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WMO-ICSU-IOC WORLD CLIMATE RESEARCH PROGRAMME

This document was prepared by the Director of the World Climate Research Programme, Prof. Pierre Morel.

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1. INTRODUCTION

The World Climate Research programme is sponsored by the IOC, the World Meteorological Organization and the International Council of Scientific Unions. Scientific guidance for the Programme is provided by a multi-disciplinary Joint Scientific Committee (JSC) with a balanced representation of the relevant disciplines in atmospheric, oceanic, hydrological and polar sciences. The latest session of the JSC (Geneva, 14-18 March 1994) was attended by Dr. G. Kullenberg. Advances in the implementation of the oceanographic components of the Programme are reported below.

2. TROPICAL OCEAN AND GLOBAL ATMOSPHERE PROGRAMME (TOGA)

The TOGA programme will be completed on 31 December 1994, although scientific work will continue within the follow-on CLIVAR programme (see below) to further develop the understanding and prediction of interannual climate variations such as the El Nino/Southern Oscillation (ENSO). Although TOGA has been successful in demonstrating the predictability of (at least) warm ENSO events and achieving significant skill in the prediction of El Nino up to one year in advance, there is still considerable scope for further improvements in ENSO prediction systems for ocean temperature and circulation as well as forecasting atmospheric anomalies associated with ENSO over the globe. This work will call for a wide range of refinements in TOGA models, observation and data assimilation in the future.

The TOGA programme completed a major field study over the warm water region of the western equatorial Pacific, the Coupled Ocean-Atmosphere Response Experiment (COARE), with the participation of scientific institutions and environmental administrations of Australia, China, the Federated States of Micronesia, France, Indonesia, Japan, Nauru, New Zealand, Papua New Guinea, Philippines, South Korea, Solomon Islands, UK and the USA. All major objectives set for the field measurements were met. The experiment completed 700 days of observation time with research vessels on location and 125 research aircraft flights, 30 buoy deployments and 12,000 atmospheric soundings within the region. Excellent meteorological radar coverage was obtained, including two overlapping Doppler radar systems in the central experimental array. The scientific community that participated in the field measurements is now engaged in assembling the COARE data and Droducinu data sets suitable for International exchange.

Pending the development of firm plans fort the implementation of the climate component of the Global Ocean Observing Systems, conservative measures have been taken to maintain International support to the co-ordination of essential TOGA observation projects. In particular, TOGA has obtained the agreement, in principle, of the Global Climate Observing System (GCOS) Planning Office to maintain the TOGA Tropical Atmosphere Ocean (array) Implementation Panel as a joint GCOS/WCRP activity, supported principally by GCOS. Likewise, the co-ordination of systematic XBT sections and the surface velocity measurements by drifting boys will be continued by WCRP (as a joint activity of WOCE and CLIVAR).

Generally, the future planning of the WCRP scientific strategy and the choice of scientific priorities are very much dependent upon the definition of the operational Global Climate, Ocean and Terrestrial Observing Systems (GCOS, GOOS, GTOS), and progress achieved in the implementation of these programmes. The climate science community is thus anxiously awaiting guidance from IOC and the other international sponsors of these operational observing systems regarding the expected schedule of development.

3. WORLD OCEAN CIRCULATION EXPERIMENT (WOCE)

WOCE is now near the mid-point of its 1990-1997 Intensive Observation Period. Analysis and interpretation of the data are expected to continue until 2005. The satellites required to give global altimetry and surface wind data (ERS-1 and TOPEX-POSEIDON) are both operational and the accuracy of altimetry measurements has exceeded expectations of its performance. The in-situ observational phase of the global survey is progressing well. Most of the Pacific and Southern Ocean lines have been covered and the Indian Ocean will be surveyed in 1995-96. In 1996-97, a rapid resurvey of the North Atlantic is scheduled and commitments of resources for the project have, for the large part, been made. By the end of 1997 the global one-time survey will be virtually complete .

It has been hard to find the resources for the global array of sub-surface floats, drifters and current meters called for in the WOCE Implementation Plan and all three will fall short of the requirements. However the highest priority measurements will be made. The technical development of ALACE (autonomous subsurface) floats has been a considerable success, particularly with the recent incorporation of temperature and salinity profiling. Similarly, the joint development with TOGA of a much improved surface drifter has been valuable. On the other hand, the coverage achieved with XBT transects is also less than that required and the recent termination of the US co-operative programme in the North Pacific is jeopardizing the integrity of an important time series of observations in that area.

Process studies in the Atlantic have been successful in measuring both diapycnal mixing and the process of subduction. Intensive observations of abyssal flow in the Brazil Basin are progressing well. The analyses of individual hydrographic sections are beginning to be published.

The overall objective of WOCE is to develop improved ocean circulation models and to collect the data needed to test them. The WOCE Numerical Experimentation Group (NEG) has formulated its modelling strategy in the past year and has highlighted the need for the development of small scale process models, high-resolution models using array processors and for more accurate fully coupled global models. The NEG sees a need for more fundamental work on data assimilation methods and for the development of a detailed plan for the assimilation of WOCE data into models. It also foresees the establishment of operational oceanographic prediction and analysis centres. The main activities required to exploit the large investment in WOCE observational programmes are in the areas of assimilation of observations into numerical models and in synthesis of the results from the wide variety of observations.

The flow of data remains a concern. All the required Data Assembly and Special Analysis Centres are established but Principal Investigators have not been able to comply with the original schedule for validation and delivery of data, that now appears to be unrealistically optimistic. This problem is being addressed with some urgency and alternative mechanisms have proposed that will still safeguard the high data quality required by WOCE.

The scientific management structure of WOCE is evolving to reflect the transition from planning and implementation of observations at sea to the exploitation and analysis of data. The Scientific Steering Group is being reduced in size and will meet less frequently, the status of the Data Management (now Data Products) Committee is being enhanced, the three core project committees are being replaced by two groups, one for the Global Survey and the other for Gyre Scale studies. WOCE is also planning a schedule of major science meetings to publicize the progress of WOCE research.

WOCE is involved in a scientific dialogue with CLIVAR on the continuation of key observations started by WOCE in order to document the oceanic variability over decadal timescales. In this respect the lack of an established plan for a follow-on mission of TOPEX/POSEIDON altimetry satellite is of concern.

4. RESEARCH PROGRAMME ON CLIMATE VARIABILITY AND PREDICTABILITY (CLIVAR)

WCRP distinguishes between "fast climate processes" that control the adjustment of the radiative balance and water budget in the atmosphere and at the earth surface, and the processes that involve the somewhat slower response of the oceanic circulation, heat storage and transport, and the dynamics of the coupled atmosphere-ocean-ice system. The WCRP Global Energy and Water CycleExperiment (GEWEX) addresses the first kind of processes. CLIVAR addresses the latter and, for the main part, will focus on the role of the ocean in climate variability and predictability.

Since the concept of CLIVAR emerged during the last two years, CLIVAR will be the first major WCRP programme planned, from its inception, with the full participation of the oceanographic science community. CLIVAR will aim at identifying, among the multiplicity of "global changes", phenomena that can be associated with specific global or regional mechanisms than ca be modelled and predicted.

The most obvious transient climate phenomenon that was so recognized is the El Nino/Southern Oscillation (ENSO) process. CLIVAR will build upon the achievements of TOGA to improve ENSO data assimilation and prediction systems, support as requested the continued operation of essential TOGA observing systems not managed by GCOS or GOOS, and contribute to augmenting existing observing systems when and where required for CLIVAR studies.

A variety of other observed climatic variations, on longer time-scales, are candidates to become scientific foci of CLIVAR studies involving many aspects of the world ocean circulation. Consultations are already taken place between CLIVAR and WOCE on the planning of the North Atlantic Gyre Dynamics Experiment and further studies of Atlantic ocean variability on interannual and decadal time-scales, that may be conducted after the completion of WOCE.

In view of the wide range of diverse scientific topics initially being considered in this new WCRP programme, the CLIVAR Scientific Steering Group is making only slow progress towards defining initial research priorities. The latest ideas are that the programme could begin along four initial sciences thrusts:

(i) Prediction of seasonal to interannual variations in (essentially) the tropical ocean-atmosphere system. and connections with the extra-tropics;

(ii) Variability and predictability of monsoonal regimes in Asia and elsewhere;

(iii) Variability and predictability of the global thermohaline circulation;

(iv) climate change scenarios and variability of the earth climate based on long-term integrations with coupled atmosphere-ocean-ice-land surface models.

5. SUPPORT OF WCRP PLANNING AND CO-ORDINATION ACTIVITIES

Inter-disciplinary co-operation does not flourish spontaneously: hard work is needed to faster inter-disciplinary scientific exchanges, formulate multi-disciplinary science projects and co-ordinate the required international co-operation. This is, in summary, the work of the Joint Scientific Committee for WCRP, its Joint Planning Staff in Geneva and the extensive framework of programme steering groups and specialized working groups they have constituted. All essential WCRP planning and international co-ordination activities are supported by the Joint Climate Research Fund, fed by equal contributions of US$ 200,000 per year from the three sponsoring organizations and, an additional contribution in excess of Sfr 2,000,000 made unilaterally by WMO.

The payments received in the Joint Climate Research Fund from IOC actually amounted to US$ 100,000 during the calendar year 1993. The support of the Executive Council is sought to ensure that IOC will be able to adhere to its commitment to the Programme in the future and maintain equal partnership with WMO and ICSU, as stinulated in the Agreement on the conduct of WCRP.