS001 **Oral Presentation** **1611**

Decadal Changes in North Pacific Subtropical Subduction

Dr. Dongxiao Zhang
JISAOUW NOAAPMEL

Michael J. Mcphaden, Wei Cheng, Bo Qiu

North Pacific subtropical subduction defines the upper ocean circulation and stratification. It is a key process for the ocean to uptake theCO2and other chemical tracers. Recent studies suggest a connection between subtropical subduction and tropical upwelling through the Subtropical Cells (STCs), which slowed down between the 1950s and 1990s. This slowdown has been linked to warming of equatorial SST, and changes in CO2out-gassing in the eastern tropical Pacific. There is however considerable debate on whether the observed change in STC are forced by tropical winds or by subtropical subduction. In this study, we use historical hydrographic data and ERA40 winds to estimate subduction rates in the North Pacific over four decades: 1956-1965, 1970-1977, 1980-1989, and 1990-1998. We find that the total subduction rate has decreased by about 25%, from 47 Sv in the 1950s to 36 Sv in the 1990s. This reduction is consistent with previous estimates of STC and upwelling decreases in the tropical Pacific. We further find that the reduction in subduction is due to changes in the Eastern Subtropical Mode Water (ESTMW) and other lighter density water masses, which dominate the upper tropical Pacific pycnocline. The subduction of denser water masses, associated with the Subtropical Mode Water (STMW) and Central Mode Water (CMW), has in contrast increased over the past several decades, with the maximum subduction rates in the 1980s. The sensitivity of our results to uncertainties in different wind products will be addressed by comparing results based on ERA40 to those based on NCEP reanalysis.

Keywords: subduction, modewater, stcs

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JPS001 **Oral Presentation** **1612**

A study of the seasonal to interannual predictability of the Iberian Peninsula winter river flow

Dr. David Pozo-Vazquez
PHYSICS UNIVERSITY OF JAEN IAMAS

Sr Gmiz-Fortis, R M Trigo, Y Castro-Dez

Seasonal and interannual streamflow variability plays an important role in the development and management of water resources in most regions of the world. The hydrological system acts as sensible spatial and temporal integrator of precipitation (rain and snow), temperature, and related evapotranspiration over a specific region. This work is the continuation of two previous works, Gamiz-Fortis et al. (2002) and Trigo et al. (2004), in which we evaluated most part of the methodology we employ here. Particularly, in this work, we present results of an analysis of the seasonal-to-interannual variability and predictability of the winter streamflow of the main Iberian Peninsula international rivers (named Douro, Tejo and Guadiana). The period of the study covers from 1923 to 2004. In a first part, Auto-Regressive-Moving-Average (ARMA) models were fitted to Singular-Spectral-Analysis filtered streamflow series and an interannual forecasting experiment was conducted. In the second part, the role of the Atlantic summer and autumn SSTs on the predictability of the winter Iberian Peninsula river flows was analyzed. Results showed, firstly, that the ARMA models present useful one-year-ahead forecasting skills. Secondly, that during autumn, the SST variability in certain areas of the North Atlantic has a statistically significant linear influence in the following winter streamflow values. Additionally, we find that, during summer and autumn, some areas of the Tropical Atlantic and south-western Atlantic SSTs have a significant non-linear influence on the following winter streamflow values. It is finally concluded that the linear interannual predictability of the Iberian Peninsula winter streamflow is considerable greater than the predictability associated with the previous autumn SSTs season.Trigo, R.M., D. Pozo-Vzquez, T.J. Osborn, Y. Castro-Dez, S.R. Gmiz-Fortis and M.J. Esteban-Parra, 2004. North Atlantic Oscillation influence on precipitation, river flow and water resources in theIberian Peninsula . Int. J. Climatol., 24, 925-944, DOI: 10.1002/joc.1048Gmiz-Fortis, S.R., D. Pozo-Vzquez, M.J. Esteban-Parra and Y. Castro-Dez, 2002. Spectral characteristics and predictability of the NAO assessed through Singular Spectral Analysis. J. Geophys. Res. (Atmospheres), 107, (D23), 4685, doi: 10.1029/2001JD001436

Keywords: sst, streamflow, nao

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JPS001 **Oral Presentation** **1613**

Estimates of ocean heat content variability using isotherms

Dr. Matthew Palmer
Hadley Centre UK Met Office

Tara Ansell, Simon Tett, Keith Haines, Helene Banks

We investigate the use of a fixed isotherm (Tref) as the reference surface for estimating global oceanic thermal changes, based on gridded quality controlled temperature profile data over the period 1956-2004. In this isothermal framework we compute the following quantities for each temperature profile: (i) the depth of Tref; (ii) the mean temperature above Tref; (iii) the heat content relative to Tref. We also compare our methodology to the more traditional approach of estimating heat content relative to a fixed depth (Zref). Spatial maps suggest that locally heat content is strongly influenced by changes in isotherm depth. However, we find a more globally uniform warming signal in the mean temperature above Tref, as might be expected for a warming signal applied at the surface. For time series analyses, we find reduced high frequency and decadal variability for the mean temperature above Tref compared to mean temperature above Zref. We suggest that these differences arise because the dynamical affects associated with vertical advection are reduced in the Tref analyses. Generally, thermal diagnostics computed relative to a fixed isotherm have a greater signal-to-noise ratio (in terms of the long term trend) than similar fixed depth analyses.

Keywords: ocean, temperature, subsurface

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JPS001 **Oral Presentation** **1614**

Future changes in internal MOC variability

Dr. Sybren Drijfhout
Oceanography Royal Netherlands Meteorological Institute IAPSO

Wilco Hazeleger, Frank Selten, Rein Haarsma

The response of the internal variability of the Meridional Overturning Circulation (MOC) to enhanced greenhouse forcing has been estimated from an ensemble of greenhouse scenario runs.Greenhouse forcing results in a weaker and shallower MOC with reduced internal variability. At the same time at 55N the overturningincreases at between 0 and 1000 m as a result of a change in the areas of deep water formation. In a warmer world the poleward retreat of the sea-ice boundary enables new regions of deep water formation located further north. The dominant pattern of internal variability associated with the MOC consists of a monopole centered around 30-40N. In a warmer world this monopole features a poleward shift. The shift is associated with a tighter relation between MOC variations and heat flux variations over the subpolar gyre. In old convective sites (Labrador Sea) convection becomes more irregular which leads to enhanced heat flux variability there.In new convective sites heat flux variations initially are coupled to sea-ice variations, but later on they become coupled to (irregular) deep water formation. Both processes act to tighten the relation between subpolar heat flux variability and MOC variability, resulting in a poleward shift of the latter.

Keywords: meridionaloverturning, subpolargyre, deepwaterformation

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JPS001 **Oral Presentation** **1615**

Impacts of no Agulhas leakage on the Tropical Atlantic in a coupled Ocean-Atmosphere simulation

Dr. Reindert Haarsma
Climate Research KNMI IAPSO

Edmo Campos, Wilco Hazeleger, Sybren Drijfhout

The filaments and rings at the retroflection of the Agulhas current constitute the mechanism for the transport of subtropical Indian Ocean waters into the Atlantic. Paleo-oceanographic records indicate that the extinction and reappearance of species of foraminifera in the South Atlantic during the last glacial period seem to be associated with the closing and reopening of the connection between subtropical gyres of the South Indian and Atlantic oceans. This has motivated us to use a coupled ocean-atmosphere model to investigate the impact of shutting off the Agulhas leakage on the South Atlantic circulation and on the Tropical Atlantic variability. Our experiments show that the resulting temperature and salinity anomalies would increase the stability of the Equatorial Atlantic mixed layer, which in consequence could inhibit the upwelling in the cold tongue region. Unable to reach the surface, after reaching the eastern side of the basin, the anomalous signal transported by the Equatorial Undercurrent would spread away from the equator in the thermocline and upwells in the Guinea and Benguela domes.

Keywords: tropical atlantic variability, agulhas leakage, climate change

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JPS001 **Oral Presentation** **1616**

Biennial and interdecadal variations in the monsoon-ENSO system of a coupled GCM under doubled CO2 conditions

Dr. Andrew Turner

Peter M. Inness, Julia M. Slingo

Basic state errors in a coupled GCM are partially removed using an annual cycle of ocean surface heat flux adjustments in the equatorial Indo-Pacific Oceans. When the same GCM is run using increased CO2 forcing, the monsoon-ENSO system features a notable tendency for strong monsoons (associated with La Nina conditions in the Pacific) to be followed by weak monsoons (associated with El Nino), as part of the tropospheric biennial oscillation (TBO). Together with this tendency is the presence of multi-decadal ENSO regimes. These range from a period of irregular small events, to one of high amplitude biennial events strongly phase-locked to the seasonal cycle, lending increased predictability to the monsoon system. The overall biennial tendency of the Indo-Pacific in the future climate scenario can be related to strong coupling between the Asian summer monsoon, Indian Ocean dipole and wind variability in the west Pacific, which leads to rapid ENSO phase change through Kelvin wave propagation along the thermocline. However the reason for the transition between the different ENSO regimes is unclear. Possible explanations for these transitions are examined, including interactions with the strength of the seasonal cycle in the east Pacific.

Keywords: climatic shifts, tbo, el nino

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JPS001 **Oral Presentation** **1617**

ENSO-Related interannual variability in the frequency of upper troughs at low latitudes

Mrs. Luise Frhlich
Institut der Atmosphre Universitt zu Mainz

Peter Knippertz

Intrusions of upper-level extratropical troughs into low latitudes are prominent examples of extratropical-tropical interactions. One visible sign of these interactions is the formation of cloud bands that often develop at the eastern flank of the troughs and extend from the Tropics poleward and eastward into the subtropics or even midlatitudes. These situations enable tropical moisture transports towards the subtropics and may lead to extreme precipitation events. In the present work a climatology of upper-level disturbances at low latitudes is constructed for the period 1980 to 2001 based on ERA40 reanalysis data. In contrast to prior studies only troughs with a certain vertical extension are considered. This is accomplished by analyzing vertically averaged (400100 hPa) fields of potential vorticity (PV) as follows: First, grid points between the equator and 17N with PV values of at least 2 PVU (1 PVU = 10-6 K m2 kg-1 s-1) are sought. Second, starting from the detected grid point all contiguous grid points south of 25N with PV values greater or equal 2 PVU are grouped together to an intrusion system. In a third step the intrusion systems are tracked based on spatial overlapping at consecutive analysis times and this way intrusion episodes are defined. Systems in the Southern Hemisphere (SH) are detected accordingly. Looking at the boreal winter climatology of intrusion systems two well-defined regions with maximum frequency appear in the Northern Hemisphere, respectively, over the eastern parts of the North Pacific (120150W) and North Atlantic (1040W). In the SH maxima are located nearly within the same longitudinal bands. In the most active regions intrusion systems are detected at about 20% of all analysis times. During the winter half year on average 20 episodes occur per ocean basin with a mean duration of almost two days. Interannual variations of intrusion frequency show a clear association with the El Nio-Southern Oscillation (ENSO). Over the North Pacific negative correlations with the Nio3.4-index of 0.78 are directly related to the eastward shift of the tropical convection maximum and the associated wind changes. The almost equally high positive correlations over the North Atlantic of +0.69, however, must be the result of a teleconnection that is currently investigated. In addition intrusion frequency over the North Atlantic also shows a significant positive correlation to the North Atlantic Oscillation (NAO) of +0.5. In the SH the link between the intrusion activity and ENSO and NAO is less pronounced. In the boreal summer the number of intrusion events is reduced except for the North Pacific where a shift of the frequency maximum towards the west is evident. The linkage with ENSO is generally weaker.

Keywords: tropical extratr interactions, potential vorticity, teleconnection

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JPS001 **Oral Presentation** **1618**

The effects of the Atlantic Meridional Overturning Circulation on Tropical Ocean-Atmosphere Variability

Prof. Ping Chang
Department of Oceanography Texas A&M University IAPSO

Xiuquan Wan, Caihong Wen, Rong Zhang, R. Saravanan

The effects of the Atlantic Meridional Overturning Circulation (MOC) on tropical coupled ocean-atmosphere variability is studied via a suite of global ocean general circulation model (OGCM) experiments and tropical coupled general circulation model (CGCM) experiments. By varying the freshwater input in the high latitude North Atlantic, the OGCM simulates the Atlantic MOC at different strengths. The varying strength MOCs are then used to force the tropical CGCM along the northern and southern open boundaries of the ocean to assess the impact of the MOC changes on coupled ocean-atmosphere variability in the tropics. The results show that the Atlantic MOC provides a major oceanic pathway linking high-latitude climate change to the tropics. A drastic change in the MOC can trigger a well-defined coupled climate system response in the tropics and have an effect on modes of climate variability, such as the Atlantic Nino and Pacific ENSO. A physical mechanism is presented to explain the linkage between the MOC change and tropical coupled climate system response.

Keywords: moc, tropical ocean atmosphere

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JPS001 **Oral Presentation** **1619**

A New Interpretation of the North Atlantic Oscillation

Dr. Tim Woollings
Dept of Meteorology University of Reading, UK IAMAS

Mike Blackburn

Here we suggest a new interpretation of the North Atlantic Oscillation (NAO) as a result of variations in the occurrence of blocking-like Rossby wave-breaking events over the North-west Atlantic. Negative NAO is envisaged as a period of frequent wave-breaking, while positive NAO is simply a period with infrequent wave-breaking. A similar, but weaker, relationship exists between wave-breaking over the Pacific and the West Pacific Pattern. Evidence is given to support this view by using a two-dimensional potential vorticity based index to identify wave-breaking at various latitudes. This is applied to Northern Hemisphere winter data from the ERA-40 re-analysis, and the events identified are then related to the NAO.Several clear patterns are often seen as precursors to Atlantic wave-breaking. These include a Rossby wave-train stretching across North America from the Pacific, a shift of the stratospheric polar vortex, and SST anomalies in the North Atlantic. These suggest mechanisms by which lower-frequency variability in the oceans and in the stratosphere can modulate the occurrence of wave-breaking, leading to NAO variability.

Keywords: blocking, wave breaking, nao

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JPS001 **Oral Presentation** **1620**

The Kuroshio extension decadal variability: modeling results suggest that internal nonlinear mechanisms may play a crucial role

Prof. Stefano Pierini
Department of Environmental Sciences University of Naples Parthenope IAPSO

Understanding the mechanisms that produce the Kuroshio Extension (KE) low-frequency variability is relevant not only from a purely oceanographic point of view but also from a more general climatic perspective, as KE changes are associated with vigorous air-sea heat exchanges known to be able to enhance considerably the variability of the midlatitude coupled ocean-atmosphere system in the North Pacific Region. In this context modeling results of a diagnostic ocean circulation model, validated with altimeter data and interpreted both in terms of geophysical fluid dynamical principles and of dynamical systems theory, suggest that the KE low-frequency (decadal) variability may be basically due to internal nonlinear mechanisms. A double-gyre reduced-gravity shallow water model of the KE (Pierini, J. Phys. Oceanogr., 36, 1605-1625, 2006), forced by a time-independent climatological wind and whose domain of integration is bounded to the west by a schematic coastline, exhibits a fairly realistic mean jet and a low-frequency variability characterized by chaotic bimodal relaxation oscillations between an energetic meandering state and a much weaker state with a reduced zonal penetration. These high and low energy states are found to be very similar to the elongated and contracted modes of the KE as detected through in situ and altimetric measurements. More specifically, the characteristic period (of around 10 years), flow patterns and transition details of a typical bimodal cycle are found to be in significant agreement with the altimeter data recently presented by Qiu and Chen (J. Phys. Oceanogr., 35, 2090-2103, 2005), obtained by merging TOPEX/Poseidon, Jason-1 and ERS-1/2 measurements for the period 1992-2004 A complex dynamical mechanism supporting such internal oscillations, and involving the bimodal behavior of the Kuroshio south of Japan, is proposed. On the basis of these modeling results and of their experimental validation, the role of internal nonlinear effects in the KE low-frequency variability is suggested to be crucial. Finally, the same variability is interpreted in the framework of dynamical systems theory as a homoclinic orbit in phase space resulting from a global bifurcation associated with the reconnection of the stable and unstable manifolds of the saddle fixed point corresponding to the weak (contracted) jet state. Besides this large amplitude relaxation oscillation, two small amplitude chaotic oscillatory gyre modes (one with a small and the other with an intermediate mean kinetic energy) have also been identified for slightly different values of the lateral eddy viscosity and forcing amplitude. The chaotic transitions observed between these three modes of variability are conjectured to be due to heteroclinic connections.

Keywords: kuroshio extension, decadal variability, diagnostic ocean model

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JPS001 **Oral Presentation** **1621**

Multi-decadal Simulation of Atlantic Ocean Climate Variability Driven by Realistic High-Frequency Atmospheric Reanalyses

Dr. Zulema Garraffo
Meteorology and Physical Oceanography University of Miami. RSMAS

George R. Halliwell, Linda T. Smith, G. Peng, Eric P. Chassignet

Atlantic Ocean climate variability is simulated from 1948-2003 using the HYbrid Coordinate Ocean Model (HYCOM) to study the ocean response to atmospheric variability associated with important climate modes such as the North Atlantic Oscillation and the Atlantic Multi-Decadal Oscillation. The initial simulation was driven by six-hourly surface fields obtained from the NCEP/NCAR (before 1979) and NCEP/DOE AMIP-II (1979-forward) atmospheric reanalyses. This NCEP run has been completed, and other runs will be performed to assess sensitivity to atmospheric forcing by driving the model with the ECMWF ERA-40 reanalysis, and also to assess sensitivity to vertical mixing parameterizations contained in HYCOM. Sensitivity to the time when the shift from climatological to interannual forcing takes place will also be assesed. The salty Mediterranean overflow layer is maintained by using the Price-Yang-Baringer boundary model in the Gulf of Cadiz. Results are being compared to observations such as sea surface temperature variations, western boundary current transport, Gulf Stream front location, deep transport, and the meridional overturning circulation. Initial analysis of the NCEP simulation demonstrates that the model reproduces the SST anomaly pattern and the subtropical and subpolar gyre responses associated with the NAO. The Florida Current transport and the meridional overturning circulation are correlated with the NAO.

Keywords: atlantic variability, ocean model, hybrid coordinate

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JPS001 **Oral Presentation** **1622**

Large-scale variability in Salinity and Oxygen Based on Recent Repeat Hydrographic Sections

Prof. Lynne Talley
Scripps Institution of Oceanography University of California San Diego IAPSO

Nathan Bindoff, Corinne Lequere, Gregory Johnson, Sabine Mecking, James Swift, Janet Sprintall, Igor Yashayaev, Nicolas Gruber, Richard Feely

Salinity and oxygen variations are reviewed or examined from each ocean basin, using repeat hydrographic data. Results are considered with respect to basin-wide analyses of salinity and oxygen trends (Boyer et al., 2005; Garcia et al., 2005). Upper ocean salinity changes suggest freshening in regions of fresher water (high latitudes and Pacific Ocean), and increased salinity in regions of saltier water (subtropical latitudes and Atlantic Ocean), suggesting a strengthening of the normal atmospheric water transport. These change are communicated to the ocean interior through water mass formation and subduction. Reported oxygen decreases in the high northern and southern mid-latitude thermoclines suggest a widespread slowing of thermocline ventilation (Emerson et al., 2004; Deutsch et al., 2005; Johnson and Gruber, 2006). However, the subtropical thermoclines of all three southern hemisphere oceans show increased oxygen, suggesting a increase in circulation that could be related to recent observations of increased dynamic height and strengthened southern hemisphere westerlies. Both the salinity and subtropical oxygen changes are consistent with anthropogenic change.

Keywords: salinity change, oxygen change, global change

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JPS001 **Oral Presentation** **1623**

ENSO and Western North Pacific Tropical Cyclone Activity Simulated in a CGCM

Dr. Satoshi Iizuka
Storm, Flood and Landslide Research NIED IAPSO

Tomonori Matsuura

The relationship between El Nio/Southern Oscillation (ENSO) and tropical cyclone (TC) activity over the western North Pacific (WNP) simulated in a coupled ocean-atmosphere general circulation model was examined. The model simulated the ENSO-like events with a period of about 5 years and with the large amplitude in Nio34 sea surface temperature (SST) anomalies comparable with the observed strong ENSO events. In the El Nio (La Nia) years, the annual number of model TCs in the southeastern quadrant of the WNP increases (decreases), while it decreases (increases) in the northwestern quadrant. In spite of the significant difference in the mean genesis locations of the model TC between the El Nio and La Nia years, however, there is no significant difference in the annual number of model TCs in either the El Nio or La Nia years. The annual number of model TCs, however, tends to decrease in the years following El Nio, relating to the development of anticyclonic circulation around the Philippine Sea in response to the SST anomalies in the central and eastern equatorial Pacific. Furthermore it is shown that model TCs have longer lifetimes and more intense in the El Nio years than in La Nia years.

Keywords: enso, tropical cyclone, cgcm

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JPS001 **Oral Presentation** **1624**

Oceanic process associated with the 2006 Indian Ocean Dipole

Prof. P. N. Vinayachandran
Centre for Atmospheric and Oceanic Sciences Indian Institute of Science IAPSO

Jaison Kurian, C. P. Neema

A positive Indian Ocean Dipole developed in the Indian Ocean during 2006. The eastern equatorial Indian Ocean showed strong negative SST anomalies and the western equatorial Indian Ocean showed strong positive SST anomalies which are characteristic of Indian Ocean dipole. There were easterly wind anomalies along the equator and alongshore wind anomalies off the coast of Sumatra. The convection was suppressed in the east and enhanced in the east. An ocean general circulation model of the Indian Ocean forced by QuickSCAT winds, TRMM rainfall and NCEP heat fluxes near realistically reproduces the anomalous conditions in the Indian Ocean during 2006. The ocean model was used to examine the oceanic processes that lead to the unusual conditions in the equatorial Indian Ocean during 2006. The model thermocline and mixed layer was shallow in the east and deeper in the west. Analysis of the temperature equation in the model show that the cooling in the east was caused by the air-sea fluxes which worked efficiently on a shallow mixed layer. Detailed analysis of the model simulation to unravel the oceanic process that led to the formation of 2006 IOD will be presented.

Keywords: indianoceandiple, sstanomaly, oceanmodel

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JPS001 **Oral Presentation** **1625**

Interannual variation of mesoscale eddy activity around the North Pacific subtropical front and its influence on the generation of Kuroshio large meander

Dr. Motohiko Kashima
Okinawa Subtropical Environment RemoteSensing Cen. NICT IAPSO

Kaoru Ichikawa, Sho-Ichiro Kojima

The Kuroshio south of Japan changed its path to the stable large meander from the nearshore path during 2004. A strong anti-cyclonic eddy from the east collided with the Kuroshio to the east of Taiwan in Sep. 2003, which was considered to induce the large meander. Our HF ocean radar observed significant increment of the Kuroshio surface current after the collision. Interannual variation of mesoscale eddy activities around the subtropical front was detected and the strong eddy was generated during the high activity period.

Keywords: mesoscale eddy, kuroshio large meander, hf radar

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JPS001 **Oral Presentation** **1626**

The Pacific Decadal Oscillation in IPCC AR4 Models

Prof. Raymond Arritt
Agronomy Iowa State University IAMAS

Christopher Kuball

We have diagnosed the signal of the Pacific Decadal Oscillation (PDO) in sea-surface temperature fields from 'Climate of the 20th Century' runs performed in support of the IPCC Fourth Assessment Report (AR4). For this purpose we use the difference in spatial mean sea-surface temperature between two regions, one in the north-central Pacific Ocean and the other in the northeast Pacific Ocean, similar to regions used in prior studies. We detect oscillations between the two regions using the regime shift detection algorithm described by Rodionov (2004). Results indicate that most of the models show a multi-decadal sea surface temperature oscillation corresponding to the PDO. Individual models tend to produce either relatively short- or long-period oscillations within the multi-decadal context of the PDO; further, the amplitudes of the regimes also tend to differ from model to model. Analysis of precipitation and near-surface temperature for warm and cold phases of the simulated PDO in each model shows that PDO influences on North American winter climate are apparent in some models, but not in others.

Keywords: climate, gcm, ipcc

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JPS001 **Oral Presentation** **1627**

Impacts of Recent El Nio Modoki on Extreme Climate Conditions in East Asia and the United States during Boreal Winter

Dr. Hengyi Weng
Climate Variations Research ProgramFRCGCJAMSTEC Researcher

Karumuri Ashok, Swadhin K. Behera, Anguluri S. Rao, Toshio Yamagata

Present work uses 1979-2005 observational data to study the impacts of El Niño Modoki on extreme climate conditions in East Asia and the USA during boreal winter, by tracing the teleconnection paths emanated from the tropical Pacific. During El Niño Modoki, the zonal SST gradients in the tropical Pacific result in anomalous two-cell Walker circulation, and related anomalous regional meridional circulations and horizontal atmospheric circulations, which cause anomalous climate conditions in East Asia and the USA. In the northwestern Pacific, there is an anomalous 500hPa high over the Okhotsk Sea and an anomalous low to its south, so that southern China and much of the southern Japan (south of 35N) are dry, while the area from the mid-reach of the Yangtze River valley to northern Japan, especially Hokkaido, are wet. During the canonical El Niño, the northwestern Pacific exhibits an opposite pattern, so that the rainfall anomalies in eastern China and Japan are basically opposite to those during El Niño Modoki. In the eastern North Pacific, during El Niño Modoki, there is a clear meridional wave train on the 500hPa geopotential height anomaly field, from the central tropical Pacific to the eastern North Pacific and North America, forming a winter Pacific/North American (PNA) pattern over the region. This pattern favors wet condition in Hawaii and the southwestern and southern USA while dry conditions in much of the rest areas. These conditions are largely different from those during the canonical El Niño when there is no clear PNA pattern in the region, and Hawaii and the Midwest/Northeast of the USA are dry while much of the rest areas are wet. The persistent large-scale drought in the western USA in the beginning of the 21st century may be influenced by the large-amplitude El Niño Modoki on decadal timescale during the same period in both summer (Weng et al. 2007) and winter seasons.

Keywords: el nio modoki, el nio, teleconnections

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JPS001 **Oral Presentation** **1628**

El Nio Modoki

Dr. Ashok Karumuri
Climate Variability Researcher

Swadhin K. Behera, Suryachandra A. Rao, Hengyi Weng, Toshio Yamagata

Based on the analysis of observed and reanalyzed datasets mainly for the period 1979-2004, we identifyanomalous warming events in the central equatorial Pacific that are distinctly different and independentfrom the conventional El Nio events. This unique warming is associated with colder sea surfacetemperature anomalies (SSTA) on both sides along the equator, and the tripolar structure is representedby the second mode that explains 12% of the tropical Pacific SST variability. We namethe phenomenon asEl Nio Modoki ("Modoki is a classical Japanese word, which means a similar but different thing), i.e. Pseudo-El Nio. Our results further demonstrate that the El Nio Modoki event involvesocean-atmosphere coupled processes, indicating the existence of a unique atmospheric component during the evolution. Analogous to the case for the SouthernOscillation and El Nio, the total entity shouldbe called either ENSO Modoki or Pseudo-ENSO. The ENSO Modoki event has significant impacts on thetemperature and precipitation over many parts of theglobe that are different from/opposite to those of the conventional ENSO events, bringing out theuniqueness of the ENSO Modoki events. We also discuss the role of the background changes behind the more frequent occurrence of theENSO Modoki event during recent decades.

Keywords: el nio modoki, regime shift, teleconnections

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JPS001 **Oral Presentation** **1629**

High Frequency Variations in Evolution of Indian Ocean Dipole Events in 2003 and 2006

Dr. Suryachandra Rao Anguluri
Climate Variations Research Program FRCGCJAMSTEC IAPSO

Toshio Yamagata

First strong IOD event in 21st century evolved in 2006. Prior to this event a weak and aborted IOD event evolved in 2003. Evolutions of these two distinct IOD events are studied using satellite data and assimilation products. Early strong warming in central Indian Ocean in 2003 resulted in abrupt termination of the 2003 IOD event. The strong warming in the central equatorial Indian Ocean in 2003 appears to be decoupled from the ocean dynamics and anomalous incoming solar radiation warmed the surface waters. Strong warming in the central equatorial Indian Ocean facilitated development of strong MJO/ISO activity in summer 2003 and that eventually terminated the 2003 IOD event. On the other hand, in 2006 the coupled ocean-atmosphere phenomenon is fully developed and the warming in the central and western equatorial Indian Ocean peaked in late summer and fall due to propagation of downwelling Rossby waves. The weak intraseasonal oscillations in summer 2006 were unable to terminate the IOD event in 2006 due to strong subsurface feedback to the SST. Various Initiation mechanisms, proposed earlier, are examined in detail.

Keywords: intra seasonaloscillations, indianoceandipole

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JPS001 **Oral Presentation** **1630**

Mechanism of biannual cyclicity of ocean and atmosphere processes and phenomenon

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

In the report the data of modern geodetic and geophysical observations testifying for the benefit of the author hypothesis (Barkin, 2002) about unity of the mechanism of variations of activity of natural processes of the Earth are discussed. This mechanism is the mechanism of the perturbed relative swing, small turns and mutual deformations of the core and the mantle and other shells of the Earth under the gravitational differential influence on the part of external celestial bodies. Observed displacements of the centre of mass of the Earth (with a wide spectrum of frequencies) on our geodynamic model are caused first of all by identical relative displacements of the centers of mass of the core and the mantle. Thus the superfluous mass of the core by its motion induces the tides, both in the elastic mantle, and in atmosphere and ocean. These tides, naturally, the most direct image influence on the activity practically of all planetary natural processes. Told proves to be true by observed cyclicities and phases of the corresponding atmospheric and oceanic processes. On the basis of GPS data of observations for period 1993 - 2003.8 oscillations of geocenter with the periods characteristic for the phenomenon El Nino, for atmospheric and oceanic processes have been determined (Tatevian et al, 2004; Barkin et al., 2007): 2.1 (3.9 mm); 2.1/2 (1.8 mm); 2.1/3 (1.4 mm); 2.1/4 (3/4 mm). In brackets the estimations of conditional amplitudes are presented in mm. The oscillation with amplitude of 3.9 mm occurs to the basic period of 2.1 approximately in the plane of meridian 90 E and has mainly the polar character. The oscillation of 1.8 mm occurs to the period of 2.1/2 approximately along the Greenwich equatorial axis. The equatorial oscillation with period of 2.1/3 is characterized by amplitude of 1.4 mm. The oscillation (with amplitude of 3.4 mm) occurs to the period of 2.1/4 approximately in the plane of Greenwich meridian. The oscillation of geocenter with period of 8.0 +.-0.4 yr and significant amplitude (11.2 mm) is allocated. At what it, as well as oscillation with period of 2.1 yr, occurs approximately in the plane of meridian 90 E. And also has mainly polar character. The oscillation with period 3.24 +.-0.5 years (and amplitude of 4.5 mm) occurs along the equatorial axis of the zero meridian. The oscillation with period of 3.6 +.-0.1 yr and amplitude of 7.0 mm has polar character. On our geodynamic model the similar cyclicities characterize relative displacements of the Earth shells and, hence, they should be shown in all natural processes, including El Nino. Really, the spectral analysis of long temporal series of indexes SOI since 1866 yr till 1996 yr and index DT since 1851 yr till 1996 yr has allowed to reveal oscillations with periods 6 yr, 3.6 yr, 2.8 yr, 2.4 yr. A feature of the revealed periods is noticed - all of them are to some extent multiple to the period of precession of lunar orbit in 18.6 years and to the Chandler period of the pole motion of 1.2 years (Sidorenkov, 2002). The atmospheric and oceanic tides with mentioned (and others) cyclicities caused by the gravitational attraction of displaced superfluous mass of the core (relatively to elastic mantle) are studied. The properties of their space and temporal display on the Earth are investigated. The obtained results confidently prove to be true the data of studies of spectrums of variations of gravity and variations of heights on gravimetry stations: Moscow, Ħestakhavi, Hannover etc. (measurements on absolute gravimeters in 1996-2000; Kaftan et al., 2004). In more wide sense discussed here mechanism of the mutual interaction and oscillations of the Earth shells directs, dictates and controls all known phenomena: ENSO, NAO, Northern and Southern Annular Modes, Pacific Decadal Oscillation and others dominant modes of variability. References Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. Sidorenkov N.S. (2002) Physics of no stabilities of rotation of the Earth. M.: "Nauka", Fizmatlit, 384 p.

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Keywords: biannual oscillation, enso periodicities, core mantledynamics

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JPS001 **Oral Presentation** **1631**

Decadal variability in the zonal structure of the Hadley circulation

Prof. Peter Baines
Dept of Earth Sciences Bristol University IAMAS

The Hadley circulation has a complex zonal structure which is largely dependent on the distribution of tropical rainfall. Recent observed changes in climate in tropical and mid-latitudes on the decadal time scale may be linked to changes in this tropical rainfall distribution. Observations and mechanisms of these changes, based on variations in fluxes of mass and energy will be described, including results based on TRMM satellite data and the example of the late 1960s global climate shift.

Keywords: climate variability, hadley circulation

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JPS001 **Oral Presentation** **1632**

Impact of Indian Ocean Variability on Australian Rainfall Patterns

Mrs. Caroline Ummenhofer
Climate and Environmental Dynamics Laboratory University of New South Wales

Alexander Sen Gupta, Matthew H. England

The effect of interannual Indian Ocean variability on Australian rainfall patterns is explored in observations, reanalysis data, and an atmosphere general circulation model. A dipole-like pattern in Indian Ocean sea-surface temperature (SST), distinct from previous definitions of the Indian Ocean Dipole and the Subtropical Indian Ocean Dipole, and associated with a reorganisation of the basin-wide wind field is found to influence rainfall in the Australasian region, especially across western and southern Australia and Indonesia. The mechanism forcing the rainfall anomalies is investigated in the atmospheric model by perturbing with the observed SST anomaly patterns across the Indian Ocean. Rainfall anomalies across the Australian continent in response to the changed Indian Ocean SST fields are found to be due to modulations in the moisture flux onto the continent and are associated with shifts in the frequency distribution of large-scale and convective rainfall. The relative contribution to Australian rainfall anomalies of the two poles making up the dipole and their specific physical mechanisms are investigated. Furthermore, an assessment is made of any additional skill in forecasting medium-term rainfall afforded by knowledge of the slowly-varying Indian Ocean SST field.

Keywords: indian ocean dipole, australia, precipitation

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JPS001 **Oral Presentation** **1633**

Pacific bidecadal variability induced by tidal mixing along the Kuril Islands

Prof. Hiroyasu Hasumi
Center for Climate System Research The University of Tokyo IAPSO

Ichiro Yasuda, Hiroaki Tatebe

Exchange of water between the Okhotsk Sea and the North Pacific is a controlling factor for the water mass and circulation of the North Pacific intermediate depths, where enhanced mixing along the Kuril Islands induced by diurnal tides plays a key role. Amplitudes of diurnal tides oscillate with an 18.6-year period due to the cycle of lunar orbital declination, which could change intensity of the mixing by up to a few tens of percents. 18.6-year periodicity has been detected over a broad region of the subarctic North Pacific. Using a coupled general circulation model (MIROC), we show that the 18.6-year tidal cycle excites significant bidecadal variability even in the Pacific mid-latitudes and tropics. The effect of changes of tidally induced mixing along the Kuril Islands propagates along the western rim of the Pacific as the Kelvin wave, which induces significant temperature anomalies at the western equatorial thermocline. These anomalies are transported to the equatorial sea surface and then affect the whole Pacific via atmospheric teleconnection.

Keywords: coupled gcm, bidecadal variability, pacific

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JPS001 **Oral Presentation** **1634**

Decadal variations and long-term trends in the Southeast Indian Ocean

Dr. Ming Feng
CSIRO Marine & Atmospheric Research

Gary Meyers, Arne Biastoch

Like ENSO, Pacific Decadal Oscillation related upper ocean variability and long-term trends in the tropical Pacific are also transmitted through equatorial and coastal waveguides into the southeast Indian Ocean and affect the ocean circulation in the southeast Indian Ocean. This study uses optimally interpolated historic data products, the CSIRO Mark 3.5 climate model outputs, and an eddy permitting numerical model simulation to assess the influences from the Pacific on the decadal variations and long-term changes in the Indonesian Throughflow, the South Equatorial Current, and the Leeuwin Current, and the thermodynamic balance in the southeast Indian Ocean, in an attempt to explain the recent warming trends in the tropical and subtropical Indian Ocean.

Keywords: pdo, southeast indian ocean, climate change

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JPS001 **Oral Presentation** **1635**

Interannual and interdecadal variability in the Northeast Asia, Northwest Pacific and its marginal seas

Dr. Vladimir Ponomarev
JPS001: Interannual and Interdecadal Climate Vari participant IAPSO

Elena Dmitrieva, Nina Savelieva, Natalya Rudykh

The climatic trends and oscillations of different time scales in the monthly/seasonal mean surface air temperature/ precipitation over the Northeast Asian, Sea Surface Temperature (SST) over the Northwest Pacific, Amur River Discharge (ARD), ice extent in the Seas of Okhotsk and are estimated from the observational records by using different statistical methods. The study is focused on the seasonality and regionality of interannual and interdecadal variability in the Northeast Asian Monsoon area. It is shown that the anomalies of different time-scale in seasonal mean ARD and precipitation in the Amur River Basin are controlled by both regional factors and large-scale anomalies in the Northwest Pacific. The significant positive statistical relationship between winter ARD and SST anomalies in Kuroshio region is found for interdecadal, decadal, and ENSO scales of variability. Changing relationship between ARD and Ice Extent in the Seas of Okhotsk and is revealed at the interdecadal time scale. This relationship is positive from 1929 to 1955, and negative from 1973 to 2002. The inversed relationship between ARD and Ice Extent during last 30 years seems to be due to changing of prevailing physical device for the river fresh / warm water impact on the ice formation during quasi-centennial warming. The interdecadal variation of cumulative anomalies of the Okhotsk,Japan Seas ice extent and Amur River Discharge is associated with the interdecadal variability of the Monsoon System and SST in both extratropic and equatorial - tropic Pacific areas.

Keywords: interannual interdecadal, variability northeast asia, okhotsk sea northwest pacific

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JPS001 **Oral Presentation** **1636**

Evidence for the Atlantic Multidecadal Oscillation as an internal climate mode from coupled GCM simulations.

Mr. Jeff Knight
The Hadley Centre for Climate Change The Met Office IAPSO

An analysis is presented which tests the consistency between multidecadal sea-surface temperature (SST) variability in observations and coupled twentieth century simulations with natural and anthropogenic forcings submitted for the IPCC Fourth Assessment report. The focus of the study is on the North Atlantic Ocean, where SST is characterised by large multidecdal variability known as the Atlantic Multidecadal Oscillation (AMO). It is found to be difficult to assess the consistencyof North Atlantic SSTs with individual model ensembles as the ensemble size is generally too small to constrain the ensemble mean. On the other hand, combining the results of the ensembles from different models creates a super-ensemble of sufficient size to allow a good estimate of the super-ensemble mean. Averaging over ensemble members causes cancellation of the intra-ensemble variability, thus the super-ensemble mean can be viewed as a best-estimate of the response to natural and anthropogenic forcings. It is found that using the super-ensemble allows a statistical separation of the observed SST from the estimated forced response, suggesting that the AMO is inconsistent with historical forcings. In this case, either (i) past climate forcings are incorrectly specified in the models, (ii) the models respond incorrectly to forcings, or (iii) the AMO is an internal climate mode. The latter possibility is consistent with results from a 1400 year simulation of the HadCM3 model with no forcing variability. This contains a realistic AMO that persists through the length of the simulation.

Keywords: amo, ar4, climate

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JPS001 **Oral Presentation** **1637**

Interannual variability in ventilation of the Okhotsk Sea and North PAcific, linked with sea ice production in the Okhotsk Sea

Dr. Kay Ohshima
Institute of Low Temperature Science Hokkaido University

Takuya Nakanowatari, Masaaki Wakatsuchi, Stephen C. Riser

Several studies have suggested that intermediate water in the North Pacific is mainly ventilated in the Okhotsk Sea (Talley, 1991; Warner et al., 1996). Active sea ice production over the northwestern shelf in the Okhotsk Sea leads to production of cold, oxygen-rich dense shelf water (DSW). This outflow of DSW, together with strong diapycnal mixing around the Kuril Straits, is regarded as the ventilation source. According to recent hydrographic observations, potential temperature of the Okhotsk Sea Intermediate Water at 26.8-27.1 sigma-theta maintained relatively high value during 1990's, abruptly dropped in 2001, and has gradually increased up to the present. According to the estimation of sea ice production in the Okhotsk on the basis of ice thickness data from the satellite microwave and a heat budget calculation, the highest ice production occurred in the 2000/2001 winter, which had the largest sea ice extent during the past 20 years. These suggest that the highest ice production in the 2000/2001 led to the largest DSW production and to the cooling of the intermediate water. For the past 50 years, intermediate water temperature on the 26.8-27.4 sigma-theta isopycnals in the northwestern North Pacific including the Okhotsk Sea has significantly increased. The largest warming occurred at the western part of the Okhotsk Sea with a 0.7 deg./50-yr increase at 27.0 sigma-theta. The warming in the Pacific is found over the Oyashio and Subarctic Current regions, where the Okhotsk water extends along the subarctic gyre. This suggests that the warming originates from the Okhotsk Sea. The warming trend is also accompanied by the significant decreasing trend of dissolved oxygen. The co-occurrence of warming and decrease in dissolved oxygen in the northwestern North Pacific implies that ventilation in the North Pacific has weakened. We propose that these trends of the water mass property and ventilation are mainly caused by DSW decrease due to the decrease in sea ice production over the northwestern shelf of the Okhotsk Sea. Sea ice extent in the Okhotsk Sea has a decreasing trend (-9 %/27-yr) from the satellite data. Wintertime surface air temperature in the upwind region of the Okhotsk, which has significant negative correlation with the sea ice extent, has increased by 2.0 deg. for recent 50-yr. These trends give indirect evidences for a decrease trend of DSW production. This study suggests that interannual variability in ventilation of the Okhotsk Sea and thus the North Pacific is strongly linked with that of sea ice production in the Okhotsk Sea. Given the fact that sea ice production in the Okhotsk is sensitive to the current global warming, further weakening of the ventilation would occur, having a possibility to give substantial impacts on the material cycle and biological productivity in the North Pacific.

Keywords: intermediate water, sea ice, ventilation

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JPS001 **Oral Presentation** **1638**

Kuroshio Large Meander Evolution in an Eddy-Resolving Global General Circulation Model

Dr. Niklas Schneider
International Pacific Research Center University of Hawaii IAPSO

Bo Qiu, Hideharu Sasaki

The Kuroshio-Large Meander south of Japan is a prime example of interannual and decadal variability controlled by ocean intrinsic dynamics. Here, we examine the Large Meander evolution in a 1950-2003 hindcast of the Ocean Model for the Earth Simulator (OfES) forced by observed surface fluxes. The model was run in a near global domain with 0.1 degree spatial resolution and 54 levels in the vertical, and provides a unique opportunity to investigate low-frequency variations of high-wavenumber processes.This OFES simulation produces variance of sea level, temperature in the thermocline and ocean pressure in the region to the south of Japan that indicates vigorous variability of the Kuroshio Path. The vertical structure appears equivalent barotropic, and is trapped in and above the thermocline. A complex empirical orthogonal function (CEOF) decomposition of anomalies of sea level or geostrophic stream function yields a leading mode that accounts for 63% of the variance in this area, and serves as an index for the large meander evolution. The phase of the principal component decreases nearly monotonically in concert with systematic variations of the magnitude. The implied time scale is irregular, but covers several years to a decade. The phase of the CEOF is used to derive composite states of the Kuroshio path. These show that when in the Large Meander state, the simulated Kuroshio detaches from the coast at Tokara Strait and returns to the coast just west of Izu Ridge. During the non-large meander state the Kuroshio follows the coast and departs at Kii peninsular to loop around the northern part of Izu Ridge. The preferred state of OFES is a large meander with the straight path occupied only 1/10 part of the time. These detachment of the Kuroshio at Tokara Strait and preponderance of the large meander are not in accordance with observations, and pose an exciting challenge to understand the model's physics and dependence on parameters.The leading principal component is used to composite the Large Meander evolution. Starting from a straight path, a meander forms close to Izu ridge. Over the course of several years, this meander grows and retrogrades until the Large Meander is established. The system then collapses rapidly in a few months back to a straight path. This evolution is independent of upstream anomalies of the Kuroshio. Rather, it is associated with a build up of low potential vorticity (PV) in the anticyclonic recirculation on the southern side of the Kuroshio. Inside the large meander high potential vorticity is found to stream from small topographic features, a process that can only be simulated thanks to the high resolution of OFES. Overall, this suggests that lateral mixing in OFES is insufficient to increase the low potential vorticity water supplied by the Kuroshio from low latitudes to ambient values. Low PV water accumulates until the system becomes unstable and resets.

Keywords: decadal, kuroshio

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JPS001 **Oral Presentation** **1639**

Formation of decadal SST variations in middle latitude Pacific during positive SST anomaly in the Eastern Equatorial Pacific

Prof. Jilin Sun
IAPSO JPS001 IAPSO

The differences and cause of SST anomalies in the middle Pacificduring El Nino event and PDOare discussed using atmospheric and oceanic data from COADS, NCEP/NCAR, SODA and numerical modeling. It was found that during years of El Nino before 1976, there seldom was negative SST anomaly in the middle latitude Pacific. After years of 1977, Warming in the equatorial eastern Pacific often companies areas of negative anomaly in the middle Pacific. Model of IAPL9 AGCM was used to examine the possible relations among middle latitude Pacific cooling, eastern tropical Pacific warming and the Tibetan Plateau warming. It seems that the eastern tropical Pacific warming and the Tibetan Plateau warming excite tele-connection patterns of PJ and PNA to induce anomalous cyclonic circulations over region of Aleutian Islands. The anomalous cyclonic patterns can be intensified through positive feedback of atmosphere-ocean interactions among Aleutian Low, the 500hPa westerly jet and the meridional gradient of SST, in decadal time scale in regions influenced both by Kuroshio and Oyashio.

Keywords: decadal variations, middle latitude pacific, atmosphere ocean interactions

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JPS001 **Oral Presentation** **1640**

Simulating El Nino in an eddy-resolving coupled ocean-ecosystem model

Dr. Ulrike Lptien
IFM-GEOMAR IFM-GEOMAR, Dsternbrooker Weg 20, 24105 Kiel

Carsten Eden, Axel Timmermann

Most coupled models still have significant biases in simulating ENSO variability, and these biases have been associated with difficulties in the simulation of the mean state of the tropical Pacific.In the present study the influence of the biologically induced changes insolar radiation is investigated with respect to the mean state, seasonal cycle and interannual variability of an eddy permitting model of the Pacific Ocean. The model which we use is SPFLAME, an extended version of the GFDL MOM-2.1 code at 1/4 resolution. A pelagic ecosystem model (NPZD) is coupled to the regional ocean model. Additionally, a solar feedback of the biological component on the ocean is implemented by changing the solar absorption schema. In the presence of phytoplankton more light is absorbed in the top layers of the ocean. This leads to considerable differences concerning temperature distribution, mixed layer depth and also the current system compared to the ocean model only. Altogether, our model shows a clear improvement through the inclusion of the biological component.

Keywords: enso, biogeochemical modeling, eddy permitting model

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JPS001 **Oral Presentation** **1641**

Role of the re-emerging SST anomalies on the winter-to-winter persistence of the NAO

Dr. Christophe Cassou
Climate Modelling and Global Change project CNRS-CERFACS IAPSO

Clara Deser, Mike Alexander

In the extratropics, thermal anomalies stored in the deep winter oceanic mixed layer persist at depth through summer where they are insulated from surface fuxes. They become reentrained back in the deepening mixed layer during the following winter and their reemergence explains part of the winter-to-winter persistence of the extratropical Sea Surface Temperature anomalies. The forcing of the oceanic reemergence on the atmosphere is investigated here in the North Atlantic using a simplified coupled model (Atmospheric Global Circulation Model coupled to a Mixed Layer Ocean Model and to a thermodynamical ice component). Such a model configuration takes the vertical oceanic processes into account and correctly represents the physics of the ocean-atmosphere interaction at the interface. Estimation of the thermal anomalies created by late-winter/early spring atmosphere and stored below the hightly stratified summer thermocline are obtained from a long control simulation. They strongly project on the so-called North Atlantic tripole associated with the phase of the North Atlantic Oscillation (NAO). These thermal anomalies are applied below 40meter depth and north of 25N, in the oceanic initial conditions of a 60-member ensemble of 1yr integration starting in August. We show that their reemergence occurs in November/December and has a significant impact on the model atmosphere. The reentrainment of the subsurface oceanic anomalies tends to favor the same phase of the NAO which created them during the previous winter. The simulated atmospheric response would confirm the hypothesized role of the oceanic reemergence in the weak but significant year-to-year persistence of the wintertime NAO. Model results suggest a probable role of the high-frequency atmospheric eddies. Storminess is clearly modified in the perturbed ensemble and eddy-mean flow interactions would explain the large-scale and persistent atmospheric response to the extratropical North Atlantic reemergence.

Keywords: reemergence, nao

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JPS001 **Oral Presentation** **1642**

Influence of ENSO on Europe in an atmospheric model

Dr. Sarah Ineson
Hadley Centre Met Office, Exeter, UK, EX13PB IAMAS

The existence of an extratropical ENSO signal in the stratosphere has been demonstrated in a number of modelling and observational studies. Filling of the polar cyclone and weakening of the polar night jet occurs during El Nino and is likely due to increased Rossby wave driving. Recent studies have also shown a weakened stratospheric jet is associated with more easterly tropospheric winds and colder European conditions resembling the negative phase of the North Atlantic Oscillation in the majority (but not all) of ENSO events.Here we show results from a 4 member ensemble of atmospheric GCM simulations from a vertically extended (60-level) version of the HadGAM model. The model uses observed sea surface temperatures from 1960-2000. A composite of El Nino events shows both an infilling of the polar vortex and a negative January-February NAO signal, indicating a potential source of seasonal predictability for Europe in winter.

Keywords: enso, stratosphere, predictability

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JPS001 **Oral Presentation** **1643**

Reconstructing Tropical Sea Surface Temperatures Using Precipitation Proxy Records: Methods and Uncertainties

Mr. Jason Furtado
Earth and Atmospheric Sciences Georgia Institute of Technology

Emanuele Di Lorenzo, Kim M. Cobb

Reconstruction of historical tropical sea surface temperatures (SSTs) over the last millennia and beyond is an active venture in current paleoclimate research. This study explores the potential of using tropical precipitation data from paleoclimate proxy locations to reconstruct tropical ocean SSTs. The goal is to quantify the range of uncertainties in the SST reconstruction and their dependence on both errors in the proxy data and distribution of the proxy network. Two reconstruction methods are presented and applied to observational and modeled datasets over the period 1950-2000. The first reconstruction method exploits the high correlation between the leading mode of variability of precipitation and SST, which corresponds to ENSO and accounts for more than 50% of the total covariance. The second method uses multiple modes of covariability between precipitation and SST. We find that in addition to the ENSO mode, the second mode of covariability (explaining about 20% of the total covariance) captures variations in the spatial expression of ENSO. This second mode has a large-scale spatial signature and is robust in all the precipitation datasets used in this study. Inclusion of this mode in the linear model leads to an approximate 30% improvement in the overall reconstruction skill. Uncertainty estimates computed from the linear model are consistent with those obtained using Monte Carlo simulations. Given the few degrees of freedom in the covariability modes, we find that a relatively sparse network of individual precipitation time series captures the phase of the modes and leads to high SST reconstruction skills in the tropical Pacific and Indian Ocean.

Keywords: enso, paleoclimate, reconstructions

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JPS001 **Oral Presentation** **1644**

Interannual trends of some atmospheric and sea surface parameters of the southern ocean on satellite radiometry, scaterrometry and altimetry data

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

As is shown in last years researches, climate changes in Antarctic , result in interannual increase trend of surface air temperature, decrease of ice thickness and change of atmospheric circulation. These tendencies are must try in the Southern Ocean hydrological regime. For that next remote sensing data: AVHRR MCSST, SSMI and satellite altimetry data (merged data of mission ERS, TOPEX/Poseidon, Jason-1, ENVISAT, GFO-1), are used to this task, which give information about sea surface temperature (SST), surface wind speed (SWS), columnar water vapor (CWV), cloud liquid water (CLW), rain rate (RR) and sea level anomaly (SLA) correspondingly. According to the obtained results, SST has positive trend 0.010.005C /yr within 3001000 km band northward of the Antarctic coast and negative trend - 0.020.003C/yr on average for the Southern Ocean for 24-yr record (1982-2006). SST rate good correspond with the trend analysis of surface air temperature of -0.0420.067C/yr inferred from the satellite 20-yr record (Comiso, 2000). SLAhas interannual trend 0.240.026cm/yr for 12-yr record (1993-2006). However in some areas (for example, Pacific-Antarctic Ridge) SST and SLAtendencies are stronger -0.0650.007C/yr and -0.210.05 cm/yr, respectively. For 19-yr record (1988-2006) next atmospheric parameters has positive trend: SWS 2.11.6cm/s/yr, CWV 1.20.7mm/yr and CLW 0.50.6mm/yr. However in some areas of the Southern Ocean tendencies of this atmospheric parameter is different. This work was partly supported by the Russian Fund of Basic Research

Keywords: interannual trend, southern ocean, remote sensing

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JPS001 **Oral Presentation** **1645**

Interdecadal fluctuations of precipitation over South America: seasonality and linkages with SST

Prof. Alice Grimm
Department of Physics Federal University of Parana

Joo Paulo Jankowski Saboi

EOF and spectral analysis is carried out on seasonal and annual precipitation data from more than 10,000 stations over South America in the period 1950-2000, in order to characterize their interdecadal variability, its seasonality and possible links with SST anomalies. Precipitation data are gridded to a 2.5 degree resolution. Modes were calculated for three periods: 1950-2000, 1955-2000, 1960-2000. The EOF patterns are generally stable, although EOFs calculated for different periods may have different relative contribution to the variance. The modes are rotated, to best separate regional oscillations within a certain time-scale and connected with a certain forcing. The first two modes of precipitation interdecadal variability over SA show strongest components over Northeast Brazil and over Central South America. The spectral analysis shows that the interdecadal variability in these two regions has different time scales. While in NE Brazil it is decadal, with periods in the range 10-15 years, in central the periods are predominantly larger than 20 years. The spectral analysis is consistent with the oscillations indicated by the principal component series. The connection of these modes with SST anomalies is tested all over the globe. During summer, there are no indications of tropical SST forcing or statistical relationship with the precipitation variability. However, in autumn, winter and spring there is significant correlation with tropical /subtropical/exctratropical SST anomalies. The correlation patterns indicate the influence of the North Atlantic oscillation and the Pacific decadal mode on the interdecadal variability over South America. The interdecadal variability of the annual precipitation shows strong seasonality, as the main contribution to each of the first modes stems predominantly from the variability in one or two season. The first annual mode has main contribution from austral spring and summer variability in central South America, which is a region very affected by the summer monsoon, while the second mode shows largest contribution from autumn. While there is some persistency in correlation patterns between SST and the first precipitation PC series from autumn through spring (which is interrupted in summer), the spatial patterns of the corresponding modes change from one season to another, showing that the impact on precipitation varies according to the varying atmospheric basic state on which the perturbations propagate. An interesting relationship is observed between one of the first rotated modes in spring and in summer. They have similar spatial distributions but show an inverse relationship, indicating reversal of precipitation anomalies over a large region in central-east South Americ. This may indicate the influence of local forcing in reversing the anomalies in summer, while in spring remote forcing is probably predominant.

Keywords: interdecadal variability, precipitation, south america

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JPS001 **Oral Presentation** **1646**

A decade of acoustic thermometry in the North Pacific Ocean, Part A: Using long-range acoustic travel times to test gyre-scale temperature variability derived from other observations and ocean models

Dr. Peter Worcester
Scripps Institution of Oceanography University of California, San Diego IAPSO

Brian D. Dushaw, Rex K. Andrew, Bruce M. Howe, James A. Mercer, Robert C. Spindel, Bruce D. Cornuelle, Matthew A. Dzieciuch, Theodore G. Birdsall, Kurt Metzger, Jr., Dimitris Menemenlis

Large-scale temperatures in the North Pacific were measured by long-range acoustic transmissions from 1996-2006. Acoustic sources off California and Kauai transmitted to receivers distributed throughout the North Pacific from 1996-1999. Kauai transmissions continued from 2002-2006. Acoustic travel-time data are inherently integrating. This averaging suppresses mesoscale variability and provides an accurate measure of large-scale temperature, subject to the limitations of the ray path sampling. At basin scales, the ocean is highly variable, with significant changes occurring at time scales from weeks to years. The interannual variability is large compared to trends in the data. Willis, et al. used objective mapping techniques applied to satellite altimetry and hydrography to derive 0-750 m temperature fields for the global ocean. Travel times equivalent to the measured travel times can be calculated using these fields. The measured and calculated travel times are similar, but also show significant differences. Similar comparisions using travel times derived from the "Estimating the Circulation and Climate of the Ocean" (ECCO) model also show similarities and differences. The ECCO model was constrained by altimetric and profile data by data assimilation, suggesting that the acoustic travel times provide meaningful additional constraints on model behavior.

Keywords: thermometry, climate

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JPS001 **Oral Presentation** **1647**

A decade of acoustic thermometry in the North Pacific Ocean, Part B: Understanding basin-wide averages of temperature by comparisions to a high-resolution numerical ocean model (POP).

Dr. Brian Dushaw
Applied Physics Laboratory University of Washington

With a decade of long-range (several Mm) acoustic propagation data obtained during the Acoustic Thermometry of Ocean Climate (ATOC) and North Pacific AcousticLaboratory (NPAL) projects, the interannual, seasonal, and higher frequency variability of transbasin-averaged ocean temperature in the North Pacific can be examined. Acoustic transmissions were made from sources located off the northern Californian coast and north of Kauai, Hawaii to several receivers of opportunity located in the North Pacific Basin. The acoustic data are a high signal-to-noise measure of large-scale temperature with excellent temporal resolution. Although only a few realizations of the seasonal cycle are available, inter- and intra-annual variabilities are significant to the temperature variability, with signal amplitudes comparable to the seasonal cycle. The seasonal cycle of temperature is mostly accounted for by local air-sea heat exchange. The time scales for some of the changes in temperature are short, sometimes of order weeks. Not all available acoustic paths are suitable for assessing the seasonal cycle, however. Near Hawaii, the acoustic sampling does not extend to the near-surface waters, so seasonal variations there are not measured. To better understand the nature of the signals, the temperature changes observed by the acoustics will be compared to temperature changes modeled by a co-temporal, high-resolution ocean model (POP: Parallel Ocean Program).

Keywords: ocean climate, ocean model, acoustic thermometry

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JPS001 **Oral Presentation** **1648**

Consecutive wet days and consecutive dry days as useful climatic indicators, case study over Iran

Mr. Ahmad Asgari
climatology ASMERC

Fatemeh Rahimzadeh, Nooshin Mohammadian

In this study, we used two indices of Consecutive Wet Days (CWD) and Consecutive Dry Days (CDD). The former is actually maximum length of wet spell and is defined as maximum number of consecutive days with precipitation equal or greater than 1 mm. The latter is also indicates maximum length of dry spell, and is defined as maximum number of consecutive days with precipitation less than 1 mm. Increased number of CWD, causes higher occurrences of events like flood, landslide, avalanche, mudflow, and erosion, and also exerts higher pressure on private and state insurance companies, and on relief and rescue systems. Increased number of CDD causes more frequent dry seasons in the heart of mid-latitude land regions, and in turn higher occurrences of drought and ultimately lower yield of agricultural products, lower quality and quantity of water resources, more probable of natural forest fires. Our results show higher number of CWD in coastal stations of Caspian Sea compared to other Iranian stations under study. For example, CWD as low as 5 days in Bandar Anzali (Coastal port of the Caspian Sea) is remarkable. Since stations like Zabol and Zahedan (Southwest) and Yazd (Central region) have experienced just 1day for the index in many years, trend analysis of the index in such stations is meaningless. We found positive trend of the index in two mall region located in north and east of the country. The rest of the country showed negative trends with strongest ones in west and southwest of the country. We also found negative trends of CDD index in most of the country. Some small regions located in northwest, east, southwest and middle of country showed positive trends for the index. Trends in some stations like Ghazvin (North) and Shahrekord (Southwest) were so weak that can be considered stationary.

Keywords: consecutive dry days, consecutive wet days, variability of precipitation

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JPS001 **Poster presentation** **1649**

On the role of the Chandler wobble in the interannual and interdecadal climate variations

Mrs. Ivashchenko Nadezda
HydrometeoService of Russia Hydrometeorological Research Center of Russia IAPSO

Sonechkin Dmitry

An idea is voiced that the seasonal, interannual and interdecadal climate variations are driven by several external periodic forces at essentially incommensurate periods. It means together with the annual Sun-induced periodic heating of the atmosphere and oceans some other external forces must be taken into consideration. Amongst these the so-called Chandler wobble in the Earths pole motion seems to be especially important. The main period of the Chandler wobble is about 14 months. It is very probable that this period is incommensurate to the annual period. It means Both forces affect the global climate system at wrong time moments, and so some complex (strange in the mathematical sense) multiscale climatic variations must be excited instead of chaos. In particular, some beats at the periods of the combinational harmonics of both, Chandlerian and annual, periods are waited to be inherent to the nonlinear responses of the global climate systems to these forces. Therefore the climatic power spectra must remain to be of a discrete character over a range of the interannual interdecadal time scales. In principle, climatic variations of such character must be predictable without any limit like the well-known atmospheric and oceanic tides. Reality of the Chandler wobble influences on the global climate system is most clearly seen in the phenomenon of the quasi-biennial oscillation of the equatorial zonal winds in the lower-stratosphere. The main period of QBO is about 28 months, i.e. it is the doubled Chandlerian period exactly. Another example is the phenomenon of the quasi-biennial and quasi-triennial cycles of El-Nino/La Nino processes. Even more, the variations of the global and hemispheric mean surface air temperatures also reveal some responses to the combine forcing at the annual and Chandlerian periods. This circumstance will be demonstrated by means of a specially designed wavelet analysis of the mentioned climatic quantity records.

Keywords: chandlerian annual cycles, nonlinearity climate response, wavelet analysis

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JPS001 **Poster presentation** **1650**

Detecting climatic jumps in 500 HPA geopotential height monthly anomalies in Antarctica

Dr. Adrian Yuchechen
PEPACG CONICET

Susana Amalia Bischoff, Pablo Osvaldo Canziani

This research deals with climatic jumps in 500 hPa geopotential height monthly anomalies series at fifteen rawinsonde stations located in Antarctica. Geopotential height is obtained from rawinsondes taken in the following upper air stations (all datasets cover the period January 1973-December 2006 and the hour used is 00Z, unless specified): Neumayer (89002) (June 1985-December 2006, 12Z), Amundsen-Scott (89009), Halley (89022) (12Z), Bellingshausen Aws (89050) (January 1973-January 1999), Base Marambio (89055) (October 1981-December 2006, 12Z), Novolazarevskaja (89512), Syowa (89532) (January 1973-July 2006), Molodeznaja (89542) (January 1973-March 1996, 12Z), Mawson (89564) (July 1985-December 2004, 12Z), Davis (89571), Mirnyj (89592), Vostok (89606) (September 1973-January 1992), Casey (89611), Dumont Durville (89642) (July 1985-December 2006) and McMurdo (89664). Stations 89002, 89022, 89050 and 89055 are located in Western Antarctica, whereas station 89009 is located in the South Pole. The rest of the stations are located in Eastern Antarctica. Climatic jumps are detected using the so-called Yamamoto test, with a confidence level of 95%. Once monthly anomalies are calculated, twelve sets of anomalies series are built, one for each month. The test is applied to each of these sets. Hence, year-to-year variability is analyzed for each month. Results are as follows: Jan 1983 (89512); 1994 (89611), 2000/1 (89664) Mar 1984/5 (89022); 1990 (89022) Apr 1978 (89512); 1992/3 (89664) May 2000 (89571) Jun 1986 (89050) Aug 1989 (89055) On the one hand, for stations located in Western Antarctica detected climatic jumps take place mostly under, or following, La Nia or neutral conditions. On the other hand, although detected climatic jumps for the stations located in Eastern Antarctica take place under a wide variety of conditions, they often do so under, or following, El Nio events.

Keywords: 500 hpa, climatic jump, antarctica

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JPS001 **Poster presentation** **1651**

Climate impacts of Atlantic Multidecadal Variability: seasonal mean climate and ENSO

Dr. Rowan Sutton
Meteorology University of Reading IAPSO

Buwen Dong, Daniel Hodson

The Atlantic Ocean exhibits prominent multidecadal variability, some of which is thought to be driven by variations in the Thermohaline Circulation (THC). There is increasing evidence that this variability can exert important influences on climate, both on the continents surrounding the Atlantic basin and in more remote regions. In this paper we will focus on two aspects: 1) impacts on boreal summer climate in North America; and 2) impacts on ENSO variability in the tropical Pacific. In the first area we will present the results of experiments we have carried out in follow-up to our 2005 Science paper, which showed that warming of the North Atlantic raised temperatures but suppressed precipitation over large parts of North America. The new experiments investigate sensitivity to the pattern of sea surface temperature anomalies and the choice of model. In the second area we will present results of experiments which suggest that a weakening of the Atlantic Thermohaline Circulation can cause an enhancement of ENSO variance. This Atlantic influence may help to explain links between the North Atlantic and tropical Pacific suggested by some paleoclimate records, and could also be a factor in the multidecadal variability of ENSO activity that was observed during the twentieth century.

Keywords: amo, thc, enso

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JPS001 **Poster presentation** **1652**

Study of the 1973-2002 variability of the Annual Cycle of ERA-40 Geopotential Height: an interhemispheric comparison.

Dr. Patricia Repossi
PEPACG Pontificia Universidad Catolica Argentina

30 years tropospheric and lower stratospheric ECMWF ERA-40 geopotential height data are studied. Here the zonal mean annual cycle is studied from pole to pole in order to evaluate the interanual variability and determine interhemispheric differences in the annual cycle evolution during the 30-year period. The first important difference noticed for all levels is the observed between the tropics/equatorial region and the extratropics/polar regions. Whereas the extratropics exhibit a strong annual cycle the upper segment of the sample shows the important contribution of the QBO and even mid tropospheric heights yield significant interannual variability. Both superposition of low frequency variability and modulation of annual cycles are visible on the 30-year sequence, at all latitudes. The Southern Hemisphere shows a more prominent interannual variability than the Northern Hemisphere. Furthermore the annual minima show larger interannual variability than the annual maxima. The possibility of interactions between low frequency oscillations from interannual to quasidecadal periods is discussed. Focusing in the Southern Hemisphere, the interannual variability and spatial structure of the Semiannual Oscilation (SAO) is studied. This half-yearly cycle dominates the long-term sea level pressure and geopotential height climatology over southern latitudes poleward of 35S and is driven by seasonal differences in energy exchange processes and heat storage between midle latitudes and Antarctica. This work aims to investigate changes in the SAO variability updating the earlier studies, and comparing this results with these obtained by other autors using different databases (measurements and NCAR reanalysis)

Keywords: sao, geopotential, modulation

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JPS001 **Poster presentation** **1653**

Rapid warming and salinification of intermediate and deep waters in the Irminger and Iceland Basins during the past decade

Dr. Artem Sarafanov
Polar Oceanography Group P.P. Shirshov Institute of Oceanology, Russia

Alexey Sokov, Anastasiya Falina

The Labrador Sea Water and Nordic Overflow Waters initially produced by the wintertime convection in the Labrador Sea and Nordic Seas inherit and transfer climate signals from the source regions throughout the North Atlantic subpolar gyre and ultimately further southward, forming the lower limb of the Meridional Overturning Circulation. Analysis of intra- and inter-decadal variability of these water masses in vicinity to their source regions is thus essential for understanding and quantification of oceanic response to the modern climate oscillations. In our study, recent changes in temperature and salinity of the Labrador Sea Water and Nordic Seas Overflow Waters are analysed on the basis of the CTD data from four repeats of the zonal transatlantic section along 60N carried out on board the Russian research vessels in 1997, 2002, 2004 and 2006. Changes of the average temperatures and salinities in the water mass layers as well as the changes in the water mass cores are quantified; the layers are defined using the uniform (for each water mass) potential density and salinity limits. The vertical distributions and zonally averaged profiles of temperature and salinity differences between the section repeats are presented to illustrate the full-depth section-wide hydrographic variability. Substantial warming and salinification of the Labrador Sea Water (LSW), mostly in the Irminger Basin, and Iceland-Scotland Overflow Water (ISOW) occurred throughout the analyzed time period. In the Irminger Basin, temperature and salinity in the layer of the classical deep LSW (dLSW) steadily increased by 0.20.35C and 0.040.05. In the Iceland Basin, dLSW became 0.010.02 saltier; variations of the dLSW temperature did not exceed 0.1C. In 19972004, the shallow LSW (sLSW) was observed only in the Irminger Basin, while in 2006, this water was detected in the Iceland Basin as well. Consequently, 1011 years had passed between the beginning of the multiyear restratification in the Labrador Sea (and thus the beginning of sLSW production) and the appearance of sLSW in the central part of the Iceland Basin. In the Irminger basin, the most warm and saline sLSW was observed in 2006. Temperature and salinity in the ISOW layer steadily increased by 0.10.2C and 0.0150.02 both sides of the Reykjanes Ridge. The observed changes point to the rapid reversal (or at least abrupt interruption) of the previously reported sustained long-term freshening of ISOW maintained since the 1960s. The substantial variations in the Denmark Strait Overflow Water (DSOW) layer do not show clear intradecadal trend. The DSOW temperature and salinity decreased by 0.30.4C and 0.020.03 between the 1997 and 2004 observations and sharply increased by ~0.5C and 0.040.05 from 2004 to 2006. Overall, 2006 was the year of the warmest and most saline LSW (both sLSW and dLSW), ISOW and DSOW. The observed changes at 60N (sustained in the case of LSW and ISOW) reveal a rapid shift to the warmer/saltier conditions at intermediate and deep levels in the subpolar North Atlantic during the past decade.

Keywords: subpolar north atlantic, labrador sea water, overflow waters

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JPS001 **Poster presentation** **1654**

Interdecadal Variability of the Typhoon Activity in Autumn

Prof. Chih-Hua Tsou
Department of Earth Science National Taiwan Normal University IAMAS

Chih-Yi Lin

The interannual and interdecadal variability of the typhoon activity over the western North Pacific Ocean in summer has received considerable attention, recently. This study found that the activity of super typhoon in autumn also exhibits significant interdecadal variability, while the interdecadal variability of categories 1-3 typhoon in autumn is not obvious. The super typhoon activity over the western North Pacific Ocean in autumn is strongly influenced by the environment change over the central Pacific Ocean. Both the SST and cloud top temperature increase (decrease) during the super typhoon active (inactive) period. This implies that the interdecadal variability of stability (efficiency) of the atmosphere is small. The variation of the moisture content associated with the variation of the SST in the central Pacific play important roles on the interdecadal variability of the super typhoon in fall. The gross characteristic of this phenomenon can be depicted by the formula of the maximum potential intensity (MPI) with slightly modification.

Keywords: interdecadal variability, typhoon

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JPS001 **Poster presentation** **1655**

Multi-scale variability patterns in NCEP/NCAR reanalysis sea-level pressure

Dr. Susana Barbosa
Applied Mathematics Faculdade Ciencias, Universidade Porto

Maria Eduarda Silva, Maria Joana Fernandes

The variability of the global sea-level pressure field is a topic of considerable interest in the analysis of the Earth climate. Since atmospheric pressure varies within a wide range of scales, a multi-scale characterisation of its variability is particularly appealing. In this study, we carry out a scale-by-scale analysis of the global sea-level pressure field from reanalysis data. The approach, consisting on the analysis of variance in the wavelet domain, yields a flexible characterisation of variability patterns in terms of the contribution of each scale to the overall variance. Signals at the seasonal scales account for the largest fraction of sea-level pressure variance (typically more than 60%) except in the Southern Ocean, in the Equatorial Pacific and in the North Atlantic. In the Southern Ocean and over the North Atlantic, high-frequency signals contribute to a considerable fraction (30 - 50%) of the overall variance in sea-level pressure. In the Equatorial Pacific, large-scale variability associated with ENSO contributes up to 40% of the total variance.

Keywords: interannual variability, climate, wavelets

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JPS001 **Poster presentation** **1656**

20-year period circulation of upper ocean heat content anomaly in the North Pacific subtropical gyre

Dr. Shusaku Sugimoto
Department of Geophysics Graduate School of Science, Tohoku University IAPSO

Takuya Hasegawa, Kimio Hanawa

Using long-term dataset of upper ocean temperature and adopting various methods such as a complex empirical orthogonal function analysis and principal oscillation pattern analysis, long-term behaviors of wintertime upper ocean (sea surface to 300 m) heat content (OHC) over the North Pacific subtropical gyre are investigated. It is found that the OHC anomalies rotate clockwise in the subtropical gyre with a period of about 20 years. It is also found that this clockwise circulation of OHC closely relates with the Aleutian Low activity. Examinations on heat balance in the upper ocean and thermocline depth indicate that 20-year OHC variation is primarily due to not atmospheric process but oceanic process such as advection of warmed/cooled water mass and temporal change of thermocline depth. 20-year variation in sea surface temperature (SST) field is found only in the northern part of subtropical gyre, which is north of 30N, and the temporal evolution is consistent win the Pacific Decadal Oscillation. Sea level pressure (SLP) filed also has the 20-year variation only in the northern part of gyre, reflecting the Aleutian Low activity. That is, since both SST and SLP is locally related to the Aleutian Low activity, circulation nature is not observed. Correlation analysis among OHC, SST, and SLP clearly shows that the OHC variation directly connects with the overlying atmospheric field through the sea surface in the northern part of gyre, while the OHC variation has no relationship with both SST and SLP variations in the southern part of gyre. These findings indicate that the northern part of gyre is a key region for generating 20-year climate variation in and over the midlatitude North Pacific.

Keywords: upper ocean heat content, 20 year climate variation, north pacific

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JPS001 **Poster presentation** **1657**

Structure and temporal variability of the bottom waters properties in the Equatorial and South Atlantic

Dr. Alexander Demidov
Oceanology Moscow State University IAPSO

Dobrolyubov Sergey

During the period from 2003 to 2006, a number of Russian expeditions worked in different regions of the Equatorial and South Atlantic within the framework of the Russian research program "Meridian-plus". The main objective of the research was investigation of the structure, transport, and variability of water properties in the layer of Antarctic Bottom water (AABW) in key regions for bottom water spreading: Vema and Romanche fracture zones, and Vema Channel. During the measurements in the Vema and Romanche fractures warming was found in the AABW layer equal to 0.034C и 0.027C, respectively, while salinity changes were less significant. Transports of AABW were calculated on the basis of the LADCP direct measurements data. They appeared the smaller than the previous estimates. Our measurements resulted in 0.1-0.6 Sv transport in the Vema fracture and 0.1-0.8 Sv in the Romanche fracture. In the Vema channel AABW propagates further to the North Atlantic and in particular to the Subpolar Atlantic. Variations in the properties of AABW influence the properties of deep waters in the North Atlantic. It was found out that the propagation of the lower part of AABW in the Vema Channel occurs in the form of strongly mixed jet (or several jets). One core of the jet is displaced to the eastern part of the channel due to Ekman friction, which agrees with the theory. Usually, the jet is mixed by vertical in the lower 100-150 m. Each year of observations demonstrates that the structure of the jet changes. Different years of observations the propagation of AABW was observed in the form of several jets (1991, 2002, 2006), or the jet was displaced to the maximal depth in the middle of the channel (March 2005). Beginning from the 1970s, a gradual increase in the potential water temperature had been observed in the Vema Channel. It was found that the tendency of temperature increase is absolutely not related to water sampling in different parts of the channel. Slight cooling and freshening of the core of the jet are observed according to the data of the Russian sections of November 2004, March 2005, and November 2006. In October 2005 temperature in the jet increased and reached the level of 2002.

Keywords: water masses, antarctic bottom water, vema channel

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JPS001 **Poster presentation** **1658**

Particular Barents Sea circulation regime

Mr. Andrey Pnyushkov
Ocean-atmosphere Interaction Arctic and Antarctic Research Institute IAPSO

On a basis of developed three-dimensional non-stationary mathematical model the current patterns of the Barents Sea at various hydrological conditions have been investigated. A two-dimensional numerical filter and improved numerical scheme are used to reduce an effect of numerical instability caused by inconsistent in the temperature, salinity and level fields. The results of numerical experiments show that the model adequately describes the main circulation features using PHC 2.0 climatology, NCEP/NCAR and ERA40 forcing. The series of numerical experiments with model were carried out on the basis of summer (August - September) temperature and salinity surveys included into new version of oceanographic database for the Nordic Seas developed under INTAS-4620. A new method of optimal interpolation based on block variant of kriging was used for hydrographic fields restoring. These data where used for model initialization and veryfication of the results. The significant role of the external forcing (the Atlantic waters inflow through open border) on the circulation regime of the Barents Sea was confirmed. It was shown also that the monthly mean circulation for specific year may differ significant from classical climatological circulation. At the same time the model show that the role of external atmosphere forsing in the formation of circulation regime isn't so much. The time interval of particular circulation regime was estimated using prognostic model run. This work was particulary supported by INTAS-4620 project and RFBR grant 06-05-64054.

Keywords: circulation, barents, modelling

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JPS001 **Poster presentation** **1659**

Utilizing the Koeppen climate classification to assess the future climate change.

Dr. Masatake Hori
Nagoya University COE Researcher

Tetsuzo Yasunari

It is suggested that global warming due to anthropogenic greenhouse gasses will cause a large change in the mean temperature and precipitation patterns of the future. One way to quantify the impact of this change is to use the climate classification method. Classifying the climate into regions with distinct properties instead of using only physical properties such as temperature and precipitation helps to give an objective view of how climate change affects the environment such as the land-surface types and vegetation. TheKoeppen climate classification has a long history of application and modification and is known to give a robust classification of the mean climate that closely follows the distribution of vegetation types. In this study, we apply theKoeppen climate classification on the result of 19 Atmosphere-Ocean GCM results provided by the PCMDI for the upcoming IPCC -AR4. By applying this method to the long-term future projection of climate models, instability of a particular climate region and its expected change in the longer timescales are quantified. The classification is performed on the 20th century simulation (20C3M) and the SRES-A1B / A2 scenario based on the long-term monthly climatology. The overall changes in classifications as well as inter-model distribution is calculated for all each model and the skill weighted ensemble mean. Results show that due to warmer climate and increase in moisture, large area of western Russian region and north America experience a shift from aDf (snow / fully moist) climate to Cf (Warm temperate / fully moist) classification which is in good agreement with the stronger NAO/AO phase in the north Atlantic. On the other hand, coastal Greenland region changes from a Ef (Polar frost) classification to Ef (Polar tundra) classification, which is in good agreement with the SST and sea-ice distribution. In contrast, northern China undergoes a change from Cf classification to Cw (Warm temperate / winter dry) classification which marks a drying of this region. Weakening of the Aleutian low and a strongerENSO signal among models may have contributed to this result. In the presentation, major changed in classification and its physical background is highlighted.

Keywords: koeppen classification, global warming, aogcm

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JPS001 **Poster presentation** **1660**

Response of Tropical Atlantic Variability to a reduction of the Meridional Overturning Circulation

Dr. Reindert Haarsma
Climate Research KNMI IAPSO

Edmo Campos, Wilco Hazeleger, Camiel Severeijns

The northward ocean heat transport in the Atlantic is dominated by a basin-wide meridional overturning circulation (MOC). The inflow of MOC water into the tropical Atlantic occurs via the South Equatorial Current and the North Brazil Current . Some of that water upwells into the surface layer, potentially affecting coupled ocean-atmosphere variability. Tropical Atlantic Variability is dominated by a zonal equatorial mode and an interhemispheric model. Climate models generally simulate that greenhouse warming induces a reduction of the MOC. In the presentation the tropical Atlantic climate with and without a strong Atlantic MOC will be discussed in detail. We will show results of the coupled SPEEDO model, that simulates tropical Atlantic variability realistically, in which the inflow of the MOC in the Atlantic basin has been artificially reduced. In response, the well-known interhemispheric gradient in surface temperature develops and the ITCZ shifts southward. These changes are characteristic of the Atlantic Meridional Oscillation. Also, upwelling on the equator reduces and characteristics of Tropical Atlantic Variability change. In particular, a deeper equatorial thermocline causes the zonal mode of interannual variability to reduce and Benguela Nino's to become more pronounced.

Keywords: tropicalatlanticvariability, meridionaloverturningcell, climatechange

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JPS001 **Poster presentation** **1661**

Spatial structure of the global surface air temperature trend changes and NAO and SOI indices

Prof. Antonio Rodrigues Tomé

Pedro M A Miranda

Using the GISS and the hadCRU datasets we have applied a new developed technique of fitting, continuous line segments to a time series (Tom andMiranda, 2005) under sensible constraints on the minimum line segment length and on the minimum trend variation at breakpoint year. The methodology of fitting continuous line segments to time series provides a new and alternative way of analyzing non-monotonic and non-periodic time series. The methodology is able to identify sensible changes in the low frequency evolution of the time series and is therefore far richer than simple linear trend analysis.The method is also much simpler and easier to interpret than most non-linear function fitting. In many cases it leads to results that are similar to subjective curve analysis. Because the method gives a continuous fit of the data it always provides a global analysis. However, if the conditions are carefully chosen, it adjusts itself to sharp changes in the series, highlighting important episodes in the series history that may be more important than its overall trend.The obtained results for the spatial variable breakpoint position year shows a strong spatial coherency, with neighboring regions experiencing similar behavior, as would be expected due to the strong spatial correlation in the temperature series. However this methodology was able to identify well defined spatial boundaries where the temperature slow evolution behavior strongly differs, as in the breakpoints years and also in the trend signals before and after breakpoints.An attempt is made to correlate, and explain, the obtained spatial structure, specially the last breakpoint structure, with the recent evolution of the NAO and SOI indices.

Keywords: temperature trends, nao, breakpoints

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JPS001 **Poster presentation** **1662**

Quality control of dissolved oxygen data measured by profiling floats: a preliminary result based on historical data

Dr. Taiyo Kobayashi
IORGC JAMSTEC IAPSO

Since the first profiling float with a Dissolved Oxygen (DO) sensor was deployed in 2002, a lot of DO profiles are obtained by floats. DO measurements by sensors are fairly improved, but it seems difficult to overcome all of their degradations (biases, long-term drifts, etc.) during 4-years float operation in the ocean without maintenance. It means we need to prepare methods of data quality control for float DO measurements, and if not, we might be unconsciously misled due to numerous biased DO data obtained by floats. Here, a prototype of quality control of DO data will be shown, which uses a similar strategy of Argo salinity measurements, based on a historical dataset as reference. The system of the reference estimation is improved so as to take account of similarities of water-mass properties, which makes geographic biases of the reference estimation reduced very much in frontal regions. The reference based on historical data clarifies negative DO biases of float measurements, which are very similar to independent results of the comparison with the shipboard observations at float deployments. This system also suggests almost no long-term drift of the sensor for the float which has moved far away from its deployed position.

Keywords: long term variability, disolved oxygen, quality control

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JPS001 **Poster presentation** **1663**

Variability in North Atlantic source waters and MOC

Prof. Friedrich Schott
IFM-GEOMAR Leibniz Institut fr Meereswissenschaften IAPSO

Observations from the Labrador Sea and subpolar North Atlantic are compared with output fields of community models, both prognostic and assimilations, regarding the water mass transformation processes and Deep Water circulation of the subpolar North Atlantic. Current and transport variability along the western slopes of the basin is compared for different phases of Labrador Sea convection activity. As recently documented, energy fluxes out of the West Greenland Current, which showed significant variations over the past decade, play an important role for stratification and preconditioning in the central Labrador Sea, leading to shortcomings in the convection realism of models not resolving these processes. While some models, such as ECCO and MICOM, favour deep convection also in the Irminger Sea, observational evidence supporting this is still indirect. Emphasis will be on the variability of the MOC during the past decade, particularly on the exchange with the subtropics across 43N where repeat hydrographic sections were carried during WOCE and where moored western-boundary arrays were in place during 1993-95 and 1999-2005. Comparisons will also include signal propagation toward the tropics along the western boundary and presumed effects in the tropics.

Keywords: convection, dwbcs, moc

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JPS001 **Poster presentation** **1664**

Hydrography and Current Measurements from Hawaii to western Pacific in summer 2006

Dr. Dongchull Jeon
Ocean Climate Environment Research Laboratory Korea Ocean Research & Development Institute IAPSO

Chang Woong Shin, Dong Gook Kim

Hydrographic survey and current measurements were carried out by KORDI team during theHawaii to western Pacific Cruisefrom August 25 and September 30, 2006. The total study area can be devided by three sub-areas by the overall temperature-salinity characteristics: 1) central Pacific (CP) region from Hawaii to , 2) island region near Chuuk, (CM), and 3) western Pacific (WP) region. Salinity maximum core is the highest (S~35.2) at the subsurface depths and the lowest (S~34.1) below the thermocline depths in CP. The range of salinity is reduced in the western Pacific; salinity maximum is up to 35.1 and the minimum is about 34.2 or higher, respectively. Near islands around Chuuk, (CM), the upper maximum is even more reduced down to 34.8 and the lower minimum is about 34.5 and there is another salinity maximum core (S~34.65) invading into the middle of the broad depths of salinity minimum layer by the North Pacific Intermediate Water (NPIW). Consistent westward flows were measured in the upper layer by ADCP, which primarily represented the North Equatorial Currents (NEC) across the latitudes 135oE and 130oE, except from 18oN to 20oN at 130oE, where the currents flow in the opposite direction (eastward). The vertical structuresof current profiles obtained from the lowered ADCP were also examined and compared one another in the study area. Consistent westward flows were measured in the upper layer by ADCP, which primarily represented the North Equatorial Currents (NEC) across the latitudes 135oE and 130oE, except from 18oN to 20oN at 130oE, where the currents flow in the opposite direction (eastward). The vertical structuresof current profiles were also examined and compared one another, which wereobtained from the lowered ADCP at the CTD stations in the central and western North Pacific Ocean. During the cruise, the SST anomalies at Nino 3.4 region were in a rising phase (beginning of El Nino), which had been persistently strengthening for the coming winter (and still going on in the next spring). The currents and hydrographic structure from the central to the western Pacific regions are considered with respect to the ENSO phases in the Pacific.

Keywords: hydrography, north equatorial currents, enso phase

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JPS001 **Poster presentation** **1665**

The effects of the Tsushima Warm Current on the interdecadal variability of the East/Japan Sea thermohaline circulation

Dr. Young-Gyu Park
Ocean Circulation and Climate Research Division Korea Ocean R & D Institute IAPSO

Using a four-box model with a throughflow system, it is shown that changes in the Tsushima Warm Current could induce thermohaline variability comparable to the ones observed in the northern deep part of the East/Japan Sea. When the current becomes stronger, salt flux to the northern surface area becomes larger. The vertical stability, then, weakens to produce warm and salty deep water through deep convection a few years after the maximum of the inflow. If the inflow salinity varies synchronously as well, deep convection could occur more easily. Interdecal variation in the atmospheric temperature also could induce thermohaline variability. When the air temperature is low, cold and fresh deep water would be formed. Therefore, neither the intensification of the current during 90s nor atmospheric cooling could explain the cold and salty deep convection observed during 2000-2001. Only when both effects are combined, the observed deep convection could be properly explained.

Keywords: east japan, sea, variability

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JPS001 **Poster presentation** **1666**

The influence of cloud cover and weekend effect on diurnal temperature range in some meteorological stations in Iran

Mrs. Fatemeh Sahraian
Meteorology Atmosheric Science and Meteorological Reseach Cent IAPSO

Fatemeh Rahimzadeh

The change in durnal temperature range(DTR) is one of the major manifestations of climate change.This parameter has decreased worldwide during the last 4-5 decades and changes in cloud cover are often cited as one of likely causes.In addition in recent studies, it is found evidence of a weekly cycle in DTR for many stations in the United State, Mexico,Japan and China.In this study we examine the role of cloud cover annual averaged and weekend effect on mean annual diurnal temperature range from 1951 to 2005 for 7 urban stations in Iran. The results indicate that the mean annual diurnal temperature range tends to decrease in all stations, either with positive trends of cloud cover annual averaged or negative trends of cloud cover and also DTR tends to increase on Fridays in Tehran (Capital of Iran) in comparison with the other days of a week.

Keywords: dtr, cloudcover, weekendeffect

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JPS001 **Poster presentation** **1667**

Resolution dependence of decadal variability over the Pacific in global warming experiments using an atmosphere-ocean coupled model effects of eddy-permitting ocean model

Dr. Takashi T. Sakamoto
FRCGC JAMSTEC IAPSO

Ahmad Asgari, Hiroyasu Hasumi

Dependence of the simulated climate that has decadal time scale over the Pacific on ocean resolution in an atmosphere-ocean coupled general circulation model is investigated, using two setups of the model: a high-resolution atmospheric component (T106) coupled with a lower-resolution (dx~140km) or higher-resolution (dx~25km) oceanic ones. Pacific decadal Oscillation (PDO) or decadal El Nino/Southern Oscillation (ENSO) is well captured in control-runs with the two setups, but responses for global warming are different by the setups. Also, it is discussed that dependence of the ocean model on the relationship between PDO/decadal ENSO and the ocean heat content over the equatorial Pacific via the subtropical cells (STCs). This relationship is clear in the setup using higher-resolution oceanic component, but it is not in one using lower-resolution oceanic component.

Keywords: pdo, stc, global warming

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JPS001 **Poster presentation** **1668**

Dominant modes of climate variability extracted by self-organizing map

Dr. Norihiko Sugimoto
Computational Science and Engineering Graduate School of Engineering, Nagoya University
IAMAS

Kanta Tachibana

We apply a relatively new technique, self-organizing map (SOM), to extract dominant modes of climate variability. In the fields of meteorology and climatology, empirical orthogonal function (EOF) analysis has been traditionally used to extract the leading patterns of climate variability. However, as the EOF analysis obtains linear mapping, the contribution rate of the 2 principal components to the total variance is less than 30% for most cases. In the present study, as an alternative to the EOF analysis, we propose a high speed spherical SOM to obtain nonlinear mapping from climatology datasets to a two-dimensional visible space. In the proposed method, starting from a few neurons, we add neurons in the most variance region step by step. In addition, neurons are moved in projected sphere. Then, we save the computational time significantly, e.g. 10000 times less than conventional SOM in a typical case. Using this high speed spherical SOM, we extract dominant modes from observational climatology datasets. One preliminary result shows that our SOM clearly distinguishes the modes which are significantly different physical patterns but projected to near positions with the EOF analysis.

Keywords: climate variability, self organizing map, dominant modes

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JPS001 **Poster presentation** **1669**

Two different features of discharge of equatorial upper ocean heat content related to El Nino events

Dr. Takanori Horii
IORGC JAMSTEC IAPSO

Takuya Hasegawa, Tamaki Yasuda, Kimio Hanawa

Oceanic and atmospheric anomaly fields in the tropical Pacific are investigated to extract some characteristics from twelve El Nino events from January 1955 to December 2003. The results show that entire equatorial upper ocean heat content (Teq) is discharged after the mature phase of seven El Nino events (A-type events), while Teq is not well discharged in the other five events (B-type events). Furthermore, A-type events generally have larger amplitudes of tropical oceanic and atmospheric anomalies than B-type events. In addition, the durations of A-type events are longer than those of B-type events. It is also found that A-type events accompany large positive wind stress curl anomalies and resultant poleward Sverdrup transports in the tropical South Pacific after the mature phase of El Nino events, while B-type events do not. This appearance of large positive wind stress anomalies may be one of the reasons why Teq is well discharged in A-type events. Furthermore, OGCM hindcast experiments show that meridional heat transports across 5S display large differences between A- and B-type events. This strongly supports the observational results described above. The observational results are based on our published paper (Hasegawa et al. 2006 GRL, doi: 10.1029/2005GL024832).

Keywords: enso, recharge discharge paradigm, ocean heat content

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JPS001 **Poster presentation** **1670**

Difference of large-scale atmospheric circulation fields between extremely severe weather in December 2005 and extremely mild weather in December 2006

Mr. Koji Yagi
Geophysics Tohoku university

Kimio Hanawa

In December 2005, has experienced an abnormally cold weather, while in December 2006 it has experienced an abnormally warm weather. In this study, the reason causing this difference is investigated from the viewpoint of large-scale atmospheric circulation fields between the two years. While December 2005 was in La Nia event, December 2006 was in El Nio event. It is known that during El Nio/La Nia events, all or some of the Western Pacific (WP), Pacific/North American (PNA) and Tropical/Northern Hemisphere (TNH) teleconnection patterns are excited over the North Pacific sector. Monthly indices of the WP and the TNH were negative values in December 2005, while they were positive values in December 2006. Especially, the difference of the WP index between the two years is remarkable. On the other hand, index of the PNA is positive value in both the two years. On the other hand, index of the Arctic Oscillation (AO), which is known to influence Japanese climate, was also the opposite signs between the two years. That is, both the WP teleconnection pattern and the AO dominantly contributed to the difference of Japanese weather systems between the two years. In contrast, the PNA teleconnection pattern is not considered to play a key role for the difference. We tried to reconstruct 500 hPa geopotential height fields at 0 - 90N, 90E - 90W in both the two years, by superposing four regression maps of 500 hPa geopotential height fields upon indices of the above three teleconnection patterns and the AO. As a result, we succeeded in reconstructing the geopotential height fields well, especially around Japan. The present study can be summarized that large-scale atmospheric circulation fields around Japan in December 2005 and December 2006 can be described by combination of the WP, PNA, TNH teleconnection patterns and the AO, and that the extreme fluctuation of Japanese weather system between the two years is primarily due to the difference of activities of the WP teleconnection pattern and the AO.

Keywords: teleconnection pattern, arctic oscillation, extreme fluctuation

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JPS001 **Poster presentation** **1671**

Interdecadal variability of the Tsushima warm current in the eastern part of the Japan Sea

Dr. Tatsuro Watanabe
Japan Sea Fisheries Oceanography Division Japan Sea National Fisheries Research Institute
IAPSO

Daisuke Simizu, Hideaki Kidokoro

The Japan Sea is one of the marginal seas in the western North Pacific, but it connects to the North Pacific and other marginal seas with a few quite shallow straits. Thus, the Japan Sea can be considered as a semi-closed sea and then there is a possibility that specific interannual and interdecadal variability of the Japan Sea occur. The Tsushima Warm Current (TWC) is basically driven by the sea level difference between the East China Sea and the Japan Sea and it flows in the eastern side of the Japan Sea with several branches. The TWC carries both subtropical water and the runoff water originated from Chinese continental shelf. Thus, as for the interdecadal variability, the TWC region is affected by both climate conditions of the North Pacific and the Japan Sea. In this study, the variation of the water properties and the circulation pattern of the TWC occurred in the late-1980s regime shift are examined by using historical CTD and SST data. Before the late-1980s regime shift the width of the TWC region is narrow and it is occupied along the Japanese coast. Hence, high temperature area of the TWC occurs only in Japanese coastal area. On the other hand, after the regime shift, the TWC extends to offshore region and the temperature of the offshore branch of the TWC becomes higher. According to sensible and latent heat flux balance, it is suggested that the heat flux in winter around the Tsushima strait before the regime shift is much larger than that after the regime shift (upward heat flux is positive). This large variation of the heat flux in winter modifies water properties of the offshore branch of the TWC. As a result, we suggest that this heat flux variation is an important factor of the specific interdecadal variations of the TWC region in the eastern Japan Sea.

Keywords: japan sea, tsushima warm current

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JPS001 **Poster presentation** **1672**

Time variations in the periodicity of atmospheric teleconnection patterns and their coherence with quasi-periodic atmospheric and extra-terrestrial phenomena

Dr. Radan Huth
na Institute of Atmospheric Physics IAMAS

Petra Auli

We apply wavelet analysis to modes of low-frequency atmospheric circulation variability (teleconnection patterns). The modes are defined by rotated principal component analysis of monthly or 10-day mean 500 hPa heights in the Northern Hemisphere north of 20N over 1950-2003. The uneven distribution of variance during the annual cycle is compensated for by weighting by its monthly (10-day) mean standard deviation. 13 modes are detected, most of which are active in winter. Morlet wavelet is selected as a basis for the wavelet transform. The main feature of wavelet spectra of the variability modes is their intermittency: generally, no period (within the range between 1 and 15 years) appears as dominant throughout the whole analyzed time domain. There are only a few exceptions, which have undergone stationary oscillations; e.g., 9 years for the North Atlantic Oscillation and 14 years for the Tropical / Northern Hemisphere pattern. The effects of the sampling interval (monthly or 10 day means) and of the way of compensation for the annual cycle of variability are marginal. We also calculate coherence between the wavelet spectra of the modes and those of quasi-periodic phenomena such as quasi-biennial oscillation, El Nio Southern Oscillation, and 11-year solar cycle. Its statistical significance is determined by the Monte Carlo test. The statistically significant coherence appears, for example, between several variability modes, including the North Atlantic Oscillation, and solar activity for periods of 8 to 9 years.

Keywords: atmospheric teleconnections, periodicity, wavelet analysis

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JPS001 **Poster presentation** **1673**

Phase-synchronized QBO in the NAO and temperature records

Dr. Dagmar Novotna
Dept of Climatology Institute of Atmospheric Physics IAMAS

Milan Palus

We demonstrate detection of oscillatory modes with periods of about 27 months in long-term records of surface air temperature from several European locations, as well as in the NAO index using the extended Monte Carlo Singular System Analysis (MC SSA). Acording to their period, the detected modes can be attributed to the quasi-biennal oscillations (QBO). The QBO modes extracted from the temperature and from the NAO index underwent synchronization analysis and their phase synchronization has been confirmed with high statistical significance.

Keywords: synchronization, analysis, variability

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JPS001 **Poster presentation** **1674**

Inversion of periodic and trend variations of climate in opposite hemispheres of the Earth and their mechanism

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

The gravitational attraction of external celestial bodies causes a secular motion and small cyclic oscillations of the core relatively to elastic mantle of the Earth. Small displacements of the core are perturbed and are determined by differential gravitational influences of the Moon and the Sun on eccentric and non-spherical shells of the Earth (Barkin, 2002). Displacements of the core obtain the reflection in observable motions of a geocenter. Therefore the basic types of relative displacement of the core and the mantle with annual, semi-annual, two-annual and other cyclicities can be restored on the available observation data about geocenter motion. In particular in variations of z coordinate of geocenter the cyclic variations with the periods (in days): 367.6 +/-0.8, 344.2 +/-2.0, 317.0 +/-2.2, 217.1 +/-1.1, 194.9 +/-1.5, 183.6 +/-0.6, 168.1 +/-0.6, 162.2 +/-1.0, 121.8 +/-0.5, 117.3 +/-0.6, 114.9 +/-0.2, 105.2 +/-0.3, 96.9 +/-0.3, 87.5 +/-0.2, 83.5 +/-0.2, 79.4 +/-0.3, 70.2 +/-0.1, 61.0 +/-0.2, 58.7 +/-0.1, 46.7 +/-0.1, 42.1 +/-0.1, 40.4 +/-0.1, 31.9 +/-0.1, 25.9 +/-0.1, 21.1 +/-0.1, 20.3 +/-0.1, 16.2 +/-0.1, 13.4 +/-0.1 are observed (Tatevian, Kuzin, Kaftan, 2004). Rather confidently components with the interannual periods also are allocated (in years): 8.0+/-0.2, 3.6+/-0.1, 5.5+/-0.3, 2.1+/-0.1, 2.6+/-0.1, 1.8+/-0.01, 1.6+/-0.01. Oscillations of the centre of mass of the Earth with amplitudes from 1-2 cm up to shares of mm and identical oscillations of the core with amplitudes approximately in 5 times big correspond to the mentioned periods. Decade and long-periodic variations in position of the Earth core should be observed also (Barkin, 2002). The gravitational attraction of moving core (of its superfluous mass) will result in variations of the tension state of all layers of the mantle, including the top layers. Cyclic stimulation of plastic layers will result to rhythmic generating of heat in contrast styles with respect to hemispheres with axis along which the core oscillates. Especially vigorous stimulation, apparently, takes place on core-mantle boundary. Atmospheric and oceanic masses cyclically are forced to be redistributed between the appropriate hemispheres and to change style and type of circulations. The complex of all marked factors results in observable variations of temperature, to variations of atmospheric pressure and to others changes of climate. Therefore the geodynamic cyclicities marked above and a wide number of others (longer periods) are actually observed in variations of mean temperature, in variations of atmospheric circulation, in variations of pressure etc. (Atlas, 1998). Thus, on the Earth the phenomenon of inversion of climatic modes in relation to opposite hemispheres of the Earth should be observed. An increasing of temperature in one hemisphere corresponds to decrease of temperature in an opposite hemisphere. And the specified phenomenon should be observed for every from cyclic variations of temperature. As an example we shall specify recently found out phenomenon of inversion changes of a climate in the Siberian and Pacific sectors of northern hemisphere. In 20 century in the specified areas it was observed an asymmetric positive trend of ground temperatures (more flat in Pacific sector). In 20 century in the Siberian sector some backlog of a temperature course from its linear trend, and in Pacific on the contrary - an advancing of a course of temperatures was observed (Byshev et al., 2005). The mentioned phenomenon is universal and should be shown for various hemispheres of the Earth in various time scales. From preliminary dynamic researches it follows, that contrast variations of a climate should be observed in northern and southern hemispheres. Global polar displacements of the core relatively to elastic mantle (with significant amplitudes) due to secular planetary perturbations of the Sun and the Moon should result in cycles of congelations (Barkin, 2004).ReferencesBarkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o

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Keywords: inversion temperature, climate variations, mechanism variability

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JPS001 **Poster presentation** **1675**

A Two-Oscillator View of ENSO and Its Decadal Modulation

Prof. Jin-Yi Yu
Department of Earth System Science University of California, Irvine IAMAS

Jin-Yi Yu, Hsun-Ying Kao, Fengpeng Sun

By analyzing ENSO persistence barrier in the past four decades(1958-2001), we propose that the ENSO cycle consists of two differentoscillators: a central Pacific oscillator which is forced byatmospheric forcing and an eastern Pacific oscillator which isresulted from the air-sea interaction involving the thermoclinevariation in the cold tongue. When the basic state (such as thethermocline depth) changes, the eastern Pacific oscillator is affectedand its onset time changes from decadal to decade. But the westernPacific oscillator is not sensitive to the thermocline depth andmaintain its onset time in Spring. As a result, ENSO SST anomaliespropagates from eastern to central Pacific in some decades (e.g.,before 1976/77) but from central to eastern Pacific in the otherdecades (e.g., after 1976/77). This two-oscillator view of ENSO is used to explain a 12-15yearmodulation cycle of ENSO intensity identified from a century-longinstrumental data and a longer multi-proxy paleoclimate reconstructedENSO index. Our composite analyses show that within this modulationcycle the El Nino and La Nina are not exactly symmetric in theirspatial structures. The asymmetric parts result in a net ENSO forcingto the basic state which gradually shifts the Pacific Walkercirculation eastward or westward from its normal location. As theWalker circulation migrates slowly, the ENSO alternates between theeastern Pacific oscillator and the central Pacific oscillator. TheseENSO-basic state interactions give rise to the 12-15year modulationcycle of ENSO intensity. The decadal modulation cycle can also beidentified from NCAR's CCSM simulations. The detailed physicalmechanism behind the modulation is further examined with bothreanalysis and CCSM simulations.

Keywords: enso, decadalmodulation, two oscillator

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JPS001 **Poster presentation** **1676**

Feature of thermohydrodynamical regime of the Caspian Sea on remote sensing data

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

Alexander Sirota, Andrey Kostianoy, Anna Ginzburg

The Caspian Sea presents the worlds largest isolated water reservoir, with only isolation being its significant dissimilarity from the open seas. The other features of the Caspian Sea including its size, depth, chemical properties, peculiarities of the thermohaline structure and water circulation enable to classify it as a deep inland sea. The isolation of the Caspian Sea from the ocean and its inland position are responsible for a great importance of the outer thermohydrodynamic factors, specifically, the heat and water fluxes through the sea surface, and river runoff for the sea level variability, formation of its 3D thermohaline structure and water circulation. There has been increasing concern over the Caspian Sea level fluctuations. Estimates provide support for the view of these fluctuations as climatically conditioned and show their intimate connection with components of the Caspian water budget, especially the Volga River runoff. Today, the monitoring of the Caspian thermal and hydrodynamical and some of the meteo parameters is organized based on the remote sensing (IR and VIS, altimetry data) and reanalysis data. In this paper results of investigation of seasonal and interannual variability of sea surface temperature, sea level, mesoscale dynamics, wave height, surface wind speed, columnar water vapor, cloud liquid water and rain rate are presented.This work was supported by INTAS Project 05-1000008-7927 ALTICORE (ALTImetry for COastal Regions - www.alticore.eu) and by the Russian Foundation for Basic Research Grant ¹ 06-05-64871.

Keywords: caspian sea, termohydrodynamic regime, remote sensing

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JPS001 **Poster presentation** **1677**

Compatibility of occurrences of higher warm spell duration index and lower cold spell duration index over Iran with earth's warmest years

Dr. Fatemeh Rahimzadeh
climatology ASMERC IAG

Mohammadian Nooshin

Years 1998, 2002, 2003, 2004, and 2005 have been warmest years of earth since 1850 respectively. Highest values of Warm Spell Duration Index (WSDI) and lowest values of Cold Spell Duration Index (CSDI) have been coincided with one of earth's warm years in last decade for many places throughout the world. WSDI is defined as annual number of days with at least 6 consecutive days when maximum temperature is greater than 90th percentile. CSDI is also defined as annual number of days with at least 6 consecutive days when minimum temperature is less than 10th percentile. In this paper, results based on using two above indices and data in period 1951-2003 are presented. Our obtained results also show that higher values of WSDI in Iranian stations under study coincide with one of earth's warm years in last decade. Highest values of WSDI belong to Tabriz (Northwest) with 58 days in year1998 and Kerman (South) with 50 days in year 2000. The index has never exceeded 20 days in a limited number of stations like Bandar Anzali (Costal port of Caspian Sea) and Esfahan (Middle). If we take into account one of the 1990s years as starting point, trends of the index will be remarkably positive in majority of stations. Significantly negative trends of CSDI will also be revealed in number of stations, if we again consider one of the 1990s years as starting point. Highest values of CSDI belong to Rasht (North) with 79 days and Zahedan (Southeast) with 54 days in year 1972. Some stations like Abadan (Southeast) and Kerman have never experienced more than 20 days for the index. Capital city of Tehran has had its highest value of the index with figure 31 days in 1964.

Keywords: cold spell duration index, warm spell duration index, extreme temperatures iran

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JPS001 **Poster presentation** **1678**

Historical changes in radiosonde temperature and humidity data in Tehran Mehrabad upper air station

Dr. Mandana Emamhadi
Climatolgy ASMERC

Fatemeh Rahimzadeh, Azit Amir

In order to characterize the physical mechanisms involved in the regional climate and long-term trend of tropospheric variables, radiosonde data records may be of high importance. However, due to some technical reasons, time series of radiosonde data are often inhomogeneous.In this study, we used several approaches to create new adjusted temperature and humidity datasets for Tehran- Mehrabad upper air station. In general, we could not find any specific patterns consistent with global results. We found increasing trends for temperatures in 850, 700, and 500 hPa levels in Tehran-Mehrabad from 1970s onward. The increasing rate of temperature in 850 hPa is comparatively higher than in others. We also experienced Decreasing trends for humidity element in all 3 levels. Main reason for such trends were due to some significant changes in cold season (JFM) after 1970s decade

Keywords: radiosonde data, inhomogeneity, upper air stations

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JPS001 **Poster presentation** **1679**

Analyses of Extreme Sea Level Events from Cananeia and UH data

Prof. Afranio Rubens De |mesquita
Physical Oceanography IAPSO IAPSO

Sea level data from the station of Cananeia (Lat 25 1'.0 ; 47 55.5' Long) Brazil were analysed for the extreme values . Analyses were conduted bearing in mind the determinism of the astronomical tides and the probabilistic meteorological action on them. Joint probabilites of astronomical and meteorological signals, calculated from the difference between the predicted and measured sea level, were estimated and used to determine the extremes. Prediction of maxima and minima extremes were made in terms of return periods The procedure was applied to hourly annual series covering a period of nearly 40 years. This allowed the analysis of the annunal variability of the maxima and minima extreme values.Other analyses were also extended to hourly sea level data with larger lengths, provided by the University of Hawaii Sea Level Center . Results are analysed under the lights of present global warming sea level changes.

Keywords: extreme sea level, uh sea data, cananeia

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JPS001 **Poster presentation** **1680**

International Collaboration and World Data Center's Role in Improving Space-Time Coverage of Global Data Bases for Observational Studies of Decadal and Interdecadal Variability

Mrs. Daphne Johnson
National Oceanographic Data CenterNOAA Ocean Climate Laboratory IAPSO

Despite a century-long effort in assembling global data bases, their time-space coverage remains patchy; in many areas the coverage is sparse. Such data gaps present a formidable problem for most global and basin-scale international and national observational, monitoring and modeling programs. These gaps are especially detrimental to observational studies of decadal and inter-decadal variability, including such phenomena as El-Nino-Southern Oscillation, North Atlantic Oscillation, Northern and Southern Annular Modes, Pacific Decadal Oscillation, Interdecadal Pacific Oscillation, Indian Ocean Dipole, Arctic Oscillation, and other dominant modes of variability. The uneven and patchy data coverage is especially worrisome since many hazardous and potentially disastrous natural phenomena originate in far-away regions with sparse data coverage. Examples are El-Nińo/La-Nińa; tsunamis; storm floods, hurricanes and typhoons; great temperature-salinity-ice anomalies in the North Atlantic etc.The World Data Center 's role is to foster international collaboration in identifying and filling spatial and temporal gaps in global data bases. This role can be fulfilled by assembling multi-disciplinary metadata on the global scale, thus helping bridge the gap between poorly coordinated international and national observational and monitoring programs. Such metadata will be regularly updated and made available on the World Wide Web to the global community in near-real time. The global community's role in providing feedback to the World Data Center is indispensable and would only grow with time as new observational technologies become available and new oceanographic sensors (gliders, ARGO drifters, autonomous tethered vertical profilers, instrumented animals etc.) go online. This poster will provide examples of the WDC – Silver Spring activities aimed at the above goals.

Keywords: decadal, interdecadal

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JPS002 **1681 - 1701**

Symposium
Abrupt Climate Change

Convener : Dr. Hans Renssen

Anthropogenic greenhouse gas emissions my cause future abrupt climate changes. Potential examples include: (1) collapse of the North Atlantic thermohaline circulation; (2) disingegration of the West Antarctic ice sheet; (3) dissociation of methane hydrates; and (4) changes in ENSO properties. Accordingly, this symposium will focus on:(1)the mechanisms of abrupt climate change; (2) simulation of past abrupt climate changes and comparison with corresponding paleoclimate observations; (3) detection of early warning signs of future abrupt climate changes; and (4) impacts of such future abrupt climate changes.

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JPS002 **Oral Presentation** **1681**

Influence of the Greenland ice sheet melting on the Atlantic meridional overturning circulation during the next millennia

Prof. Thierry Fichefet
Institut d'Astronomie et de Géophysique Université Catholique de Louvain IAPSO

E. Driesschaert, H. Goosse, P. Huybrechts, I. Janssens, A. Mouchet, G. Munhoven, V. Brovkin, S.L. Weber

A three-dimensional Earth system model of intermediate complexity including a dynamic ice sheet component has been used to investigate the long-term evolution of the Greenland ice sheet and its effects on the Atlantic meridional overturning circulation (AMOC) in response to a range of stabilized anthropogenic forcings. Our results suggest that the Greenland ice sheet volume should experience a significant decrease in the future. For a radiative forcing exceeding 7.5 W m-2, the modeled ice sheet melts away within 3000 years. A number of feedbacks operate during this deglaciation, implying a strong non-linear relationship between the radiative forcing and the melting rate. In the most extreme scenario considered, the freshwater flux from Greenland into the surrounding oceans is higher than 0.1 Sv during a few centuries. This is however insufficient to induce a shutdown of the AMOC in the model.

Keywords: greenland, ice sheet, ocean circulation

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JPS002 **Oral Presentation** **1682**

Meridional reorganizations of tropical marine and terrestrial productivity during Heinrich events

Mrs. Laurie Menviel
Oceanography SOEST, University of Hawaii at Manoa

Axel Timmermann, Anne Mouchet, Oliver Timm

Freshwater perturbation experiments under pre-industrial and glacial conditions are conducted with an earth system model of intermediate complexity (LOVECLIM) to study the response of the global carbon cycle to a weakening of the Atlantic Meridional Overturning Circulation (AMOC). A shutdown of the AMOC leads to substantial cooling of the North Atlantic, a weak warming of the Southern hemisphere, intensification of the Northeasterly trade winds and a Southward shift of the ITCZ. This in turn drives changes of tropical upwelling and hence of marine productivity and terrestrial primary productivity, respectively. The freshwater perturbation experiments simulate a reduction of terrestrial carbon stocks mainly in Northern Africa and Northern South America, both under pre-industrial and glacial conditions. The ocean acts as a sink of CO2, primarily through increased solubility. The net atmospheric CO2 anomaly due to the AMOC shutdown amounts to about +15 ppmv and -10 ppmv for pre-industrial and glacial conditions, respectively. This discrepancy can be explained by the fact that the glacial climate is drier (less decrease of terrestrial carbon stocks) and the glacial ocean is colder (increased solubility). The modeling results will be compared in detail with available paleo-proxy data for vegetation distribution, ocean productivity and atmospheric CO2 concentration.

Keywords: amoc, vegetation, carbon

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JPS002 **Oral Presentation** **1683**

Ocean core evidence for past THC changes

Dr. Trond Dokken
Bjerknes Centre for Climate Research University of Bergen IAPSO

Ocean circulation changes may play a fundamental role in the control of climate change and rapid climate transition seen in numerous climate records around the world. High resolution records from the Atlantic Ocean clearly document that changes as recorded in polar ice core records are showing a consistent change with ice core records, either recorded in reconstructed sea surface temperature records (SST), or in changes in deep ocean proxy records. It is increasingly clear that the oceans current mode of ventilation is not unique but can, and has, switched rapidly between dramatically different states with severe and far-reaching repercussions. However, the various processes hypothesized to have driven these past ocean reorganizations remain largely unconstrained, preventing reliable assessments of oceans vulnerability to future changes. If the most fundamental questions concerning the behaviour of the ocean circulation, and its role in rapid climate change, are to be answered it is clear that research as to focus on investigating the full range of time scales that are recorded in the geological archive, from seasonal or interannual to multimillennial, and should emulate contemporary physical oceanographic observational design more closely. Past changes in the dynamics of the Atlantic Meridional Overturning Circulation (MOC) may only be better constrained if paleo-property gradients can be estimated along transects perpendicular to main ocean currents feeding the MOC. Some of these issues will be discussed, and a new theory of the operation of ocean circulation during glacial time, D/O events and the deglaciation will be presented.

Keywords: thc, moc

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JPS002 **Oral Presentation** **1684**

Rapid response of Antarctica and Greenland to external forcing

Prof. Jonathan Bamber
not known EGU IAPSO

The recently published fourth assessment report of the IPCC could not reach a consensus on the future response of the ice sheets to external forcing and their contribution to sea level rise in the 21st Century. This is because recent results, based on remote sensing, in-situ observations and modelling studies, have challenged our understanding of, and ability to reproduce, observed ice sheet behaviour. The results suggest that there may be a range of mechanisms that could induce a rapid (years rather than millennia) dynamic response of both the Antarctic and Greenland ice sheets to small perturbations in the climate system. The mechanisms proposed for Antarctica and Greenland have different origins but potentially similar consequences. They include the influence of ice shelf back-pressure on grounded ice velocities, surface melt percolating through ~1 km thick ice resulting in increased basal sliding and tidally-induced changes in basal drag. Here, I review the observations and model results and the possible mechanisms that have been proposed and consider what implications they may have for the stability of the ice sheets in a warming world. Whether the present generation of GCMs and ice sheet models, and predictions based on them, adequately represent the envelope of possible responses is also considered.

Keywords: ice sheets, antarctica, greenland

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JPS002 **Oral Presentation** **1685**

Northward energy transport in a coupled climate model

Dr. Peili Wu
Hadley Centre Met Office IAPSO

Michael Vellinga

The climate GCM HadCM3 is used to analyse changes in northward energy transport after a complete loss of the Atlantic meridional overturning circulation ('MOC'). Suppression of the MOC causes a reduction in northward ocean heat transport across 30N by 0.75PW, or 75%. The atmosphere compensates for the reduction of northward ocean heat transport by increasing its northward transport of moist static energy. This compensation is very efficient at low latitude s, but is incomplete at northern mid-latitudes. By lowering the amount of radiation at the top of the atmosphere at those latitudes, the model is able to reach a new global radiative equilibrium. In a perturbed physics ensemble of HadCM3 simulations an anticorrelation is found between time-averaged energy transports in atmosphere and ocean. The global mean top of the atmosphere radiative imbalance exerts a strong control: a radiative surplus leads to a stronger poleward energy transport in the atmosphere, but to a weaker MOC and poleward ocean heat transport. Model versions that are close to net radiative equilibrium also have ocean heat transport and MOC close to observed values.

Keywords: energy transport, moc, climate

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JPS002 **Oral Presentation** **1686**

Impact on the Ocean Circulation of Extreme Nordic Seas Heat Loss in a Range of Coupled Ocean-Atmosphere Models

Dr. Simon Josey
OOC National Oceanography Centre, Southampton, UK IAPSO

Jeremy P. Grist, Bablu Sinha, Adam T. Blaker

The ocean response to extreme winter heat loss in the Nordic Seas is investigated using the control runs of two coupled ocean-atmosphere models from the Hadley Centre, HadCM3 and HadGEM1. The comparison between these two models is instructive because HadGEM1 was developed to improve on the scientific performance of HadCM3. We contrast the meteorology and surface characteristics of extreme heat loss years in the two models. In addition we examine the impact of extreme heat loss on Greenland Sea T-S properties as well as showing that it can lead to abrupt changes in the transport of overflow waters through the Denmark Strait and across the Iceland-Scotland Ridge. Implications for the Atlantic Meridional Overturning Circulation are also considered. Results from a third model, the Fast Ocean Rapid Troposphere Experiment (FORTE) coupled climate model, will also be presented which enable an examination of the ocean response to more extreme winter heat flux anomalies than those found within the Hadley Centre Models.

Keywords: nordicseas, heatloss, abrupt

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JPS002 **Oral Presentation** **1687**

Unraveling carbon cycle dynamics during Early Paleogene transient global warming events using biomarkers and dinoflagellates

Dr. Appy Sluijs
Palaeoecology; Institute of Environmental Biology Utrecht University

The Paleocene-Eocene thermal maximum (PETM, ~55.5 Ma), Eocene Thermal Maximum 2 (ETM2, or Elmo, ~53.5 Ma) and ETM3 (or X, ~52.5 Ma) were short-lived (< 200 kyr) episodes of globally elevated temperatures superimposed on already warm background conditions. All these hyperthermals are characterized by prominent a negative carbon isotope excursion (CIEs) in sedimentary carbon, which reflect transient massive injections of isotopically light carbon into the ocean-atmosphere system. These events are, hence, similar to modern carbon injection and can serve as a model for climate response to a rapid increase in atmospheric carbon concentrations. The PETM is the best studied and most extreme hyperthermal and is associated with major changes in ocean chemistry and the hydrological cycle, as well as dramatic biotic response. For example, our studies show that subtropical dinoflagellates inhabited the Arctic Ocean during the PETM at temperatures exceeding 23C. Such temperatures cannot be reproduced by current generation fully coupled climate models that are fed with Paleocene-Eocene boundary conditions. Many authors have assumed that the isotopically light carbon led to pronounced global greenhouse warming during the PETM. However, from an expanded record in New Jersey, we record that both the onset of the global abundance of the subtropical dinoflagellate Apectodinium and surface-ocean warming as recorded by TEX86 preceded the CIE by several thousands of years. The offset between Apectodinium and the CIE was confirmed in other sites from New Jersey, the North Sea and New Zealand. The ~3 kyrs time lag between the onset of warming and the CIE is consistent with the expected lag between bottom water warming and submarine methane hydrate dissociation, suggesting that the latter mechanism indeed caused the CIE. If time allows, new results from ongoing studies will be presented, focusing on e.g., the PETM in the Southwestern Pacific, ETM2 in the Arctic Ocean, and ETM3 in the Tethys. The research presented is a result of collaborations with researchers from, amongst others, the Institute of Environmental Biology and Earth Sciences Department at Utrecht University, the Royal Netherlands Institute for Sea Research (NIOZ), the Earth Sciences Department at the University of California Santa Cruz, the Department of Earth Sciences at Rice University, Department of Paleoclimatology and Geomorphology at the Vrije Universiteit Amsterdam, the Earth and Atmospheric Sciences Department at Purdue University, the Department of Geology and Geophysics at Yale University and the Department of Geosciences at Bremen University. This research used samples provided by the Integrated Ocean Drilling Program.

Keywords: carboncycle, petm, ch4 hydrates

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JPS002 **Oral Presentation** **1688**

Slowdown in the Atlantic meridional overturning circulation since 1980

Prof. Harry Bryden
School of Ocean and Earth Science University of Southampton IAPSO

Analysis of transatlantic hydrographic sections at 25N show that the Atlantic meridional overturning circulation (MOC) has varied in strength by approximately 25% over the last 50 years, with weaker overturning in 2004 than in previous years. Temporal resolution of the data set is increased through decomposition of the Atlantic MOC at this latitude into its Ekman component computed from wind stress climatology, transport of the Florida Current from cable observations and mid-ocean geostrophic transport from CTD or moored temperature and pressure derived boundary dynamic height profiles. In addition to interannual fluctuations in strength of the MOC of 3 Sv, we present evidence for a 2 to 3 Sv weakening of the MOC between 1980 and 2005. We show that the southward upper ocean flow has been stronger since 1997 when thermocline temperatures at the western boundary rose. This was associated with an increased increased basinwide thermocline slope and hence stronger southward transport of these waters. Freshening of Lower North Atlantic Deep Water (LNADW) near the western boundary, which is consistent with observed freshening of the overflow waters at northern sills, leads to a reduced southward flow of LNADW by 3 to 5 Sv since 1980. The increased mid-ocean southward transport of thermocline waters and decreased southward flow of LNADW are consistent in sign, although of reduced magnitude, with the reduction in overturning reported from analysis of transatlantic hydrographic sections. We discuss these findings in the context of the relative merits of different datasets for quantifying interannual variability.

Keywords: ocean circulation, climate change, monitoring system

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JPS002 **Oral Presentation** **1689**

Is the stability of the Atlantic MOC changed by global warming?

Dr. Sybren Drijfhout
Oceanography Royal Netherlands Meteorological Institute IAPSO

Eric De Swaluw, Suzanne Weber

We investigate the stability of the Atlantic meridional overturningcirculation (AMOC) for the pre-industrial climate and a future climatewith doubled and quadrupled CO_2 concentrations, using data from thearchive of coupled atmosphere-ocean model output of the IntergovernmentalPanel on Climate Change. We determine the stability of the AMOC by examiningthe oceanic fresh water budget of the Atlantic basin. Earlier work has shownthat the sign of the net freshwater flux into the Atlantic basin that iscarried by the AMOC determines whether it is in the monostable or bistableregime where a MOC collapse is possible. Wedetermine the freshwater flux in pre-industrial control runs and climatechange runs from several coupled climate models. This enables us to study thechange in stability of the AMOC due to increased greenhouse gasconcentrations. First results indicate that the net evaporation increasesover the Atlantic. Nevertheless, freshwater input by the MOC decreases,making the MOC less stable. The freshwater deficit is compensated bya strong increase of freshwater input by the azonal (gyre) circulation.

Keywords: meridionaloverturning, stability, greenhouseforcing

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JPS002 **Oral Presentation** **1690**

Historical reconstruction of the Atlantic Meridional Overturning from the ECMWF ocean analysis

Dr. Magdalena Alonso Balmaseda
Seasonal Forecasting ECMWF

Keith Haines, David Anderson, Arthur Vidard

The Atlantic meridional overturning circulation is composed of a warm near-surface branch flowing northward as part of the Gulf Stream and areturn flow of cold waters at depth. Numerous modelling studies have highlighted the importance of this circulation as a regulating mechanism ofthe climate system, and its variability plays an important role in futureclimate change scenarios. However, knowledge of this variability is sorelylacking. Here we provide a continuous historical reconstruction of themeridional overturning circulation over the period 1959 - 2006 by combining an ocean model with a complete set of in situ and satellite observations fromthe historical database record. We find that the model agreement with previousestimates of MOC intensity, based on 5 snapshot ship cruises, is good once observations are synthesised. Results show recent changes in the verticalstructure of the circulation with a shallower recirculation cell within thethermocline and a decrease of the deep ocean circulation.A significant downward trend of about 15% in the last 40 years isfound, with an equivalent reduction in the northward heat transport.This trend is smaller than previously thought, although the changesin vertical structure are in good agreement with previous results.

Keywords: atlantic, meridional overturning, trends

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JPS002 **Oral Presentation** **1691**

Monitoring Rapid Climate Change with Ocean Reanalyses

Prof. Benjamin Giese
Department of Oceanography Texas A&M University IAPSO

Yangxing Zheng

A new reanalysis using SODA (Simple Ocean Data Assimilation) and POP (Parallel Ocean Program) is used to explore variability of the circulation in the North Atlantic Ocean. The ocean reanalysis provides an estimate of the strength of the meridional overturning circulation , as well as the poleward transport of heat, for the period fro m 1958 to near present. There is variability of the poleward transport of heat on timescales that range from weeks to decades. The reanalysis also shows a distinct trend of heat transport, with an increase of about 0.20 PW in the North Atlantic Ocean over the last 40 years. The ocean model resolution is 0.4 degrees of longitude, 0.28 degrees of latitude and has 40 vertical levels. The model was run from 1958 - 2001 using the ERA-40 reanalysis winds, GPCP precipitation, and bulk formulae for the surface heat flux. Temperature and salinity are assimilated using the SODA implementation of the sequential estimation routines. A second reanalysis using QuikSCAT winds covers the period from 2000-2004. Although not suitable for predicting rapid climate change, the reanalysis could be used to monitor climate transitions.

Keywords: climate, circulation, reanalysis

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JPS002 **Oral Presentation** **1692**

Changes in ocean carbon cycle by weakening of the Atlantic meridional overturning circulation

Dr. Akira Oka
The University of Tokyo Center for Climate System Research IAPSO

Hiroyasu Hasumi

The ocean circulation in the Atlantic deep ocean is characterized by thermohaline circulation originating from deep water formation in northern high latitudes. The heat transport associated with this circulation is comparable to that by atmosphere and has a great role in the present climate. In addition, the deep ocean stocks about 50 times as much carbon as the atmosphere and the deep ocean circulation is also important for the global carbon cycle. Simulations by using coupled atmosphere and ocean general circulation models (CGCMs) suggest that the Atlantic meridional overturning circulation weakens in global warming climate. This weakening is expected to cause changes in ocean carbon cycle and may induce further climate changes through its effect on the global carbon cycle. In this study, we investigate changes in ocean carbon cycle in global warming climate especially focusing on response to weakening of the Atlantic meridional overturning circulation. In order to make use of physical field obtained from global warming simulation by our CGCM (MIROC3.2 developed at CCSR/NIES/FRGCG), we develop offline tracer calculation model by extracting tracer calculation routine from our ocean general circulation model (COCO4 developed at CCSR) and incorporate ocean biogeochemical processes into this. After we spin up the model for 2000 years under control physical field of the CGCM, we conduct two sensitivity simulations in order to separately evaluate how SST and ocean circulation changes affect atmospheric carbon dioxide concentration via air-sea carbon exchanges. In spite of significant weakening of the Atlantic meridional overturning circulation, the model results suggest that change in atmospheric carbon dioxide concentration caused by ocean circulation is very small compared with that by SST. Then, we investigate reasons of this small impact of ocean circulation to atmospheric carbon dioxide concentration. In the model simulation, biological pump gradually weakens especially in the Atlantic Ocean because nutrient supply to surface decreases due to weakening of the Atlantic meridional overturning circulation.This tends to cancel out effects of decrease in carbon supply to surface by ocean circulation. It indicates that the small impact of ocean circulation to the atmospheric carbon dioxide is partly due to the response of the biological pump.

Keywords: ocean carbon cycle, atlantic deep circulation, global warming

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JPS002 **Oral Presentation** **1693**

The Probability of Rapid Climate Change in an Intermediate Complexity Climate Model

Mr. Peter Challenor
Ocean Observing and Climate National Oceanography Centre, Southampton IAPSO

Doug Mcneal

If we are to take action to mitigate against abrupt climate changes we need to be able to specify the risk, and how that risk can be modified. In this paper we present a general method for the calculation of such risks and apply it to the risk of the collapse (or severe reduction) of the Atlantic circulation given a proposed emission path. We investigate this problem using an intermediate complexity climate model GENIE. Such a model gives us a good test bed for developing methods that can be applied to GCMs at a later date. We apply methods developed by the statistical community to analyse computer experiments. These centre around the concept of an emulator. An emulator is a statistical approximation to the dynamical model. Where we have run the model the fit is exact, between positions where we have run the model the emulator gives an estimate of what the model would have given plus a measure of uncertainty. We describe how we have built such an emulator for the GENIE model. This involves running the model at the reasonable limits for its parameters. Later we simulate from the uncertainty distributions of these input parameters. We use a Latin Hypercube as our design for this experiment. We spin GENIE up for 4000 years to remove (as far as possible) the dependence on initial conditions. We then build our emulator using this set of model runs. This gives us an emulator for the strength of the MOC at the present day. The addition of two extra parameters the rate that the ice sheets on Greenland melt and the rate at which carbon is removed from the atmosphere enables us to run the model to 2100 under each of the six illustrative SRES scenarios (A1B, AIFI, A2, B1, B2 and A1T). We can now build an emulator for GENIE at 2100. We propagate the uncertainty on the inputs through to the uncertainty on the outputs. Using a Monte Carlo technique we can now calculate the probabilities of the overturning circulation being less than some specified value, 5Sv say. We will discuss the results we have obtained and discuss ways of improving the methodology. These will include looking at not simply the strength of the MOC at 2100 but also the path to get there. We will also look at ways of including data in the process.

Keywords: thermohaline circulation, risk

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JPS002 **Oral Presentation** **1694**

On LSW and the making of the 8.2 kyr event

Dr. Allegra N. Legrande
NASA Goddard Institute for Space Studies and Center for Climate Systems Research,

Gavin A. Schmidt

The last major abrupt climate change event, aptly named the 8.2 kyr event for its occurrence in time, likely occurred as a result of a slowdown in NADW following the collapse of the Hudson Bay ice dome dam and drainage of Lakes Agassiz and Ojibway through the Hudson Strait into the Labrador Sea. However, production of Labrador Seawater (LSW), a vital component of modern North Atlantic Deep Water (NADW) with the closest proximity to the freshwater, did not begin until around 7000 years ago, calling into question this theory for the catalyst for the 8.2 kyr event. Using different starting points in a long control run of GISS ModelE-R, a fully coupled atmosphere-ocean GCM equipped with water isotope as well as other tracers, ideal for making exact comparisons with the proxy record of past climate change, I address the role of initial climate conditions (1) consistent with LSW production (2) consistent with no LSW production in producing an abrupt climate change, analogous to the 8.2 kyr event and find both the magnitude and duration of the abrupt climate change event sensitive to the initial climate conditions, even where all other factors remain the same; i.e., no changes in orbital forcing, GHG, topography, or freshwater fluxes (additional run-off).

Keywords: 8k event, nadw

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JPS002 **Oral Presentation** **1695**

An amplification mechanism for multicentennial Holocene climate variability involving bistable Labrador Sea convection

Dr. Jochem Jongma
Department Paleoecology & Paleoclimatology Faculty of Earth and Life Sciences IAPSO

During the Holocene, the North Atlantic climate has experienced pronounced variability at multicentennial to millennial timescales. Important evidence comes from drift-ice deposits measured in deep ocean cores, showing multicentennial-scale fluctuations that have been interpreted as a series of southward shifts of the Labrador Sea surface waters, accompanied by cooler ocean surface temperatures (Bond et al 2001, 1999).Using a three-dimensional global climate model, we illustrate an amplifying mechanism of relatively weak climate perturbations. We demonstrate that under Holocene climate conditions, there exists a regime where the North Atlantic climate is highly sensitive to weak climate variability on a multicentennial timescale. In this regime, a subthreshold periodic freshwater forcing with a 500 yr period in the Labrador Sea, causes quasi-deterministic (stochastic yet phase-locked) on and off switches in Labrador Sea convection.These state-switches lead to temperature changes in the order of 1 to 2 C over Northern Europe and 2 to 3 C over the Labrador Sea (Schulz et al 2007). Essentially the local small periodic forcing is amplified with the assistance of noise, to have a large-scale impact on North Atlantic overturning circulation and climate. Therefore these results illustrate a stochastic resonance mechanism that can operate under Holocene boundary conditions.This indicates that changes in the three-dimensional configuration of North Atlantic deep water formation, and specifically the resultant potential sensitivity of Labrador Sea convection on a multicentennial time-scale, might be an important component of millennial scale climate variability during interglacials.

Keywords: stochastic resonance, labrador sea, millennial scale

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JPS002 **Oral Presentation** **1696**

Thermodynamic efficiency and reactivity of the AMOC

Dr. Remi Tailleux
Walker Institute for Climate System Research University of Reading

Jonathan M. Gregory

A conclusion of the latest IPCC report is that the increase in anthropogenic gases is likely to induce a slowdown of the Atlanticmeridional overturning circulation. A recent result by Gregory etal. (2005) comparing the response of several coupled climate modelssuggests that the amount by which the AMOC will decrease dependson the initial magnitude of the AMOC. The purpose of this study is to provide simple ideas suggesting that this behaviour can beexplained in terms of the thermodynamic efficiency of the models,i.e., their reactivity to surface buoyancy fluxes.

Keywords: thermodynamic efficiency, amoc slowdown, global warming

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JPS002 **Poster presentation** **1697**

Detection of Climate Change using Extreme Climate Index Software(ECIS) in Iran

Dr. Farahnaz Taghavi
department of space physics University of Tehran,Institute of Geophysics IAPSO

Damage resulting from extreme events in Iran already imposes a heavy toll on society that few economics are easily able to absorb. In this study, the behavior of extreme events in Iran was investigated using extreme climate index software (ECIS). In ECIS,the trend and return period of climatic extreme indices was calculated on the basis of daily series of temperature and precipitation observation from 16 synoptic stations in Iran during 1951-2003. The indices were selected from the list of climate change indices recommended by the CLIVAR. Averaged over all stations, the TR (tropical day) index has increased trend, and the warm extremes indices such as T40, CDD, SU and GDD show increasing trend rather than cold extremes for example FD,ID, HDD have decreasing trends. Symmetric warming in tails of the most indices is seen overall and the results demonstrated positive trends in extreme warm temperature over most region of Iran except on the Hamedan and Orumieh and the frequency of warm(cold) extreme indices are increased (decreased). Changes in total and extreme precipitation vary depending upon geographic location.. Besides, results indicate that the Tret of cold extremes indices such as FD increased and the Tret of warm extreme index (SU) decreased and the Tret of precipitation extreme indices such as WD increased.On the basis of a systematic analysis of observed changes in indices of climate extreme,we conclude that a significant proportion of the Iran was increasingly affected by a significant change in climate extremes during 1951-2003 and probability, the frequency of extreme events will be increased..These clear signs of changes very robust, however large areas are still not represented, especially East and Southeast of Iran .

Keywords: climatechange, extremeindices, trend

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JPS002 **Poster presentation** **1698**

Archaeological and abrupt environmental

Dr. Galina Lewkovskaya
Russian Foundation for Basic Research (partly) Russian Foundation for Basic Research (partly)

Hoffecker John, Housley Rupert, Anikovich Michail, Popov Viktor, Lisizin Sergei, Sinizin Sergei, Anisutkin Nikolai, Pospelova Genrietta

Volcanic ash appeared in some regions of Russian Plain and at Kostenki from Campanian Ignimbrite (CI) [Melekeszev et al., 1984; Pyle et al., 2006]. The age of CI according to last data - 39300 kyr BP [Fedele et al., 2003]. There were two abrupt climatic changes in Kostenki region between 45000-35000 BP according to the new multidisciplinary data on Kostenki 12 site [Levkovskaya, Hoffecker et al., 2005] and on the bore pit from the Borshevo V site. Data on Kostenki 12 show that the latest abrupt climatic change is the environmental "answer" on the Campanian Ignimbrite in Southern Italy. The detailed characteristics of environment of this time is given in the presentation. The problems of correlations of two Kostenki abrupt extremal cryoarid climatic phases with pollen standard of Monticchio lake in Italy with 14 horizons of buried volcanic ashes and with HE4 event are discussed in the presentation. The following items of correlations are viewed: 1. with pollen standard of Monticchio lake in Italy with 14 horizons of buried volcanic ash; 2. with HE4 event; 3. with Upper Palaeolithic layers of Kostenki-Strelezki and Spizinskaya archaeological layers at Kostenki 12, Kostenki 14 and Borshevo V sites.

Keywords: abrupt, climatic, change

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JPS002 **Poster presentation** **1699**

The abrupt cold event and culture subrogation 4,400 AB.P. in Yuchisi site, Mengcheng, Anhui, China

Dr. Jianjun Wang
Global Change and Marine-Atomsphere Chemistry Third Institute of Oceanography,SOA, China IAGA

Liguang Sun, Libin Xu

Archaeological excavation showed that there were two paleoculture: Dawenkou Culture (5,050 aB.P.-4,400 aB.P.) and Longshan Culture (4,400 aB.P.-4,000 aB.P.) exited in Yuchisi Site, Mengcheng, Anhui, China. The culture substitution, from Dawenkou Culture (local) to Longshan Culture (from Northern China) happened in about 4,400 aB.P.. What caused the culture subrogation? We analyzed the biomarkers, TOC, TN and pollen of the sediment from Yuchisi Site. All the proxies, showed a big change at the substitution layer including fatty acid ratio C18:2/C18, and it seemed that a cold event happened about 4400 years ago, which droved the changes of the cultures. We also found a new series of biomarkers in the acid fraction, alkyl amides, in the sediment. Depth profiles of alkyl amides showed that they were also quite sensitive to the cold event in the sediment core.

Keywords: coldevent, c182c18, paleoculturesubrogation

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JPS002 **Poster presentation** **1700**

Simulation of the 8.2 kyr BP event with a coupled climate model: the impact of catastrophic meltwater drainage on the early Holocene climate

Dr. Hans Renssen

Faculty of Earth and Life Sciences Vrije Universiteit Amsterdam IAPSO

A.P. Wiersma, H. Goosse, T. Fichefet

In the North Atlantic region, the most distinct Holocene climatic event with a duration of about 150 years occurred at 8.2 kyr BP (thousand calendar years before present). In this region, this 8.2 kyr BP event is clearly registered as a cooling in high resolution proxy data, such as Greenland ice cores, ocean sediments, European lake cores and tree-ring records. The main hypothesis is that the 8.2 kyr BP event has been caused by a perturbation of the North Atlantic thermohaline circulation (THC) by a catastrophic release of meltwater associated with the final stages of deglaciation of the Laurentide ice sheet. In recent years, widely varying estimates for the volume of the involved freshwater pulse have been published, ranging from 0.3 to 5.0x1014 m3. In addition, estimates for the duration of the meltwater pulse range from less than a year to a decade. We present an overview of simulation experiments on the 8.2 kyr BP event performed with two versions of the ECBilt-CLIO coupled atmosphere-ocean model. In these experiments, the models THC was perturbed by releasing freshwater pulses into the Labrador Sea. To test the robustness of the response, each of the meltwater drainage scenarios was repeated 5 times with different initial conditions (i.e. 5 ensemble members). A few years ago, we tested the response to relatively long (10, 20 or 50 yr) and large (4.67x1014 m3) freshwater pulses with version 2 of ECBilt-CLIO. In these experiments, the duration of the THC perturbation events depended on the freshwater release rate, with longer events simulated when the same freshwater volume was released in less time. However, the response was stochastic, as the duration of the THC weakening varied between 150 years and more than 1000 years within a set of ensemble members. Recently, we performed a new set of experiments with version 3 of ECBilt-CLIO. In these simulations three different freshwater volumes were considered (1.63 x 1014 m3, 3.26 x 1014 m3 and 4.89 x 1014 m3), together with three freshwater release durations (1, 2 and 5 yr). These experiments were repeated in simulations that included the effect of the background-melting of the Laurentide ice sheet by releasing a fixed rate of 0.172 Sv in the Labrador Sea. The results of version 3 suggest that the amount of freshwater released is the decisive factor in the response of the ocean, while the release duration only plays a minor role, at least when considering the short release durations of the applied freshwater pulses. Furthermore, the experiments with the background melting of the Laurentide ice sheet produce a more realistic early Holocene climate state without Labrador Sea Water formation. Meltwater pulses introduced into this climate state produce a prolonged THC weakening, implying that less freshwater is required to produce an event with the same duration. In contrast to the earlier simulations, the THCs response in our model was not stochastic, i.e. the duration and magnitude of the THC weakening was similar within a set of 5 ensemble members.

Keywords: holocene, thc, abrupt

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JPS002 **Poster presentation** **1701**

Impact of Sea Level Rise on Hydrodynamics of Estuarine Systems: Case Study of Mtwapa Creek, Kenya

Dr. Charles Magori
Kenya Marine & Fisheries Research Institute Research IAPSO

Mtwapa creek is a tropical estuarine system located along the Kenyan coast in the Western Indian Ocean region, just 15 km North of Mombasa Island. The creek is surrounded by vast mangrove wetlands while its offshore area is shielded by extensive shore parallel coral reefs. It receives runoff from a seasonal river. In this study, water levels, current velocities, salinity, water temperature and bathymetry were measured at selected locations within the creek.A mathematical model using a fully implicit scheme for solving shallow-water equations is presented. The model is based on RMA2, a finite element hydrodynamic numerical model for two-dimensional (depth-averaged) simulations. It operates within the framework of the Surface Water Modeling system (SMS) software package. The model was applied to Mtwapa ! creek and a finite element mesh of the creek was generated containing 1429 quadratic elements defined by 4544 nodes. The equations are integrated over the flow depth by assuming that the flow is incompressible and homogeneous. Vertical flow is considered negligible resulting in a hydrostatic pressure distribution. The Newton Raphson iterative scheme is used to solve the set of nonlinear equations.The model is forced by observed water levels at the mouth of the creek. Using the model, the sensitivity of Mtwapa creek to anticipated sea-level rise in the 21st century has been investigated. This involved applying successive increases in mean sea level to the tidal boundary conditions at the mouth of the creek using projected values by Intergovernmental Panel on Climate Change (IPCC). The model results suggest that if the morphology of the creek remains constant, sea-level rise could have some significant impacts on the hydrodynamics of the ! system. Furthermore, using the numerical model, estimates of Mtwapa cr eek's volume, surface area and tidal prism during spring and neap tides are computed. It is concluded that the numerical model presented in this study can be used as a research tool for investigations of estuarine hydrodynamic processes. It can also be used to model scenarios of climate change induced extreme oceanic events such as sea-level rise, tsunamis, storm surges and tropical cyclones.

Keywords: sea level rise climate change, estuary numerical model, mtwapa creek kenya

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JPS003 **1702 - 1715**

Symposium
Environmental Controls on Marine Biota

Convener : Dr. Denise Smythe-Wright

This symposium encourages the development of further interdisciplinary collaborative studies concerning the processes that influence marine biota. It will focus on physical (e.g., temperature, light, mixing, turbulence and currents), chemical (e.g., element concentration, distribution, and bioavailability), and biological (e.g., grazing and predation) processes which control organisms at the lower end of the food web. Understanding how biogeochemical cycles and fluxes integrate with food web dynamics is a major challenge in marine science today. We encourage papers on all aspects of this wide ranging topic including nutrient availability and limitation; molecular processes; impact of physical processes on biological populations; the impacts of biogeochemical cycles on marine food webs, etc.

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JPS003 **Oral Presentation** **1702**

Influence of Oceanic eddies on Chlorophyll-a distribution in the tropical marine waters derived from Satellite Altimetry and Ocean Color data

Dr. Ajith Joseph.K
Ocean Sciences Nansen Environmental Research Centre (India) IAPSO

Roshin P. Raj

Mesoscale eddies play a major role in the distribution of chlorophyll-a and thereby controlling the marine biota in the oceanic water bodies. The generation and propagation of eddies depend on the environmental conditions prevail in the region and the present study focuses on the seas around India, a tropical water body with changing seasons and current patterns. In the summer monsoon, chlorophyll-a concentration (Chl-a) maps derived from the SeaWiFS Ocean colour indicates high chlorophyll-a presence in the waters around southern India. The physical processes associated with this high chlorophyll concentration are studied with the aid of TMI-SST data and sea level anomaly from TOPEX/POSEIDON/JASON merged SLA data. It is found that the flow pattern of South-West Monsoon Current (SMC) is greatly influenced by the presence of mesoscale eddies which are of the order of 100km in diameter. From the geostrophic velocity anomaly, chlorophyll-a concentration and SST data, presence of eddies were resolved and a shaped spreading of chlorophyll-a is identified during this season. From Satellite Altimetry, the propagation of SMC in between the 4 eddies can easily be found in the region along with eddies in the Palk Bay and southern coast off SriLanka that causes intense upwelling. The SST map confirms upwelling associated with mesoscale eddies. The intensification in the chlorophyll-a concentration pattern is clearly controlled by the strengthening and respective positioning of the eddies. Nutrient transport in to the upper layers is caused by coastal upwelling driven by monsoon winds whereas eddy induced upwelling contributed to the high chlorophyll-a distribution in this region during summer monsoon and influencing the potential fishing grounds in the region. This study is a novel approach and gives an insight into the influence of mesoscale eddies on the distribution of chlorophyll concentration in the coastal waters of the seas around India which controlls the marine biota in the region and quite often occurrence and spreading of Harmful Algae Blooms in the Indian waters.

Keywords: eddies, altimetry, chlorophyll

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JPS003 **Oral Presentation** **1703**

Simulating ice-ocean-ecosystem in response to a changing climate in the Bering-Chukchi -Beaufort seas using the Physical-Ecosystem Molde (PhEcoM)

Prof. Jia Wang
International Arctic Research Center University of Alaska Fairbanks IAPSO

Meibing Jin, Clara Deal, Haoguo Hu, Kohei Mizobata

Physical-Ecosystem Model (PhEcoM), consisting of a 9-compartment ecosystem model and a 4-comparment sea ice algae model, was coupled to the CIOM (Coupled Ice-Ocean Model), and used to study the ice-ocean-ecosystem dynamics in the Bering-Chukchi-Beaufort (BCB) seas. The data from nutrient and plankton moorings was used to validate this model. This coupled ice-ocean-ecosystem model will be used to test the hypotheses: 1) North-south connection/advection of nutrients and planktons, 2) West-east seesaw of plankton blooms due to a change of location of the Aleutian Low, and 3) On-shelf nutrient supply by mesoscale eddies for sustainable Green Belt booms. The simulations can explain the high primary productivity region, along the Green Belt (i.e., along the Bering Slope), seasonal blooms and the interannual variability in the BCB seas, and ice edge variability and sea ice algae due to climate changes and the impacts on primary and secondary productivity. The model results in 1997 and 1999 in the Bering Sea suggest that the ice-associated blooms were seeded by sea ice alga released from sea ice. A difference in the ice-associated bloom vs. open water bloom was not found in terms of the total primary production, but rather in the shift of phytoplankton species and the timing and magnitude of the bloom. These changes, superimposed on the gradual ecosystem shift due to a warming climate, can dramatically alter the Bering Sea ecosystem.

Keywords: coupled ice ocean model, bering sea green belt, ice associated blooms

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JPS003 **Oral Presentation** **1704**

Relationship between fronts of the Antarctic Circumpolar Current and surface chlorophyll concentrations in the Southern Ocean

Dr. Serguei Sokolov
Marine and Atmospheric Research CSIRO, Australia IAPSO

Stephen R. Rintoul

We re-examine the relationship between circulation, bathymetry and surface chlorophyll in the Southern Ocean, using new high resolution maps of the frontal structure of the Antarctic Circumpolar Current (ACC) derived from satellite altimetry. The maps reveal the ACC consists of multiple filaments or jets. By averaging surface chlorophyll measurements along streamlines, we show that the fronts define the limits of zones with similar concentrations and seasonality of surface chlorophyll. The overall pattern of surface chlorophyll is consistent with strongest upwelling of nutrient-rich deep water south of the PF. However, the distribution of chlorophyll in the Southern Ocean is concentrated in a number of persistent blooms, observed downstream of islands and bathymetric features. In contrast to previous studies, we find little evidence that the fronts of the ACC are associated with enhanced productivity, at least where the fronts are distant from topography. Rather, we find that most regions of elevated chlorophyll in the open Southern Ocean can be explained by upwelling of nutrients (both macro- and micro-nutrients) where the ACC interacts with topography, followed by downstream advection. The upwelling is shown to be the consequence of the bottom pressure torque established by the large-scale flow, rather than being due to small-scale instabilities of the jets. In this sense, the interaction of the flow with the topography both establishes the large-scale dynamical balance of the ACC and determines the productivity of the open Southern Ocean. South of the Polar Front, in the Antarctic Zone, there is a distinct spring bloom, which occurs earlier, persists for longer and reaches higher maximum values further south near Antarctica. The seasonal changes in chlorophyll pattern in this zone are predominantly driven by melting sea ice through the freshening of the ocean surface layer and quick release of iron with ice melt water. The seasonal signal in chlorophyll concentrations related to the seasonal ice melting is particularly strong between the southern ACC front and the southern boundary of the ACC. The effect of other environmental factors is also investigated.

Keywords: acc, phytoplankton, fronts

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JPS003 **Oral Presentation** **1705**

Phytoplankton distributions in the Eastern Equatorial Pacific: patterns governed by FE-limited growth and microzooplankton grazing

Dr. Karen Selph
Department of Oceanography University of Hawaii

Michael R. Landry, Robert R. Bidigare, Stephanie Christensen, Christopher I. Measures

Phytoplankton community dynamics were investigated along a transect from 4N to 2.5S at 140W and along the equator from 140W to 110W as part of two research expeditions to the equatorial Pacific in December 2004 and September 2005. Seawater dilution experiments were performed to estimate phytoplankton growth and mortality rates due to microzooplankton, and standing stocks were estimated using HPLC-pigment analyses and flow cytometry. Concentrations of dissolved Fe were also measured on board ship using flow injection analysis. Results showed that from 4N to 1N (surface down to 50 75 m), phytoplankton standing stocks were ~0.25 g total chlorophyll a (Chl a) liter-1, increasing to ~0.35 0.4 g Chl a liter-1 between ~0.5N 1.5S, returning to ~0.25 g Chl a liter-1 at 2S. The chlorophyll maximum occurred at the latitudes spanned by the Equatorial Undercurrent (EUC) and the South Equatorial Current. The EUC is a source of upwelled Fe to the surface waters here, likely the reason for the observed biomass increase. The same pattern was seen for the pigments divinyl chlorophyll a (a proxy for Prochlorococcus) and zeaxanthin (found in Synechococcus and Prochlorococcus). Prochlorococcus and Synechococcus cell abundances (flow cytometry) showed the same pattern as pigment concentrations. Eukaryotic phytoplankton pigment markers (fucoxanthin and 19-hexanoyloxyfucoxanthin) and cell abundances were also high here, but their maxima extend further north (1 2N) than the prokaryotic phytoplankton maxima. Phytoplankton growth rates were high (average of 0.7 d-1 based on Chl a) all along the transect at 140W. Mortality rates accounted for 53% of growth on average, and were even higher at the biomass maximum between the equator and 1S (72% of growth). The highest rates of growth in the phytoplankton community (> 1 d-1) were estimated for diatoms, as indicated by changes in fucoxanthin. Interestingly, microzooplankton grazing accounted for a minimum of 35% of diatom growth, suggesting that heterotrophic dinoflagellates were an active part of the grazing community. Prochlorococcus was estimated to grow at an average rate of 0.4 d-1, balanced by grazing mortality. Synechococcus grew at an average rate of 0.6 d-1, with over 80% of the population grazed per day. An equatorial transect, from 140W to 110W, revealed shoaling of the EUC, along with decreasing concentrations of Fe in the EUC as it proceeded eastward. This decrease in supply of Fe to the surface layer is consistent with an observed decrease in phytoplankton biomass to the east, as indicated by the pigments monovinyl chlorophyll a, divinyl chlorophyll a, and fucoxanthin. Exceptions to this decrease in biomass were stations which crossed tropical instability vortices (as evinced by isopycnal doming) which brought nutrients (nitrate, phosphate and Fe) to the surface waters. Co-located with these nutrient injections were phytoplankton and heterotrophic bacteria biomass peaks.

Keywords: phytoplankton, grazing, equatorial pacific

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JPS003 **Oral Presentation** **1706**

Concomitant top-down and bottom-up controls and associated regime shifts in the Black Sea

Prof. Temel Oguz
Institute of Marine Sciences Middle East Technical University IAPSO

Functioning of the Black Sea ecosystem has profoundly changed since the early 1970s under cumulative effects of excessive nutrient enrichment, strong cooling/warming, over-exploitation of pelagic fish stocks, and population outbreak of gelatinous carnivores. Applying a set of criteria to the long-term (1960-2000) ecological time-series data, the Black Sea ecosystem was shown to be reorganized in different forms of top-down controlled food web structure through successive regime-shifts of distinct ecological properties. The Secchi disk depth, oxic-anoxic interface zone, dissolved oxygen and hydrogen sulphide concentrations also exhibit abrupt transition between their alternate regimes, and indicate tight coupling between the lower trophic food web structure and the biogeochemical pump in terms of regime-shift events. The first shift, in 1973-1974, marks a switch from large predatory fish to small planktivore fish-controlled system, which persisted until 1989 in the form of increasing small pelagic and phytoplankton biomass and decreasing zooplankton biomass. The increase in phytoplankton biomass is further supported by a bottom-up contribution due to the cumulative response to high anthropogenic nutrient load and the concurrent shift of the physical system to the cold climate regime following its ~20-year persistence in the warm climate regime. The end of the 1980s signifies the depletion of small planktivores and the transition to a gelatinous carnivore-controlled system. By the end of the 1990s, small planktivore populations take over control of the system again. Concomitantly, their top-down pressure when combined with diminishing anthropogenic nutrient load and more limited nutrient supply into the surface waters due to stabilizing effects of relatively warm winter conditions switched the high production regime of phytoplankton to its background low production regime. The Black Sea regime-shifts appear to be sporadic events forced by strong transient decadal perturbations, and therefore differ from the multi-decadal scale cyclical events observed in pelagic ocean ecosystems under low-frequency climatic forcing. The Black Sea observations illustrate that eutrophication and extreme fishery exploitation can indeed induce hysteresis in large marine ecosystems, if they can exert sufficiently strong forcing onto the system. They further illustrate the link between the disruption of the top predators, proliferation of new predator stocks, and regime-shift events. Examples of these features have been reported for some aquatic ecosystems, but are extremely limited for large marine ecosystems.

Keywords: blacksea, top downandbottom upcontrols, regimeshifts

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JPS003 **Oral Presentation** **1707**

Three-dimensional simulation of a coupled hydrodynamic-biogeochemical model in the Java Sea

Mr. Alan Frendy Koropitan
Graduate School of Environmental Science Hokkaido University, Japan IAPSO

Motoyoshi Ikeda

A coupled hydrodynamic-biogeochemical model has been applied to the Java Sea in order to explore the physical effects on biogeochemical processes. The three-dimensional simulations are driven with the monthly climatological mean wind, rivers discharge, solar radiation and riverine input of nutrients. The previous study has shown the strong tidal mixing caused by co-oscillation tide of K1 constituent in the Java Sea. The hydrodynamic model is a barotropic model and forced by the principal component of K1 tide at the open boundary. The biogeochemical model is consisted of nitrate, ammonium, phosphate, phytoplankton, zooplankton, pelagic detritus and benthic detritus. We considered the nutrient benthic fluxes and used cohesive sediment processes for benthic detritus at the bottom boundary layer. The coupled model was run separately for two distinct of different monsoon (northwest monsoon-NWM in February and southeast monsoon-SEM in July) until a quasi steady-state solution. The model output was then analyzed by averaging one tidal cycle for each monsoon condition. The simulated chlorophyll-a and primary production are in reasonable agreement with satellite data and field observation, respectively. The observed nitrate riverine input is a major source compared with the adjacent seas. However, the modeled phytoplankton growth shows that phosphate is a nutrient limiting factor. Generally, simulated nutrient uptake is similar for both monsoon conditions where the main source of nutrient is coming from regeneration/excretion processes (54 %) and the others are riverine input (RI) and adjacent seas (OI).The contribution of RI and OI are mainly influenced by monsoon condition where wet season (high rivers discharge) and eastward water flowing occur in NWM, but dry season (low rivers discharge) and westward water flowing occur in SEM.The role of benthic flux seems weak caused by low deposition of pelagic detritus. Strong tidal mixing is responsible for the cohesive sediment processes especially in the central part with relatively low productivity.

Keywords: java sea, physical effects, biogeochemical processes

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JPS003 **Oral Presentation** **1708**

Impact of Sea Level Rise on Hydrodynamics of Estuarine System: Case Study of Mtwapa Creek, Kenya

Dr. Charles Magori
Kenya Marine & Fisheries Research Institute Research IAPSO

Mtwapa creek is a tropical estuarine system located along the Kenyan coast in the Western Indian Ocean region, just 15 km North of Mombasa Island. The creek is surrounded by vast mangrove wetlands while its offshore area is shielded by extensive shore parallel coral reefs. It receives runoff from a seasonal river. In this study, water levels, current velocities, salinity, water temperature and bathymetry were measured at selected locations within the creek. A mathematical model using a fully implicit scheme for solving shallow-water equations is presented. The model is based on RMA2, a finite element hydrodynamic numerical model for two-dimensional (depth-averaged) simulations. It operates within the framework of the Surface Water Modeling system (SMS) software package. The model was applied to Mtwapa creek and a finite element mesh of the creek was generated containing 1429 quadratic elements defined by 4544 nodes. The equations are integrated over the flow depth by assuming that the flow is incompressible and homogeneous. Vertical flow is considered negligible resulting in a hydrostatic pressure distribution. The Newton Raphson iterative scheme is used to solve the set of nonlinear equations. The model is forced by observed water levels at the mouth of the creek. Using the model, the sensitivity of Mtwapa creek to anticipated sea-level rise in the 21st century has been investigated. This involved applying successive increases in mean sea level to the tidal boundary conditions at the mouth of the creek using projected values by Intergovernmental Panel on Climate Change (IPCC). The model results suggest that if the morphology of the creek remains constant, sea-level rise could have some significant impacts on the hydrodynamics of the system. Furthermore, using the numerical model, estimates of Mtwapa creeks volume, surface area and tidal prism during spring and neap tides are computed. It is concluded that the numerical model presented in this study can be used as a research tool for investigations of estuarine hydrodynamic processes. It can also be used to model scenarios of climate change inducedextreme oceanic events such as sea-level rise, tsunamis, storm surges and tropical cyclones

Keywords: sea level rise climate change, estuary numerical model, mtwapa creek kenya

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JPS003 **Oral Presentation** **1709**

Implications of lazy plumes for entrainment of vent larvae into seafloor hydrothermal vents

Dr. Karen Bemis
Geological Sciences Rutgers University

Peter Rona

Vent larvae are spawned near the vents of seafloor hydrothermal plumes, the adults live there lives near these vents, and yet genetic studies indicate that similar species occupy distant vent sites. One of the oft cited potential transport mechanisms is entrainment into and lofting by seafloor hydrothermal plumes. This study considers some aspects of the basic physics of such processes. Seafloor hydrothermal vents form a wide variety of chimney and mound structures ranging from single isolated chimneys (typical of the East Pacific Rise (EPR) at 9N and 21N) to mounds/chimney clusters with multiple orifices (typical of the Juan de Fuca Ridge (JdFR)) to mega-mounds with multiple chimney clusters (for example, TAG on the Mid-Atlantic Ridge). Entrainment by plumes sets up a small (relative to ambient currents) but significant horizontal velocity field (predicted ~0.2 m/s for Main Endeavor Field (MEF), JdFR vents). This suggests that rising fluids and vent larvae near black smokers are likely to be entrained. Near can be determined by a consideration of the merging of plumes. Plumes merge when their velocity fields overlap: we predict merging of seafloor hydrothermal plumes when chimneys are closer than 1-5 m. Merging changes the balance of momentum, volume, and buoyancy fluxes because total volume flux is conserved. Acceleration, due to the dominance of buoyancy over the other fluxes in merged plumes, may result in a deficit of volume flux beneath the plume, which may facilitate entrainment of rising fluids near black smokers. The relative importance of volume (Q), momentum (M) and buoyancy (B) fluxes is quantified by a non-dimensional parameter: G ~ BQ2/M5/2. The merging of plume is observed for most of the vent clusters in the Main Endeavour Field, JdF. Individual plumes usually have very low G (0.04-0.14 for a selection of plumes on the JdFR and EPR) in the vicinity of the chimney (vent). However, the larger scale plumes observed in acoustic images have higher G (1.4 - 4.0).We present acoustic images and other data from 21N EPR, North Cleft, JdFR and the MEF, JdFR to show that the plumes from small isolated chimneys (<10 m tall, >10 m spacing) are dynamically distinct from the plumes of large mounds (>10 m tall mound, <5 m chimney spacing) due to the effects of merging plumes. We predict that diffuse flow and vent larvae will be entrained primarily if emitted within a cluster of chimneys.

Keywords: hydrothermal, larvae, entrainment

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JPS003 **Oral Presentation** **1710**

Modelling the influence of mussel farming on benthic and pelagic biogeochemical processes

Mr. Daniele Brigolin
Physical Chemistry University of Venice

Roberto Pastres, Tomas Lovato, Gabriele Dal Maschio, Alexey Davydov, Angelo Rubino, Pierre Regnier

Coastal areas assigned to mussel aquaculture are rapidly increasing throughout the world, raising questions about coastal zone management and ecosystem carrying capacity at different scales. With respect to the water column, these farming areas can act as sinks of particulate matter and sources of nutrients, while the intense organic enrichment underneath the farm may locally alter sediment biogeochemistry and nutrient fluxes at the water-sediment interface. This work attempts to study the influence of suspended mussel farms on the spatial distribution of particulate and dissolved compounds in the water column and the sediment, at a local scale, by means of an integrated numerical model. The model is made up of three parts: a) a 3-layer pelagic reaction-transport model which simulates the dynamics of DOC, POC, nitrate, ammonia, reactive phosphorous and silicates, phytoplankton and zooplankton; b) an individual based growth model of the mussel; c) a 1D reaction-transport model of early diagenesis. Preliminary model results show that the water column in correspondence of the farmed area is affected by a depletion of the phytoplankton biomass accompanied with an increase in dissolved ammonia concentration. A general enhancement in the concentrations of ammonia, reactive phosphorous and sulphides in superficial sediment, as well as sediment oxygen demand, is predicted underneath the farm. On the basis of these results, the model can be seen as an useful tool both for the theoretical study of processes and the management of coastal zone activities.

Keywords: benthic pelagic coupling, aquaculture

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JPS003 **Oral Presentation** **1711**

An analytical model for smal-scale thermally forced upwelling; with application to Bahia de Concepcion, Chile

Prof. Johan Rodhe
Oceanography Gteborg University IAPSO

An analytical model describing thermally forced upwelling in a semi-enclosed deep bay is presented. The model is 2-dimensional (integrated in the lateral direction) and models the vertical circulation as response to a surface heat flux. It is assumed that the water outside the bay is kept cold. The cold water enters the bay where it becomes exposed to intense heating and thus becomes less dense. The heated and low-density water forms an outward directed divergent surface current which gives rise to an upwelling spread over the bay and a compensating inflow of cold water at depth. It is assumed that the scales are such that the surface layer outflow is geostrophic. This solution is thought to be applicable to a bay at a low-latitude coast where large-scale upwelling along the coast brings cold water to the surface (e.g. Chile). Four equations are used: conservation of heat in the surface layer, geostrophic surface outflow, continuity of volume and a mechanical-energy equation. The model is forced by a constant surface heat flux. The system of equations is solved using dimensional analysis, and thus leaves a universal non-dimensional constant to be determined by observations. The model predicts a divergent outflow in the heated surface layer, which increases linearly (for a rectangular bay) from the head of the bay. The upwelling velocity is thus constant and so is the surface excess temperature. Numerical experiments using a 3D-model in a simple setup show similar response after a few days of spin up. The model predictions are found to be in reasonable good agreement, booth in a qualitative and a quantitative sense, with observations from Bahia de Concepcin, Chile, during some summer days with low winds. The intense upwelling in the bay those days resulted in a very high primary production as was indicated by the green color of the water and the small Secchi-disk depth).

Keywords: thermally forced upwelling, vertical nutrient flux, bahia de concepcion chile

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JPS003 **Poster presentation** **1712**

Seasonal along-isobath geostrophic flows on the West Florida Shelf with application to Karenia Brevis red tide blooms

Mr. Daniel Carlson
Oceanography Student Member

Allan J. Clarke

TOPEX/Poseidon (T/P) sea surface height (SSH) measurements along tracks 91 and 15 crossing the West Florida Shelf (WFS) are used to estimate seasonal across-shelf SSH gradients. These gradients and the knowledge that geostrophic flow approximately follows the isobaths enables an estimation of the seasonal along-isobath geostrophic flows. The seasonal geostrophic along-isobath flows are highly correlated with the seasonal along-shore wind stress. Southeastward directed along-isobath flows are predicted in December, January, February, and March. Northwestward directed along-isobath flows are predicted in June, August, and September. The along-isobath geostrophic component of the flow is small in the remaining months. Karenia brevis, the Florida red tide organism, usually blooms on the south/central WFS in the summer and fall months. It is likely that the northwestward along-isobath flow in June, August, and September transports the red tide blooms northward to the Big Bend shelf region during these months. K. brevis blooms in 2005 and 2006 are used as a case study to examine the northward transport mechanism. Above average northwestward along-shore wind stress caused by hurricane activity in the Gulf of Mexico most likely resulted in the northward transport of K. brevis in 2005 while below average along-shore wind stress in 2006 suggests why a K. brevis bloom on the central WFS was not observed farther north.

Keywords: satellite altimetry, red, tide

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JPS003 **Poster presentation** **1713**

Phytoplankton feedbacks in a water column (Guinea dome)

Mr. Olaf Duteil
Laboratoire d'Ocanographie et du Climat Universite Pierre et Marie Curie, Paris, FRANCE
IAPSO

Yves Dandonneau, Alban Lazar, Ilana Wainer

To survive, phytoplanktonic algaes use solar light to produce energy by photosynthesis. Their concentration depend directly of the light they receive. In the same time, phytoplankton, which can be estimated by chlorophyll concentration, has an impact on solar irradiance absorption, and thus on absorption of heat locally: ocean temperature, mixed layer depth, advection, diffusion and turbulent processes may be influenced. In return, phytplankton concentration may be modified (feedback of feedback).To investigate this complex system, we have used a state-of-art optical model which incorporates this chlorophyll feedback on light absorption in 3 different wavelengths, red, green and blue. The transport model used is a vertical 1D model derived from the OPA (Ocan PAralllis) French OGCM; this model has been forced by lateral conditions provided by climatologies of the OPA 3D version. The vertical resolution has been set at 1m in the upper 100m. Biological tracers concentration have been computed by the PISCES biogeochemical model, which contains 24 compartments. The model zone is the Guinea Dome, around 20W, 12N. This zone, a thermal dome, has been chosen primary because of its dynamics mainly associated with vertical processes (vertical advection + vertical TKE diffusion), which justify the 1D model selection, and also because of the existence of a pronounced Deep Chlorophyll Maximum (DCM), associated with a shallow thermocline, which leads to a strong feedback on light absorption. The temperature or phytoplankton seasonal cycle of this 1D model are much closer to reference climatologies and observations than the standard OPA ORCA05 version. Two experiments have been made; in the first one named Constant Optical Ocean (CO), the chlorophyll value used to parametrize the Photosynthetic Available Radiations (PAR) has been set to 0: the water is optically pure. In the second one, named Interactive Optical Ocean (IO) the optical chlorophyll value is given by the PISCES biogeochemical model. A pronounced temperature difference can be seen between the 2 experiments, with a warming of the IO run during the whole year at sub-surface, and a cooling at depth below the DCM: phytoplankton contributes to the reinforcement of the thermocline gradient, very steep in this zone. The order of this temperature variation is about 0.5 to 1C. We have also shown that this chlorophyll feedback have an impact on the temperature vertical advection and diffusion. The feedback of feedback of the phytoplankton on itself leads to an augmentation of about 10% of its own concentration, as well as a DCM and a nitracline shallowing, especially in boreal summer when the vertical advection is the most important.

Keywords: phytoplankton, optics, thermal dome

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JPS003 **Poster presentation** **1714**

Ecosystem model optimization

Dr. Svetlana Losa
Climate SciencesOcean Dynamics AWI IAPSO

Jens Schrter, Yann Ourmires, Pierre Brasseur, Iris Kriest, Andreas Oschlies

Ecosystem mathematical modelling, especially when combining with data assimilation, is one of the tools for investigating and understanding the ocean biogeochemical cycles. Several versions of biogeochemical models have been conducted within the MERSEA EU project. Being of a different complexity and possessing a number of unknown parameters, which are to be optimized, all the versions have been developed for reliable simulating theNorth Atlanticecosystem dynamics under the ocean physics. We compare the ecosystem models and validate them against existing satellite colour data and time-series data, while adjusting unknown parameterizations of biogeochemical processes. A probabilistic data assimilation method is used for the parameter optimization problem

Keywords: biogeochemical, parameteres, optimization

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JPS003 **Poster presentation** **1715**

Interannual Variability in the Gulf of Alaska: A perspective based on a coupled bio-physical model

Dr. Wei Cheng
JISAO University of Washington IAPSO

Albert Hermann, Sarah Hinckley, Ken Coyle, Phyllis Stabeno

A coupled bio-physical model is used to investigate temporal and spatial variability of the physical and lower trophic level biological processes in the Gulf of Alaska, with a focus on understanding mechanisms regulating upper ocean stratification and its control on biological dynamics. The physical model is an ocean general circulation model based on the Regional Ocean Modeling System (ROMS), and the biological model uses 11 boxes to represent key lower trophic level components in the region including micronutrients (iron, ammonia, and nitrate). To help interpreting results from the fully coupled model, a 2-dimensional model is developed to test the sensitivity of modeled stratification to: 1)different vertical mixing schemes, specifically, the Mellor/Yamada turbulence closure scheme vs. K-profile Parameterization(KPP); 2) parameters within the KPP; 3)variable surface momentum and buoyancy flux forcing. In particular, we investigate the sensitivity of stratification to coastal freshwater input under the various mixing schemes. These results highlight the need to further improve vertical mixing parameterization, and especially its treatment close to the sea surface, in ocean models.

Mariotti Annarita	1577
Yu Bin	1578
Chen Youmin	1579
Capotondi Antonietta	1580
Wang Jia	1581
Schubert Siegfried	1582
Reason Chris	1583
Rahimzadeh Fatemeh	1584
Kim Hey-Jin	1585
Tayan Mete	1586
Carvalho Leila	1587
Hsu Pang-Chi	1588
Sidorenkov Nikolay	1589
Griesser Thomas	1590
Jevrejeva Svetlana	1591
Drbohlav Hae-Kyung	1592
Barbosa Susana	1593
Sugimoto Shusaku	1594
Josey Simon	1595
Minvielle Marie	1596
Pena-Molino Beatriz	1597
Hill Katy	1598
Karnauskas Kristopher	1599
Iskandar Iskhaq	1600
J Rajesh	1601
Yuan Dongliang	1602

Holbrook Neil	1603
Biastoch Arne	1604
Farneti Riccardo	1605
Lei Yonghui	1606
Dixon Keith	1607
Meyers Gary	1608
Holbrook Neil	1609
McPhaden Michael	1610
Zhang Dongxiao	1611
Pozo-Vazquez David	1612
Palmer Matthew	1613
Drijfhout Sybren	1614
Haarsma Reindert	1615
Turner Andrew	1616
Frhlich Luise	1617
Chang Ping	1618
Woollings Tim	1619
Pierini Stefano	1620
Garraffo Zulema	1621
Talley Lynne	1622
Iizuka Satoshi	1623
Vinayachandran P. N.	1624
Kashima Motohiko	1625
Arritt Raymond	1626
Weng Hengyi	1627
Karumuri Ashok	1628

Anguluri Suryachandra Rao	1629
Barkin Yury	1630
Baines Peter	1631
Ummenhofer Caroline	1632
Hasumi Hiroyasu	1633
Feng Ming	1634
Ponomarev Vladimir	1635
Knight Jeff	1636
Ohshima Kay	1637
Schneider Niklas	1638
Sun Jilin	1639
Lptien Ulrike	1640
Cassou Christophe	1641
Ineson Sarah	1642
Furtado Jason	1643
Lebedev Sergey	1644
Grimm Alice	1645
Worcester Peter	1646
Dushaw Brian	1647
Asgari Ahmad	1648
Nadezda Ivashchenko	1649
Yuchechen Adrian	1650
Sutton Rowan	1651
Repossi Patricia	1652
Sarafanov Artem	1653
Tsou Chih-Hua	1654

Barbosa Susana 1655

Sugimoto Shusaku 1656

Demidov Alexander 1657

Pnyushkov Andrey 1658

Hori Masatake 1659

Haarsma Reindert 1660

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Bryden Harry	1688
Drijfhout Sybren	1689
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Oka Akira	1692
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