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Background, progress, and future directions for the WMO-IOC-ICSU World Climate Research Programme (WCRP)

This document has been prepared by the Secretariats of the IOC and the WCRP for the 23rd Session of the IOC Assembly (Paris, 21–30 June 2005).

History of the WCRP and IOC sponsorship

The World Climate Research Programme (WCRP), sponsored by the World Meteorological Organization, the International Council for Science, and the Intergovernmental Oceanographic Commission of UNESCO celebrates its 25th anniversary this year.

The goals of the WCRP are, ***to determine the extent to which climate can be predicted and to determine the extent of human influence on climate***. These were set in 1980 and have taken on even greater importance in today's world. The impact of climate change and climate variability and the need for improved predictions are being felt more acutely than ever in areas such as fisheries, coastal zone management, tourism and risk assessment. Understanding, monitoring and modelling the ocean's role in climate are fundamental to improving climate information and predictions. Already in the early 1990s, IOC Member States recognized that in order for progress to be made in climate research there needed to be enhanced cooperation between oceanographers and meteorologists at all levels. The WCRP provided a unique and very effective international framework for cooperation and coordination amongst all those involved in climate research, and particularly oceanographers and meteorologists. Hence in 1991 the IOC Assembly decided that IOC should become full and equal partners with WMO and ICSU in the further development and implementation of the WCRP. Subsequent to IOC Executive Council approval in March 1992, a formal co-sponsorship Agreement signed by all three sponsors came into effect on 1 January 1993. As a result of this Agreement, the Joint Scientific Committee for the WCRP was increased to 18 members, six of whom would be oceanographers. IOC also agreed to contribute USD 200,000 per annum to the Joint Climate Research Fund that supports WCRP activities; this was later increased to USD 250,000. In this way, IOC would contribute directly to the success of the WCRP and help to direct its efforts in ways that would most benefit its members.

The Importance of WCRP to the IOC

The Home Page of the IOC lists seven issues of fundamental importance to IOC. These are:

- Marine Environmental Protection
- Fisheries and Ecosystems
- Climate Change
- Ocean Observing and Monitoring
- Coastal Area Management
- Data and Information Management
- Disaster Mitigation

WCRP research results and related outputs are crucial to success in each of these areas. Environmental protection, coastal area management and fisheries management require scientific knowledge of the critical factors affecting ecosystem dynamics and the coastal zones, not the least of which are climate and the physical properties of the ocean. A large part of WCRP's efforts are devoted to reducing scientific uncertainty about the role of the oceans in climate change, as well as the effects of climate change on ocean processes and resources. Most of the tools and techniques that form the basis for today's ocean observing, monitoring and data and information systems were developed as part of WCRP research projects. Marine-related environmental disasters are a result of natural physical processes of the ocean-

atmosphere system as well as human activities. Mitigating the impacts of these events includes understanding their causes and timely forecasting of their occurrence.

The WCRP provides an international framework for observations, basic climate research, and climate modelling and prediction. It generates, promotes and supports new initiatives, sets priorities through an internationally-agreed agenda, facilitates the sharing of computer resources and data, and supports scientific networking. It also develops common methodologies and protocols, organizes data and information management and model intercomparisons, synthesizes results, and provides input to the Intergovernmental Panel on Climate Change (IPCC) which in turn advises the UN Framework Convention on Climate Change (UNFCCC).

The legacy of WCRP research programmes

Two major WCRP projects, successfully completed in the last decade, made major contributions to our understanding of the ocean's role in climate variability and change, and left legacies of sustained ocean observing networks that are flagships of the global climate module of the Global Ocean Observing System (GOOS). The WCRP Tropical Ocean and Global Atmosphere (TOGA) project (1985–1994) established the physical basis for the understanding and prediction of El Niño temperature signals and associated changes in ocean state and in the global climate. This led to a major breakthrough in operational seasonal climate forecasting not only for the tropical Pacific, but also for other affected regions globally. The TAO-TRITON tropical moored array currently observing the upper ocean in the tropical Pacific grew out of TOGA. Moored buoys have been extended to the tropical Atlantic Ocean (the PIRATA array), and recently the tropical Indian Ocean has begun to be instrumented. These observations enhance seasonal forecasts and contribute to reduced scientific uncertainty in the role of ocean processes in coupled climate variability and change.

The WCRP World Ocean Circulation Experiment (WOCE) (1982–2002), the biggest and most successful global ocean research programme to date, collected observations of the world's oceans of unprecedented quality and coverage, and led to the development of important new ocean observing techniques and improved understanding of physical processes in the ocean. The Argo profiling float network, which in April 2005 had reached 60% of its goal of global 3° resolution coverage, is one such observing system that came out of WOCE. These observations improve our understanding of the variability of the ocean (in some areas Argo has contributed more vertical profiles than the entire historical database), and are used in seasonal-to-interannual climate predictions and in shorter-term weather forecasts. WOCE also advanced the monitoring of sea level through integration of satellite altimetry, ocean hydrography and sea level gauge observations. Sea level variability including regional change and potential sea level rise is of concern to many countries whose populations are concentrated on the coasts.

Current WCRP programmes are likely to yield other such innovations in our methods of observing and understanding the oceans. The WCRP is presently organized around four major projects, with the Climate Variability and Predictability (CLIVAR) project having the closest ties to ocean science and observations. In addition, WCRP promotes and supports several working groups and various cross-cutting and co-sponsored activities of direct relevance and benefit to the IOC, including: the Climate and Cryosphere (CliC) core project; the Surface-Ocean – Lower Atmosphere (SOLAS) project (co-sponsored mainly with IGBP); the Working Group on Surface Fluxes; the Working Group on Coupled Modelling; the Ocean

Observations Panel for Climate; and the Global Carbon Project of the Earth System Science Partnership.

Climate Variability and Predictability project (CLIVAR)

The first meeting of the Joint Scientific Committee for the WCRP in which IOC-appointed members participated was also the first to consider the proposal for a new WCRP activity focused on the fundamental role of the oceans in climate, namely the Climate Variability and Predictability project (CLIVAR). CLIVAR addresses climate variability and predictability with a particular focus on the role of ocean-atmosphere interactions in climate. The oceans' great heat capacity both exerts a moderating influence on seasonal and longer climate changes, and provides a mechanism for sustained oceanic influence on the atmosphere. CLIVAR builds on both TOGA and WOCE and the International CLIVAR Conference that launched the project publicly and internationally was held at IOC, UNESCO, Paris, in December 1998.

CLIVAR investigations address large-scale characteristics of the coupled climate system such as the El Niño-Southern Oscillation, monsoonal circulations in Asia, the Americas and Africa, the North Atlantic Oscillation and its link to climate in the region, and the Pacific Decadal Oscillation and its influence on climate. The organizational structure of CLIVAR also consists of four Ocean Basin Sector Panels covering the Atlantic, the Pacific, the Southern Ocean, and, jointly with IOC, the Indian Ocean. The CLIVAR Global Synthesis and Observations Panel integrates across these Panels and serves as the main WCRP focus for liaison with activities such as GOOS and ocean data management.

CLIVAR scientists contribute to setting the requirements for the global ocean observing system for climate through direct cooperation with the Ocean Observations Panel for Climate, an expert group whose technical secretariat lies with the IOC, and is sponsored by GOOS, WCRP, and the Global Climate Observing System (GCOS). CLIVAR and the IOC oceans and climate programmes cooperate to foster the growth of emerging observing networks important to ocean climate observations, and to improve our understanding of the ocean's role in climate.

Facing the future: WCRP Strategic Framework 2005–2015

The WCRP has developed a new strategic framework for 2005–2015, entitled Coordinated Observation and Prediction of the Earth System (COPES)[1], with the aim of facilitating 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.

Under COPES, the WCRP will promote the creation of a comprehensive, reliable, end-to-end global climate observing system for the dual purpose of describing the structure and variability of the climate system, and of generating a dynamically balanced and internally consistent description of the state of the coupled climate system for numerical prediction of climate. This will require the identification of gaps and deficiencies in the existing observing systems, and will encourage and facilitate repeated reanalyses of *in situ* and space-based observations.

[1] this section adapted from WCRP Strategic Framework 2005–2015: Coordinated Observation and Prediction of the Earth System (COPES), available at http://copes.ipsl.jussieu.fr.

Through COPES, the WCRP will provide the soundest possible scientific basis for the predictive capability of the total climate system for the benefit of society, including an assessment of the inherent uncertainty in probabilistic prediction of climate on various space and time scales. A new generation of models will be necessary for the WCRP to enable improved and more detailed prediction of the climate system. WCRP programmes and scientists will work to improve their seasonal forecasts and work in partnerships to enhance their application for social and economic benefit. The WCRP will also increase its focus on anthropogenic climate change and on the potential regional scale expressions of climate change such as regional long-term droughts and sea level rise. A workshop to address the key outstanding questions concerning sea level rise is already being organized. Strong collaboration will be sought with other research, development and applications programmes, satellite agencies, numerical weather/climate prediction centres, and with a broad range of stakeholders and users of climate information.

Developing country involvement will be actively sought and strongly encouraged. The global change SysTem for Analysis, Research and Training (START), established by the WCRP, the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP), will increase the involvement of developing country scientists in the evaluation of both useful seasonal forecasting skill and climate model simulations in their regions. START provides training and career development and supports infrastructure for environmental change research.

This coordinated and integrated framework treats ocean observations and ocean models as an integral component of the total climate system, ensuring that advances made in our understanding and in extending the predictability of the oceans are applied in the widest possible way.

Facing the future: establishing a sound financial footing for WCRP activities

The Joint Planning Staff for the WCRP, based in Geneva, and most of the activities of the Programme are financed through the Joint Climate Research Fund (JCRF), maintained and managed by the WMO and contributed to by the three sponsors (see Annex). The WMO is the major contributor, but contributions from ICSU and UNESCO/IOC are absolutely crucial to maintain an appropriate level and range of activities to assure the progress needed on all fronts. In recent years, the IOC contributions have fallen short of the WCRP-budgeted USD 250,000. IOC's contributions in the recent past have come from a generous non-earmarked extra-budgetary contribution from the USA. These funds are now earmarked.

ANNEX

Budget for the WMO/ICSU/IOC Joint Climate Research Fund (JCRF) for the WCRP for the first biennium (2004–05) of the WMO Fourteenth Financial Period 2004–07

1. Commitments to the WCRP are governed by an official Agreement between WMO, ICSU and IOC (UNESCO), which came into force on 1 January 1993. This Agreement replaced an earlier WMO/ICSU Agreement on the WCRP, which entered into force on 1 January 1980.

2. The Agreement deals with the 'Financial Arrangements' for the WCRP. In particular, it states that: a special account, to be known as the Joint Climate Research Fund (JCRF) will be established by the Secretary-General of WMO; the administration of the Fund shall be the responsibility of the Secretary-General of WMO; and, the WMO Financial Regulations shall apply, including the arrangements for external audit. Contributions are made to the JCRF by WMO, ICSU and IOC, by agreement. The general pooled Fund is then used to provide support for a very wide range of WCRP-sponsored activities, ranging from expert group meetings, to meetings of the Scientific Steering Groups of its core activities, to full and open scientific conferences, to the annual meeting of its governing Joint Scientific Committee (JSC). The JCRF also supports a small central secretariat of 7.6 full-time equivalent staff (the Joint Planning Staff for the WCRP), located at the Headquarters of WMO in Geneva, Switzerland.

3. WMO operates four-yearly 'Financial Periods'. The budget for the WMO Fourteenth Financial Period, 2004–07, was approved at the WMO Fourteenth Congress held in May 2003. The representative of IOC at that Congress expressed satisfaction with the arrangements and management of the WCRP, and informed Congress that the twenty-first IOC Assembly had expressed great satisfaction at the achievements of the WOCE programme. The IOC Assembly had attributed the programme's unqualified success to the sustained WMO/ICSU/IOC WCRP partnership and cited WOCE as an outstanding example for planning, managing, and executing large-scale international ocean science programmes. Recognizing the fundamental role of the ocean in the climate system, IOC was now strongly committed to working with WCRP and WMO to ensure the success of CLIVAR. In concluding, the representative of IOC re-affirmed the continuing commitment to supporting the Joint Climate Research Fund, and through IOC governing bodies, continuing efforts to encourage IOC Member States to support and participate in the marine-related activities of WCRP.

4. Immediately following the WMO Fourteenth Congress, the fifty-fifth session of the WMO Executive Council, May 2003, approved the budget for the JCRF for the biennium 2004–05 (see Appendix). It noted that ICSU was expected to contribute SFR 786,000 (equivalent to USD 600,000, using the UN official exchange rate of May 2003 (SFR 1.31/USD)) and IOC was expected to contribute SFR 655,000 (equivalent USD 500,000) to the fund for 2004–05. It authorized a total WMO contribution of SFR 3,935,400 for 2004–05.

APPENDIX

BUDGET FOR THE WMO/ICSU/IOC JOINT CLIMATE RESEARCH FUND (JCRF) FOR THE BIENNIUM 2004–05

	SFR'000	USD'000
Institutional support to WCRP		
Staff costs	3294.7	2515.0
Temporary staff	10.2	7.8
Activities of the JSC	208.3	159.0
Operation of the JPS	111.6	85.2
Climate Modelling Programme	277.2	211.6
Global Energy and Water Cycle Experiment (GEWEX)	452.8	345.6
Climate Variability and Predictability (CLIVAR)	434.4	331.6
Climate and Cryosphere (CliC)	223.4	170.5
Stratospheric Processes and their Role in Climate (SPARC)	223.4	170.5
Co-operation/joint activities with global environmental change programmes	140.4	107.2
TOTAL	5376.4	4104.0
ICSU contribution to the JCRF (1)	786.0	600.0
IOC contribution to the JCRF (1)	655.0	500.0
WMO contribution to the JCRF	3935.4	3004.0

(1) Note: At UN official exchange rate of May 2003 (SFR 1.31/US Dollar)