**CLIVAR related sessions in IAPSO meeting**

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## Joint Sessions

### JP 1 - TURBULENCE, INTERNAL WAVES, AND MIXING ON ALL SCALES (IAPSO, IAGA, IAMAS)

**Convenor - Trevor McDougall**

**Co-convenors: Toshi Hibiya, Sarah Nicholson, Daniel Schertzer and Irina Repina**

Session JP1 covers all aspects of internal waves and mixing processes in the ocean, atmosphere and in the solar carona and solar wind. Ocean mixing plays a crucial role both in the coastal ocean as well as in the open ocean. Nutrient supply resulting from vertical mixing influences productivity in the local coastal area, whereas deep-ocean mixing maintains abyssal stratification thus playing a key role in driving global overturning circulation. Nevertheless, our understanding of these ocean mixing processes is far from complete. Contributions are encouraged on a wide variety of aspects of coastal and open ocean mixing processes, including the cascade of internal wave energy from the large scales of generation to the small scales of mixing, mixing processes caused by internal wave breaking and their roles in the biological processes and productivity of the ocean, global distribution of baroclinic energy conversion and fine-scale parameterizations of turbulent mixing. Theoretical, modelling numerical, laboratory, and observational approaches are all welcome.

### JP 2 - POLAR OCEANOGRAPHY AND METEOROLOGY (IAPSO, IAMAS)

**Convenors - Thomas Haine, Thomas Lachlan-Cope**

**Co-convenors - Sebastiaan Swart, Jennifer Jackson, John Fyfe, Amelie Kirchgaessner, Sarah Fawcett, Marcello Vichi, Timo Vihma**

Polar processes in the ocean and atmosphere shape, and respond to, climate dynamics at low and middle latitudes. Some of these processes are unique to the Arctic and Antarctic, in particular those involving sea ice and its mediation of air/sea exchange. High latitudes are also places of exacerbated environmental change, such as Arctic amplification of global warming, Antarctic stratospheric ozone depletion, the poleward migration of mid-latitude species, and the complex impacts of ocean acidification. Despite the changes occurring in the high latitudes, these regions remain a difficult place to study due to extreme weather and remote locations. Recent progress has been made in observing and understanding new aspects of the polar climate system.

This session invites contributions that address natural and anthropogenic polar variability, the coupling between ocean, ice, and atmosphere, and the two-way interactions between the polar regions and the rest of the planet. Studies of physical and biogeochemical processes are welcome. The session will bring together observers, modelers, and theorists to report latest research on the oceanography and meteorology of the polar and subpolar regions.

### JP 3 - THE SECOND INTERNATIONAL INDIAN OCEAN EXPEDITION (IIOE-2) AND RELATED OCEANIC AND COUPLED ATMOSPHERIC RESEARCH IN THE INDIAN OCEAN (IAPSO, IAMAS)

**Convenor – Nick D’Adamo**

**Co-convenors – Juliet Hermes, Christopher Duncombe Rae, Tamaryn Morris, Rajan Sivaramakrishnan**

The Second International Indian Ocean Expedition (IIOE-2: 2015-20) was launched in Goa, India, on 4 December 2015. It is being guided by a Steering Committee Chaired by the IIOE-2’s founding co-sponsors: UNESCO Intergovernmental Oceanographic Commission (IOC); Scientific Committee on Oceanic Research (SCOR); and Indian Ocean Global Ocean Observing System (IOGOOS) Regional Alliance. The IIOE-2 science objectives are framed by an inter-disciplinary IIOE-2 Science Plan (Hood et al, 2015) developed under the auspices of SCOR, and being effected under an Implementation Strategy (www.iioe-2.incois.gov.in).

The IIOE-2 is five decades on from the first coordinated basin-wide IIOE investigation of the Indian Ocean undertaken during 1959-65 under SCOR and IOC. It will again consist of sub- to basin-wide surveys and process studies, cutting across coupled oceanic/climatic characterisation, including physical and biogeochemical oceanography, modelling and knowledge transfer through capacity development, in order to foster a lasting legacy that spans across scientifically developed to less developed communities.

The symposium aims to distil Indian Ocean science from across the underpinning interests of IAMAS, IAPSO and IAGA, as relevant to the cross-disciplinary objectives of the IIOE-2 Science Plan. This will take place through the eyes of its six key science themes: Human impacts; Boundary current dynamics, upwelling variability and ecosystem impacts; Monsoon variability and ecosystem response; Circulation, climate variability and change; Extreme events and their impacts on ecosystems and human populations; Unique geological, physical, biogeochemical and ecological features of the Indian Ocean. The way in which specific research questions will be addressed in IIOE-2 includes via collaborative multi-institutional and multi-national efforts, such as through the Eastern Indian Ocean Upwelling Research Initiative (EIOURI), already having a science plan, and its emerging kindred equivalent in the Western Indian Ocean (WIOURI).

This symposium occurs 2 years after the launch of IIOE-2, constituting a significant scientific gathering for IIOE-2 to review the most recent research findings in the context of our current scientific knowledge of the Indian Ocean and to highlight the scientific challenges and multi-disciplinary approach being addressed in IIOE-2. There will also be an underlying focus on future research and opportunities within the context of IIOE-2.

### JM 1 - OBSERVING OUR PLANET FROM SPACE (IAMAS, IAGA, IAPSO)

**Convenor - BJ Sohn**

**Co-convenors - Stewart Bernard, Stefano Vignudelli, Igor Kozlov, Mioara Mandea, Mike Purucker, Anne Mee Thompson, Matthew Lazzara**

Over the past decades, satellite technologies and related sciences have advanced to provide observations on global scale on various parameters (temperature, clouds, snow/ice coverage, magnetic field, sea level, ocean colour, surface roughness) from which evolution of our Earth's environments can be monitored and understood over space and time. Earth's environment changes are thus natural topics that can be drawn from such long-term space-borne observations, and this session focuses on how we measure, analyse and interpret satellite observations. Soliciting contributions are placed on

1. our understanding of physical processes in Earth’s system (climate change, magnetic field changes, ocean circulation changes) from satellite observations,
2. how we can continue and improve our current satellite observations, and
3. how we could enhance the value of existing observation records for geoscience and applications.

Special interests in soliciting contributions in topics covering three-association related topics.

### JM 2 - CLIMATE VARIABILITY AND CHANGE ON ALL SCALES (IAMAS, IAPSO)

**Convenor – Fei Fei Jin**

**Co-convenors - Andrew Charlton-Perez, Seok-Woo Son, Hisashi Nakamura, Noel Keenlyside, Babatunde Abiodun**

Instrument records revealed that our earth climate system features rich climate variability dominated by climatic modes from sub seasonal to multi-decadal timescales. They include, but not limited to, El Niño and Southern Oscillation (ENSO), ENSO and Annual Cycle Combination mode, Pacific Decadal and Inter-decadal Oscillation/Variability, Pacific Meridional Modes, Indian Ocean Dipole and Indian Ocean Basin modes, Atlantic Meridional mode and Atlantic Multi-decadal Oscillations, as well as Arctic Oscillation and Antarctic Oscillations, North Pacific Oscillation, North Atlantic Oscillations, Pacific North/South America Patterns, Madden Julian Oscillation etc. These modes, dominating natural climate variability and mostly subjecting to and projecting on climate change, have great global impacts including the upper atmosphere, and form the main sources for sub-seasonal to decadal climate predictability.

In this session, we welcome papers of observational, diagnostic, and theoretical analyses, modelling, prediction and predictability studies of the modes of climate variability. We also welcome studies on the interaction of climatic modes their changes under global warming, and their global and regional impacts.

### JM 4 - FUTURE CLIMATE FOR THE AFRICAN CONTINENT (IAMAS and IAPSO)

**Convenor – Charles Williams
Co-convenors - Richard Washington, Katye Altieri, R Maidment, R Cornforth, A Gaye**

It is widely agreed that climate variability and future change, combined with socioeconomic issues such as population pressures, are having and will continue to have a significant impact on societies across Africa.  A better understanding of present-day climate variability is of course needed, however an improved understanding of future climate change is also urgently required, to assist in possible adaptation and resilience building schemes.

As an example of current research initiatives, Future Climate for Africa (FCFA) is a new five-year international research programme jointly funded by the UK's Department for International Development (DFID) and the Natural Environment Research Council (NERC).  The programme is aimed at improving our understanding of climate science affecting Africa and ensuring that such findings have an impact on human development across the continent.

We welcome papers covering all aspects of climate change in Africa.  Topics include (but are not limited to): regional/global climate modelling, past(palaeo) climate change, future climate change, and potential climate change impacts.  Papers on the impact of oceanic processes on African climate change are particularly welcomed.  The main period of interest is the 5-40 year timescale, although papers outside this will be considered.

Papers from FCFA projects are particularly welcomed, but this is not exclusive so papers from other projects are also invited

### JA 3 - FRONTIER CHALLENGES IN DATA ASSIMILATION AND ENSEMBLE FORECASTING FOR THE ATMOSPHERE, OCEAN AND SOLID EARTH. (IAGA, IAMAS, IAPSO)

**Convenors - Weijia Kuang, Craig Bishop
Co-convenor – Andrew Moore, Nick Iakovlev, Wansuo Duan, Alexandre Fournier and Daniel Lathrop**

The fields of Earth system data assimilation and ensemble forecasting are confronted with both new and long standing challenges in probabilistic state estimation: (i) the identification and representation of systematic and stochastic aspects of model error; (ii) coupled models; (iii) non-Gaussian uncertainty distributions; (iv) ensemble forecast verification and postprocessing; (v) the use of multi-model and/or multi-resolution ensembles; (vi) achieving balanced initial states that are free of artificial transient waves (or oscillations) ; (vii) the use of analogue observation system simulation experiments with both numerical models and/or laboratory systems to validate and improve real state estimation schemes, and (viii) strategies for dealing with non-linear observation operators in Ensemble Kalman filters. This symposium will bring together atmospheric, oceanic, and solid Earth data assimilation and ensemble forecasting experts to jointly address the aforementioned challenges and create an exchange of ideas likely to advance Earth systemstate estimation across its many facets. Papers are invited on all aspects of data assimilation and ensemble forecasting for the ocean, atmosphere and solid Earth. Presentations pertaining to coupled model forecasting and coupled model data assimilation are particularly encouraged.

We also welcome papers aimed at increasing understanding of the fundamental limits of predictability. Such papers could include: analyses of the relevant initial error dynamics and model error physics, ideas for estimating error growth that limits predictability, methods that attempt to quantify the predictability of specific phenomena in the solid Earth, ocean or atmosphere.

## IAPSO Sessions

### P01 - General topics in oceanography

**Convenor: Eugene Morozov
Co-Convenors: Edmo Campos, Stefano Pierini**

The symposium welcomes presentations of new results of research in physical and chemical oceanography concerning large-scale circulation and eddies, water masses and their interaction, coastal currents, frontal zones and fronts, coastal upwellings and filaments, as well as SST, SSS and sea level variations, wind waves and storm surges, internal waves and tides, and other phenomena in different regions of the ocean, including inland seas.

The topics of the sessions also include key problems in ocean colour, oil pollution, carbon cycle, acidification, and various extremes in the sea. Applications of remote sensing, numerical modelling, and marine chemistry will be discussed. The symposium will cover topics of ocean physics and chemistry not addressed by other symposia.

### P04 - The Meridional Overturning Circulation: Mean State and variability

**Convenors: Chris Meinen**

**Co-Convenors: Agatha De Boer, Gerard McCarthy, Sabrina Speich, Eugene Morozov**

The meridional overturning circulation (MOC) have been shown to correlate with important climate variables such as sea level rise, surface air temperature, precipitation patterns, hurricane intensification, atmospheric CO2, and other important quantities to society. Recognition of the importance of the MOC has over the last few decades made it the focus of intensive international research efforts. Insights have come from all latitudes: from the deep-water formation regions in the Greenland-Norwegian and Antarctic Seas to the subtropical Atlantic basins and everywhere in between. Investigations of the role of the MOC in other climate states than today, such as the Eocene-Oligocene transition or the Quaternary glacial cycles, have also produced exciting results.

Major advances have depended upon theoretical and numerical modeling studies as well as on in situ observations, and taken together these breakthroughs are bringing into better focus the role that the MOC is playing in the global climate and carbon systems.

This session welcomes abstracts on observations, theory, and numerical modeling of the MOC at all time periods and time scales, from the mean state, to daily, interannual, decadal, centennial and beyond. Abstracts discussing the mean and variability of the warm upper and cold deep flows associated with the MOC, and on MOC interactions with the broader climate system, are also welcome.

### P05 - Advances in Monitoring, Detecting, Understanding, Hazard Assessment and Forecasting of Mean and Extreme Coastal Sea Level

**Convenor: Christa G. von Hillebrandt-Andrade**

**Co-Convenors: Phil Woodworth, Vasily Titov, Alexander Rabinovich**

Rapid growth of coastal populations and nearshore development have increased the need for sea level data to understand, monitor, detect, predict and forecast current, long term and extreme variability. Data from sea level monitoring stations have a wide range of applications including research, planning, hazard assessment and operational and warning systems.

The session seeks contributions on developments in technology and operations as well as the status of sea level stations and networks. It also welcomes presentations on advances in scientific research and studies on understanding the dynamics of sea level change, as well as extreme sea level events. The session will also discuss the use of sea level data for coastal operations, hazard studies and warning systems. Advances in sea level data use for the detection and forecasting of tsunamis, storm surges, climate change and other sea level extremes are welcome, as well as contributions on techniques of sea level data analysis and data archival.

### P06 - Western boundary current systems

**Convenor: Marjolaine Krug**

**Co-Convenors: Amandine Schaeffer, Jonathan Durgadoo, Lionel Renault**

Western Boundary Currents (WBCs) are deep, strong and narrow flows driven by the integrated zonal wind stress over the adjacent basins. These current systems have a major impact on the global meridional circulation through the transport of heat from the tropics to high latitudes. Furthermore, they contribute directly to inter-ocean eddy heat and salt transport in the southern hemisphere. Mid-latitude WBCs and their extensions are regions of strong ocean heat loss and carbon uptake, impacting both regional and global climate on time scales of days to decades. These strong currents and their interaction with complex topography also result in an energetic, often non-linear ocean field, which evolves over a wide range of scales and processes. This presents a great challenge for both modelling studies and observing systems.

This session aims to bring together research on all aspects of WBCs, from observational systems and studies to theoretical and numerical modelling. We encourage presentations on the role WBCs play in the global climate, including their connections with subtropical regions, air/sea coupling processes, carbon uptake, or inter-ocean transport. On smaller scales, we also welcome studies with a focus on energy transfer pathways, frontal dynamic processes or interactions with coastal and shelf ecosystems.

### P07 - Upwelling systems and ocean economy

**Convenors: Tarron Lamont, Ken Findlay**

**Co-Convenors: Issufo Halo, Isabelle Ansorge**

The world’s major ocean basins are characterized by narrow, swift, persistent flows along their western boundaries and relatively shallower, slower and broader current systems along their eastern boundaries. Such eastern boundary current systems generally consist of meandering longshore equator-ward coastal currents, undercurrents that transport properties poleward, offshore jets and rich eddy fields. Longshore wind stress produces rapid coastal upwelling and these currents are the locations of some of the highest biological productivity in the world’s oceans.

Nonlinear dynamics including eddy-mean flow and wave-eddy interactions, barotropic and baroclinic instability processes, and flow over topography increase the complexity of these systems and can induce intrinsic low-frequency variability over a broad range of spatial and temporal scales. Understanding the mechanisms that produce the structures and variability of these boundary currents is necessary to further understand their roles in delivering provisioning, regulatory and/or cultural ecosystem services within expanding oceans economies in these regions.

In this symposium we welcome contributions on all aspects of oceanic eastern boundary current systems, based on experimental, theoretical and numerical modeling studies. We also welcome contributions that connect ecosystems, physical processes and derived ecosystem services.

## IAMAS Sessions

### M04 - Past Climate Changes: a key for the future

**Convenor: Andre Berger**

**Co-Convenors: A.Haywood, Q.Z.Yin, A Timmermann, M.MacCracken**

According to the Intergovernmental Panel on Climate Change (IPCC, 2013), without rapid and dramatic reductions in carbon dioxide emissions, the Earth’s climate can warm by a few °C. This change may occur over a few hundred years, accompanied by sea level rising at a rate of as much as a meter, or perhaps more, per century. Such a climate appears to be unprecedented over the last 150 years. This requests therefore to go back in the past history of the Earth looking for the closest analogues. As we are presently in an interglacial (the Holocene), the warm climates of the past few million years are particularly well suited.

Understanding the nature and mechanisms of past climate changes in general and particularly the relative stability of the past warm periods has the potential to provide context and insight into climate and sea-level response to human activities over the industrial period and into the future, as well as the impacts of such climate change on the environment.

This symposium invites researchers who investigate the long-term behavior of the climate system and of the environment in the past and how it is projected to change into the future. We encourage both modelers and empirical scientists who focus on different aspects of the climate system to participate.

Session 1. Reconstructing and understanding the Pliocene and earlier warm periods - Convener: A. Haywood

Session 2. Reconstructing and understanding the Pleistocene - Convenor: Q.Z. Yin

Session 3. Reconstructing and understanding the climate, sea level, environment and civilization changes over the Holocene and the Anthropocene - Conveners: A Timmermann, M. MacCracken

### M06 - Oceans as a source and sink for aerosols and related feedbacks

**Convenor: Zev Levin**

**Co-convenors: Ilan Koren, Paul DeMott**

Production of CCN and IN from the ocean and the role of aerosols like dust and pollution in affecting the ocean acidity.

This session is perfect opportunity to collaborate with the SOLAS community. It can link research related to marine ecosystems and aerosols in both ways (i.e. how ecosystems affect aerosol fluxes and properties and how aerosols affect the ecosystem) and on the complex interactions with clouds (i.e marine aerosols affect clouds and clouds affect the ecosystem).

### M08 - Advances in Atmospheric Dynamics

**Convenor: Thomas Spengler**

**Co-convenors: Elizabeth Barnes, Nili Harnik, Thando Ndarana, Gwendal Rivière**

The symposium focuses on advances in atmospheric dynamics based on theoretical, observational, diagnostic, and modelling studies. Contributions can cover a range of topics including, but not limited to, storm track and jet-stream dynamics, eddy-mean flow interactions, cyclone and anticyclone evolution, stationary waves, stratosphere-troposphere coupling, dynamical connections between low, middle, and high-latitudes, and modes of atmospheric variability. In addition, the symposium is interested in studies that discuss the dynamics of mid-latitude blocking.

Invited speakers: George Craig, Michael Reeder, and Ted Shepherd

### M10 - Tropical Circulation Systems

**Convenor: Patrick Harr**

**Co-Convenors: Michael Reed**

The tropical atmosphere exerts significant influence on regional and global environments, societies and economies over time scales that range from days, to years. This symposium addresses tropical circulation systems such as individual convective systems, tropical cyclones, tropical waves, regional and large-scale circulations, intraseasonal circulations, and systems that vary over interannual and decadal time scales. Topics can address fundamental physical properties that relate to lifecycles of circulation systems, their variability, and interaction. Contributions may also address the diverse linkages among tropical, subtropical, and mid-latitude global latitude bands.

Over the past several years, many field programs have been conducted on a variety of tropical circulation systems. Therefore, there is special interest in contributions that utilize new observations, technologies, and models to advance understanding on specific phenomena that were targets of special studies.

**M11 - The Seasonal Cycle over the African Continent and Adjoining Oceans, Today and in** the Past

**Convenor: Sumant Nigam**

The proposed session, which has a focus on the African continent and its three very different surrounding oceans but does not exclude other regions, targets observational and modeling studies that address the questions posed below. The seasonal cycle, though a huge and familiar climate signal in regional circulation and surface hydroclimate, nonetheless has unexplained facets, and is a challenge for sophisticated climate models, especially over southern Africa and its surrounding oceans.

* What are the inadequacies of the observational networks?
* What are the atmospheric and oceanic deficiencies of the models, and how can they be remedied?
* What can be learnt from past seasonal cycles? (The cycle of today is but one realization from a wide range of possibilities; those of the past were different because of variations in the two reasons for the seasons: obliquity, and precession of the equinoxes.)

### M12 - Middle Atmosphere Symposium (ICMA)

**Convenor: Elisa Manzini**

**Co-Convenors: Bernd Funke, Michaela Hegglin, Christoph Jacobi, Irina A. Mironova, Eugene Rozanov**

The middle atmosphere extends from the tropopause to the lower hermosphere and is of particular interest to Earth system science due to its relevance to life on Earth and climate. Main features of the middle atmosphere include the ozone layer, which protects the Earth’s surface from harmful UV-radiation, and stratospheric dynamical phenomena, such as the polar vortex and the Quasi-Biennial Oscillation, which together with smaller scale gravity waves, are crucial to the circulation, weather teleconnection patterns, and global climate. The Symposium covers all aspects of middle atmospheric science, with emphasis on the interaction between dynamics, radiation and chemistry within the middle atmosphere itself and between the middle atmosphere and the troposphere. This is the core symposium of ICMA (International Commission on the Middle atmosphere).

Observational, modeling, theoretical, and laboratory studies are all solicited. Research topics include (but are not limited to):

Gravity waves: their generation, propagation and breaking

Intraseasonal, interannual and longer timescale dynamical variability

Middle atmosphere response to anthropogenic and natural forcings

Stratospheric/mesospheric chemistry and ozone

Radiation, microphysics, chemistry and dynamics at the tropopause

Transport and mixing in multiple spatial scales

Tropical / extratropical dynamical interactions

Mechanisms of stratosphere-troposphere coupling, at all time scales

### M14 - Vertical Atmospheric Coupling the Polar Atmosphere

**Convenor: Tracy Moffat-Griffin**

**Co-Convenors: William Ward, John King, Andrew Kavanagh**

This session will cover all aspects of vertical coupling (including dynamical, chemical and electric circuit), throughout the polar atmosphere from the troposphere to the exosphere. Submissions on upward (wave generation/propagation from the surface/middle atmosphere) and downward (space weather effects impacting on the atmosphere) coupling effects are encouraged.

### M15 - Energy balance of the Earth

**Convenor: Peter Pilewskie**

**Co-Convenors: Martin Wild, Norman Loeb, Werner Schmutz,**

The Earth's energy balance is a key parameter of the Earth’s climate system. Its components can be altered by anthropogenic and natural processes resulting in climate change.

We invite papers on observations and modeling of the Earth and Surface Radiation budget as well as the variability of its components in space and time. We welcome papers which can improve our understanding and quantitative characterization of the radiative forcing by solar irradiance, atmospheric species, clouds and aerosol. Papers based on the comparison of the simulated radiation budget with observation data are especially encouraged.

### M17 - High-impact Weather and Climate Extremes

**Convenors: Richard Grotjahn, Julia Keller**

**Co-conveners: Lisa Alexander, Brian Golding, Neil Holbrook, Richard Swinbank, Xuebin Zhang**

Papers are solicited on topics related to understanding and prediction of weather and climate extremes. Observational, synoptic-dynamical, statistical, and modeling contributions are encouraged. Papers on topics relevant to the World Weather Research Programme project on High-impact Weather (HIWeather) and to the World Climate Research Programme Grand Challenge on Climate Extremes including cross-cutting themes are solicited.

Key challenges for the climate community are to document: how extremes have varied or are likely to vary under a changing climate and how well climate models capture these events. Presentations that assess: model simulations, changes in the observed record, and the extent to which humans are responsible for changes in extremes, and individual extreme weather events are encouraged. Weather extremes occur in various events over a broad range of time scales (e.g. heavy precipitation and drought, damaging winds, heat waves over land, marine heat waves, extreme winter events) and space scales (global to convective). Understanding underlying physical processes includes diabatic effects on meso- and synoptic-scale dynamics. Simulation, improved prediction, and deeper scientific understanding are key to increase resilience to high-impact weather events and are within the scope of this symposium. Contributions on observing strategies, field campaigns and demonstration projects, and dynamical and statistical analysis methods are solicited. Presentations on the communication of forecasts and their skill and uncertainties, weather impacts and on the assessments of vulnerability and risk are also sought.

### M18 - Advances and Frontier challenges in Global Monsoon Studies

**Convenors: Jianping Li, Andrew Turner**

**Co-conveners: E. Hugo Berbery, Harry Hendon,,Jun Matsumoto, Kyung-Ja Ha, R. Krishnan, Fred Kucharski, Allesandra Giannini, Serge Janicot**

The symposium focuses on advances and frontier challenges in global monsoon studies, including observational, diagnostic, theoretical, modelling and prediction studies of the monsoons. Contributions can cover a large range of topics including: formation, variability and dynamics: formation, features and variability of the global monsoons from the paleomonsoon to the present day at various time-scales and relevant fundamental physical processes; scale interactions between climate mean state and different modes of monsoon variability; interactions among different spatial-temporal scales and different latitudes as well; teleconnection patterns related to the global monsoons;

Linkages: linkages with the principal modes of climate variability and related underlying mechanisms; relationships among different monsoon systems; interactions between Northern Hemispheric atmosphere and Southern Hemispheric atmosphere;

Impacts: impacts of monsoons on extreme weather and climate events; the role of monsoons in Earth's energy budget and water cycle; impacts of anthropogenic forcings (aerosols, land use change, greenhouse gas emissions etc.) on monsoons; the role of monsoons in global change;

Predictability: predictive skill of the coupled atmosphere-ocean-land system in the monsoon regions; model intercomparisons on monsoon simulation and prediction; future projection of the monsoons under global warming;

Presentations are also invited on the latest results from monsoon in-suit experiments.

### M19 - Precipitation at all scales

**Convenors: Ioulia Tchiguirinskaia**

This session will be devoted to the measurement analysis and modeling of the extreme variability of precipitation over oceans and continents across a wide range of space-time scales, in particular their application to downscaling and forecasts.

### M20 - Role of Ocean-Atmosphere Interactions in Climate Variability, Change and Predictability

**Convenors: Hisashi Nakamura ,Noel S. Keenlyside**

**Co-convener: Mat Collins , Meghan F. Cronin, Ruiqiang ,Mojib , Shoshiro Minobe, Mathieu Rouault, Tomoki Tozuka, Tim Woollings,Shang-Ping Xie**

Ocean-atmosphere interactions are an important source of climate variability and predictability. Great progress has been made during the past two decades in understanding, modeling and predicting interannual variability over the tropical oceans, including the El Niño – Southern Oscillation (ENSO) and associated global teleconnections. The role of the extratropical oceans in climate variability is less well understood with regard to its origin and multi-scale impacts. The latter especially concerns the influence of the western boundary current regions, including the Agulhas system, and associated frontal zones on the overlying atmosphere, storms and blocking and possible teleconnections. While ocean-atmosphere interaction in the tropics is better understood, its poor representation in climate models leads to large systematic errors and degrades climate predictions. Tropical-extratropical interactions and interactions between ocean basins are other areas where progress is required. As today’s climate includes a significant contribution from anthropogenic forcing, regional anomaly patterns and the role of ocean-atmosphere interactions have to be considered in the context of global climate change.

We invite contributions on topics including, but not limited to: 1) theoretical, observational and/or modeling studies on the processes involved in ocean-atmosphere interactions, in the tropics and extratropics (and their interaction), and their role in climate variability and predictability; 2) impacts of ocean variability on the coupled troposphere/stratosphere system at various spatial scales up to global; 3) the response of the ocean to multi-scale atmospheric variability; and/or 4) the evaluation and improvement of ocean-atmosphere coupling in climate models.

### M22 - Sub-seasonal to Seasonal Prediction--except extremes

**Convenors: Frederic Vitart**

**Co-convener: Iracema Cavalcanti, Chris White**

There is a growing interest in the scientific, operational and applications communities in developing sub-seasonal to seasonal (S2S) forecasts (2 weeks to a season) that fill the gap between medium-range weather and seasonal forecasts. Sub-seasonal forecasting is at a relatively early stage of development, yet operational models are beginning to exhibit some skill based on a number of sources of sub-seasonal predictability (e.g. sea-ice, soil moisture, MJO, stratosphere-troposphere interactions, teleconnections, etc.). This symposium seeks contributions on all aspects of S2S, with emphasis on relevant phenomena and mechanisms responsible for predictability, design of S2S forecast systems, forecast quality and uncertainty quantification, and approaches to leverage S2S forecasts for applications. Contributions that exploit the newly established WWRP/WCRP S2S project database are particularly welcome.