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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
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PROGRESS IN THE PLANNING OF PROJECTS AND EXPERIMENTS WITHIN THE OCEANOGRAPHIC COMPONENTS OF THE WORLD CLIMATE RESEARCH PROGRAMME

SC-83/WS/66

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INTRODUCTION

The Committee on Climatic Changes and the Ocean (CCCO) was established jointly by SCOR and IOC in 1979 in order to develop the oceanographic component of the World Climate Research Programme. The Joint Committee is doing so in collaboration with the Joint Scientific Committee (JSC) for the WCRP of WMO and ICSU. The Commission, in addition to being a co-sponsor of CCCO, has accepted wider WCP responsibilities, particularly within the World Climate Data Programme and has recognized that many of it's programme elements must be associated with the oceanographic component of the WCRP. The effort explained in this document, therefore, is being carried out as appropriate in cooperation with a number of programme elements (IGOSS, IODE, WESTPAC and El Niño) and opportunities are being sought to entrain others.

Between 1979 and early 1983, CCCO was actively developing the scientific programme. Various projects have been considered in detail and some have been submitted to feasibility studies or preliminary planning. A number of international meetings organized by CCCO have been instrumental in the formulation of this programme. These include conferences or workshops on such topics as satellite observations, time series of ocean measurements, ocean monitoring requirements, mean sea level measurement and, especially noteworthy, a Study Conference on Large-Scale Oceanographic Experiments in the WCRP. As a result of these meetings and of the work of panels and subgroups, the major aspects of the scientific programme for the oceanographic component of the WCRP have now been defined and approved by CCCO and JSC and subsequently accepted by WMO and IOC (see Resolution XII-4). The core programmes will include two large-scale oceanographic experiments TOGA and WOCE and an extensive ocean observational system. CCCO is now entering a phase of detailed planning and experimental design prior to actual implementation of the scientific programme.

Both of the major experiments being proposed by CCCO involve oceanographic operations of a larger-scale and complexity than any ever before attempted. They will involve the newest technology and some of the more traditional means of making oceanographic measurements.

Timetable

The Study of the Interannual Variability of the Tropical Oceans and the Global Atmosphere (TOGA) is scheduled to begin on 1 January 1985 and continue for ten years. The World Ocean Circulation Experiment (WOCE) timetable is dictated by Satellite launches and therefore its major field phase will occur during the period 1989-1994. The ocean observation system will be implemented as soon as possible with the expectation of that it will continue indefinitely or with the view of designing a system that could be continued indefinitely.

WORLD OCEAN CIRCULATION EXPERIMENT (WOCE)

The concept of WOCE grew out of the realization that the latest satellite instrumentation now permits the design of a truly global experiment to improve our understanding of the circulation of the world ocean and our ability to model it quantitatively. The lack of knowledge in this field has been identified by both CCCO and JSC as one of the most important limiting factors in meeting the objectives of the WCRP.

The Goals of WOCE

One objective of the WCRP is to establish the scientific basis for prediction of climate change over the next century. To accomplish this goal, requires prognostic global models of the coupled ocean and atmosphere. An intermediate step of great value, is the construction of prognostic models of the world ocean circulation driven by surface fluxes. Such prognostic models permit study of questions concerning the changes in the ocean circulation and water mass conversion rates under prescribed changes in surface fluxes. These changes could be due to natural variability, or to anthropogenic changes such as increasing CO_2. Construction of such models will be difficult: testing them will be crucial. Thus the primary goal of WOCE is:

> To collect the data necessary to develop and test models useful for predicting climate change.

Because a realizeable observational programme must necessarily be confined to a finite length of time, there will be, in addressing goal 1, major issues of the representativeness of the data obtained during the intensive WOCE field phase (1989–1994) for understanding longer-term oceanic behavior. The second goal of WOCE, therefore is:

> To determine the representativeness of the specific WOCE data sets for the long-term behavior of the ocean, and, to find methods for determining long-term changes in the ocean circulation.

Meeting these goals

Determining what the data sets will be is the crux of the design problem for WOCE. Studies are therefore underway of requirements related to: Surface forcing; the velocity field; critical aspects of the temperature and salinity distribution; regional variation of mechanisms of diapycnic mixing in the interior ocean; and the depth of winter mixing. To exploit the naturally integrating properties of tracer distributions to understand the ability of models based on the finite duration data set, tracer distribution, measured over a longer period of time, would be used to infer the behavior of the oceanic system over decadal and longer time periods.

The major elements of WOCE

The likely major elements of WOCE will be:

I - An Ocean Circulation Modelling effort.

II - An altimetric satellite mission of high accuracy for a minimum period of three years. Candidates with accuracies and precisions adequate for the WOCE objectives are: 1) The US-French Topex Mission, 2) The European Space Agency ERS-1 Mission, 3) The Japanese MOS-2, although the latter is scheduled to fly somewhat later than the others. At least one of these missions must be available. If no altimetric satellite were available, the entire basis of the WOCE programme would need to be re-considered. The MOS-2 launch towards the middle of the major field phase is considered as priority to obtain the necessary duration of the altimetric data sets.

III - A wind measuring satellite of adequate accuracy for a minimum of one year, preferably for much longer, and preferably overlapping maximally with the altimetric mission.

IV - Global chemical distribution surveys for both anthropogenic and natural biogeochemical tracers.

V - A global scale hydrographic programme.

VI - A basin scale sub-surface drifting float programme.

WOCE Science Planning Office

The establishment of an International WOCE Science Planning Office in 1984 is under consideration. The Science Planning Office would assist the Joint CCCO/JSC WOCE Scientific Steering Group in the detailed planning of WOCE. The Office would receive technical guidance from the WOCE/SSG and guidance on intergovernmental aspects and support will be provided by IOC and SCOR as appropriate. A tentative offer to host such an office has been made by the Institute of Oceanographic Sciences of the United Kingdom. A Schematic of the WOCE and TOGA Planning Mechanism is attached.

INTERANNUAL VARIABILITY OF THE TROPICAL OCEANS AND GLOBAL ATMOSPHERE (TOGA)

Some very significant relationships have been found to exist between the tropical oceans and the atmosphere worldwide, particularly for change on time scales of two to five years. These changes have strong impact on many nations because they are associated with droughts or floods, extreme temperatures, failures of fisheries and the frequency of tropical storms.

In support of the endeavour to increase our understanding of these changes, two programmes have emerged as part of the WCRP. These are TOGA and the Monsoon Climate Programme (MCP). Although the scientific aims of the MCP are somewhat more restrictive than those for TOGA, the basic data set required for planetary-scale aspects are almost exactly the same. For that reason, the MCP has been included as an element of TOGA.

The overall objectives of TOGA are:

(i) To determine to what extent the time dependent behaviour of the coupled atmosphere-ocean system is predictable on time scales of months to years and to understand the mechanism of this behaviour.

(ii) To study the feasibility of modelling the coupled ocean-atmosphere system for the purpose of predicting its variations on time scales of months to years.

In line with the above definition of overall objectives of TOGA, the Programme will consist of the following components:

(i) An oceanographic observational programme aiming at characterising the time-dependent thermal field and circulation of the upper layers of the tropical oceans in the latitude band of interest ($20^{\circ}N - 20^{\circ}S$) for the purpose of determining the nature of the oceanic variability and establishing the data base for prediction.

(ii) In addition to the World Weather Watch (WWW) observing and data processing systems, a limited programme of supplementary atmospheric observations and data processing projects, aimed at providing a description of the atmospheric forcing on tropical oceans and additional global atmospheric data sets needed to document the interannual variability of global atmospheric dynamics, thermodynamics and hydrological cycle, with special emphasis on large scale interannual changes of the monsoonal circulation and the southern oscillation.

(iii) An ocean modelling programme aiming at the development of dynamic and thermodynamic models of the tropical oceans suitable for coupling with global atmospheric circulation models.

(iv) An atmospheric modelling programme to establish the sensitivity of the atmospheric regime to various possible forcings on time scales of several months to several years.

Basic Components of the Oceanographic Observational Programme of TOGA

PLATFORM	
Geosynchronous Satellites	Sea-surface temperature, Low-Level winds, monthly average sea level air humidity, daily average insolation
Polar Orbiting Satellites	Sea-surface temperature, monthly average sea level air humidity, sea level, wind stress
Land based stations, island and coastal stations	Sea level, sea-surface temperature
Ships-of-Opportunity	Sea-surface temperature, subsurface temperature profiles, surface parameters for momentum and heat flux estimates
Drifting and moored buoys	Ocean surface currents and subsurface profiles, subsurface temperature profiles, surface parameters of momentum and heat flux estimates

TOGA Programme Conference

An International TOGA Programme Conference will be held 17-21 September 1984, in Paris at UNESCO House. The Conference will have two main objectives:

(i) To provide a form for discussing scientific priorities for TOGA, and

(ii) To inform national representatives and interested scientists of TOGA scientific opportunities and plans as a basis for subsequent national commitments.

The TOGA Plan (First version) will serve as the primary document for the session which will be organized as a governmental expert meeting. Participants will include experts and science administrators designated by Member States. Member States will be invited to designate participants by the Commission and WMO as co-sponsors of the conference along with SCOR and ICSU.

TOGA Planning Office

An International TOGA Planning Office is being established in the USA, housed in the National Oceanic and Atmospheric Administration. The charge to this office is to assist the joint CCCO/JSC TOGA Scientific Steering Group in the detailed planning of TOGA by:

(i) Preparing detailed implementation and operations plans for the various components of TOGA

(ii) Preparing detailed plans for the processing of observational data and the production of reference data sets for climate research.

(iii) Assisting with activities concerned with the documentation or organizational duties relevant to the planning of TOGA.

The Planning Office Staff will include members seconded by the USA and two or three others made available through WMO, IOC and/or SCOR. The office will receive technical guidance from the TOGA/SSG and guidance on intergovernmental aspects and support will be provided by WMO and ICSU as appropriate. Discussions are underway to associate the IOC with this activity.

Modelling and Satellite Activities Related to WOCE and TOGA

Both TOGA and WOCE will rely heavily on analytical and simulation modelling in order to plan for and guide observing programmes and to facilitate the analysis of the large amounts of data which will be collected. CCCO's own Modelling Panel and JSC's Working Group on Numerical Experimentation are encouraging these activities in cooperation with the Steering Groups for WOCE and TOGA. Two modelling meetings are planned in 1984 in support of these, and other, CCCO studies:

1) CCCO/JSC Symposium on Coupled Atmosphere-Ocean Models, 7-11 May 1984 (being held as the 16th International Liege Colloquium on Ocean Hydrodynamics)

2) CCCO/JSC Workshop on Modelling the Upper Ocean Boundary Layer for WCRP Objectives, 26-28 July 1984, Sendai, Japan

Another sub-group of CCCO which has direct relevance to the two large-scale experiments is the newly established CCCO/JSC Satellite Working Group. Amongst other tasks, this group will assist in the coordination of satellite requirements for the WCRP programmes and provide liaison between the groups planning experiments and the space agencies.

OCEAN OBSERVATIONAL SYSTEM

In response to WMO and IOC requests, CCCO and JSC submitted an "Action Plan for an Ocean Observing System" to their respective executive bodies in 1982. These bodies accepted the plan as a general framework for the development of an observational programme but called for its further elaboration. A document entitled "Ocean Observational Systems" was then drafted and submitted to CCCO-IV (January 1983) in response to these requests. CCCO then suggested that this new version of the "Action Plan" be revised by:

a) Aligning it with the observational strategy associated with the WCRP Streams,

b) Presenting the scientific reasons for data requirements, and

c) Providing guidance on how to effectively channel national contributions.

The revised document will be reviewed at CCCO-V (December 1983) for approval for submission to JSC and the Executive Bodies of WMO and IOC.

The Ocean Observational System, as described here in the Context of the WCRP, will eventually evolve into the global ocean monitoring system, for which IOC has responsibility, consisting of a mix of observations taken from ships-of-opportunity and specially deployed in situ equipments with remote sensing from and communications through Satellites. The data will largely be shared with shorter time scale operational needs for example, for ship routing and analyses of ocean currents and temperatures. In such, the development of the ocean observational system will be carried out in conjunction with IGOSS and IODE.

The WCRP has been divided conceptually into three streams of activity:

1 The physical basis for long-range weather forecasting

2 Interannual variability

3 Long-term climate trends and sensitivity

The Ocean Observational System is closely connected to each of these streams and, to be cost effective, must serve the requirements of all three. Many aspects are already clear, and these provide the initial focus of the system plan.

Objectives of the System

In view of the long timescales involved in characterising the climate system, the present state of our knowledge of the system, and the prospects for important new technology, the Ocean Observational System must be evolutionary in concept and implementation. Initially it will provide selected multivariable data sets and time series:

(1) To characterize large-scale phenomena on seasonal and longer-time scales of variability, leading to analyses with well established quality and probable error characteristics.

(2) To provide inputs on ocean conditions for atmospheric long-range prediction models.

(3) To provide a data base for intercomparison with new observation technologies and analysis methods, both to enable thorough evaluation and to preserve continuity with past records.

(4) To begin to provide quantitative information on key derived fields, such as wind stress and surface heat flux, needed on a broad scale for validation of numerical ocean models.

(5) To provide the basis of experience from which, as deeper understanding becomes available of the mechanisms for climate variability and change, a more cost effective system can be designed, to be used on a pilot basis for climate prediction.

The Nature of the System

The activity intended is characterized by a number of features which set it apart from most forms of oceanographic research. It has a major observational component shared between many individuals. It is undertaken with the intention of continuing on a uniform basis for a number of years, longer than normally considered appropriate to a single research project. It draws on more widely available platforms and personnel than research vessels and research scientists. Satellite systems will play an increasing role during the coming years. It is intended to characterize trends and phenomena rather than providing complete information about individual processes within the system being observed. This system comprises those activities that must be carried out now to meet this objective.

Elements of the System

Some of these observing systems have already been identified as timely and feasible and CCCO is encouraging their implementation and/or expansion and continuation through the Member States. These include an expansion of the current programme of expendable bathythermograph observations, using tide gauges at coastal and island stations and measurement of surface and subsurface salinity and temperature near the tide gauges. A series of training courses for technicians involved in making sea level measurements is being organized by the Institute of Oceanographic Sciences in the U.K. with IOC support. IOC has initiated the publication of a regular brochure on monitoring which is intended to encourage and foster enthusiasm for the rather routine tasks of monitoring and to provide those making measurements with information on data being collected elsewhere. The first volume of this "brochure", entitled "Time Series of Ocean Measurements - Vol I, 1983" will be available as IOC Technical Series Report No. 24. The elements of the observational System are:

1) Sea Level Observations at Coastal and Island Stations (Full Responsibility for this element has been assumed by the IOC and programme planning and implementation are being coordinated through the secretariat).

2) Sea Surface Temperature

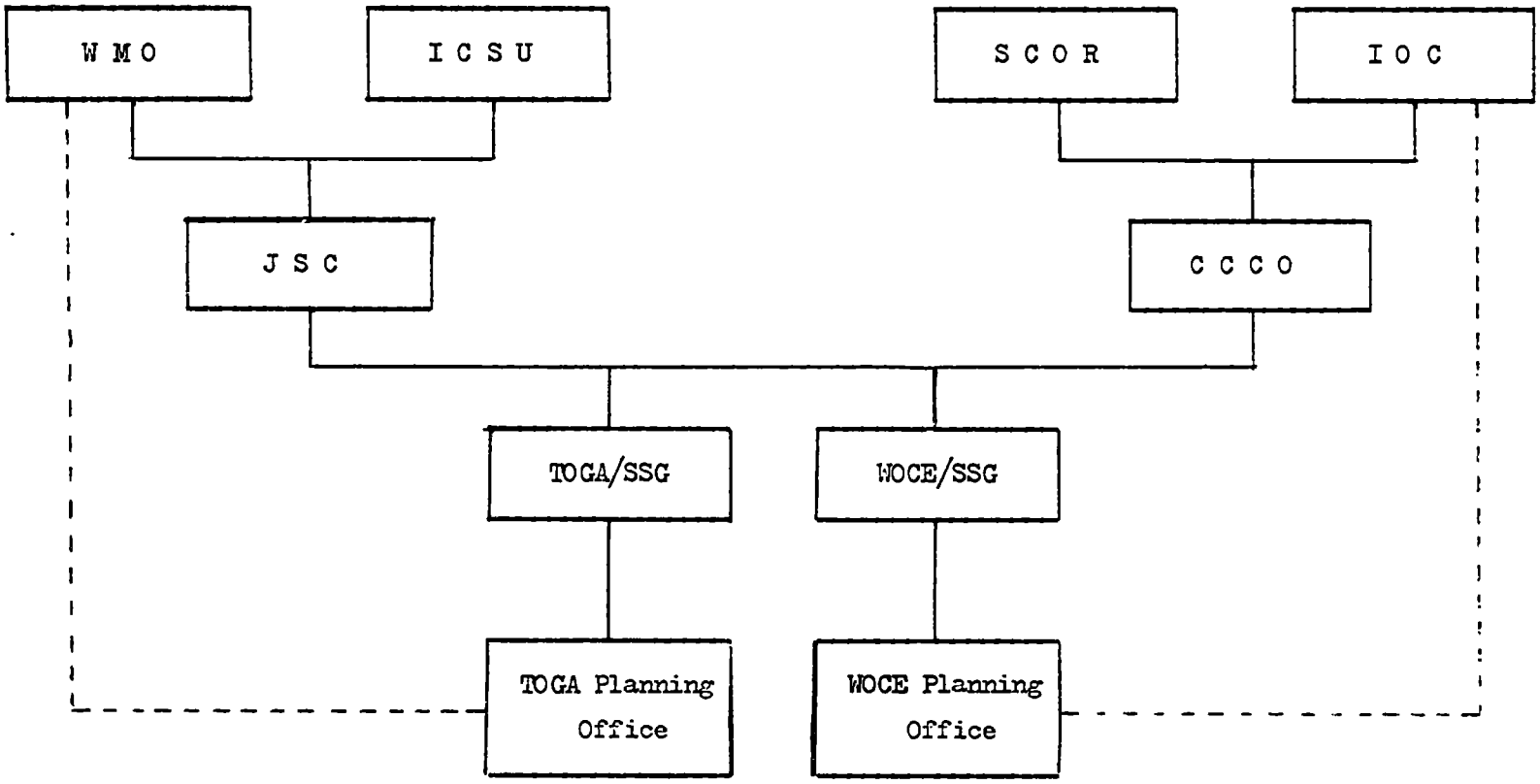
3) Surface Wind

4) Heat and Salt Content of the oceanic upper layer

5) Surface Drifters

6) Monitoring of Heat and Mass Transport at Straits and Passages

TOGA and WOCE Planning Mechanism



SSG Scientific Steering Group

JSC WMO/ICSU Joint Scientific Committee for the WCRP

--- Intergovernmental Aspects and Support