CLIVAR related sessions in EGU General Assembly 2017

OS1 –Ocean General Circulation and Climate

OS1.1 Open Session on Ocean Circulation and Climate

Convener: Boris Dewitte
Co-Conveners: Niklas Schneider , Virginie Guemas , Antonietta Capotondi

For the open session, we welcome contributions on all aspects of ocean circulation from observations, models and theory, and from regional to global scales. This year we particularly encourage studies on the decadal to interdecadal variability and its internal and externally forced physical processes. As usual the OS1.1 session also welcomes submissions that do not fit to any of the other special sessions.

OS1.2/AS1.20 The North Atlantic: natural variability and global change (co-organized)

Convener: Monika Rhein
Co-Conveners: Paul G. Myers , Richard Greatbatch , Rym Msadek , Susan Lozier

The North Atlantic exhibits a high level of natural variability from interannual to centennial time scales, making it difficult to extract trends from observational time series. Climate models, however, predict major changes in this region, which in turn will influence sea level and climate, especially in western Europe and North America. One important issue is the interaction between the atmosphere and the ocean, and how this affects the climate in Europe.

We welcome contributions from observers and modelers on the following topics:
-- climate relevant processes in the North Atlantic region in the atmosphere, ocean, and cryosphere
-- response of the atmosphere to changes in the North Atlantic
-- atmosphere - ocean coupling in the North Atlantic realm on time scales from years to centuries (observations, theory and coupled GCMs)
-- interpretation of observed variability in the atmosphere and the ocean in the North Atlantic sector
-- Comparison of observed and simulated climate variability in the North Atlantic sector and Europe
-- Dynamics of the Atlantic meridional overturning circulation
-- variability in the ocean and the atmosphere in the North Atlantic sector on a broad range of time scales
-- changes in adjacent seas related to changes in the North Atlantic
-- role of water mass transformation and circulation changes on anthropogenic carbon and other parameters
-- linkage between the observational records and proxies from the recent past

Invited speakers:
Amy Bower, WHOI, Woods Hole, USA
Carsten Eden, CEN, Hamburg, Germany
Antje Weisheimer, NCAS, Oxford, United Kingdom
Chris Wilson, NOC, Liverpool, United Kingdom

OS1.3/CL1.29 North Atlantic Subpolar Gyre variability and abrupt climate events: An integrated perspective (co-organized)

Convener: Andreas Born
Co-Conveners: Juliette Mignot , Paola Moffa Sanchez , Femke De Jong

The cyclonic circulation of the North Atlantic subpolar gyre (SPG) is a key component of North Atlantic climate variability on a wide range of time scales. It is intrinsically linked to water mass transformation, and thus to the deep overturning circulation (MOC) and oceanic heat transport towards high northern latitudes. Observations and coupled climate models suggest a tight coupling of decadal climate variability in the Northern Hemisphere and modulations in the SPG intensity and shape. On these time scales, this region has the highest skill for climate predictions worldwide. However, the widespread warming during the 20th century was accompanied by a remarkable cooling trend in the SPG that is not yet fully understood. Recent years have also seen significant progress in our understanding of the gyre's dynamics, thanks to advances in observing systems and modeling studies ranging from realistic configurations at high-resolution to idealized simulations. Furthermore, in addition to observational data a fast-growing number of paleoceanographic reconstructions highlight the important role of the SPG in past abrupt climate events and variability.

Given the large progress in these various related fields of research, we believe it is time to synthesize the existing knowledge on this crucial component of the North Atlantic circulation. We encourage contributions from all disciplines that contribute to an integrated perspective of the SPG dynamics.

OS1.4 Changes in the Arctic Ocean and Sea Ice System: Observations, Models and Perspectives

Convener: Yevgeny Aksenov

Co-Conveners: Markus Janout , Agnieszka Beszczynska-Möller

The past decades of observations have shown sustained changes in the Arctic Ocean and the Arctic sea ice cover. Since the beginning of satellite observations in 1979, the Arctic sea ice extent has declined throughout all seasons, with the largest reduction occurring in summer. Furthermore, the Arctic sea ice cover is now thinner, weaker and drifts faster. The ocean shows an increase in the Arctic freshwater storage and warmer inflows from the Atlantic and Pacific Oceans. Coastal runoff from Siberia and Greenland has also increased. As the global surface temperature rises, the Arctic Ocean is speculated to become seasonally ice-free in the 21st century, which prompts us to revisit our perceptions of the Arctic system as a whole. What could the Arctic look like in the future? How are the present changes in the Arctic going to affect the lower latitudes? What aspects of the changing Arctic should future observations and modeling programs address? The session invites observation- and modeling-based submissions on past, present and future states of the Arctic, on the mutual interaction between ocean, atmosphere and sea ice, and links to global processes. The session promotes results from current Arctic programs and encourages discussions on future plans for Arctic Ocean modeling and measurement strategies.

OS1.5/CR6.8 Freshwater in the Arctic and Sub-Arctic Seas (co-organized)

Convener: Benjamin Rabe

Co-Conveners: Paul Dodd , Matthew Alkire , Craig Lee , Julienne Stroeve

Understanding processes affecting the supply, transport, accumulation and release of the various sources of freshwater in the Arctic is important as they have significant effects on regional sea-ice processes, ocean stratification, nutrient distribution and ocean acidification. Arctic freshwater has the potential to modulate climate on both regional and global scales. This includes the Atlantic meridional overturning circulation, atmospheric Arctic-mid-latitude linkages, release of additional greenhouse

gases from thawing subsea permafrost and advection of waters corrosive to calcium carbonate to the North Atlantic.

We welcome contributions from observers and modellers on the following topics:
- Sources of freshwater to the Arctic under a changing climate
- The Arctic freshwater budget and storage anomalies
- Freshwater tracers and propagation of anomalies
- Coherence between different time series of freshwater observations
- The fate of freshwater exported from the Arctic
- Hydrological feedbacks between the liquid ocean, the cryosphere and the atmosphere
- Effects of freshwater variability on biogeochemistry and ecosystems

OS1.6 Under cover: The Southern Ocean's connection to sea ice and ice shelves

Convener: Torge Martin
Co-Convener: Ralph Timmermann

In recent years the interaction between the ocean and the cryosphere in the marginal seas of the Southern Ocean has become a major focus in climate research. Questions such as "Why does the Antarctic sea ice cover not shrink like in the Arctic?" or "How far does warm ocean water advance into Antarctica's ice shelf cavities? What are the consequences for ice shelf stability and global sea level?" have attracted scientific and public attention. Recent advances in observational technology, data coverage, and modeling provide scientists with new opportunities to understand the mechanisms involving ice-ocean interaction in the far South much better. Processes on the Antarctic continental shelf have been identified as a missing link between the cryosphere and the deep open ocean and need to be captured in large-scale and global model simulations.

This session calls for studies of the Southern Ocean's marginal seas including the Antarctic continental shelf and ice shelf cavities. The interaction between ice shelves and sea ice with the open ocean is of major interest, for example the spreading and modification of water masses including those shaped by glacial meltwater input and sea ice formation. This includes work on all scales, from local via basin-scale to circumpolar. Studies based on in-situ observations and remote sensing as well as regional to global models are welcome. We particularly invite cross-disciplinary topics involving physical and biological oceanography, glaciology or biogeochemistry.

Invited speaker:
Elin Darelius (University of Bergen , Norway) on current research in the Filchner Trough area, a key region of ice-ocean interaction and ongoing change.

OS1.7 The Southern Ocean in a changing climate: open-ocean physical and biogeochemical processes

Conveners: Lavinia Patara , Ivy Frenger
Co-Conveners: Carolina Dufour , Julien Le Sommer , Judith Hauck , Jean-Baptiste Sallee

The Southern Ocean around the latitudes of the Antarctic Circumpolar Current is a key region for the vertical and lateral exchanges of heat, carbon and nutrients, with significant impacts on the climate system as a whole. The role of the Southern Ocean as a sink of heat and carbon in present and future climate conditions remains uncertain. To reduce this uncertainty, understanding the physical and

biogeochemical processes underlying the Southern Ocean internal variability and its response to external forcing is critical. Recent advances in observational capabilities, such as autonomous floats, gliders, and satellite systems, as well as numerical models at unprecedented resolution and complexity, are providing a deeper insight into the three-dimensional patterns of Southern Ocean change. This session will discuss the current state of knowledge and novel findings concerning the role of the Southern Ocean in past, present and future climates, including its mixing and mesoscale processes, ocean-topography interactions, biogeochemical cycling, pathways of upwelling and subduction, water mass exchanges with lower latitudes, and ocean-atmosphere interactions.

Solicited speaker: Nicole Lovenduski, University of Colorado Boulder, US

OS1.8/CL2.08 Tropical & Subtropical Ocean Circulation, Equatorial to Mid-Latitude Air-Sea Interactions (co-organized)

Convener: Alban Lazar

Co-Conveners: Marcus Dengler , Noel Keenlyside

Observations and simulations of ocean circulation and marine atmosphere processes are rapidly growing for meso- to basin scale on diurnal to interannual time scale. This session focuses on tropical and subtropical ocean dynamics as well as local interaction between the ocean and the overlying atmosphere from the equator to mid-latitudes. Relevant processes in the ocean include deep and upper ocean circulation variability, mild SST gradients to sharp fronts, eddies, filaments, tropical instability waves, warm pools, upper ocean various layers, cold tongues and eastern boundary upwelling. Regarding air-sea interactions, we seek studies that analyse the local to regional scales, and those discussing the conditions under which they may lead to a large-scale atmospheric response. Surface wind modulations, Madden-Julian Oscillation, cyclones, and convective systems, as well as scale interactions are welcome. In the extra-tropics, we seek also contributions on the role of extra-tropical fronts in anchoring mid-latitude storms and precipitation, and generally on how the air-sea interactions may shape modes of climate variability.

OS1.9/AS1.17/BG9.60/CL4.16 The Indian Ocean’s past, present, and future – A session in Honour of Gary Meyers (co-organized)

Convener: Caroline Ummenhofer

Co-Conveners: V. VIALARD , Rayleigh Hood , Susan Wijffels , Birgit Gaye , Gregory L. Cowie , Tim Rixen

The Indian Ocean received a lot of attention before the 1980s, due to its very dynamic seasonal variability in response to reversing monsoon winds. At the turn of the millennium, the discovery of the Indian Ocean Dipole and new work on the Madden-Julian Oscillation underscored the basin's importance for global climate. This invigorated efforts to improve observing systems in that basin, which has, in turn, stimulated a renewed interest in characterising and understanding biogeochemical and ecological variability. As a result, significant advances have been made in our understanding of the Indian Ocean's circulation, interactions with adjacent ocean basins, biogeochemistry and ecology, and the role of the basin in regional and global climate. Nonetheless, significant gaps remain in the observing system and our understanding. With one third of the world population living in countries around the Indian Ocean, it is also very important to better understand its response to anthropogenic climate change. This session invites contributions that address Indian Ocean variability and change across a range of timescales, based on observations, modelling, and theory. In particular, research that

focuses on interactions between physical, biogeochemical, and ecological processes in the Indian Ocean and links between the Indian Ocean and other oceanic basins is encouraged. Contributions are also sought that address research on the grand challenges in the Indian Ocean system, as formulated by the Oceans and climate: variability, predictability, and change (CLIVAR), the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER), and the International Indian Ocean Expedition 2 (IIOE-2) programs.

This session is dedicated to honour the late Gary Meyers. His contributions have been instrumental in advancing Indian Ocean research. Gary Meyers played a pivotal role in establishing sustained ocean observing systems in the Indian Ocean, and he made major contributions to understanding the circulation in the Indo-Pacific, including the Indonesian Throughflow, the role of the Indian Ocean for regional climate variability and change, and facilitating interdisciplinary research.

Invited speaker: Ming Feng (CSIRO, Australia)

OS1.10 Air-Sea Energy and Mass Exchanges and their Impacts on the Ocean and Atmosphere

Convener: Sergey Gulev | Co-Convener: Bernard Barnier

Air-sea energy and mass exchanges represent the language of ocean-atmosphere communication. Surface energy fluxes force ocean and atmospheric dynamics and provide feedbacks in a coupled climate system. Accurate estimation of surface energy and mass fluxes is critical for the closure of the ocean energy balance. Surface energy fluxes play a crucial role in the multiscale variability of a coupled climate system and remain effective indicators of climate change. This session intends to provide a dialogue between developers and users of surface air-sea flux products. We invite papers dealing with a broad range of surface flux studies, including those focusing on the fundamentals of air-sea flux physics, on the production of air-sea flux estimates, and on application of air-sea flux products in other fields of climate science. Papers dealing with direct flux measurements, remotely sensed fluxes, air-sea fluxes from reanalyses and operational analyses will be welcome, first of all in the context of validation and inter-comparison of different products. We especially welcome studies of space-time variability at all scales - from synoptic and mesoscale to decadal and centennial. We also welcome analyses of model experiments with ocean, atmospheric and climate models driven by surface fluxes.

OS1.11 Ocean salinity / Marine hydrological cycle

Convener: Gilles Reverdin
Co-Conveners: Jacqueline Boutin , Thierry Delcroix , Detlef Stammer , Tong Lee

The ocean surface salinity is strongly influenced by the water exchanges with the atmosphere, sea ice formation and melt, as well as inputs from river runoffs and ice shelves. Salinity plays key dynamical roles on the ocean circulation and on recent or past climate variability in addition to being a tracer of ocean circulation. The observation of surface salinity is at the core of major ongoing in situ and satellite programs.

We encourage the presentation of investigations on processes maintaining both the salinity maxima in the subtropical gyres and low surface salinities under or near the marine ITCZ, river estuaries and at the high latitudes, in particular on or near shelves. Results pertaining to the 'modern' ocean using in situ observations or new satellite data (for example, from the SMOS, Aquarius, and SMAP missions) and related numeral modelling and assimilation, will be particularly welcome. Diagnostics from other related

tracers, such as water isotopes or their signatures in different oceanic archives of the last millenium, as well as studies of shorter-term (decadal or centennial) future evolution of ocean salinity, can also be accepted.

This intends to bring together communities working on all aspects related to ocean surface salinity and freshwater studies in the ocean, to review most recent results and to discuss further progress that is required.

CL4.10/CR1.13/OS1.12 Sea level rise: past, present and future (co-organized)

Convener: Svetlana Jevrejeva
Co-Conveners: Aslak Grinsted , Guy Woppelmann , Nadya Vinogradova , Detlef Stammer , Marta Marcos

We invite contributions from studies using historical and recent estimates of sea level from tide gauges, satellites, ocean, cryosphere, and earth models to improve our understanding of the past and present changes in sea level, and to produce better predictions of future change.

Various questions will be discussed in this session. For example, do we fully understand the reasons for the global and regional sea level rise in the past, present and future? What is the role of ocean dynamics and fresh water flux from melting glaciers and ice sheets in determining patterns of sea level change? How unusual is the rate of present day sea level rise compared to the last centuries? What fraction of this recent sea level rise can be attributed to human activities? What observations are needed to better understand sea level rise and variability, in particular to anticipate future changes and impacts at the coast? What is the level of confidence in latest estimates of sea level change? Are there ways to reduce uncertainties of the predicted future climate?

CL2.03/AS4.9/CR1.12/OS1.13 Taking the temperature of Earth: Variability, trends and applications of observed surface temperature data across all domains of Earth's surface (co-organized)

Convener: Darren Ghent
Co-Conveners: Stephan Matthiesen , Janette Bessembinder , Nick Rayner , G.C. Hulley , Simon Hook

Surface temperature (ST) is a critical variable for studying the energy and water balances of the Earth surface, and underpinning many aspects of climate research and services. The overarching motivation for this session is the need for better understanding of in-situ measurements and satellite observations to quantify ST. The term "surface temperature" encompasses several distinct temperatures that differently characterize even a single place and time on Earth’s surface, as well as encompassing different domains of Earth’s surface (surface air, sea, land, lakes and ice). Different surface temperatures play inter-connected yet distinct roles in the Earth’s surface system, and are observed with different complementary techniques.

The EarthTemp network was established in 2012 to stimulate new international collaboration in measuring and better understanding ST across all domains of the Earth’s surface including air, land, sea, lakes, ice. New and existing international projects and products have evolved from network collaboration (e.g. ESA Climate Change Initiative SST project, EUSTACE, FIDUCEO, International Surface Temperature Initiative, ESA GlobTemperature, HadISST, CRUTEM and HadCRUT). Knowledge gained during this EarthTemp session will be documented and published as part of the user

requirements exercises for such projects and will thus benefit the wider community. A focus of this session is the use of ST's for assessing variability and long-term trends in the Earth system. In addition there will be opportunity for users of surface temperature over any surface of Earth on all space and timescales to showcase their use of the data and their results, to learn from each others' practice and to communicate their needs for improvements to developers of surface temperature products. Suggested contributions can include, but are not limited to, topics like:

* The application of ST in climate science
* How to improve remote sensing of ST in different environments
* Challenges from changes of in-situ observing networks over time
* Current understanding of how different types of ST inter-¬relate
* Nature of errors and uncertainties in ST observations
* Mutual/integrated quality control between satellite and in-situ observing systems.
* What do users of surface temperature data require in practical applications?

Oral and poster sessions focussing on users' applications will be supplemented by splinter sessions that provide an opportunity for developers of state-of-the-art products to discuss with potential users possible new methods and types of information provision (e.g. concerning communication of uncertainties).

CL4.05/CR1.8/OS1.14 Processes and Impacts of climate change in the Arctic realm: from past to future (co-organized)

Convener: Anne de Vernal

Co-Conveners: Paul G. Myers , Michal Kucera , Georg Schwamborn , Paul Knutz , Brice Rea , Marit-Solveig Seidenkrantz , Hugues Goosse , Eric Wolff

The Arctic Realm is rapidly changing at a pace exceeding the average rate of the ongoing global warming. Particularly sensitive to this change is the cryosphere, including both Arctic sea ice, glaciers and the Greenland Ice Cap. Melting of ice has large impact on the radiative energy budget and sea level. At the same time, the meltwater discharge may affect oceanic circulation. Many of these processes and feedbacks operate on time scales too long for instrumental observations and the sensitivities and natural variation in key Earth System Components in the Arctic can be best studied on natural experiments from the geological past. In this session, we invite contributions from a range of disciplines and across time scales, including observational data, proxy data, model simulations and forecasts. The common denominator of these studies will be their focus on a better understanding of the involved processes and their impacts.

CL3.03/AS1.22/CR1.6/OS1.15 Polar Climate Predictability and Prediction (co-organized)

Convener: Neven-Stjepan Fuckar

Co-Conveners: Virginie Guemas , Torben Koenigk , Matthieu Chevallier , Ed Hawkins , Edward Blanchard-Wrigglesworth , Rym Msadek , Helge Goessling

The Arctic sea ice cover and many other elements of the cryosphere are experiencing significant changes over the modern observational era. The polar climate is crucial for the Earth’s energy and water budget, and its variability and change have direct socio-economic impacts. However, most of climate models are not yet in position to provide us with accurate predictions of polar climate. We welcome presentations advancing understanding of the mechanisms that control polar climate variability on sub-seasonal to multi-decadal timescales and climate change in both hemispheres. We

encourage submissions that examine sources of polar climate predictability in a hierarchy of models, and link polar processes and predictions with mid- and low-latitude climate. We look forward to studies using remote sensing data, field observations, proxy data, theory and numerical models encompassing climate projections, reanalyses and forecast systems. This session aims to further connection between the atmospheric, oceanic and cryospheric research and operational communities. Furthermore, the session is an opportunity to present and discuss plans for the Year of Polar Prediction (YOPP), with its Core Phase commencing mid-2017.

CL4.04/OS1.16 On the dynamics of Dansgaard-Oeschger events: perspectives from paleoclimate data and modeling (co-organized)

Convener: Joel Pedro

Co-Conveners: Ruth Mottram , Kerim Nisancioglu , Helle Astrid Kjær , markus jochum , Mari F. Jensen

The stability of the cryosphere depends on processes that are still poorly understood. New insights into the causes of sea ice and ice sheet variability are coming from their improved representation in numerical models and modern observations. In addition marine core and ice core records document in increasing detail the local and global sequence of sea ice, atmosphere and ocean circulation changes during the abrupt Dansgaard-Oeschger (D-O) events of the last glacial period. Capturing the processes responsible for D-O events and their Southern Hemisphere counterparts (Antarctic Isotope Maxima) in climate models remains a major challenge, but understanding their dynamics should provide fundamental information on the stability of the cryosphere and its connections to lower latitudes. In this interdisciplinary session we welcome model and observational research which tests hypotheses on causes and processes behind D-O events and research which helps us to understand past, present and future changes to the cryosphere. The session is hosted by the ERC SyG project ice2ice.

G3.1/CL5.14/CR6.10/GD3.6/GM10.6/NH8.3/OS1.17 How much does glacial isostatic adjustment contribute to earth system modelling? (co-organized)

Convener: Holger Steffen

Co-Conveners: Maaria Nordman , Pietro Sternai , Wouter van der Wal

Glacial isostatic adjustment (GIA) is the response of the Earth to past and present-day fluctuations of glaciers, ice caps, and ice sheets. Due to the many physical parameters affected, GIA generates measurable changes to sea level, horizontal and vertical crustal motion, as well as the Earth's gravitational field, rotation and stress field. GIA, in addition, influences predictions of future sea-level change and is assumed as a potential trigger for historic intraplate earthquakes as well as increased volcanic activity during the current interglacial.

GIA is often corrected for in different geoscientific fields by removing its contribution based on methods without thorough error estimates. Thus, in this session we not only invite papers focusing on worldwide GIA phenomena and/or the usage of observations for determination of Earth's rheological parameters, but also papers that investigate and highlight the contribution of GIA in Earth system modelling. We name here studies dealing with the effect of uncertainty of GIA model predictions on sea-level change, the influence of Earth model parameters on ice dynamics, or potential stress changes in the far field of formerly glaciated areas leading to increased volcanism. In addition, we welcome papers introducing new analyses and collections of GIA observations such as relative sea-level (RSL), tide gauge records, levelling, GNSS, satellite altimetry, terrestrial (absolute and relative) and space-borne gravity measurements. Furthermore, we welcome new modelling developments such as inclusion of

crustal/lithospheric structures (sedimentary basins, faults, subduction zones), mantle rheology variation, surface erosion treatment, and contributions to analysis of potential feedbacks between GIA and climate changes.

Invited speaker is Lev Tarasov from the Memorial University of Newfoundland.

CR6.1/OS1.18 Rapid changes in sea ice: processes and implications (co-organized)
Convener: Daniel Feltham
Co-Conveners: Daniela Flocco , Andrew Wells

In 2012 the Arctic summer sea ice extent was the lowest in satellite history, exceeding the previous low in 2007. In fact, the last ten years (2007 to 2015) have seen the ten lowest Arctic summer sea ice extents in the continuous satellite history. While the changes in the Southern Ocean sea ice cover have not been so dramatic, there has been a redistribution of sea ice and a slight net increase in recent years.

The scientific community is investing considerable effort in organising our current knowledge of the physical and biogeochemical properties of sea ice, exploring poorly understood sea ice processes, and forecasting future changes of the sea ice cover.

In this session, we invite contributions regarding all aspects of sea ice science and sea ice-climate interactions, including snow and sea ice thermodynamics and dynamics, sea ice-atmosphere and sea ice-ocean interactions, sea ice biological and chemical processes, and sea ice models. A focus on emerging processes and implications is particularly welcome.

CL1.19/AS4.17/OS1.19 Advances in integrating ice core, marine and terrestrial records and their timescales (INTIMATE and IntCal) (co-organized)
Convener: Christine Lane
Co-Conveners: Edouard Bard , Achim Brauer , Irka Hajdas , Tim Heaton , W.Z. Hoek , Alan Hogg , Raimund Muscheler , Christof Pearce , David Richards , Didier Roche

Extending instrumental records using well-dated, quantified palaeoenvironmental and palaeoclimate data from ice-core, marine and terrestrial records, is critical to understanding and modelling the timing, mechanisms and impacts of past and future climate change. Recent improvements in radiocarbon calibration and methods for correlation of independently dated archives have revealed both spatial and temporal climate variability on decadal to millennial timescales. Such findings provide key insights into complex drivers, feedbacks and responses operating within the global climate system. With a focus on records from the last 60,000 years, this session co-organised by the INTIMATE network and IntCal, invites contributions that address: the integration of data from diverse palaeo-archives using robust chronological techniques; developments and applications in radiocarbon calibration; novel palaeoclimate modelling approaches and results; research into the nature and variability of past climate change and impacts on the environment. For further information on INTIMATE and IntCal research, see: http://intimate.nbi.ku.dk/ and http://intcal.qub.ac.uk/

CL1.24/AS4.19/CR1.11/OS1.20 Decadal to millennial scale climate variability of the late Quaternary (co-organized)

Convener: Marit-Solveig Seidenkrantz

Co-Conveners: Antoon Kuijpers , Marie-Alexandrine Sicre , Mads Faurschou Knudsen , Christof Pearce , Camilla S. Andresen , Kaarina Weckström

Increasing evidence underlines the importance of understanding the natural atmosphere and ocean variability, including the ocean-atmosphere-ice interaction, at decadal to millennial time scales during both glacial and interglacial periods. It remains a matter of debate, to which extent solar and volcanic forcing or internal ocean oscillations account for these climatic shifts which, among others, involve significant changes in Arctic sea-ice conditions, ocean and atmospheric temperature, storminess, and precipitation patterns around the world. Outlet-glacier dynamics may also be influenced due to subsurface ocean warming affecting glacier melting. The main objective of this session is to focus on the origin and mechanisms involved in decadal- to millennial-scale ocean and atmospheric variability.

CL1.22/CR1.10/OS1.21 Antarctic palaeoclimates, sea level change and ice dynamics in past warm episodes: marrying models and data (co-organized)

Convener: Peter Bijl

Co-Conveners: Carlota Escutia , Aisling Dolan

Evidence from field observations of sedimentological records alongside geochemical, microfossil and seismic data analysis suggests that the entire Cenozoic Antarctic ice sheet witnessed several episodes of dramatic waxing and waning in concert with evidence for climates moderately warmer than today. In contrast, numerical modelling studies have not always been able to predict such dynamic behaviour given reasonable climate forcings. In general, the causes and consequences of major ice sheet volume and sea level changes in the past are often poorly understood.

This session aims to bring together research fields of numerical ice sheet, climate and oceanographic modelling and field/proxy data, as a way to foster model-data comparison. We invite submissions that aim to present new insights from improved numerical modelling experiments of ice sheet, oceanographic and sea ice dynamics as well as those presenting new field data from sedimentary records around the Antarctic Margin (e.g., those from Integrated Ocean drilling program Leg 318 to the Wilkes Land Margin, ANDRILL and their predecessors) or proxy data pertaining to conditions in the Southern Ocean. We welcome research from all areas related to ice sheet dynamics, e.g. bedrock responses to ice sheet changes, the gravitational isostatic responses to glaciation, potential thresholds in climate (induced by orbit or carbon dioxide changes). Submissions considering both proxy-evidence and modelling studies are encouraged.

CL4.17/AS1.16/OS1.22 Tropical Climate Variability and Teleconnections: past, present and future (co-organized)

Convener: Joke Lübbecke

Co-Conveners: Belen Rodríguez de Fonseca , Irene Polo , Elsa Mohino , Fred Kucharski , Teresa Losada

This session is devoted to the understanding of tropical climate variability and teleconnections. Contributions will examine the impacts, teleconnections and underlying physical mechanisms of tropical climate features such as the El Nino-Southern Oscillation (and El Nino-Modoki), Walker Circulations

and Hadley Cells, the Indian Ocean Dipole, Tropical Atlantic Variability, the tropical monsoons, the Inter-Tropical Convergence Zone, Intra-seasonal variability, and the Indo-Pacific Warm Pool.

To provide insights into past, present and future changes in tropical climate, this session will focus on research based on historical observations, instrumental records and GCM simulation results at interanual and multidecadal timescales.

IE3.7/OS1.23 Surface Drifters for Addressing Big Questions and Applications in Interdisciplinary Ocean Science (co-organized)

Convener: Inga Monika Koszalka
Co-Conveners: Joe LaCasce , Annalisa Griffa

The global drifter data comprises nearly 1400 surface buoys around the world, many with temperature and salinity sensors, and over 20 years of high-quality data at sub-daily resolution. This session will address the collection, analysis and application of the surface drifter observations and drifter-inspired Lagrangian models in a range of disciplines:

- studies of oceanic variability (dispersion, variability on different time scales)
- diagnosis of eddies and related processes
- marine ecosystem applications (plankton dispersion, genetic connectivity)
- usage in weather forecast services and reanalyses
- comparison of drifter-borne SST and SSS measurements with remotely-sensed observations
- ocean model evaluation and Lagrangian data assimilation
- dispersion of plastic and oil spills studies
- drifter array design and drifter platforms and sensors

The session aims at a productive exchange between the different ocean science disciplines. We encourage contributors to consider broader aspects and applications, as well as future prospects through questions like:

- what are the needs for drifter development (biogeochemical sensors, turbulence sensors) and are they being addressed?
- what are the goals for the current array strategy and can they be improved e.g., to resolve specific temporal or regional current variability?
- is the drifter-derived diffusivity applicable to ocean models as a surface mixing rate, and over which temporal and length scales?
- what advances are required for plastics and oil spill pollution prediction?
- is the variability seen in SST/SSS measurements from drifters and other platforms consistent, and on which temporal and spatial scales? What does it mean for deployment strategy and reanalysis products?
- how can drifter assimilation into the reanalysis products and models be further improved?

Such questions will be addressed during short formal and long informal discussions, with the aim of fostering future interdisciplinary collaboration.

OS2 – Coastal Oceans, Semi-enclosed and Marginal Seas

OS2.3 Oceanography at coastal scales. Modelling, coupling and observations

Convener: Agustín Sánchez-Arcilla

Co-Conveners: Emil Stanev , Sandro Carniel

Oceanographic processes at coastal scales present a number of differences with respect to deep water oceanography, which result in higher prediction errors. In shallow water coastal domains the bottom topography, via the sea-bed boundary condition, exerts a strong control on the resulting wave and current fields. In addition to this, other factors need to be accounted for, such as the relevance of the tidal influence, stratification and mixing effects, land boundary condition (affecting the wind fields), the presence of distributed run off and point-wise river mouths, the effects of densely populated areas with many ongoing economic activities.

Moreover, the coupling between wind, waves, currents and sediments at limited scales, or even the choice of the numerical strategy (including the option between nested meshes, finite-difference or finite-element discretization, variable grid, etc.) may also play a critical role in the quality of the predictions. Coastal observations are therefore necessary to drive numerical models, combining point-wise data from multi variable buoys, high frequency radar images and a number of satellite images, the accuracy of which however tends to degrade as we get closer to the shoreline border. The advent of new satellite capabilities (resolution and sensors like for instance those of the Sentinel constellation) and new modelling advances (local parametrizations and enhanced coupling and boundary conditions) together with in-situ data from coastal observatories should allow starting a quantum leap in coastal oceanography.

These issues are even more relevant in a framework of changing climate, since coastal and transitional areas are strongly impacted both by the anthropogenic activities going on along the shores, and the ocean shaping the environment, as stressed by the IPCC last report. Because of the above mentioned reasons, and with the aim to identify also key-parameters that will allow to detect and monitor likely changes, it is timely to discuss recent advances in fields such as: integrated ocean-atmosphere-sediment modeling approaches and the physics of their coupling mechanisms; the hydrological, biogeochemical, geomorphological variability of coastal regions; the availability and use of coastal in-situ observations; and standards procedures and data formats to make data ready for use in an integrated ocean processes monitoring system. Some of the themes we invite for this session are: satellite/in-situ measurements, coastal assimilation, model coupling and error/prediction limits as well as the contribution of coastal ocean science to operational oceanography. And these for the main processes controlling coastal variability (hydrodynamics, morphodynamics and bio-geochemical processes). Applications to improve our knowledge on how these processes interact with coastal infrastructure or activities are also welcome.

CL1.23/BG9.14/CR6.3/OS2.5 Polar continental margins and fjords – climate, oceanography, tectonics and geohazards (co-organized)

Convener: Kelly Hogan

Co-Conveners: Matthias Forwick , Jan Sverre Laberg , Berit Oline Hjelstuen , Michele Rebesco , H. Christian Hass

During the last decade significant advances in our understanding of the development of polar continental margins during the Cenozoic have been made. These include more detailed reconstructions of the climatic, oceanographic, and tectonic evolution of high northern and southern latitudes over various time scales, as well as reconstructions of past ice-sheet dynamics and studies of marine

geohazards. Results have been obtained from conventional 2D and high-resolution 2D and 3D seismic surveying, as well as from short sediment cores and longer drill cores (e.g. IODP, MeBo).

Fjords are regarded as “small oceans” that incise high latitude coastlines and link continental margins with the interiors of landmasses. Fjord settings allow us to study a variety of geological processes similar to those that have occurred on glaciated continental margins, but typically at smaller scales. The contribution of several sediment sources (e.g. glacial, fluvioglacial, fluvial, biological) to fjord basins along with relatively high sedimentation rates also provides the potential for high-resolution palaeoclimatic and palaeooceanographic records on decadal to centennial timescales.

The aim of this multi-disciplinary session is to follow on from the success of previous years by bringing together researchers working on northern and southern high-latitude continental margins and fjords, investigating the dynamics of past ice sheets, climate, tectonics, sedimentary processes, physical oceanography, and palaeo-biology/ecology.

NH5.4/AS4.30/OS2.7 Natural Hazards and climate change impacts in coastal areas (co-organized)

Convener: Joern Behrens
Co-Conveners: Goneri Le Cozannet , R. Ranasinghe , Michael Herzog , Renske de Winter

With presumed sea level changes in the near future and changed patterns of atmospheric and hydrological events coastal areas appear to be a hot spot of vulnerability under climate change impact. This statement, however, involves a large amount of uncertainty calling for better understanding of the underlying physical processes and systems. Examples are the ongoing research projects under the EU-FP7 theme “Coasts at threat in Europe: tsunamis and climate-related risks”. ASTARTE attempts to reach a higher level of tsunami resilience. The goal of PEARL and RISK-KIT is to reduce impact and increase resilience to low-frequency, high-impact hydro-meteorological events in the coastal zone.

While global scale climate modelling is reaching a mature stage, the robust assessment of impacts at regional and local scales is still an emerging science. This understanding cannot be achieved through observations alone due to the rarity and the extreme character of the events or since it concerns future impacts. Numerical models play therefore a crucial role in characterizing coastal hazards and assigning risks to them.

This session will focus on assessments and case studies from a global and regional perspective of potential impacts of tsunamis, storm surge, sea level rise, waves, and currents on coasts. Also of interest are near-shore non-linear wave interaction processes, onshore flooding processes, and coastal coupled system modelling approaches. Finally, the consequences of such physical phenomena on societies and corresponding coping capability can be a topic of this session.

OS3 – Ocean Biogeochemistry, Biology, Biodiversity and Physical Coupling

OS3.1/BG9.69 Ocean biogeochemistry: novel approaches and synthesis (co-organized)

Convener: Daniela Turk

Co-Conveners: Olaf Duteil , Judith Hauck , Siv K Lauvset , Vincent Rossi , Maribel I. García-Ibáñez , E.P. Achterberg , Jošt Valentin Lavrič , Nicholas Bates

The cycling of carbon, oxygen, and nitrogen in the world's oceans is undergoing unprecedented change as a result of anthropogenic pressures. Observations and future projections at all spatio-temporal scales of the complex interactions within these biogeochemical cycles and their perturbations will help us to understand the implications of future changes for marine ecosystems and ocean sustainability.

This session will bring together researchers that use a range of novel techniques, including observations, experiments, models and remote sensing, as well as global data sets to further our understanding of the biological carbon-pump, the biogeochemical cycles in the ocean and their connections to ecosystems and climate. We welcome contributions dealing with the cycling of carbon, oxygen, and nitrogen in the ocean, dissolved and particulate stoichiometry and elemental ratios, ocean acidification, exchange processes at the air-sea interface, role of sea-ice in global biogeochemical cycles and synthesis studies including those using global data sets such as SOCAT and GLODAP.

AS4.4/BG9.1/OS3.7 Air-sea exchanges: Impacts on Biogeochemistry and Climate (co-organized)

Convener: Maria Kanakidou

Co-Conveners: Peter S. Liss , Parvadha Suntharalingam , Frank Dentener , Manmohan Sarin , Robert Duce

Atmospheric inputs of natural and anthropogenic substances and their impact on ocean biogeochemistry and climate have been subject of major debate. Enhanced atmospheric deposition of anthropogenic nitrogen, iron, and phosphorus to the ocean surface may induce low-level ocean fertilization, in turn increasing marine 'new' productivity and sequestering additional atmospheric CO2 into the ocean. Recent changes in anthropogenic and climatic conditions may result in enhanced nutrients deposition to the open ocean, with impacts on marine productivity, CO2 drawdown, N2O production and the emissions of marine organic compounds. Atmospheric inputs of other toxic substances, e.g., lead, cadmium, and persistent organic pollutants, into the ocean are also of concern. This session will address the atmospheric deposition fluxes, impact of nutrients and toxic substances to the ocean, emissions and fate of gases and aerosols emitted from the ocean surface, and major uncertainties limiting our understanding and evaluation of these impacts on marine biogeochemistry and climate. We welcome new findings from both measurement programmes and atmospheric and oceanic models.

This session arises from the work of GESAMP Working Group 38 on ‘Atmospheric Deposition of Nitrogen and its Impact on Marine Biogeochemistry’.

OS4 – Ocean Modelling, Observing, Forecasting and Societal Applications

OS4.1 Open Session on Operational Oceanography

Convener: Richard Allard

Co-Conveners: Paolo Oddo , Jacopo Chiggiato , Emanuel Coelho

We welcome contributions in the area of Operational Oceanography which demonstrate skill assessment, uncertainty estimation, end-to-end applications and risk analysis. Discussions can include the use of metrics comparing model simulations with data and other operational criteria (already existing in oceanography or novel methods taken from other disciplines), data assimilation, analysis of error covariances and error distributions and risk assessment due to forecast errors. Disciplines can range from physical (e.g waves, currents, ice, the thermohaline structure, and related fields) to physical-biogeochemical (e.g. inherent optical properties, chlorophyll concentration, primary production, nutrient cycling) along with their downstream operational implementations. We invite papers describing assessment of local, regional and global models and the complementary observing systems (e.g. fixed in-situ, satellite, ferries, gliders, floats) which provide the data required for assessment, from the open ocean to the nearshore. This session will provide a forum for real-time applications of ocean forecasting systems based on hydrodynamic, ecological, and/or integrated land-air-ocean-wave-ice coupled modeling systems. Topics we would like to focus on include: risk analysis, forecast validity and uncertainty; observational network assessment and adaptive sampling; reconciliation of multi-model / ensemble simulations. With the move towards the routine dissemination of oceanographic services we also welcome contributions reflecting the current trend in this area.

OS4.2 Ocean Remote Sensing

Convener: Aida Alvera-Azcárate

Co-Conveners: Guoqi Han , Tong Lee , Craig Donlon , Ad Stoffelen , Christine Gommenginger

Advanced remote sensing capabilities provide unprecedented opportunities for monitoring, studying, and forecasting the ocean environment. An integrated approach for synthesizing remote sensing data with in situ measurements and ocean models is highly desirable, both for physical and biological oceanography, polar oceanography and for marine gravity and geodesy on the regional, basin and global scales. This session provides a forum for interdisciplinary discussions of the latest advances in all aspects of oceanographic applications of remote sensing.

We welcome contributions on all aspects of the remote sensing of the ocean. Topics for this session include but are not limited to: physical oceanographic variability and interactions with the atmosphere, ocean currents, winds and surface waves, biological variability and the carbon cycle; sub-mesoscale processes, marine gravity and space geodesy, advances in the measurement and interpretation of the ocean surface salinity, and new instrument and techniques development in ocean remote sensing. Applications of multi-sensor observations to study ocean and climate processes and applications using international (virtual) constellations of satellites are also welcome.

A topic of interest for this year's Ocean Remote Sensing session is the remote sensing of Polar Oceans and their connection with the atmosphere, sea ice, biogeochemistry and hydrology. Polar regions play an essential role in the Earth's climate and are experiencing fast changes that will have long-term consequences. We encourage presentations addressing movements of interior carbon on the Polar Oceans, freshwater discharge and flow of carbon from the land, atmosphere-ocean gas exchanges, heat fluxes, ocean acidification, primary production, sea ice dynamics and ice sheet change, as well as

the effect of winds and waves on the polar regions. Methodological issues and uncertainty estimation studies of these applications are also welcome.

OS4.3 Advances in water column and seafloor fixed point observatories

Convener: Richard Lampitt
Co-Conveners: Martin Heesemann , Luisa Cristini , Susanne Neuer , Eric Delory , Mairi Best

Fixed-point observatories and repeat sampling sites in the open ocean provide long-term time series data in order to investigate processes and detect changes in ecosystems, ocean dynamics, and seafloor environments in remote regions. Multidisciplinary research is carried out at various sites throughout the world oceans allowing observations from the air-sea interface to the deep ocean.

Ocean observatories provide power, communications, sensors, and data infrastructure for continuous, high resolution, (near)-real-time, interactive ocean observations across a truly interdisciplinary range of research areas including biology, geology, chemistry, physics, engineering, and computer science; from polar to tropical environments, down to the abyss. Such coordinated data allow us to pose multivariate questions in space and time, rather than focusing on single data streams. Continuous data are required to document episodic events, such as phytoplankton blooms, earthquakes, and pollution episodes. Together, water column and seafloor observatories face the next challenge in Earth-Ocean Science: How to co-ordinate ocean data acquisition, analysis, dissemination and response across provincial, national, regional, and global scales?

In this session we bring together researchers from all ocean disciplines working on in situ observations in the open ocean to share results and discuss challenges and future plans for such observatories. We welcome contributions in all areas of ocean science including physics, geology, biology, chemistry and biogeochemistry and encourage those addressing intersections between disciplines and research themes. This could also include using ocean observatories to inform satellite algorithms and numerical models.

Examples of topics include, but are not limited to:

1. Results from specific fixed-point water column and seafloor open ocean observatories, particularly from long term sustained programmes.
2. Insights from collaborations and international programmes
3. Specific methodologies to address technical and scientific challenges.
4. Air-sea interactions, ocean surface meteorology and processes
5. Ecosystems structure and function in the water column
6. Processes and ecosystems at the seafloor and across the sediment/water interface
7. Management of open ocean observatories

OS4.4 Experiments with gliders: new challenges for observations and modeling

Convener: Reiner Onken
Co-Conveners: Aniello Russo , Ines Borrione , Anthony Bosse , Emma Heslop

During the last decade, sub-surface gliders became a popular tool for the exploration of the oceans. Due to their high-resolution sampling capability and their long endurance, they are applied to a wide spectrum of spatial scales from sub-mesoscale to basin-scale structures. Meanwhile, a variety of

different payloads allows comprehensive investigations in oceanography and bio-geochemistry, both by means of observational and modeling studies.

In this session, any contribution is welcome concerning
• Development, operation and piloting of gliders,
• Legal issues,
• Quality control and dissemination of glider measurements,
• Analyses of glider observations,
• Assimilation of glider data in numerical models.

The contributions may be related both to sub-surface and wave gliders.

OS4.5 Open session on observing the ocean

Convener: Francesco Marcello Falcieri
Co-Conveners: Francesco Barbariol , Mariona Claret , Stylianos Flampouris , Aleksandra Kruss

Direct observation of the ocean is still one of the pillars on which modern ocean sciences are built. From a technological and methodological point of view monitoring the ocean is an ever evolving field, with a growing interest on interdisciplinary observations.

This open session on observing the ocean has a twofold intent: to provide an opportunity to discuss instruments used to collect data in the ocean (i.e. common observational tools as well as innovative platforms and procedures) and to act as a forum to present ocean observations using a broad and interdisciplinary spectrum and range of scales.

The session is organized by early career scientists and, while it is directed to the whole scientific community, we strongly encourage contributions from young scientist. We welcome contributions from all fields in oceanography, from local to global and form macro to micro ocean scales.

OS4.6 Copernicus Marine Environment Monitoring Service (CMEMS)

Convener: Angelique Melet
Co-Conveners: S. Ciavatta , Ananda Pascual , Giovanni Coppini , Emanuela Clementi

The Copernicus Marine Environment Monitoring Service (CMEMS) provides regular and systematic reference information on the physical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas. This capacity encompasses the description of the current situation (analysis), the variability at different spatial and temporal scales, the prediction of the situation a few days ahead (forecast), and the provision of consistent retrospective data records for recent years (re-analysis and reprocessed datasets). CMEMS provides a sustainable response to European user needs in four areas of benefits: (i) maritime safety, (ii) marine resources, (iii) coastal and marine environment, (iv) weather, seasonal forecast and climate.

The session will cover research activities that are required to maintain CMEMS systems at the state of the art and prepare their long-term evolution (e.g. physical and biogeochemical modeling, coupling with coastal systems; coupling with sea-ice, atmosphere & waves; data assimilation both for physics and biogeochemistry). We also welcome scientific presentations on the verification, validation and uncertainty estimates of CMEMS products and on the use of CMEMS products for downstream

applications and the monitoring and long-term assessment of the ocean physical and biogeochemical states. Presentations should not be limited to research teams directly involved in CMEMS and participation from external teams (e.g. from H2020 projects relevant to CMEMS) is strongly encouraged, as well as presentations on the use of Sentinel products.

OS4.9 Recent algorithmic developments in oceanic and sea-ice models : numerical schemes and test-cases for model assessment

Convener: Florian LEMARIE

Co-Conveners: Sergey Danilov , Mehmet Ilicak , Thierry Penduff , Laurent Debreu

Ocean/sea-ice simulation models are widely used in realistic contexts for climate studies (coupled to the atmosphere), coastal applications or for the study of the atmospherically-forced oceanic circulation, and in more simplified contexts for investigating isolated processes (e.g. idealized test-cases). Thanks to advances in computational power, those models are now configured with increasingly higher horizontal/vertical resolution which requires continuous rethinking of numerical methods and modeling assumptions. The objective of this session is to bring together scientists working on the improvement/development of numerical kernels of ocean/sea-ice models (and/or simplified models like transport or shallow-water equations), including their synergy with physical parameterizations. The scope is on the design, testing, and application of new numerical methods, and the assessment of methods currently used in existing state-of-the-art models in realistic or idealized configurations. This includes three main topics (i) horizontal/vertical discretization techniques adapted to fixed/variable structured/non-structured meshes, and the associated time-integration techniques, (ii) the adaptation of numerical methods to physical constraints : monotonic/positive-definite schemes for passive tracers, the control of numerically-induced mixing, and more generally physics-dynamics coupling issues, (iii) the development of semi-idealized test-cases and/or realistic configurations to exploring the merits of different numerical approaches and highlighting successes, deficiencies or biases in model code, approximations or parameterizations.

CL5.08/AS1.3/OS4.10 Downscaling: methods and applications (co-organized)

Convener: Douglas Maraun

Co-Conveners: Erika Coppola , Sabine Radanovics , Marlis Hofer

Dynamical systems such as atmosphere and oceans are characterized by variability on a large range of temporal and spatial scales. Consequently, the resolution of models, measurements and retrievals are often insufficient. Downscaling methods, based on dynamical or statistical approaches or their combination, are then needed to generate time series and fields with an appropriate spatial or temporal resolution. This session aims to bring together scientists from all geoscientific disciplines working on downscaling problems. The focus will be on studies addressing methodological questions, introducing new algorithms, as well as research comparing and validating methods and assessing their added value as well as limitations. Also state-of-the-art applications of downscaling methods highlighting these issues are welcome. Contributions are sought both on dynamical and statistical downscaling, including bias correction.

G3.2/CR2.4/HS11.8/OS4.12 Fluid signatures in the hydrosphere, ocean and cryosphere from space geodesy (co-organized)

Convener: Roelof Rietbroek

Co-Conveners: Mohammad J. Tourian , Henryk Dobslaw , Carmen Boening

Spaceborne geodetic sensors have established themselves as valuable tools for hydrological, oceanographic, and cryospheric applications. For example, satellite altimetry serves now as virtual lake and river gauges, and surface water extent quantification with satellite imagery data allows for the high-resolution monitoring of the geometry of flooded regions. The satellite mission GRACE provides a fundamentally new remote sensing tool for a wide spectrum of Earth science applications by measuring changes in the Earth's gravitational field and thereby mass changes in both oceanic and terrestrial storages. Various Global Navigation Satellite Systems (GNSS) that are currently operating provide a wealth of information on several components of the water cycle, including GPS-based atmospheric sounding for tropospheric water vapour content assessment; GNSS-network deformations reflecting loading effects from hydrological, cryospheric and atmospheric mass changes; and GNSS-reflectometry aiming at the measurement of both changes in water-level heights and local soil moisture. In addition to signals at weekly to interannual time-scales that are well resolved from repeated space observations, high-frequency variability and episodic events are potentially observable with space geodesy. Extreme precipation events cause rapid changes in soil moisture, root zone storage and surface waters, which may affect the time-varying gravity field. Furthermore, temperature and moisture variability in the troposphere cause dispersion of, for example, GPS and radar signals.

This session welcomes multidisciplinary contributions that demonstrate new uses of spaceborne geodetic sensors for hydro-/geodesy/meteorology, oceanography, and cryospheric applications, as well as reports about state-of-the-art approaches to observe or model high-frequency variability of geophysical origin. We encourage contributions which target a multidisciplinary audience interested in space geodesy.

AS4.11/CL5.23/OS4.15 Recent Developments in Numerical Earth System Modelling (co-organized)

Convener: Christopher Eldred
Co-Conveners: Werner Bauer , Christiane Jablonowski , Christian Kühnlein

In both climate modelling and numerical weather prediction, numerical models of the Earth System are used extensively. For the both the atmosphere and ocean such models consist of a fluid dynamics solver (dynamical core) coupled to physics parameterizations to represent processes that occur below the grid scale (physics). Over time these models have become capable of sophisticated simulations, incorporating such features as multi-scale prediction, structure-preserving discretization and a detailed treatment of physics. New work is constantly being undertaken to improve the accuracy and efficiency of these models, both the dynamical core and the physics.

This session encompasses the development, testing and application of novel numerical techniques for Earth system models, including new discretizations, test cases, advection schemes, vertical discretizations, adaptive multi-scale models, physics-dynamics coupling, global and regional climate and NWP models, structure-preserving discretizations and parameterizations (that are not covered in other sessions).

OS5 – Theory and Dynamical Processes

OS5.1/AS1.12 Internal Gravity Waves (co-organized)

Convener: Ulrich Achatz
Co-Conveners: Erich Becker , Riwal Plougonven , Bruno Ribstein , Chantal Staquet

In many respects internal gravity waves (IGWs) still pose major questions both to the atmospheric sciences, to ocean sciences and to stellar physics. Important issues are IGW radiation from their various relevant sources, IGW reflection at boundaries, their propagation through and interaction with a larger-scale flow, wave-induced mean flow, wave-wave interactions in general, wave breaking and its implications for mixing, and the parameterization of these processes in models not explicitly resolving IGWs. Also the observational record, both on a global scale and with respect to local small-scale processes, is not yet sufficiently able to yield appropriate constraints. The session is intended to bring together experts from all fields of geophysical and astrophysical fluid dynamics working on related problems. A special focus this year will be results from the DFG research unit MS-GWaves (https://ms-gwaves.iau.uni-frankfurt.de/). However, presentations on theoretical, modeling, experimental, and observational work with regard to all aspects of IGWs are most welcome.

OS5.2 Surface Waves and Wave-Coupled Effects in Lower Atmosphere and Upper Ocean

Convener: Francisco J. OCAMPO-TORRES
Co-Conveners: Alexander Babanin , Miguel Onorato , Fangli Qiao

We invite presentations on ocean surface waves, and wind-generated waves in particular, their dynamics, modelling and applications. This is a large topic of the physical oceanography in its own right, but it is also becoming clear that many large-scale geophysical processes are essentially coupled with the surface waves, and those include climate, weather, tropical cyclones and other phenomena in the atmosphere and many issues of the upper-ocean mixing below the interface. This is a rapidly developing area of research and geophysical applications, and contributions on wave-coupled effects in the lower atmosphere and upper ocean are strongly encouraged.

AS2.6/OS5.4 Turbulence in Atmospheric and Oceanic Boundary Layers (co-organized)

Convener: Arakel Petrosyan
Co-Convener: Stephen Belcher

This session is focused on fundamental advances in understanding the mean dynamical and thermodynamical structure and the turbulence and mixing properties of boundary layers in the atmosphere and ocean. Contributions reporting theoretical, numerical or experimental work are welcome. Topics of particular interest in 2015 include: (i) Turbulence and mixing characterization in convective, neutral and stably stratified boundary layers. (ii) The scale dependent parametrization of turbulence and mixing (ranging from large-eddy simulations of boundary layer flows with subgrid parametrization, regional models with subgrid boundary-layer flow parametrization, and global climate and weather prediction models). (iii) The mixing height over heterogeneous and complex terrains. (iv)The role of organized vortices and other coherent motions, such as roll vortices in the planetary boundary layer and Langmuir circulations in the ocean mixed layer. (v) Boundary-layer clouds and marine, cloud toped boundary layers within atmospheric GCMs.

Turbulence in cloudy boundary layers. (vi) The roughness sublayer of the turbulent boundary layer. Near-surface turbulent fluxes over land (vegetation, urban canopy, dust, snow, etc.) and over water (open ocean, costal waters, storms, swell). (vii) Advanced turbulence closure models (achievements, experimental verification, limits of applicability, alternative approaches).

AS2.3/CR6.4/OS5.5/SSS9.27 Boundary Layers in High Latitudes: Physical and Chemical Exchange Processes over Ocean-Ice-Snow-Land Surfaces (co-organized)

Convener: William Neff

Co-Conveners: Günther Heinemann , Anna Jones , Michael Tjernström , Philip Anderson , Thorsten Bartels-Rausch , Stefania Argentini , Christopher Cox

Given the rapid changes in the polar regions, this session addresses key physical and chemical processes, especially in the boundary layer, over the Arctic and Antarctic whose understanding is needed to improve predictability of future changes in the polar regions. These processes include surface exchange of heat, momentum, moisture, and chemical constituents over increasingly complex ocean-ice-snow-land surfaces. Also of importance is dynamical connection of polar regions to the mid-latitudes for their supply of heat, moisture, and various chemical species. Of increasing interest is the role of extremes in the atmospheric circulation, particularly meridional transport events that can disturb the physical and chemical state of the high latitudes (that may be associated with rapid sea ice reduction, melting of the ice sheets, and marine physical and ecosystem changes, etc.).

This session is intended to provide an interdisciplinary forum to bring together researchers working in the areas of high-latitude weather and climate, boundary layer exchange processes, chemistry, and oceanography. We invite contributions in the following areas:

1. Observations and research that explore physical and chemical exchange processes over ocean-ice-snow-land surfaces in the polar latitudes ranging from molecular to regional scales.
2. Results from high-elevation sites where similar exchange processes over snow and ice are important are also welcome.
3. Results from field programs and observatories, insights from laboratory studies, and advances in modeling including parameterization of the boundary layer and reanalysis.
4. Advances in observing technology.
5. External controls on the boundary layer such as clouds, aerosols, radiation and transport processes.
6. The role of boundary layers in polar climate change and implications of climate change for surface exchange processes, especially in the context of reduced Arctic sea ice and physical and chemical changes associated with an increasing fraction of first year ice.

CL5.15/AS2.5/OS5.6 Ocean waves in the Earth's climate (co-organized)

Convener: Mikhail Dobrynin

Co-Conveners: Xiaolan Wang , Alvaro Semedo , Mark Hemer

The roles of surface gravity wave-driven processes in the climate system are being increasingly recognized. This includes both the effects of climate variability and change on the characteristics of the wave field and consequent impacts on coastal and offshore environments and infrastructure, and the influence of waves on the dynamics of the atmospheric and ocean boundary layers and consequent feedbacks. Wind waves also affect basic physical processes such as heat, momentum and mass exchange between the ocean and the atmosphere. Wind waves generate additional turbulence in the

ocean, modify ocean currents, and control the state of the sea surface. All these processes affect the air-sea exchanging processes, general circulation patterns, and have an impact in the wind in the atmosphere, changing the turbulence structures in the lower troposphere over the ocean. Following the outcome from the CMIP3 and CMIP5 projects, several studies of past and future of wave climate have been conducted, based on global climate and Earth system models. Single- and multi-model ensembles of historical and future wave climate projections, done under the auspices of the Coordinated Ocean Wave Climate Project (COWCLIP), are being generated to assess the evolution of the present wave climate and its correspondent evolution in the future. Some recent developments also introduce wave-driven processes into fully coupled Earth system model.

We welcome researchers to discuss trends and variability in the historical and future projections of wave climate on global and regional scales. Aspects of the building of wave reanalyses and hindcasts, future projections, downscaling and evaluation of model results by observations are also welcome. We encourage contributors to discuss further understanding of the mechanisms behind significant impact of wind wave on the Earth's system dynamics. This session aims to bring together climate and wave researchers to access the role of wind waves in the Earth climate, and discuss possible implications of wave-driven effects in coupled Earth system models

NH5.2/OS5.7 Extreme seas and non-linear waves (co-organized)
Convener: Alexey Slunyaev
Co-Conveners: Efim Pelinovsky , Alessandro Toffoli , Elzbieta Bitner-Gregersen

The scopes of the session involve different aspects of the large-amplitude wave phenomena in the Ocean such as freak or rogue waves, storm waves; large-amplitude edge and internal waves: dynamical and statistical theories, field observations and laboratory modelling, numerical simulations in the frameworks of approximate and primitive equations. Special attention is paid to the description of the wave breaking process, and also large-amplitude wave interaction with coastal structures. An essential concern of the session is all kinds of sea hazards related to marine operations: extreme storm conditions, collisions with abnormally high and steep solitary waves, etc. The session is addressing also wave description for marine structure design. General marine extremes such as climate change, tropical cyclones are in the focus of the session as well.