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**WMO-IOC-ICSU WORLD CLIMATE RESEARCH PROGRAMME (WCRP):
YEAR 2011 REPORT**

Summary. This document has been prepared by WCRP to the attention of the IOC Assembly at its 26th session (UNESCO, Paris, 22 June–5 July 2011).



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General background

The World Climate Research Programme (WCRP) was established in 1980 by the World Meteorological Organization (WMO) and International Council for Science (ICSU) to address two objectives: to determine the predictability of climate and to determine the effects of human activities on climate for use in an increasing range of practical applications of direct relevance, benefit and value to society. Since 1993 WCRP has also been cosponsored by IOC of UNESCO.

Since the 25th IOC Assembly in 2009, WCRP has continued active support to and promotion of global coordination and integration of climate research sponsoring ~60 conferences, workshops, meetings and symposia focused on all aspects of the Earth's climate system (i.e. oceans, atmosphere, cryosphere and land-surface). WCRP pursues its research objectives through observations, process-understanding research, modelling and analysis, with an emphasis on practical results of regional and global importance.

The central focus of the WCRP Strategic Framework for the years 2005-2015 (http://www.wcrp-climate.org/documents/WCRP_IP_2010_2015.pdf) is to translate achievements in fundamental understanding of climate processes contributing to the variability and change in global and regional climate into a range of information products such as seasonal, regional and decadal climate predictions, projections and assessments of high societal value for a broad range of applications and users. WCRP continues to bring together scientists from around the world to formulate new research agendas and to leverage scientific know-how between researchers and across disciplines and between developed and developing countries. Ocean research in relation to climate remains very high on the WCRP science agenda.

This report provides a brief summary of main ocean-related WCRP activities since mid - 2009 – the time of IOC 25th Assembly. More information on WCRP activities including its activities linked to oceanography is available from the WCRP and CLIVAR websites (<http://wcrp.wmo.int> and <http://www.clivar.org>).

Planning and implementing the WCRP activities

The Programme Implementation Plan for the interim period (up to 2015, with a focus on completing the tasks formulated in its Strategic Framework COPEs) was completed and published in September 2009 (WCRP 2009, WMO/TD-No. 1503, (http://www.wcrp-climate.org/documents/WCRP_IP_2010_2015.pdf)). The Plan addresses priorities identified in the ICSU/WMO/IOC/IGFA independent review of WCRP and outlines how WCRP would deliver the best available state of knowledge on climate variability and change to the decision-makers, in an unbiased, policy relevant but not policy prescriptive manner consistent with the challenges and opportunities associated with prediction of weather and climate across all time and space scales. The Plan describes how WCRP would focus its activities and partnerships on fulfilling the existing and emerging societal needs. In addition to the Implementation Plan, WCRP assembled a report highlighting its main achievements since the initiation of COPEs. A forward-looking strategy beyond 2015 is being developed based on an assessment of the future scientific priorities and requirements of the WCRP sponsors and the international science community.

32nd Session of the WCRP Joint Scientific Committee

The 32nd session of WCRP Joint Scientific Committee (JSC) was convened on 4-8 April 2011 in Exeter, UK. Its main focus was on developing the Programme's long-term strategy and the role of WCRP research in the Global Framework for Climate Services and Global Sustainability Research Programme. The Session also reviewed implementation plans of WCRP core projects, main working groups, and the progress of the pan-WCRP cross-cutting activities (e.g. sea-level change, extreme climate/weather conditions, seasonal and regional climate prediction, etc.) that are aimed

at delivering climate information for an increasing range of practical applications to the benefit of the society. Drs Wendy Watson-Wright and Luis Valdes of the IOC Secretariat participated in the session and provided to the JSC an overview of the IOC plans, priorities and expectations from WCRP. Several specific actions resulted from these presentations. For example, WCRP and its CLIVAR project will discuss with IOC a possibility of a cross-cutting activity on communication. Some of the actions that were specific to CLIVAR were also presented and discussed at the 18th Session of the Scientific Steering Group of CLIVAR that was hosted by IOC on 2-5 May 2011 in Paris, France.

In his presentation to the CLIVAR SSG, Dr Valdez made suggestions as to how WCRP, and in particular CLIVAR, could further help IOC meet its objectives. These included increased efforts on regional modeling and sea-level change and broadening ocean climate research to include activities aimed at adaptation and mitigation of climate change in the oceans. He encouraged direct links between WCRP and IOC regional programmes and closer collaboration on pilot projects, working groups and outreach activities. The CLIVAR SSG reacted favorably to all these suggestions and went on to develop specific recommendations to address individual items. There was a clear recognition of the need to enhance interactions with coastal research communities, and a Task Force was formed to develop mechanisms for enhancing collaboration and exchange of research findings with these communities and with the International Geosphere - Biosphere Programme (IGBP) Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project. Each CLIVAR panel was asked to report to the SSG on ongoing and planned activities relating to regional sea level change and upwelling. Climate indices were identified as an important element in developing adaptation and mitigation strategies, and a CLIVAR Task Force will work with other interested groups to further develop ocean climate indices on time scales from days to centuries. The importance of ocean indices and data in using formats compatible for model intercomparison and evaluation was stressed. Collaboration with IOC on outreach activities, such as regional fora, was discussed and will be pursued in the coming year.

WCRP ocean and climate research including observations, modeling and prediction

Most WCRP projects are involved in aspects of oceanographic research. CLIVAR provides the focus within WCRP on understanding the role of the oceans in climate, develops observing systems, promotes reanalysis of existing ocean data, and develops ocean modules of global climate models. CliC contributes to these activities on cryospheric and polar aspects. GEWEX does so in the areas of surface flux research. As a co-sponsor of the Ocean Observations Panel for Climate (OOPC), WCRP strives to ensure high-quality and long-term ocean observations for climate and oceanographic research and prediction.

Climate model development and prediction experiments

WCRP is actively spearheading the improvement of climate predictions and projections. The WCRP Climate Model Intercomparison Project (CMIP5) coordinated by the WCRP JSC / CLIVAR Working Group on Coupled Modelling provides the framework for climate change modelling research and the basis for the next IPCC Assessment (AR5). As part of the CMIP5, WCRP is exploring the potential of decadal predictions that can provide useful information for developing adaptation strategies. Over 20 groups and about 40 models are participating in CMIP5. A data submission procedure is in place to publish CMIP5 data to the Earth System Grid (ESG) including multiple quality control tests. A CMIP5 analysis workshop is being planned for spring of 2012. The CMIP5 archive has started receiving model output and serving to users. More than 2 Petabytes of data are expected to be available for users, about 100 times more data than was produced for CMIP3 that served as the basis for the IPCC Fourth Assessment Report (AR4) in 2007. Coordinated use of CMIP5 climate projections and predictions for ocean research and coastal zone management applications is encouraged. As an example of facilitating a well-thought through use of the CMIP5 archive, WCRP and WMO/IOC JCOMM held on 11-13 April 2011 in Geneva, Switzerland, a workshop on Coordinated Ocean Wave Climate Projections (COWCLIP).

WCRP's efforts to improve regional climate projections and predictions are organized through a coordinated regional climate downscaling experiment (CORDEX) that is producing regional climate projections for many areas of the world with an initial focus on Africa. A team of regional scientists evaluate the strengths and limitations of the regional climate model results that will be used for a range of climate adaptation and risk management practices. WCRP regional activities also cover the ocean-atmosphere-land interactions of monsoonal nature, which are coordinated through the Asian- Australian Monsoon Panel (AAMP), Variability of the American Monsoon Systems (VAMOS), and Variability of the African Climate System (VACS) project. A major effort similar to CMIP5 is underway to promote the use of CORDEX results in a wide range of applications at the regional level in such areas as water resources, food production, ecosystems management, etc.

WCRP is examining in depth the capabilities and limitations of current generation of climate models that represent the major components of the Earth system, including the oceans, and their interactions. A community-wide consultation on the model evaluation and improvement involves a survey that was developed and circulated in 2009. Over 100 independent responses were received. The results are currently being analyzed to evaluate and document the model uncertainties. The resultant analysis will be published in the open literature, and a workshop will be held in 2012 to define the major areas of research for model development/improvement based on the survey results, and to draw up an implementation plan with active engagement of international community to address them. The CLIVAR SSG has formed a Task Force to explore how CLIVAR can best contribute to improving components of Earth system models.

Ocean model development and prediction experiments

The Working Group on Ocean Model Development (WGOMD) is developing the Coordinated Ocean - ice Reference Experiments (CORE), particularly the CORE II protocol. There are plans for coordinated analysis, as well as the status and developments of the CORE InterAnnual Forcing (IAF) dataset and the Repository for Evaluating Ocean Simulations (REOS). The analysis will be relevant for the evaluation of the ocean component of CMIP5 participating models as well as for the initialization of decadal predictions. It will cover time mean diagnostics over 1988-2007 and variability defined with respect to this mean, trends and changes over this period. Regional case studies such as one on changes in the strength of the Atlantic sub-polar gyre will contribute to understanding of observed variability. The CORE II simulations can also explore sensitivity of the ocean to changes in precipitation at high latitudes, in zonal wind trend over the Southern Ocean and to abrupt shifts in the buoyancy and mechanical forcing. WGOMD will produce CORE II synthesis papers within the timeframe for evaluation by IPCC AR5. A Workshop "Decadal Variability, Predictability and Prediction: Understanding the role of the Ocean", held on 20 - 23 September 2010 in Boulder, USA, discussed prospects for the broader community to develop a common framework for research in decadal variability, predictability and prediction including the role of the ocean observations and modeling. At its most recent meeting, the CLIVAR SSG formed a Task Force to identify and coordinate decadal variability and predictability activities across all its panels and working groups.

Ocean – atmosphere fluxes and micro-scale studies

WCRP collaborates with IGBP, SCOR and the international Commission on Atmospheric Chemistry and Global Pollution on the Surface Ocean-Lower Atmosphere Study (SOLAS) to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and how this coupled system affects and is being affected by climate and environmental changes. SOLAS is implementing its mid-term strategy, which adds the following elements to the scope of these collaborative activities:

- Sea-ice biogeochemistry and interactions with the atmosphere
- Atmospheric control of nutrient cycling and production in the surface ocean
- Air-sea gas fluxes at Eastern Boundary upwelling systems
- SOLAS Observatory and MOIN: the Minimalist OceanSITES Interdisciplinary Network
- Ship plumes: impacts on atmospheric chemistry climate and nutrient supply to the oceans

A conference on 'Earth Observation for ocean- atmosphere interactions science is being planned for 29 November - 2 December 2011 in Frascati, Italy. This conference is co-sponsored by ESA, SOLAS, EGU and COST Action 735. Plans are underway to hold the next SOLAS Open Science Conference in 2012.

OceanObs'09 and sustained ocean observations

WCRP was a co-Sponsor, active participant and supporter of OceanObs'09 (Venice, 25-29 September 2009) organized by the IOC and European Space Agency (ESA). Chairs of the OOPC and CLIVAR Global Synthesis and Observations Panel were the Co-chairs of the Symposium. The resulting Integrated Framework for Sustained Ocean Observations will be discussed by the 26th IOC Assembly under agenda item 6.1. At its 32nd Session the WCRP JSC agreed that this report will guide WCRP contribution to the development of sustained ocean observations.

A Workshop "XBT Bias and Fall Rate" was held on 25-27 August 2010 in Hamburg, Germany. It made recommendations for future work on reducing biases in both historical and future XBT data sets.

GO-SHIP:

The IOC-SCOR International Ocean Carbon Coordination Programme / CLIVAR Global Ocean Ship based Hydrographic Investigations Programme (GO-SHIP) held an international planning meeting on 21 February 2011, in Portland, Oregon, USA. The GO-SHIP committee published a Community White Paper developed for the OceanObs'09 Conference as a strategy document, which was presented to the 43rd Session of the IOC Executive Council. The committee has now finalized the GO-SHIP Development Plan, which outlines priorities and timelines for coordinating national hydrography programs into a global coordinated network, and the organizational framework and budget required to develop a sustained program. The Plan will be published soon. GO-SHIP has also published the Repeat Hydrography Manual (<http://www.goship.org>). At the 32nd Session of the JSC for WCRP, IOC requested WCRP to consider how the future organization of WCRP will accommodate the activities of GO-SHIP.

Global Synthesis and Observations, Reanalysis

A variety of reanalysis and data synthesis activities are underway for the atmosphere and ocean. Products of global reanalysis have provided the basis for advances in many areas, including climate now-casting and diagnostic studies of complex systems such as monsoons or the El Niño-Southern Oscillation. Global reanalysis is also the foundation for regional reanalysis projects and downscaling to study local climate and climate impacts. In addition, the development of comprehensive Earth system models requires expanding the scope of reanalysis and conduct of coupled atmosphere-ocean data assimilation. As the science of reanalysis grows, there is an urgent need to align financial and infrastructural resources for data handling and processing and to foster sustained international cooperation. The WCRP-GCOS co-sponsored Observation and Assimilation Panel (WOAP) is embarking on an inventory of WCRP data sets to facilitate access and assist in model validation and verification. USA hosted a series of workshops to: (1) review the current status of reanalyses and the lessons learned from them, and (2) identify the primary technical issues (from assimilation system and observation perspectives) that need to be addressed in the next reanalyses as well as new reanalysis systems (CFSR, 20thC, and MERRA), observations, and integrated Earth system analysis. The CLIVAR Global Synthesis and Observations Panel (GSOP) considered the development of ocean data syntheses at its 5th Session in Grenoble, France, on 11-13 May 2011. The CLIVAR SSG, at its most recent meeting, recommended increased interaction between GSOP and the Working Group on Ocean Model Development on the intercomparison, evaluation and development of ocean synthesis products and ocean models. The 4th International Reanalysis Conference is planned for May 2012 in USA.

Climate Change Detection and Indices (ETCCDI)

The CLIVAR/CCI/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI) held its 4th session on 23-25 February 2011 in Victoria, Canada. Through its JCOMM representation, the Expert Team (ET) is exploring extending its scope to include marine indices. The ET is preparing a position paper on marine indices, variability and extremes that will include the usefulness of developing a selected set of place-based indices and the possibility of extending land based indices to the ocean (e.g., linking SST to land surface temperature). ET will also explore the use of marine data to infer land indices where land observations are missing (e.g., for small islands).

WCRP regional oceanographic activities

Atlantic Ocean

As part of the coordination of Atlantic Meridional Circulation (AMOC) activities, CLIVAR Atlantic Implementation Panel (AIP) participated in the 3rd South Atlantic Meridional Overturning Circulation (SAMOC) workshop (Rio de Janeiro, Brazil, May 2010) and the 2010 US AMOC meeting (Miami, USA, June 2010). The AIP also sponsored a workshop entitled “Coupled Ocean Atmosphere Land Processes in the Tropical Atlantic” motivated by biases in coupled climate models common to the Atlantic and Pacific basins. These problems include the so-called “double ITCZ” (Intertropical Convergence Zone) systematic model error and an associated SST bias along the equator and in the southeastern tropical basins. Targeted observations and high-resolution modelling are improving understanding of the relevant processes and have encouraged a stronger physical basis to the boundary layer representation in climate models. A goal is to develop a coherent synthesis of existing knowledge for this region, to identify a network of interested researchers, and articulate an effective way forward.

Pacific Ocean

The CLIVAR Pacific Implementation Panel (PIP) met in Guayaquil, Ecuador on 15-16 October 2010, in association with a WCRP-cosponsored International Workshop on ENSO, Decadal Variability and Climate Change in South America (12-14 October 2010). The workshop participants recognized the importance of authoritative and reliable scientific information for developing effective risk management, mitigation and adaptation strategies in a world changing under the influence of human activity that is dependent on our understanding and ability to predict climate in the region on seasonal and longer time scales. Participants in the workshop “New strategies for evaluating ENSO processes in climate models” (17-19 November 2010, Paris, France) agreed to establish an inventory of the existing approaches and relevant observations. The panel also provides a forum for coordination of Pacific western boundary science projects. A highlight is the successful conclusion of a 52-day long investigation survey to the Northwestern Pacific as part of the Northwestern Pacific Ocean Circulation and Climate Experiment (NPOCE).

Indian Ocean Panel

Under the coordination of the CLIVAR/GOOS Indian Ocean Panel (IOP), which met in Perth, Australia, 12-16 July 2010, the Research Moored Array for African–Asian–Australian Monsoon Analysis and Prediction (RAMA) continues to develop and is now some 59% complete. Also, four new buoys are planned to be deployed in 2011. Jointly with the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER), a major regional activity under the IGBP IMBER Project and the biogeochemical and ecosystem research component of Indian Ocean GOOS, there are planned biogeochemical measurements to be made using the RAMA array. New instrumentation will be deployed that will provide data for defining biogeochemical variability in key regions of the Indian Ocean and for understanding the physical, biological and chemical processes that govern it.

The CINDY2011/DYNAMO process studies in the Indian Ocean region have been endorsed by CLIVAR. Their aim is to collect in-situ observations to advance our understanding of Madden-Julian Oscillation (MJO) initiation and to improve MJO prediction and simulation. The CLIVAR Indian Ocean Panel and the Pacific Panel have formed an Indonesian Throughflow (ITF) Task Team that will coordinate scientific efforts in the region. The Task Team will also provide a more complete description of the pathways, structure, and variability of the ITF (including related property transports), develop diagnostics and metrics for validation of ocean and climate models and improve data and product distribution from ITF programs.

The SCOR/WCRP/IAPSO WG 136 “Climatic Importance of the Greater Agulhas System” held its meeting on 20-21 February 2010, Portland, Oregon, USA. The significance of the transport of waters from Pacific and Indian by the Agulhas Current System that supports the Atlantic overturning circulation at a time when several other climatic factors tend to weaken it was recently published in (Beal et al., 2011)¹.

WCRP polar activities

The recent WCRP Workshop “Seasonal to multi-decadal predictability of polar climate (Bergen, Norway, 25-29 October 2010) reviewed the current state of knowledge of feedbacks and teleconnections that may be governing the polar climate change and lead to the existence of its predictable elements. The discussions made a solid input into the efforts of the community to develop a road map for Arctic climate prediction and design prediction experiments, data assimilation systems and models that will enable practical prediction of the Arctic climate on seasonal, inter-annual, and decadal scale. The sea-ice aspects of this work will continue under the CliC Arctic Sea-Ice Working Group (CASIWG). Expertise of this group is being extended to include not only sea-ice observations but also all sea-ice modeling aspects. The Workshop also recommended that the follow-on research in the Antarctic Region and Southern Ocean should encompass the whole system “stratosphere – troposphere – ice and ice shelves – ocean”. It is yet premature to speak about actual prediction of the climate system in that region, and the research there should focus on explaining the causes of observed trends and variability.

WCRP-coordinated polar research activities made a significant contribution to the International Polar year 2007-2008 (IPY) program. WCRP polar activities continue to contribute expertise and scientific knowledge to many, if not all, major polar and cryosphere initiatives including Sustaining Arctic Observing Networks (SAON), integrated Arctic Ocean Observing System (iAOOS), Southern Ocean Observing System (SOOS), the WMO Antarctic Observational Network (ANTON), Global Integrated Polar Prediction System, and the Global Cryosphere Watch (GCW). For example, CliC organized the “Satellite-derived Sea Ice Products Community Workshop” (Washington DC, USA, 15 and 16 March 2011). This meeting brought together algorithm developers, product distributors, operational organizations providing ice services, and users of such data and information. Participants in the Workshop discussed the large sea-ice climate records, different fields produced and used, with a view of evaluating and documenting them more thoroughly. They also reviewed intercomparisons of algorithms, errors/uncertainty estimates or confidence levels at grid point level, importance of data versioning and citing both products and input data, standards, documentation, conventions and methods (e.g., concentration threshold, land masks, etc.), and data formats. The future plans include consideration for a possible “ensemble” sea-ice extent estimate, which will comprise a key contribution to GCW, GOOS and GCOS.

¹ Lisa M. Beal, Wilhelmus P. M. De Ruijter, Arne Biastoch, Rainer Zahn, & SCOR/WCRP/IAPSO Working Group 136, 2011: On the role of the Agulhas system in ocean circulation and climate, *Nature*, 472, doi:10.1038/nature09983

Arctic Ocean

Together with the Arctic Monitoring and Assessment Programme (AMAP) and in cooperation with the International Arctic Science Committee (IASC), the WCRP Climate and Cryosphere (CliC) Project has been developing the Snow, Water, Ice and Permafrost in the Arctic (SWIPA) Assessment. The SWIPA project was established by the Arctic Council in April 2008 as a follow-up to the Arctic Climate Impact Assessment (ACIA). Its goal is to assess current scientific information on changes in the Arctic cryosphere, including the impacts of climate change on the ice, snow, and permafrost characteristics of the Arctic, which have potentially far reaching implications for both the Arctic and the Earth as a whole. CliC scientists have made a very strong contribution to the final SWIPA report, which was presented to the Arctic Council in May 2011 and will serve as an Arctic contribution to the IPCC AR5.

The CLIVAR SSG has asked its Working Group on Ocean Model Development and its Global Synthesis and Observations Panel to explore linkages with the Arctic Ocean research community and to seek guidance and advice on facilitating Arctic Ocean data synthesis. The development of the Polar Climate Predictability initiative as a pan-WCRP activity and ongoing consultations on the International Polar Decade initiative will provide the framework and opportunities for stronger collaborations. For example with the Arctic Ocean Science Board (AOSB), which acts now as the Marine Working Group of IASC, is planning to conduct a joint workshop with WCRP on IPY ocean data synthesis.

Southern Ocean

The science goals of the CLIVAR/CliC/SCAR Southern Ocean Region Implementation Panel (SOP) focus on furthering the objectives of the Southern Ocean Observing System (SOOS) and planning collaborative studies with emphasis on ocean carbon. The Southern Ocean Vision Document was finalized and a community paper on SOOS entitled “Rational and strategy for sustained observations of the Southern Ocean” is out for broad community input. The panel works closely with the SCAR/SCOR Oceanography Expert Group to move the SOOS Design Plan forward. The plan has now been completed, consulted upon and reviewed.

The role of sea-ice in the Antarctic will be studied under the renewed SCAR/CliC activity “Antarctic Sea Ice Processes and Climate” (ASPeCt). It will establish closer working relationships between the modelling and observing communities, identify the needs of the modelling community with respect to Southern Ocean data (scale issues, processes, properties, validation data), identify current observed data, determine whether current and planned observing systems are adequate to initialize models for decadal predictions, convey information to modellers, and promote interaction between modellers and observers. This group is also expected to contribute to the design and implementation of the SOOS.

Significant changes in the deep ocean were observed in the Southern Ocean and adjacent ocean basins. A workshop “Observed and Model Simulated Property Changes in the Deep Ocean of the Southern Hemisphere” was held on 21-23 June 2010 in Hobart, Australia. A working group was formed to write a synthesis peer-reviewed paper on Southern Ocean Antarctic Bottom Water (AABW) and deep ocean changes.

WCRP/IOC Task Group on Sea-Level Variability and Change

In 2009 the WCRP and IOC established the WCRP-IOC Task Group on Sea-Level Variability and Change (<http://www.wcrp-climate.org/SeaLevel.shtml>). The decision was made by the 30th Session of the WCRP Joint Scientific Committee (6-9 April 2009, College Park, Maryland, USA), and it was endorsed by the 25th Assembly of IOC. The Task Group addresses issues relevant to both global average of sea-level rise and also its variability in space and time. The overall goal of

the group is to help improving our ability to monitor, explain, predict global and regional sea level and all environmental factors related to it, and use this information for decision making.

A small Steering Group co-chaired by J. Church and K. Steffen leads the Task Group. A meeting of the Steering Group was held in Bern, Switzerland, on 24 March 2010 where the following initial activities of the Task Group were identified:

- consideration of the growing number of statistical approaches for prediction of sea-level rise the 21st century,
- fostering analysis and synthesis of observational and model results for inclusion in the IPCC AR5 (e.g. through the IPCC Workshop “Sea Level and Ice Sheet Instabilities”, Malaysia, 21-25 June 2010) and preparation of a review paper for the IPCC AR5 process,
- preparation of a periodic status statement on global sea level (a two page note every year or two),
- development of links with those interested in the impacts of sea-level rise, and
- identification of groups preparing adaptation and mitigation strategies for coastal planning and development.

Some of these activities have already resulted in actions, For example, as a result of the workshop organized in June 2006 by WCRP and IOC, the book “Understanding Sea-Level Rise and Variability” was published in August 2010 (<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-1444334514.html>). The book identifies the major impacts of sea-level rise, presents up-to- date assessments of past sea-level change, thoroughly reviews all of the factors contributing to sea-level rise, and explores how sea-level extreme events might change. It describes what is known and outlines the research and observations required to reduce the uncertainties in our understanding of sea-level rise so that more reliable future projections can be made. A synthesis of findings provides a concise summary of past, present and future sea-level rise and its impacts on society.

For the UNFCCC COP15 (Copenhagen, Denmark, December 2009), WCRP and WMO published an update on sea-level variability and change. The document reviews recent assessments of contributions to sea-level rise from the loss of mass of glaciers and ice sheets, combined with corrected estimates of the oceans’ thermal expansion, resulting in the combined contributions to sea-level change.

A “Regional Sea-Level Workshop” was held in IOC, Paris, France, on 7-9 February 2011. It was called by the Task Group organized by CLIVAR/GSOP, and sponsored by WCRP. The workshop discussed regional changes of sea level in comparison with global changes, underlying their time and space scales and mechanisms. It confronted observed regional sea level changes with those inferred from numerical simulations and compared future predictions and their analysis in terms of processes. This process distilled current challenges and possible ways forward in observing, modelling and predicting the regional sea level.

The WCRP Open Science Conference

WCRP is organizing an Open Science Conference (OSC) to be held in 24-28 October 2011, in Denver, Colorado, USA (<http://conference2011.wcrp-climate.org/>). At this Conference, the WCRP will assemble, for the first time ever, its entire research community and engage other key international research programmes. Through a synthesis of research findings, the OSC will assess our current state of knowledge on climate variability and change, identify the most urgent scientific issues and research challenges, and ascertain how the WCRP can best facilitate research and develop partnerships critical for progress. The OSC will appraise the current state of climate science, thereby making a measurable contribution to the IPCC AR5. It will identify key opportunities and challenges in observations, modeling, analysis and process research required to understand and predict responses of the Earth as a system. By entraining as many young

scientists and students as possible from across the world, including less-developed and developing countries, the OSC will facilitate growth of the diverse future workforce needed to meet the increasingly complex scientific challenges of the future.

IOC is invited to give a key note speech at the opening of the conference. There are several plenary talks on ocean observations and research. In each thematic area of the OSC there is an ocean subset.

WCRP and international climate change policy fora

Through the activities aimed at improving the scientific understanding of climate and transferring the new knowledge to environmental assessments (e.g. of ozone, climate, water, etc.), WCRP makes an important contribution to the UNFCCC process and the development of the post-Kyoto regime. WCRP also made great strides in providing the scientific information and knowledge about the Earth's climate system for policy decisions through the IPCC, the UNFCCC Conference of Parties, and its Subsidiary Body for Scientific and Technological Advice (SBSTA).

WCRP and climate services

WCRP-affiliated scientists played a major role in the success of the World Climate Conference-3 held in Geneva in August 2009 (http://www.wmo.int/pages/gfcs/index_en.html). The High-Level Segment of the Conference agreed to establish a Global Framework for Climate Services (GFCS) to strengthen production, availability, delivery and application of science-based climate prediction and services. Strengthening of WCRP as well as Earth system science and GCOS is seen as key to a successful GFCS.

WCRP will support the implementation of the Global Framework of Climate Services by 1) strengthening and mainstreaming research observations to serve as prototypes for future climate observing systems; 2) developing climate prediction systems with lead times from seasons to centuries; 3) ensuring development of reliable high-resolution products needed for climate adaptation and risk management; 4) promoting interdisciplinary research to develop sector applications, tools and tailored information; 5) facilitating flow of user requirements to the research community and climate services sectors through user feedback; and 6) improving the availability of highly-skilled talent to undertake climate research, operational prediction, and communication, particularly in the developing regions/countries.

Capacity development and partnerships

WCRP entrains many scientists, especially the early career scientists from developing regions and nations, into its activities. Many of the scientific and technical workshops that WCRP organized during last year offered travel grants to students and early career scientists, to ensure their full engagement in these events and follow-up activities. WCRP is planning to reinforce, on a sustained basis, such support in future events. A significant support program for early career and developing country scientists is being implemented as a part of preparations for the WCRP OSC. WCRP will continue to pursue its two pronged approach to capacity development by: 1) providing support to scientists from developing countries, and 2) building the research community of the future to ensure the transfer of appropriate skills and knowledge for the development of Earth system science and provision of resulting knowledge for decision makers.

WCRP continued to build on its existing partnerships with other international research programmes such as the IGBP on biogeochemical aspects, the International Human Dimensions Programme on Global Environmental Change (IHDP) on social and human dimensions of climate change research, and with the global Change SysTem for Analysis, Research and Training (START) and regional

organizations such as the Asian-Pacific Network (APN) and the Inter-American Institute (IAI) on capacity building, education and outreach. The WCRP work with START promotes research-policy dialogues in order to integrate climate change adaptation in development planning. The project involves the WMO, UNEP, the IPCC, START, the Universities of Ghana and Dar es Salaam, and the Bangladesh Centre for Advanced Studies.

WCRP, through its affiliated scientists, serving on the organizing Committee is contributing to the preparations of the second 2nd PICES/ICES/IOC Symposium "Effects of climate change on the world's oceans" (Yeosu, Republic of Korea, 15–19 May 2012, in conjunction with Ocean Expo-2012).

Recognition of IOC as a WCRP Sponsor

The 23rd IOC Assembly (2005) *"reaffirmed its continued co-sponsorship and its support of the WCRP"*. It has been also reconfirmed by decisions at the 24th (2007) and 25th (2009) sessions of the IOC Assembly. In particular, the 25th IOC Assembly agreed that the sponsorship should be *"at a level of US\$ 125,000 per annum, ideally through Regular Programme budget"*. The 43rd Session of the IOC Executive Council (2010) *"encouraged Member States to support execution of the WCRP Implementation Plan 2010–2015 through the participation of their scientists; [and] requested the Executive Secretary, in consultation with the WCRP Joint Planning Staff and its CLIVAR Project, to identify and carry out actions to highlight to WCRP scientists the IOC sponsorship [of WCRP]."*

The Joint planning Staff of WCRP and all International Project Offices of WCRP projects always make sure that all their publications and reports include an acknowledgment of IOC as a WCRP Sponsor. The visibility of the WCRP sponsorship by IOC is also facilitated because many of key WCRP meetings take place at IOC of UNESCO (including recent meetings on climate extremes, regional sea level and the most recent 18th Session of the WCRP CLIVAR Project Scientific Steering Group). The Executive Secretary of IOC is invited to take part or be represented at every meeting of the WCRP Joint Scientific Committee. IOC is invited to speak at the opening of the WCRP Open Science Conference (OSC, Denver, USA, 24-28 October 2011), and a dedicated display space is provided to IOC for the entire duration of the Conference. Ocean research is highly visible on the WCRP Open Science Conference Program including plenary talks and dedicated oral and poster sessions.

The 16th World Meteorological Congress (Geneva, Switzerland, 16 May–3 June 2011) noted the decision of the 25th session of IOC Assembly regarding the level of IOC sponsorship of WCRP. Congress expressed the hope that the IOC contribution in the future could increase to a level similar to that of WMO. WCRP activities are very important for the IOC lead within UNESCO on the Inter-sectoral Platform on Climate Change, and UNESCO's joint lead with the WMO on the "Knowledge Base" within of the UN system-wide response to climate change. WCRP confirms its strong commitment to continue actively supporting IOC in fulfilling its mission and developing its vision for the future.