



CLIVAR
Open Science Conference
Qingdao, 2016



CHARTING THE COURSE FOR CLIMATE AND OCEAN RESEARCH

18-25 SEPTEMBER 2016 QINGDAO, CHINA

18, 24-25 September: **Early Career Scientists Symposium**

19-23 September: **Open Science Conference**

OSC Town Halls

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CLIVAR OPEN SCIENCE CONFERENCE

TOWN HALLS

Introduction	1
Town Hall schedule	1
List of Town Halls	2
Town hall 1: Introduction to YMC (Years of the Maritime Continent) and program 1 of WPOS (Strategic Priority Research Program of the Chinese Academy of Sciences) (Introduction to YMC and WPOS).....	3
Town Hall 2: Ocean-observing satellites – progress and future plans	4
Town hall 3: PAGES Town Hall meeting	6
Town hall 4: Atmospheric and Oceanic Teleconnection Across the Indo-Pacific Ocean (Indo-Pacific Teleconnection):	7
Town Hall 5: Future of WCRP	8
Town hall 6: Ocean Pathways of Glacier Melt: drivers, processes, impacts (Glacier Melt).....	9
Town hall 7: Coordinated analysis of HighResMIP (HighResMIP)	10
Town Hall 8: CLIVAR Science Plan	12
Town hall 9: Scoping out an agenda for a global Knowledge-Action Network on sustainable oceans and solutions (Future Earth)	13
Town hall 10: Ocean and Climate Modeling and CLIVAR (Ocean and Climate Modeling)	14
Town Hall 11: Ocean Observing	15

Introduction

Town Halls are seen as a key element of the CLIVAR 2016 Open Science Conference to focus on aspects that may not be explicitly or fully covered in the main programme (e.g., regional observational efforts, modelling and/or data initiatives, services, etc.), or to develop or promote new scientific directions, projects or experiments. Eleven Town Hall events have been proposed and scheduled on both Tuesday and Wednesday evenings (6:00-7:00 pm or 7:30-8:30pm), and Thursday afternoon (4:00pm-5:00pm).

Town Hall schedule

Date	Sep-20, Tuesday			Sep-21, Wednesday		Sep-22, Thursday
Session 1: 16:00-17:00						11: Ocean Observing
Session 2: 18:00-19:00	1: Introduction to YMC and WPOS	2: Ocean observing Satellites - future plans	3: PAGES	7: HighResMIP	8: CLIVAR Science Plan	
Session 3: 19:30-20:30	4: Indo-Pacific teleconnection	5: WCRP Future	6: Glacier Melt	9: Future Earth	10: Ocean and Climate Modeling	
Room	Hyatt Ballroom 1	Hyatt Ballroom 2	Hyatt Ballroom 3	Hyatt Ballroom 1	Hyatt Ballroom 2	Hyatt Ballroom 1

List of Town Halls

ID	Title	Lead	Affiliation/Role
1	Introduction to YMC and WPOS	Dongxiao Wang	SCSIO/CAS, China
2	Marine satellite progress and future plan	Fei Chai	State Key Laboratory of Satellite Ocean Environment Dynamics, SIO/SOA
3	PAGES Townhall Meeting	Marie-France Loutre; Pascale Braconnot	Executive Director, PAGES IPO
4	Atmospheric and Oceanic Teleconnection Across the Indo-Pacific Ocean	Dongliang Yuan; Mattieu Lengaigne	IOCAS, China LOCEAN, France
5	Future of WCRP and CLIVAR	Guy Brasseur	Max Planck Institute for Meteorology, Germany
6	Ocean Pathways of Glacier Melt: drivers, processes, impacts	Inga Monika Koszalka	GEOMAR, Germany
7	Coordinated analysis of HighResMIP	Rein Haarsma	KNMI, Netherlands
8	CLIVAR Science Plan	Detlef Stammer	CLIVAR SSG co-chair
9	Future Earth Ocean Network	Thorsten Kiefer	Director Global Hub Paris, Future Earth, France
10	Ocean and Climate Modeling and CLIVAR	Gokhan Danabasoglu	CLIVAR OMDP
11	Ocean Observing	Toshio Suga	former OOPC co-chair ; member of the GOOS Steering Committee.

Town hall 1: Introduction to YMC (Years of the Maritime Continent) and program 1 of WPOS (Strategic Priority Research Program of the Chinese Academy of Sciences) (Introduction to YMC and WPOS)

The townhall session is expected to coordinate planned research as well as identify gaps of Years of the Maritime Continent (YMC) and program 1 of the Strategic Priority Research Program of the Chinese Academy of Sciences (Western Pacific Ocean System: Structure, Dynamics and Consequence, WPOS). The aim of YMC is observing the weather-climate system of the Earth's largest archipelago to improve understanding and prediction of its local variability and global impact. The science themes of YMC include atmospheric convection, ocean and air-sea interaction, stratosphere-troposphere interaction, aerosol, and prediction improvement. These themes of YMC address the concerns and important issues of CLIVAR. In the tropical Western Pacific, the program 1 of WPOS has been aiming to achieve creative breakthroughs on the three-dimensional structures, characteristics and dynamic mechanisms of the variabilities of the major currents, as well as the feedback mechanisms of the Warm Pool to the East Asian climate since 2013. The objective of the session is to review and discuss the research progress featuring new findings during the execution of YMC and WPOS.

Lead Person:

Dongxiao Wang (South China Sea Institute of Oceanology, Chinese Academy of Sciences, P. R. China)

Presenters:

- Dongxiao Wang, South China Sea Institute of Oceanology, Chinese Academy of Sciences, P. R. China
- Hans von Storch, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany
- Jin-Song von Storch, Center for Marine and Atmospheric Sciences Hamburg, Germany
- Ming Feng, The Commonwealth Scientific and Industrial Research Organisation, Australia
- Jiang Zhu, Institute of Atmospheric Physics, Chinese Academy of Sciences, P. R. China
- Fan Wang, Institute of Oceanology, Chinese Academy of Sciences, P. R. China
- Weidong Yu, the First Institute of Oceanography, State Oceanic Administration, P.R. China
- Dongliang Yuan, Institute of Oceanology, Chinese Academy of Sciences, P. R. China

Town Hall 2: Ocean-observing satellites – progress and future plans

This session will focus on Chinese and European satellite missions and applications. Drs Xingwei Jiang and Mingsen Lin of the China National Satellite Ocean Application Service and the Key Laboratory of Space Ocean Remote Sensing and Application of the State Oceanic Administration will discuss Chinese ocean-observing satellite missions and plans, as well as applications of the data. Dr. HE Qianjiang from the State Key Laboratory of Satellite Ocean Environment Dynamics of the SOA Second Institute of Oceanography will focus on progress in ocean color remote sensing in China seas. Dr Anny Cazenave of the International Space Science Institute, Switzerland, and Laboratoire d'Etudes en Géophysique et Océanographie Spatiales, France, will give an overview of the European Space Agency's Earth Observation Programme for Oceans.

Lead person:

Fei Chai (School of Marine Sciences, University of Maine, USA and State Key Laboratory of Satellite Ocean Environment Dynamics, SIO SOA, China)

The Development Program of China's Ocean Satellite

Xingwei Jiang^{1,2}, Mingsen Lin^{1,2}

¹National Satellite Ocean Application Service, Beijing, China

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State Oceanic Administration, Beijing, China

The ocean satellite programs in China aim to provide global coverage of geophysical parameters over the ocean in the coming 10 years after the successful operations of the HY-1A/B and HY-2A satellites. It will be planned more than 15 satellites before 2025. The satellite missions are categorized as three types: ocean color satellites (HY-1 series), ocean dynamic environment satellites (HY-2 series) and ocean surveillance satellites (HY-3 series). The three types of ocean satellites launched in the coming 10 years will operate a wide range of electro-magnetic frequencies that measure the sea surface salinity, ocean vector winds, wave spectrum, sea surface temperature, sea surface height, significant wave heights, ocean color and biological productivity. After cross platform calibrations, the new set of satellite observations are thus expected (1) to significantly improve the temporal and spatial sampling frequencies of the surface ocean parameters that enable us to study the diurnal cycles of geo-bio-chemical processes (2) and to have great potential to maintain a long time series of satellite observations for climate studies. There are many applications for ocean environment monitor, ocean disaster monitor and forecast assimilation by ocean application in China. This paper will show the monitor results about the sea ice, sea surface wind, sea surface height, significant wave height, sea surface temperature and sea island survey and mapping by ocean satellite.

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New progresses of satellite ocean color remote sensing in China seas

Xianqiang He

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The China seas have many unique characteristics for the ocean color remote sensing, e.g. wide shelves with heavy terrestrial inputs and high turbidity. The complex ocean and atmosphere optical properties make the challenge for satellite ocean color remote sensing in these regions. In this talk, five aspects of new progresses of satellite ocean color remote sensing in China seas will be presented. First, the achievement of the radiative transfer model in the coupled ocean and atmosphere system will be introduced, that is the foundation of satellite ocean color remote sensing. Second, the atmospheric correction algorithms for turbid waters have been proposed for the coastal waters in China seas. Third, some of the new algorithms for the ocean color retrieval will be introduced, especially the identification of the harmful algal bloom. Fourth, new progresses of satellite remote sensing of marine carbon cycle will be presented. Finally, some of the new applications of ocean color remote sensing by using geostationary satellite data will be demonstrated.

The ESA Earth Observation Programme for Oceans

Jérôme Benveniste (1) and Anny Cazenave (2)

(1) European Space Agency (ESA), Frascati, Italy

(2) Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Toulouse, F and International Space Science Institute (ISSI), Bern, CH

The recently revisited ESA Living Planet challenges for the oceans include better understanding of (1) role of oceans on climate change and variability, (2) physical and bio-chemical air/sea interaction processes, (3) marine ecosystem variability, (4) role of land-ocean interactions on climate, and (5) ocean state and its predictability. To respond to some of these challenges, ESA has implemented the Climate Change Initiative Programme, with the objective of accurately monitoring from space a number of Essential Climate Variables (ECVs, as defined by the Global Climate Observing System). The ESA Earth Observation Programme includes several current and near future missions dedicated to monitor these ECVs. For example, the Sentinel-3 series of the Copernicus flagship missions are designed to improve the observation of ocean variables, in particular sea surface temperature, sea surface height and ocean colour. Besides, the SAR and high-resolution optical imagery systems of the Sentinel-1 and Sentinel-2 missions will also provide useful information on a number of ocean processes. In a few years, Sentinel-6/Jason CS will allow the continuation of long-term monitoring of the global mean sea level, a key indicator of global warming. Among the Earth Explorer missions, some of them have been developed for measuring ocean variables. This is the case of the recent GOCE mission that provided the reference geoid information needed to study the ocean dynamic topography (if combined with altimetry), hence the large scale ocean circulation; of the current CryoSat mission designed for estimating precise changes in the thickness of polar ice sheets and floating sea ice but also very efficient at measuring sea level in the ice-infested Arctic Ocean, and of SMOS for measuring sea surface salinity. In this presentation, we will briefly review the present and near future ESA Programme for the oceans, highlighting its contribution to the Copernicus climate services and to the monitoring of current climate and global environmental changes.

Town hall 3: PAGES Town Hall meeting

The PAGES (Past Global Changes) (<http://www.pastglobalchanges.org/about/general-overview>) project invites you to discuss common questions among the paleo, present day and future climate communities with the objective to strengthen the linkages between ongoing research in WCRP and PAGES.

PAGES is a core project of Future Earth and a scientific partner of WCRP that addresses observations, reconstructions and mechanisms of paleoenvironmental variations. PAGES deals with the physical climate system, biogeochemical cycles, ecosystem processes, biodiversity, and human dimensions, on different time scales --- Pleistocene, Holocene, last millennium and the recent past. The meeting will explore how scientists working on long and short time scales (past---present---future) might interact more effectively to tackle some of WCRP's Grand Challenges and CLIVAR research foci and benefit from common model simulations, data synthesis and methodologies.

The meeting will be organized with short presentations:

- PAGES and the WCRP/PAGES collaboration
- The status of the PMIP4 project
- Results and ongoing activity of some of the relevant PAGES working groups
- <http://www.pastglobalchanges.org/ini/wg/intro>
- Attendee are invited to bring a one-slide presentation on their favourite subject to stimulate the discussion

Among many potential themes, we anticipate interactions on the following topics: long-term ocean variability, linkages between the hydrological cycle, climate trends and variability, the characterization and analyses of extreme events, and emerging constraints from the past that can contribute to assess the credibility of future projections.

In order to have a stimulating and efficient meeting, please send your expression of interest to Marie-France Loutre and Pascale Braconnot with a few key words indicating which subjects you would like to discuss, so that the final agenda will best reflect the interest and goals of participants.

Lead Persons:

Marie-France Loutre – PAGES (Past Global Changes) - Switzerland

Pascale Braconnot - IPSL/LSCE, unité mixte CEA-CNRS-UVSQ - France

Presenters:

Representatives of PAGES and WCRP

Representatives of PAGES working group involved in the different OSC sessions

Town hall 4: Atmospheric and Oceanic Teleconnection Across the Indo-Pacific Ocean (Indo-Pacific Teleconnection):

The variability of the Pacific and Indian Oceans is of great importance to the global and regional climate variations and predictability. Latest studies suggest that Indian Ocean plays an important role in ENSO variability and predictability. The dynamics are either teleconnected by the atmospheric bridge or through the oceanic channel of the Indonesian seas. In this session, studies about the interactions of Pacific and Indian Ocean climate variabilities through the atmospheric bridge and the oceanic channel are reviewed and compared, the effects of which on the predictability of ENSO and monsoon are discussed.

Lead Persons:

Dongliang Yuan (Institute of Oceanology, Chinese Academy of Sciences, China), and Mattieu Lengaigne (Institut de Recherches pour le Développement (IRD), Laboratoire d'Océanographie - Expérimentation et Approches Numériques (LOCEAN), France)

Presenters:

- Jong-Seung Kug, University of Hawaii, USA
- Mattieu Lengaigne, Institut de Recherches pour le Développement (IRD), Laboratoire d'Océanographie - Expérimentation et Approches Numériques (LOCEAN), France
- Dongliang Yuan, Institute of Oceanology, Chinese Academy of Sciences, P. R. China
- Wansuo Duan, Institute of Atmospheric Sciences, Chinese Academy of Sciences, P. R. China

Town Hall 5: Future of WCRP

The mission of the World Climate Research Programme is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. The Joint Scientific Committee is charged with providing guidance and oversight on future directions for WCRP and its activities. Several Core projects including CLIVAR contribute to the development and success of WCRP.

In this Town Hall, the JSC invites OSC participants to discuss their views on the future strategy of WCRP. A few presentations will be made by members of the JSC as well as by Prof Hui-Jun Wang, Chair of the China National Committee for the WCRP. A discussion will take place to address several questions such as: (1) What should be the novel areas and new directions in fundamental climate research? (2) What new observations do we need? – where and how else should we look? and (3) How can our communities best support science innovation?

We hope that the informal discussion will suggest novel and under-explored research directions, along with the tools and infrastructure needed to drive them. Such research will serve to enable societal preparedness for surprises emanating from within the climate system. While investigating these themes, we invite discussions on how WCRP structures and programmes can be best set up and prepared to identify and meet future challenges in climate research.

Lead person:

Guy Brasseur, JSC Chair, Max Planck Institute for Meteorology, Germany

Town hall 6: Ocean Pathways of Glacier Melt: drivers, processes, impacts (Glacier Melt)

The Town Hall session "Ocean Pathways of Glacier Melt: drivers, processes, impacts" highlights the role of ocean circulation modulating glacier response (impact) to (on) the changing climate. The two main objectives are (1) to synthesize and share knowledge about different processes contributing to ocean-induced melting of glaciers in Greenland and Antarctica (warm water pathways to the marine-terminating glaciers and ice tongues, thermodynamics of glacier melt, circulation in the glacial fjords, ice melange and ice bergs dynamics) and (2) their expected regional and global impacts on fresh water budgets, marine ecosystem, and sea level.

This session engages several scientific disciplines: glaciology, ocean and climate dynamics, biogeochemistry, and marine biology. It offers a possibility to explore interdisciplinary and focused collaboration in terms of regional and global modeling, sustained observations, reanalysis systems, and operational services, model validation and improvement, interdisciplinary process observing programs, assessment of impact on coastal communities and the large scale climate. The scope of this session is bi-polar, with a goal to engage scientists active in the Northern (Greenland) and Southern (Antarctica) regions.

The Town Hall addresses the WCRP Grand Challenge on "Melting Ice & Global Consequences". It is relevant to International CLIVAR Panels on Ocean Model Development, Global Synthesis of Observations, and Climate Dynamics as well as to all the CLIVAR Regional Panels and in particular to the CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP) and to the US CLIVAR GRISO (Greenland Ice Ocean Science Network). It complements another activity held at the CLIVAR OSC Conference, the Poster Cluster "Ocean and cryosphere interactions in a warming climate".

The Town Hall aims to advance ocean-cryosphere interactions as one of the main themes of the new CLIVAR science plan, and possibly of a new dedicated CLIVAR/CliC Research Focus.

Lead Person:

Prof. Dr. Inga Monika Koszalka (GEOMAR – Helmholtz Centre for Ocean Research Kiel, Germany)

Presenters:

- Prof. Thomas Haine, Johns Hopkins University, USA
- Prof. Matthew England, UNSW CCRC and ARCCSS, Australia
- Prof. Monika Rhein, University of Bremen, Germany
- Dr. Karina Schuckmann (CLIVAR RF Concept Heat), Mercator-Ocean, France
- Dr. Inga Smith, (CLIVAR SORP), University of Otago, New Zealand
- Dr. Bin Zhao (ISMIP6), NASA, USA, Bin.Zhao@nasa.gov

Town hall 7: Coordinated analysis of HighResMIP (HighResMIP)

The High Resolution Model Intercomparison Project (HighResMIP) (Haarsma et al. 2016) consists of a coordinated set of experiments to assess both a standard and an enhanced horizontal resolution simulation in the atmosphere and ocean. The set of HighResMIP experiments is divided into three tiers consisting of atmosphere-only and coupled runs and spanning the period 1950-2050, with the possibility to extend to 2100, together with some additional targeted experiments.

Presently 19 modeling centers have promised to participate in Tier 1 and at least 6 centers participating in the European H2020 project PRIMAVERA will participate in all 3 Tiers. This provides an unique data set for coordinated analysis.

The main purpose of the Town Hall meeting is to identify a topic of coordinated analysis of HighResMIP data that will result in a joint paper in a high impact journal. Obvious topics are small scale extreme events, such as tropical cyclones, for which the added value of HighResMIP is most prominent. Regional phenomena like monsoons, or a more general assessment of the benefits of increased resolution are also possible topics.

After defining the topic, the coordinated analysis and organization of it will be discussed. Due to the large amount of data, new approaches of coordinated analysis have to be devised. Instead of "bring the data to your script" the approach of a "bring your script to the data" appears to be more suitable for large data sets. This approach has been followed by the PRIMAVERA partners where the storage and post processing of the data will be on the JASMIN server at the UK. Whether a similar solution as for PRIMAVERA could be applied for HighResMIP will be discussed. Also the type of analysis and the need for additional experiments will be discussed.

Finally a working group and next steps that will lead to coordinated analysis and a joint publication will be formulated.

The anticipated outcome of this Town Hall meeting is: Initiation of a coordinated analysis of HighResMIP data for a specific topic that would result in a joint high impact paper. Defining a working group that will take the lead in this and that will organize next steps.

The coordinated analysis of HighResMIP simulations, focusing on a specific scientific and socio-economic relevant topic is a clear contribution to CLIVAR's mission: to understand the dynamics, the interaction, and the predictability of the coupled ocean-atmosphere system. This for enabling better understanding of climate variability and dynamics, predictability, and change, to the benefit of society and the environment in which we live.

Structure of the Town Hall meeting:

- 1-2 speakers outlining the purpose of this meeting and suggestions for coordinated topics and analysis (15 minutes)
- Defining topic (15 minutes)
- Organization of coordinated analysis (15 minutes)
- Defining working group and next steps (15 minutes)

During the discussion participants can show 1-2 sheets to illustrate their ideas.

Haarsma, R.J. and 25 co-authors: High Resolution Model Intercomparison Project (HighResMIP).
Geosci. Model Dev. Discuss., doi:10.5194/gmd-2016-66, 2016

Lead Person:

Rein Haarsma/KNMI/Netherlands

Presenters:

Rein Haarsma/KNMI/Netherlands

Malcolm Roberts/Met. Office/United Kingdom/

Town Hall 8: CLIVAR Science Plan

The CLIVAR 2016 OSC has brought together over 600 people, including scientists with diverse interests from more than 40 countries and over 150 early career scientists. The CLIVAR leadership (Scientific Steering Committee) invites all participants to join in a review of the current draft of a new CLIVAR Science Plan and to discuss what is needed in the future to help advance the science being presented at the OSC. What should be the new directions of climate research, and what should be the respective CLIVAR goals as part of WCRP? Detlef Stammer, CLIVAR SSG co-chair, will summarize the current status of the new Science Plan that will be made available to participants in draft form prior to the conference. Contributions will be made at the town hall by representatives of WCRP and sister programmes on how CLIVAR fits with their future plans. Participants will have an opportunity to present their own views on the future of CLIVAR science and what kind of project is needed.

Lead person:

Detlef Stammer, U Hamburg, Germany

Town hall 9: Scoping out an agenda for a global Knowledge-Action Network on sustainable oceans and solutions (Future Earth)

Oceans, including coastal and nearshore areas, provide services essential for life on earth and to the history, culture and livelihoods of people across the globe. However, oceans are also facing multiple challenges from climate change, overfishing, acidification, de-oxygenation and pollution. Recently, an increasing concern about the health of the oceans has placed oceans prominently on several global science-policy agendas, e.g. by inclusion in the set of Sustainable Development Goals and among the upcoming IPCC special reports. Accordingly, research and information activities on ocean topics exist in abundance. Why do we wish to establish yet another ocean research network, and what do we hope to achieve with it that could not be covered by the existing structures?

The new global network intends to be an umbrella over the major existing international activities in order to coordinate research and advocacy efforts more effectively across disciplines, regions, and societal sectors. To that effect, Future Earth has recently launched an open and inclusive Knowledge-Action Network on the topic of ocean sustainability, with the objective to address societal challenges through solutions-oriented, transdisciplinary research. The network wants to build on strong fundamental research and innovative agendas of projects, organizations and communities worldwide, including WCRP, SCOR, GOOS and many others.

The network is currently scoping out its shape and agenda over the coming decade by consulting with global communities of researchers and societal actors with stakes in the generation and use of ocean knowledge. As part of this process, this townhall session solicits discussion of ideas from the CLIVAR community about the most pressing societal challenges, scientific questions and inter- and transdisciplinary opportunities to inform the framing of the agenda of this new ambitious ocean network.

Lead Person:

Thorsten Kiefer (Future Earth Secretariat, Global Hub in Paris, France)

Presenters:

Thorsten Kiefer (Future Earth Secretariat, Global Hub in Paris, France)

Martin Visbeck (GEOMAR, Germany)

Town hall 10: Ocean and Climate Modeling and CLIVAR (Ocean and Climate Modeling)

The mission of CLIVAR is to understand the dynamics, the interactions, and the predictability of the coupled ocean – atmosphere system. To accomplish this mission and its related objectives, CLIVAR enables science through the collection and analysis of observations and the development and applications of models of the coupled climate system. CLIVAR modeling capabilities to advance CLIVAR science activities cover efforts primarily on ocean system models that include both forward models and ocean reanalysis frameworks. The reanalysis work is undertaken by the Global Synthesis and Observations Panel (GSOP). The forward modeling efforts occur within the Ocean Model Development Panel (OMDP) which is the only global modeling panel within CLIVAR. One of OMDP's major foci is the development of ocean models for research in climate and related fields. Another one is to promote interactions amongst the broader ocean modeling community and, in particular, within CLIVAR, noting that all other CLIVAR panels and cross-cutting Research Foci teams have vital modeling needs.

The proposed Townhall Session is intended to provide i) brief summaries of recent developments and efforts from the ocean and coupled climate modeling, reanalysis, and decadal prediction communities, and ii) a discussion venue for all CLIVAR panels and Research Foci teams to discuss their modeling needs. The topics for the latter may include the next generation of ocean and climate models. The Townhall is expected to have representatives from the two WCRP modeling panels, i.e., WGCM and WGSIP, as well as the WCRP Modeling Advisory Council (WMAC).

Lead Person:

Gokhan Danabasoglu , National Center for Atmospheric Research (NCAR), USA

Co-chairs:

Stephen M. Griffies , NOAA Geophysical Fluid Dynamics Laboratory, USA

Fangli Qiao, First Institute of Oceanography, State Oceanic Administration, China

Town Hall 11: Ocean Observing

Sustained ocean observing is essential to document and understand decadal and longer climate variability. The recently articulated Framework for Ocean Observing has suggested to develop a concept of a set of Essential Ocean Variables (EOVs) which can be used to guide priority setting and system implementation. In addition research programs such as WCRP-CLIVAR are expected to support the development and innovation of new observing elements as well as spearhead the regional implementation by enhancing the efficiency and overall information content of integrated ocean observing systems (OOS). Several best practice examples exist for the Atlantic (AtlantOS), the Southern Ocean (SOOS, OOI, SOCCOM), the Pacific (TPOS2020), the pan-Arctic (SAON) and the Indian Ocean (IndOOS). One of the main goals for an integrated, fit-for-purpose global OOS is to enhance the efficiency and capability of all observing networks by strengthening the international partnerships within each of the networks to cover the global ocean. This town hall invites participants to a discussion of observation requirements for in situ systems in the global oceans with a focus on societal drivers (which includes research) and EOVs within the context of existing national capabilities, impediments, gaps and opportunities.

Lead person:

Toshio Suga, Tohoku U, Japan