**Intergovernmental Oceanographic Commission**
*Reports of Governing and Major Subsidiary Bodies*


# IOC-WMO Intergovernmental WOCE Panel

## Second Session

Paris, 3-4 March 1992

**UNESCO**

**Intergovernmental Oceanographic Commission**
*Reports of Governing and Major Subsidiary Bodies*

# IOC-WMO Intergovernmental WOCE Panel

## Second Session

Paris, 3-4 March 1992

SC/92/CONF/203/LD/1

**UNESCO**

IOC-WMO/IWP-II/3
Paris, 11 May 1992
English only

| In this Series | *Languages* |
|---|---|
| **Reports of Governing and Major Subsidiary Bodies**, which was initiated at the beginning of 1984, the reports of the following meetings have already been issued: | |
| 1. Eleventh Session of the Working Committee on international Oceanographic Data Exchange | E, F, S, R |
| 2. Seventeenth Session of the Executive Council | E, F, S, R, Ar |
| 3. Fourth Session of the Working Committee for Training, Education and Mutual Assistance | E, F, S, R |
| 4. Fifth Session of the Working Committee for the Global Investigation of Pollution in the Marine Environment | E, F, S, R |
| 5. First Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions | E, F, S |
| 6. Third Session of the *ad hoc* Task Team to Study the Implications, for the Commission, of the UN Convention on the Law of the Sea and the New Ocean Regime | E, F, S, R |
| 7. First Session of the Programme Group on Ocean Processes and Climate | E, F, S, R |
| 8. Eighteenth Session of the Executive Council | E, F, S, R, Ar |
| 9. Thirteenth Session of the Assembly | E, F, S, R, Ar |
| 10. Tenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific | E, F, S, R |
| 11. Nineteenth Session of the Executive Council | E, F, S, R, Ar |
| 12. Sixth Session of the IOC Scientific Committee for the Global Investigation of Pollution in the Marine Environment | E, F, S |
| 13. Twelfth Session of the IOC Working Committee on International Oceanographic Data Exchange | E, F, S, R |
| 14. Second Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions | E, F, S |
| 15. First Session of the IOC Regional Committee for the Central Eastern Atlantic | E, F, S |
| 16. Second Session of the IOC Programme Group on Ocean Processes and Climate | E, F, S |
| 17. Twentieth Session of the Executive Council | E, F, S, R, Ar |
| 18. Fourteenth Session of the Assembly | E, F, S, R, Ar |
| 19. Fifth Session of the IOC Regional Committee for the Southern Ocean | E, F, S, R |
| 20. Eleventh Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific | E, F, S, R |
| 21. Second Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean | E, F |
| 22. Fourth Session of the IOC Regional Committee for the Western Pacific | E only |
| 23. Twenty-first Session of the Executive Council | E, F, S, R |
| 24. Twenty-second Session of the Executive Council | E, F, S, R |
| 25. Fifteenth Session of the Assembly | E, F, S, R |
| 26. Third Session of the IOC Committee on Ocean Processes and Climate | E, F, S, R |
| 27. Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific | E, F, S, R |
| 28. Third Session of the Sub-Commission for the Caribbean and Adjacent Regions | E, S |
| 29. First Session of the IOC Sub-Commission for the Western Pacific | E only |
| 30. Fifth Session of the IOC Regional Committee for the Western Pacific | E only |
| 31. Twenty-third Session of the Executive Council | E, F, S, R |
| 32. Thirteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange | E only |
| 33. Seventh Session of the IOC Committee for the Global Investigation of Pollution in the Marine Environment | E, F, S, R |
| 34. Fifth Session of the IOC Committee for Training, Education and Mutual Assistance in Marine Sciences | E, F, S, R |
| 35. Fourth Session of the IOC Committee on Ocean Processes and Climate | E, F, S, R |
| 36. Twenty-fourth Session of the Executive Council | E, F, S, R |
| 37. Sixteenth Session of the Assembly | E, F, S, R, Ar |
| 38. Thirteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific | E, F, S, R |
| 39. Second Session of the IOC-WMO Intergovernmental WOCE Panel | E only |

# TABLE OF CONTENTS

## 1. OPENING

1 The second session of the IOC-WMO Intergovernmental WOCE Panel (IWP) was held in Paris, 3-4 March 1992. Dr Leo Otto, Chairman of the IWP, opened the session and welcomed the participants who included Members from 13 nations and Observers from 2 nations. He emphasized the responsibility of IWP to promote WOCE and ensure its successful implementation. The Members from observer nations were encouraged to take part in the session, express their on-going involvement or intention to participate in the implementation of WOCE, and consider becoming Members of the Panel. The List of Participants in included as Annex II.

2 Dr Gunnar Kullenberg, Secretary IOC, addressed the Panel and noted that, since the first session of the IWP (Paris, 22-25 October 1990), the IOC along with the WMO, ICSU, and SCOR have worked hard at raising society's awareness of the significant role that the oceans have in climate change. Significant efforts have been made towards ensuring that oceans are addressed at the conference on the Agenda of Science for Environment and Development for the 21st Century (ASCEND 21), the Negotiating Committee for the Framework Convention on Climate Change, the Intergovernmental Panel on Climate Change (IPCC), and the UN Conference on Environment and Development (UNCED). WOCE provides the building blocks upon which the uncertainties of climate change predictions will be reduced. He recognized that considerable additional support from nations would be needed to fully implement WOCE. The IWP was described as the key intergovernmental mechanism needed to address WOCE resource gaps. He urged that the IWP be used intersessionally to get new resources for critical WOCE resource gaps. The WOCE International Project Office (IPO) and IOC Secretariat should be utilized to support this effort. He concluded by suggesting that the IWP identify specific actions required of responsible parties and to report their recommendations to the IOC Executive Council.

## 2. ADMINISTRATIVE ARRANGEMENTS

### 2.1 ADOPTION OF THE AGENDA

3 The Panel adopted the Agenda as given in Annex I.

### 2.2 DESIGNATION OF RAPPORTEUR

4 The Panel adopted the proposal by Spain to elect Dr D. Kester (USA) as Rapporteur for the session.

### 2.3 ESTABLISHMENT OF A WORKING GROUP TO SUMMARIZE THE FINDINGS OF THE PANEL

5 Drs T. McDougall (Australia), B. Mendes de Castro Filho (Brazil), and R. Lambert (USA) were appointed Members of the Working Group responsible for summarizing the discussion under Agenda Item 9.

## 3. REVIEW OF INITIAL RESULTS OF WOCE

6 Dr A. Clarke, Co-Chairman of the WOCE SSG, summarized a number of the WOCE accomplishments during 1991. He showed how, for the North Atlantic Ocean, the best estimates of air-sea heat fluxes are inconsistent with best estimates of the heat transported by ocean processes. He pointed out that VSOP North Atlantic Pilot Programme has addressed the question of the accuracy of the primary data that contributes to air-sea flux calculations [See also Annex III, item 4(vi)a]. Considerable progress has been made in the more rapid assembly of upper ocean temperature data especially in the North and tropical Atlantic and Pacific Oceans; these will be used to estimate changes in ocean heat content over the seasonal cycle. About 35,000 global temperature and salinity observations were transmitted in real-time and 4,000 had been received in delayed mode by December 31, 1991. There has been an increase in global T-S data between 1990 and 1991. The TOGA-WOCE surface drifters are providing the necessary density of data in much of the tropical northern Pacific Ocean. A prototype atmospheric pressure sensor for the surface drifter has been shown to be capable of surviving the frequent submergence of the instrument. This will allow meteorological agencies to use surface drifters in their programmes.

7 A second major technological development has been the Autonomous Lagrangian Circulation Explorer (ALACE) float. The first operational deployment in the Drake Passage has been very successful. The floats presently being deployed in the Pacific will be positioned each month for 75 months to provide a 5-year velocity record at 1000m to provide a reference level to the geostrophically computed transport. A further development to provide T/S profiles as the ALACE float rises to the surface each month is being tested. The ALACE floats cost about $10,000 U.S. per float, which results in a very cost-effective data acquisition.

8 During 1991, American, British, Canadian, Dutch, German and Russian WOCE programmes in the northern North Atlantic served as pilot projects for Core Project 3; they generated about the same amount of data as did the International Geophysical Year in 1957-58. A workshop is planned for the data set at the WHP SAC in the fall of 1992. Data in recent years have revealed significant decadal scale changes in the amounts of formation and properties of Labrador Sea Water and Denmark Straits Overflow Water, both of which are important components of North Atlantic Deep Water.

9 WOCE has made considerable progress in bringing modellers and observationalists together. The eddy resolving North Atlantic model, first developed in the US then continued in Germany, has been compared against a number of long-term data sets. These show how far model development needs to proceed. The UK FRAM model of the Southern Ocean has been used in planning WOCE cruises and moorings. Finally, developments of isopycnal models offer hope that processes such as ventilation and shelf-ocean exchange can be fully incorporated.

10 A suggestion was made by the Panel that WOCE should consider a mid-term Conference in late 1993 or early 1994 to bring together and summarize WOCE accomplishments up to that point. This Conference would be similar to the one convened by TOGA after five years. It would provide a basis to inform governmental agencies about WOCE accomplishments at the half-way mark and to identify any critical needs for successful completion of WOCE. In addition, the conference should address how the WOCE results are impacting the design of other research programmes and the early phases of the Global Ocean

Observing System. The conference should focus on global issues, possibly using modelling as a context, and should be held in late 1993 or early 1994 in order to assist in attracting the necessary resources to complete WOCE.

*11* The Panel recommended that the Committee on Climatic Changes and the Ocean (CCCO) and the Joint Scientific Committee (JSC), assisted by the SSG and IPO, and their sponsoring organizations, plan a conference which demonstrates and reviews the results of WOCE to date, with a focus on its contribution to achieving the objectives of the WCRP.

## 4. REVIEW OF ACTION ITEMS ARISING FROM IWP-I

*12* Action items resulting from IWP-I were reviewed. These included actions for the SSG, for Member States and for intergovernmental bodies. A summary is included in Annex III. Concerning the preparation by the SSG of statements on the general importance of WOCE and that of specific elements of it, it was noted that the WOCE Brochure and the meeting document on Programme Gaps [see Annex IV] were addressing these requests. The Panel was informed on the actions taken by the IOC Assembly with respect to WOCE work in coastal waters. The Panel noted that the IOC Secretariat was successful in providing a mechanism which assisted the People's Republic of China to obtain clearances from the Philippines and Papua-New Guinea to conduct WOCE research in their Exclusive Economic Zones (EEZ). The Panel noted, however, that problems of this nature continue to exist, and it is necessary that the IOC Secretariat gives support to solve these problems as they arise.

*13* One participant noted that the need to establish better communications between space agencies and WOCE could best be addressed via the Committee on Earth Observations Satellites (CEOS) through IOC and WCRP participation or through the Scientific and Technical Committee for the Global Climate Observing System (GCOS).

## 5. WOCE PLANS, PRIORITIES AND GAPS

### 5.1 WOCE PLANS

*14* Dr Nick Fofonoff, Director WOCE International Project Office, introduced the *Summary and Assessment of Resource Commitments, WOCE Report No. 80/92*[1], for this agenda item and as a basis of the detailed discussions that followed. The summary contains the latest information of WOCE resource commitments that have been made available to the WOCE International Project Office. It is to be noted that the term commitment as used in this summary includes funded, proposed, and intended commitments, i.e., it does not in all cases imply that funding has been secured.

### 5.2 WOCE PRIORITIES

*15* Dr George Needler, WOCE Chief Scientist, summarized the most recent evaluation of WOCE priorities completed by the WOCE SSG. At WOCE-17, Wormley, 20-22 November 1991, the SSG evaluated the status of committed resources to the planned WOCE field and modelling programmes. The scope and timing of the commitments that are now firm has led to a reassessment of

---

[1] Copies of this report may be obtained from the WOCE International Project Office, Deacon Laboratory/IOS, Wormley, Godalming, Surrey GU8 5UB, United Kingdom.

programme scheduling. It is clear that many important WOCE objectives will not fully be met unless firm commitments by nations remain firm, commitments that are now tentative are strengthened and additional resources are found. The SSG has evaluated programme objectives and timing as noted below, with first priority being given to establishing on a systematic basis the required global coverage.

**(i) GLOBAL SURVEY**

**Hydrographic Programme**

16 Given the timing of commitments for the WOCE Hydrographic Programme, the WHP is initially concentrated in the S. Pacific and S. Atlantic, and will move its major concentration of effort to the northern oceans and Indian Ocean later. The data requirements for modelling suggest that collecting a basin-scale data set in each ocean over a limited time period is essential. Moving the concentration of effort from basin to basin (but with overlap in coverage) will allow collection of such data in a time of limited resources. This needs to be coincident with the collection of data within the basin from floats and drifters, which require five years of data, as well as from moored arrays and other systems.

17 This basin-by-basin (with overlap) approach, given existing commitments, means that the intensive field programme period will of necessity be seven years, 1990-1997, longer than the five years originally proposed. Further lengthening of this period would lead to the failure to meet some WOCE objectives. Thus, the commitments needed to implement WOCE are required within this seven year time frame.

**Oceanic Heat Flux**

18 The SSG puts high priority on the need for global heat flux measurements. This requires at least one zonal "heat flux" section in each ocean basin including current meter arrays at each end of the hydrographic section. Nations are asked to make their commitments to these arrays firm and secure.

19 All sections of the one-time WHP survey are required for determination of the global heat transport. The SSG emphasizes the importance of complete (coast-to-coast) hydrographic sections and discourages partial lines. No partial lines will be designated as meeting WOCE requirements unless specifically approved by the Core Project Working Groups.

20 The SSG also emphasizes the priority of the Southern Ocean "choke point" sections where the transport of heat and mass can be measured between the ocean basins. The final design of these sections and commitments to their implementation needs to be pursued.

**Mid-depth Floats**

21 Technological developments for the float programme have been successfully completed. The SSG noted the importance of focussing float releases on a single deep level, and of having an adequate number of floats in any one basin to directly measure the flow at that level.

22 Current commitments of floats permit the start of a basin-by-basin deployment. However, additional commitments are required if global coverage meeting WOCE goals is to be obtained. Elsewhere, there are not adequate commitments of floats for the required enhancement of the global coverage. At the equator this enhancement calls for floats at different levels and in the Atlantic for better spatial resolution of the global coverage at the deep reference level.

**Moored Current Measurements**

23 The commitments for current meter arrays are not strong. The SSG urges that first priority be given to the moorings for the heat flux sections in each ocean basin and for the Southern Ocean choke point sections. Next priority should be given to those arrays that define the transport of water masses through major topographic features.

**Surface Layer Programme**

24 Measurements are required throughout WOCE of the evolution of the upper ocean and its surface forcing through the fluxes of momentum, heat and fresh water. The VOS low density XBT and surface drifter programmes which approach adequate coverage in the northern hemisphere, support this effort. In the case of limited commitments, these programmes should give priority to continuing coverage in regions where it is now adequate.

**(ii) TIME AND SPACE-DEPENDENCE: DEFINING VARIABILITY**

**Global Measurements**

25 The SSG recognizes the need for temporal data and emphasizes the importance of repeat hydrography (subscribed at the 70% level now). In this context, SSG also emphasizes the need for high resolution XBT sections to estimate variability of the circulation, especially near heat flux and choke point sections. Continuation of XBT sections that have been taken over closely-repeated tracks is also given priority. Few time series stations are now committed. Because time series data are most useful after decades of data has been collected, WOCE encourages the continuation of existing stations and secondly the establishment of new ones.

**Critical tests of models: Core Project 3**

26 Higher resolution in both space and time is the objective of the basin- and gyre-scale measurements of Core Project 3. The importance of such information in determining the response of the ocean to seasonal and interannual changes in surface forcing is becoming increasingly evident. It is essential for the development of coupled ocean/atmosphere models for the prediction of climate change and the definition of ocean data required for their initialization.

27 Given the present basin by basin approach of the global programme, the SSG gives priority to the development of Core Project 3 in the North Atlantic later in WOCE (1993-1997). Special attention needs to be given to enhanced basin-scale measurements using floats and drifters as well as to measurements of the spatial and temporal variability of both the surface forcing and the full-depth oceanic response using repeat hydrography, VOS measurements and a variety of moored and ship-borne instrumentation. The

success of this programme would be greatly enhanced by completing the one-time WHP lines in the Atlantic within as short a time as feasible during the same period.

28 The components of the basin- and gyre-scale Core Project 3 field programme remain seriously under-committed. Substantial resources are required in addition to those already committed to the Deep Basin Experiment, the Subduction Experiment, the Tracer Release Experiment and to other experiments (within and outside WOCE) being undertaken earlier.

### (iii) SATELLITE MEASUREMENTS

29 The success of WOCE depends on global measurements, and satellites are required for this purpose. WOCE has been designed to take full advantage of satellite measurements of surface wind stress by scatterometer and surface topography by altimeter. It is essential to WOCE that such satellite measurements continue throughout the WOCE field programme. Thus, the SSG fully endorse and support ERS-1 and its continuation through ERS-2 for altimeter and scatterometer measurements, TOPEX/POSEIDON for precision altimeter measurements and NSCAT on ADEOS for precision scatterometer measurements. The SSG supports measurements of the earth's radiation balance by satellite since they provide the overall context for the ocean heat flux within the climate system. Inference of mean currents requires both surface topography and the geoid. The geoid over the ocean can only be measured by satellite but no such satellite mission is proposed. Thus, the SSG endorses a new gravity mission, such as the ARISTOTELES mission being discussed.

30 The SSG also notes the continuing requirement for satellite altimeters and scatterometers for climate research, monitoring and prediction beyond the WOCE intensive observation period.

### (iv) MODELLING

31 The development of models for the prediction of climate change is the primary goal of WOCE. The SSG emphasizes that models need good data sets to test them and that a close interaction between modellers and observations needs to be maintained. Noting the importance of coupled models for climate prediction, the SSG encourages national and international institutes to strengthen ocean and coupled ocean-atmosphere modelling and the comparison of models with observations. These endeavors need to be in addition to the present climate modelling effort. The SSG emphasizes the need for significant investment in people and computer power well before the end of the WOCE intensive field period, and that data assimilation techniques need to be further developed in preparation for the WOCE data sets.

32 The SSG recognizes that resource problems vary from country to country (people, money, facilities), but emphasizes the importance of modelling as a central element of WOCE. Without substantial advances in modelling, WOCE will not meet its major objectives.

### (v) TECHNOLOGY DEVELOPMENT AND TRANSFER

33 There remain a number of instrumentation developments that are required for WOCE to fulfil its goals and/or increase the field programme's

required for WOCE to fulfil its goals and/or increase the field programme's efficiency. These developments need to progress beyond prototypes used by individual scientists to tools available to the wider community. The SSG supports developments to increase the lifetime of subsurface floats, enable their use under ice and the coupling of "continuous" tracking and satellite reporting; to provide reliable sea-surface atmospheric pressure from surface drifters and to increase their lifetime and/or improve their cost per year of use; and to enable the measurement of continuous sea-surface salinity and salinity profiles in the upper ocean. The development of the fast fish into an operational instrument could lead to its effective use during WOCE to augment hydrographic measurements.

*34* The SSG also supports the development of other instrumentation which, although it may not be available in time to help meet WOCE objectives, will be required to support long-term ocean climate observing systems. In this category one can presently identify autonomous profiling vehicles, long-range tomography for integrated measurements of ocean properties and better ocean data telemetry systems.

### 5.3 WOCE GAPS

*35* A series of specific critical WOCE resource gaps which were considered essential to meet the objectives of the experiment by the WOCE SSG had been identified, addressed and brought to the attention of the Panel Members in advance of the IWP's second session. Members were requested to consider how they could respond to the specific priority needs at IWP-II, see Annex IV. The items addressed were (1) Southern Ocean Choke Point Sections, (2) Core Project 3, (3) Rapid Delivery Sea Level Data Assembly Center (DAC), (4) Staffing of WOCE Facilities, (5) High Density XBT Lines, (6) South Pacific WHP Lines, (7) Intermediate Depth Floats, (8) Western and North Pacific WHP Lines and (9) Contingency Funding for WOCE.

*36* Mr B. Thompson stressed the need for prompt action on the funding and establishment of the Rapid Delivery Data Assembly Center (DAC) for Sea Level. This need will become critical over the next year as TOPEX Poseidon data comes on stream.

*37* The WOCE sea level programme has as its objectives the provision of *in situ* data for ERS 1 and 2 and TOPEX/Poseidon altimeter observations and the measurement of changes of sea-level across selected major current systems. A two-component Sea Level Data Assembly Center is required: (1) Rapid Delivery to collect and process data delivered via satellite or other near-real time systems. This center would make data sets available within 2 months. (2) Slow Delivery to assemble and distribute all data and ensure archival as a WOCE data set in the WOCE system. Data sets would be available from this center in 24 months.

*38* The latter center is operational within the UK but the former, the Rapid Center in the USA, is not operational on a global scale and therefore does not meet WOCE requirements. Data are available for the Pacific north of 40°S and a few locations in the Indian Ocean through the Rapid Delivery Center that could be used to support the altimeter missions as this center at the University of Hawaii already acts as an Integrated Global Ocean Services System (IGOSS) [Pacific] and TOGA [Pacific and Indian Oceans] sea level center. Data may also be available from nations operating rapid delivery gauges, for example in the Atlantic.

*39* A proposal to expand the University of Hawaii activity to meet WOCE global requirements will be submitted to USA funding agencies in March 1992. If approved, funds would be available in October 1992. If indications are that funds will be available, IPO will support co-ordination of the expanded effort at mid 1992. This would permit the director of the center to visit the potential data contributors and establish the links so that full operation can begin immediately after funds become available.

*40* Dr A. Clarke described how high density XBT sections are being used to describe the time variability of the circulation of the major gyres of the Pacific Ocean as well as the heat transport through the heat flux sections in the other oceans. Some of these sections already represent a retreat on original proposals to use repeat hydrographic sections to meet these objectives. The lack of commitments for some of these sections or their repeats will jeopardize the ability of WOCE to estimate ocean heat transport to the level that will be useful to the climate programmes.

*41* The Panel was informed of the lack of commitments to the one-time WHP sections in the SW South Pacific. If these sections are not completed over the next few years, there will be a hydrographic/tracer data set for the Pacific basin, but without good information concerning the character of the deep and intermediate waters entering the basin during the approximate time frame.

*42* The Panel was informed that a number of national agencies committed to doing one-time WHP sections in the western North Pacific do not have the appropriate technical equipment to meet WHP standards. Lack of precision, accuracy and resolution in the boundary currents will make it difficult to describe how these currents distribute deep and intermediate waters through the Pacific.

*43* The three Southern Ocean choke point sections (south of Africa, south of Tasmania, and the Drake Passage) along with the Indonesian flow-through from the Pacific to Indian Oceans are required to characterize the magnitude and variability in the global ocean conveyor belt circulation. Attempts will be made by specific countries with ongoing oceanographic work in the choke point and Southern Ocean regions to meet the WOCE requirements.

*44* Gaps were identified in the WOCE Core Project 3 which will provide the resolution of the space and time scale variability for one ocean basin (the North Atlantic) that will be necessary to test the gyre dynamics parts of ocean models. This work is to be scheduled for 1993-1997 and at present there is little in the way of commitment for the enhanced drifters and floats or for hydrography/tracers in the tropics and subtropics. It was suggested that WOCE should emphasize further North Atlantic circulation modelling in the next 2-3 years to help define and optimize the Core Project-3 (CP-3) observational requirements and thereby increase the probability that the CP-3 gaps will be filled within the next few years.

*45* In considering the need for rapid response to unanticipated problems that have arisen, and will undoubtedly continue to arise, it was suggested that some resources by earmarked to handle these items. It may be possible to establish a communication network among funding agencies and the IPO to address these needs.

46 The staffing requirements of the IPO and other WOCE centers were reviewed. The IPO faces the possibility of being reduced to only 4 persons by the summer of 1992 and urgently requires secondment and/or funds for an additional scientist. WOCE has identified candidates that could be used if resources were available. WHPO will also require additional staff as the large data sets of 1992-1995 begin to flow through the system.

### 5.4 NATIONAL RESPONSES TO ADDRESSING WOCE GAPS

47 The Chairman referred to the gaps document [Annex IV] and requested the Members to express their interest in helping address the gaps. Many of the Members recognized that they could only make preliminary assessments and not national commitments at this time. It was noted that the Members would make an effort to address the gaps as follows:

(i) Southern Ocean choke point sections : Brazil, Chile, China, Spain, UK, USA

(ii) Core Project 3 : France, Germany, The Netherlands, UK, USA

(iii) Rapid delivery sea level DAC : USA

(iv) Staffing of WOCE facilities : Canada, UK

(v) High density XBT lines : Australia, China, The Netherlands

(vi) South Pacific WHP lines : China

(vii) Intermediate depth floats : France, UK, USA

(viii) Western and North Pacific WHP lines : Canada, Japan

48 The contingency funding for WOCE was generally supported. Several Members indicated possibilities for assistance in certain situations.

49 Countries that were not represented at IWP-II, which normally participate or may be able to assist WOCE such as Columbia and New Zealand, will be contacted and informed about the present gaps in the WOCE programme.

## 6. NATIONAL STATEMENTS

50 National plans of Australia, Brazil, Canada, Chile, China, France, Germany, Japan, The Netherlands, New Zealand, Russian Federation, Spain, United Kingdom, and United States are summarized in Annex V.

## 7. INTERNATIONAL DEVELOPMENTS RELATIVE TO WOCE

51 The Panel was informed about the developments during the past year concerning a Global Ocean Observing System (GOOS) that relates to Goal 2 of WOCE. Dr D.J. Baker, Co-Chair of the WOCE SSG and Chair of the IOC Committee on Ocean Processes and Climate (OPC), summarized the charge of the Ocean Observing System Development Panel (OOSDP), the impetus provided by the Second World Climate Conference (November 1990) to establish a Global Climate Observing System, including an ocean component through GOOS, and the considerations that the OPC may become the intergovernmental body responsible for GOOS implementation.

*52* Dr G. Needler reported that the OOSDP has met three times with its fourth meeting scheduled for Southampton, UK, 17-19 March 1992. The OOSDP is scheduled to meet three time per year. The basic outline of its report has been established and some of the background work has been completed. The exact design of an observing system is in the process of being formulated. It is clear that GOOS will build upon international research programmes such as TOGA and WOCE.

*53* One Member expressed hope that early in the 21st century there would be more operational oceanography than at present to complement ocean research. Such an operational effort must address not only the climate concerns, but also the needs for ocean data related to coastal water quality concerns. Another Member indicated that a new stream of resources must be established to support GOOS, so it does not draw upon the resources available for ocean research programmes.

*54* Discussion of GOOS suggested that the second half of WOCE may benefit from efforts to conduct some of the more mature observing efforts such as sea level measurements and drifting buoy deployment on an operational basis.

## 8. RECOMMENDATIONS OF THE PANEL

*55* Dr T. McDougall presented the Working Group's report [established under agenda item 2.3] which summarized the findings of the Panel's Second Session.

*56* The following recommendations were adopted by the Panel and were to be presented by the Chairman to the Fifth Session, IOC Committee on Ocean Processes and Climate, Paris, 5-7 March 1992 :

(i) The Panel recommends that the CCCO and JSC, assisted by the SSG and IPO and their sponsoring organizations, plan a conference which demonstrates and reviews the results of WOCE to date, with a focus on its contribution to achieving the objectives of the WCRP. In addition, the conference should address how the WOCE results are impacting the design of other research programmes and the early phases of the Global Ocean Observing System. The conference should focus on global issues, possibly using modelling as a context, and should be held in late 1993 or early 1994 in order to assist in attracting the necessary resources to complete WOCE.

(ii) The Panel recommends that the Chairman, in collaboration with the IPO, establish a network of informal contacts among the resource managers in each country, in order to provide a rapid exchange of information and to facilitate solutions to unforeseen contingencies that arise during WOCE.

(iii) The Panel urges the WOCE Hydrographic Programme Office (WHPO) to facilitate technical visits between institutions in order to transfer the engineering expertise involved in conducting Conductivity, Temperature, Depth (CTD) operations, in particular, the proper use and maintenance of winches, cables and blocks.

(iv) The Panel reiterated the importance of completing the one-time WHP sections in each ocean basin as synoptically as possible. It noted that the most recent plans have A17, A14 and A13 being done two years after the other one-time sections in the South Atlantic, and urges that the plans be changed to minimize this time delay.

*57* The Panel noted with pleasure the actions by the IOC and CCCO Secretariats to assist China in obtaining clearance for WOCE work in coastal waters of the Philippines and Papua New Guinea. It urges the Secretariat to continue its efforts where required. Having noted the positive reactions from the Members present with respect to support in filling some important gaps in the WOCE programme, the Panel decided that similar reactions were required from Members not-present, as well as from potential Panel Members. Consequently, the Panel requested the Chairman, in collaboration with the IOC Secretariat and the WOCE IPO, to contact these nations and seek further support. The Panel noted that as a result of the political developments in the former Soviet Union, commitments with respect to WOCE that were made by the all-union WOCE committee needed to be reconfirmed. It asked the Chairman to investigate via the appropriate channels the position with respect to WOCE of the oceanographic communities in the Russian federation, Ukraine, Estonia and possibly other Members of the former Soviet Union.

## 9. ELECTION OF CHAIRMAN

*58* The Panel elected unanimously Dr L. Otto (The Netherlands) to serve as Chairman until the closure of its third session.

## 10. DATE AND PLACE OF NEXT SESSION

*59* The Panel noted that according to its terms of reference, IWP sessions are normally held every 18 months. The Panel proposed that it should next meet in association with the WOCE Conference which is contemplated in late 1993 or early 1994.

## 11. CLOSURE

*60* In his concluding remarks, the Chairman thanked the Members of the Panel and Observers for their participation in what he described as a very productive session. He thanked the Rapporteur, the CCCO and IOC Secretariats for their support. The Chairman brought the session to a close.

ANNEX I

# AGENDA

1. OPENING

2. ADMINISTRATIVE ARRANGEMENTS

   2.1 Adoption of the Agenda
   2.2 Designation of Rapporteur
   2.3 Establishment of a Working Group

3. REVIEW OF INITIAL RESULTS OF WOCE

4. REVIEW OF ACTIONS ARISING FROM IWP-I

5. WOCE PLANS, PRIORITIES AND GAPS

6. IOC AND WMO SUPPORT FOR WOCE

7. NATIONAL STATEMENTS

8. INTERNATIONAL DEVELOPMENTS RELATIVE TO WOCE

9. RECOMMENDATIONS OF THE PANEL

10. ELECTION OF CHAIRMAN

11. DATE AND PLACE OF NEXT SESSION

12. CLOSURE

ANNEX II

# LIST OF PARTICIPANTS

## I. MEMBERS OF PANEL + ALTERNATES

**AUSTRALIA**

**Head of Delegation**

Trevor McDOUGALL
CSIRO, Division of Oceanography
GPO Box 1538
Hobart, Tasmania 7001
Tel: (61 02) 206 250
Fax: (61 02) 240 530
Tlm: T.MCDOUGALL

**BRAZIL**

**Head of Delegation**

Belmiro MENDES DE CASTRO FILHO
Praça do Oceanográfico, 191
05508 São Paulo - SP
Tel: (55 11) 210 4311 ext. 276

**CANADA**

**Head of Delegation**

Geoffrey L. HOLLAND
Director-General
Physical and Chemical Sciences Directorate
Dept. of Fisheries and Oceans
200 Kent St. 12th Floor
Ottawa, Ontario K1A OE6
Tel: (1 613) 990 0298
Fax: (1 613) 996 5510
Tlm: OCEANSCIENCE.OTTAWA

**CHILE**

**Head of Delegation**

Carlos BIDART
Presidente
Comité Oceanográfico Nacional
Servicio Hidrográfico y Oceanográfico de la Armada de Chile
Errazuriz 232 P. Ancha
Casilla 324
Valparaiso
Tel: (56 32) 282 704
Fax: (56 32) 283 537
Tlx: 230362 HIDRO CL

**Alternate**

Bernardo UCCELLETTI
Secretario Ejecutivo
Comité Oceanográfico Nacional
Errazuriz 232 P. Ancha
Casilla 324
Valparaiso
Tel: (56 32) 282 697
Fax: (56 32) 283 537
Tlx: 230362 HIDRO CL

**CHINA**

**Head of Delegation**

LI Haiqing
Deputy Chief
Division of International Organization
State Oceanic Administration
1, Fuxingmenwai Avenue
Beijing 100860
Tel: (86 1) 867 283
Fax: (86 1) 803 3515
Tlx: 22536 NBO CN

**FRANCE**

**Head of Delegation**

Bach Lien HUA
IFREMER/Laboratoire de Physique
des Océans
B.P. 70
29280 Plouzané
Tel: (33 16) 9822 4149
Fax: (33 16) 9822 4545
Tlm: L.HUA

**GERMANY**

**Head of Delegation**

Jens MEINCKE
Institut für Meereskunde
Universität Hamburg
Troplowitzstrasse 7
D-2000 Hamburg 54
Tel: (49 40) 4123 2605
Fax: (49 40) 4123 4644
Tlx: 212586 IFMHH D
Tlm: IFM.HAMBURG

**JAPAN**

**Head of Delegation**

Nobuo SUGINOHARA
Center for Climate System Research
University of Tokyo
4-6-1 Komaba, Meguro-ku
Tokyo 153
Tel: (81 3) 5453 3956
Fax: (81 3) 5453 3964
Tlm: N.SUGINOHARA

**Alternates**

Yoshiharu NAGAYA
Senior Staff
Ocean Development Division
Science and Technology Agency
2-2-1 Kasumigasaki, Chiyoda-ku
Tokyo 100
Tel: (81 3) 3580 6561
Fax: (81 3) 3581 7442
Tlm: JAMSTEC.STA

Kihei MAEKAWA
First Secretary
Permanent Delegation of Japan
to UNESCO
1, rue Miollis
75732 Paris Cedex 15
Tel: (33 1) 4568 3541
Fax: (33 1) 4734 4670

**NETHERLANDS (The)**

**Head of Delegation**

Leonard OTTO **(Chairman)**
Netherlands Institute of Sea
Research (NIOZ)
PO Box 59
1790 AB Den Burg
Texel
Tel: (31 2220) 69427
Fax: (31 2220) 19674
Tlm: NIOZ.TEXEL

**RUSSIAN FEDERATION**

**Head of Delegation**

Sergey LAPPO
Director
State Oceanographic Institute
Kropotkinsky per. 6
Moscow 119034
Tel: (7 095) 246 7288
Tlx: 411968 OKEAN SU
Tlm: GULEV.BOBA (Attn: S. Lappo)
**(Also representing Chairman SCOR-IOC CCCO)**

**SPAIN**

**Head of Delegation**

Gregorio PARRILLA
Instituto Español de Oceanografía
Dependencias de Corazón de María
N°8, 1ª Planta
28002 Madrid
Tel: (34 1) 347 3608
Fax: (34 1) 413 5597
Tlx: 44460

**UNITED KINGDOM**

**Head of Delegation**

Raymond POLLARD
James Rennell Centre for Ocean Circulation
Gamma House
Chilworth Research Centre
Chilworth
Southampton SD1 7NS
Tel: (44 703) 766 184
Fax: (44 703) 767 507
Tlm: R.POLLARD

**Alternate**

John WOODS
Director - Marine Sciences
Natural Environment Research Council
Polaris House
North Star Avenue
Swindon, Wiltshire SN2 1EU
Tel: (44 793) 411 500
Fax: (44 793) 411 545
Tlx: 444293 ENVRE-G
Tlm: J.WOODS

**Representative**

David PUGH
Institute of Oceanographic Sciences
Deacon Laboratory, Brook Road
Wormley, Godalming
Surrey GU8 5UB
Tel: (44 42) 868 4141
Fax: (44 42) 868 3066
Tlm: D.PUGH

**USA**

**Head of Delegation**

Richard LAMBERT
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550
Tel: (1 202) 357 9614
Fax: (1 202) 357 7621
Tlm: R.LAMBERT

**Alternates**

Dave GOODRICH
NOAA/Office of Global Programs GP
1335 East-West Highway
Silver Spring, MD 20910
Tel: (1 301) 427 2089
Fax: (1 301) 427 2082
Tlm: D.GOODRICH

Grant GROSS
Division of Ocean Sciences, Rm. 609
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550
Tel: (1 202) 357 9639
Fax: (1 202) 357 7621
Tlm: G.GROSS

Dana KESTER **(Rapporteur)**
NOAA/Office of the Chief Scientist
Universal Building, Rm. 625
1825 Connecticut Ave., N.W.
Washington, DC 20235
Tel: (1 202) 606 4243
Fax: (1 202) 387 8945
Tlm: D.KESTER

## II. EX OFFICIO MEMBERS

**Chairman SCOR-IOC Committee on Climatic Changes and the Ocean (CCCO)**

**(representing Chairman CCCO)**

Sergey LAPPO
Director
State Oceanographic Institute
Kropotkinsky per. 6
Moscow 119034
Tel: (7 095) 246 7288
Tlx: 411968 OKEAN SU
Tlm: GULEV.BOBA (Attn: S. Lappo)
**(also Head of Delegation of the Russian Federation)**

**Chairman ICSU-WMO Joint Scientific Commmittee (JSC)**

**(representing Chairman JSC)**

D. James BAKER
President JOI
Suite 800
1755 Massachusetts Ave., NW
Washington, DC 20036-2102
USA
Tel: (1 202) 232 3900
Fax: (1 202) 232 8203
Tlm: J.BAKER.JOI
**(also Chairman IOC OPC and Co-Chairman WOCE SSG)**

**Chairman IOC Ocean Processes Committee (OPC)**

D. James BAKER
President JOI
Suite 800
1755 Massachusetts Ave., NW
Washington, DC 20036-2102
USA
Tel: (1 202) 232 3900
Fax: (1 202) 232 8203
Tlm: J.BAKER.JOI
**(also Co-Chairman WOCE SSG and representing Chairman JSC)**

**Co-Chairmen WOCE Scientific Steering Group (SSG)**

D. James BAKER
President JOI
Suite 800
1755 Massachusetts Ave., NW
Washington, DC 20036-2102
USA
Tel: (1 202) 232 3900
Fax: (1 202) 232 8203
Tlm: J.BAKER.JOI
**(also Chairman IOC OPC and representing Chairman JSC)**

Allyn CLARKE
Bedford Institute of Oceanography
Ocean Circulation Division
PO Box 1006
Dartmouth, N.S. B2Y 4A2
CANADA
Tel: (1 902) 426 2502
Fax: (1 902) 426 7827
Tlm: BEDFORD.INST

## III. OBSERVERS FROM NON-MEMBER STATES

**ESTONIA**

**Head of Delegation**

Ain AITSAM
Institute of Thermo- and Electrophysics
Paldiski Street 1
Tallinn, EE 0001
Tel: (7 142) 453 598
Fax: (7 142) 452 435

**MEXICO**

**Head of Delegation**

Mario MARTINEZ GARCIA
Center for Scientific Research and Higher Education of Ensenada (CICESE)
Espinoza Ave. 843
Ensenada, B.C. 23830
Tel: (52 667) 44900
Fax: (52 667) 44880

**Alternate**

Ruben LARA-LARA
Director, Oceanology Division
CICESE
Espinoza Ave. 843
Ensenada, B.C. 23830
Tel: (52 667) 44200
Fax: (52 667) 45154

## IV. REPRESENTATIVES AND OBSERVERS OF ORGANIZATIONS

**Scientific Committee on Oceanic Research (SCOR)**

Elizabeth GROSS
Executive Director SCOR
Dept of Earth & Planetary Sciences
Johns Hopkins University
Baltimore, MD 21218
USA
Tel: (1 410) 516 4070
Fax: (1 410) 516 7933
Tlm: E.GROSS.SCOR

## V. SECRETARIATS

**Intergovernmental Oceanographic Commission (IOC)**
UNESCO
7, place de Fontenoy
75700
FRANCE
Tel: (33 1) 4568 1000
Fax: (33 1) 4056 9316
Tlx: 204461 PARIS
Tlm: IOC.SECRETARIAT

Gunnar KULLENBERG
Secretary IOC

Muriel COLE
Iouri OLIOUNINE
Albert TOLKACHEV
Yves TREGLOS
Klaus VOIGT
John WITHROW
Tim WRIGHT

**SCOR-IOC Committee on Climatic Changes and the Ocean (CCCO)**
UNESCO/IOC
7, place de Fontenoy
75700 Paris
FRANCE
Tel: (33 1) 4568 1000
Fax: (33 1) 4056 9316
Tlx: 204461 PARIS
7401429 CCCO UC (USA)
Tlm: CCCO.PARIS

Raymond GODIN
Secretary CCCO
**(Technical Secretary for IWP)**

Arthur ALEXIOU

**World Meteorological Organization (WMO)**
41, avenue Giuseppe Motta
PO Box 2300
CH-1211 Geneva 2
SWITZERLAND
Tel: (41 22) 730 8246
Fax: (41 22) 734 2326
Tlx: 23260 OMM CH
Tlm: P.MOREL

Pierre MOREL
Director WCRP

**WOCE International Project Office (IPO)**
Institute of Oceanographic Sciences
Deacon Laboratory, Brook Road
Wormley, Godalming
Surrey GU8 5UB
Tel: (44 42) 868 4141
Fax: (44 42) 868 3066
Tlx: 858833
Tlm: WOCE.IPO

Nick FOFONOFF
Director WOCE IPO

Penny HOLLIDAY
Bertrand THOMPSON

**WOCE Chief Scientist**

George NEEDLER
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, N.S. B2Y 4A2
CANADA
Tel: (1 902) 426 3145
Fax: (1 902) 426 7827
Tlm: G.NEEDLER

ANNEX III

# REPORT ON IMPLEMENTATION OF RECOMMENDATIONS FROM THE FIRST SESSION OF THE INTERGOVERNMENTAL WOCE PANEL

The Report of the First Session of the Intergovernmental WOCE Panel [IOC-WMO/IWP-I/3] identified various aspects of the observation programme which needed firm commitments and dates and called for specific actions by the WOCE Scientific Steering Group, Member States and Intergovernmental Bodies. The following is a summary of the state of implementation of the various aspects of the observation programme and specific actions which were identified at IWP-I. The information in this report was provided by the WOCE International Project Office, WOCE Scientific Steering Group, WOCE Chief Scientist, WMO and IOC Secretariats.

## 1. IDENTIFICATION OF CRITICAL RESOURCE ISSUES REQUIRING NATIONAL ATTENTION

### 1.1 Heat Flux Sections

| | | |
|---|---|---|
| (i) | P2: | Japan has planned for 1993, but with no tracers and not at 30 nm spacing (ie not up to WHP standards). |
| (ii) | PCM2: | USA has planned for 1992, but CP1-4 notes it will require additional deep current meters. |
| (iii) | PX12: | Started by France as a low density section (18 sections per year, 4 observations per day). No high density plans. |
| (iv) | PX12A: | Interest expressed by USA and Australia. |
| (v) | P6: | USA will complete the whole line in 3 sections during May-July 1992. |
| (vi) | AR2: | South African commitment, 1992. |
| (vii) | ACM2: | Uncommitted. |
| (viii) | AR1: | Uncommitted. |

### 1.2 Choke Points

In late 1990 a working group met to plan measurements on the choke point sections. It was noted that although pressure gauges were to be deployed across the sections there was a lack of mooring resources to measure the transport at all the sections and no repeat hydrography was planned for Drake Passage. It has been decided by the Core Project 2 Working Group and the SSG that the best overall strategy is to support pressure measurements and repeat hydrography on all sections and to concentrate direct current measurements on the section south of Australia. This forms the basis of the identified priority programme gap being presented to IWP-II (see Section 5 of the IWP-II/3).

### 1.3 One-Time Survey

| | | |
|---|---|---|
| (i) | A19: | A17 has been extended to incorporate A19. France is committed to doing A17 in 1993. |
| (ii) | P7: | Uncommitted. |
| (iii) | P14S: | Uncommitted. |
| (iv) | S4(Atl): | Uncommitted. |
| (v) | P6: | USA will complete in 3 sections during May-July 1992. |
| (vi) | P15: | Canada is committed to P15N (north of 10S). P15S is uncommitted. |

## 1.4 Sea Level

PSMSL and the WOCE Data Assembly Center in Bidston UK are in the process of determining which of the WOCE Sea Level sites have been geodetically levelled. A questionnaire has been jointly developed between the two activities and will be sent to tide gauge and GPS operators during February 1992. There are old lists available but these are probably out of date as there has been a lot of GPS activity recently. From the GLOSS handbook, information on geocentric measurement is available for the following WOCE sites:

| | | | |
|---|---|---|---|
| (i) | 278 | Casey: | Precise ephemeris (1985) |
| (ii) | 47 | Christmas Is.: | Precise ephemeris (1985) |
| (iii) | 46 | Cocos Is.: | Doppler observations (1969) |
| (iv) | 62 | Darwin: | Precise ephemeris (1974) |
| (v) | 56 | Hobart: | Mount Pleasant Observatory |
| (vi) | 130 | Macquarie: | Precise ephemeris (1982) |
| (vii) | 22 | Mawson: | Precise ephemeris (1982) |
| (viii) | 13 | Durban: | GPS measurements taken |
| (ix) | 20 | Marion Is.: | GPS measurements taken |
| (x) | 76 | Port Elizabeth: | GPS measurements taken |
| (xi) | 268 | Simonstown: | GPS measurements taken |

## 1.5 Floats

(i) North Atlantic: CP1 is 75% subscribed, CP3 is 30% subscribed.

(ii) Equatorial Atlantic: (15S-15N) CP1 is 75% subscribed, CP3 is 50% subscribed.

## 1.6 VOS

(i) Uncommitted lines are: AX6, AX13, AX19, AX26 and IX7, IX11, IX15, IX18, IX24, IX26 and PX1, PX12A, PX15, PX16, PX21, PX23, PX24, PX27, PX36. This amounts to 19 lines, of which 3 are high density lines (IX15, PX12A, PX36), from a total of around 80 lines in the programme.

(ii) High density lines presently operated or planned at low density are: AX7, IX21, PX12, PX14 and PX29. USA has expressed plans to begin high density sampling of AX7 in 1992 according to the request of CP1-4. IX21, PX12, PX14 and PX29 have no high density commitments.

(iii) Most of the XBT programmes now use T7 probes.

## 1.7 Drifters

(i) Coverage for Atlantic in 1995 includes a fraction of 130 USSR and Brazil drifters to be deployed from 1992 to 1995, and a fraction of 120 UK drifters to be deployed from 1993 to 1995. It is not known by the IPO what numbers will be deployed in the North Atlantic of these drifters.

## 2. ACTIONS FOR SSG

(i) The WOCE Brochure was issued in 1991.

(ii) The SSG has prepared statements on 10 critical programme gaps [See Annex IV] which it believes are the type of statements the IWP asked them to produce. The IWP is invited to comment on their format and content as well as requesting nations to take actions based on these gaps.

## 3. ACTIONS FOR MEMBER STATES

(i) The data sharing and pricing policy outline to IWP-I by ESA representatives has evolved since that time. Principal investigators (PIs) will receive the data that is needed for their proposed work free of charge. They are not allowed to copy the data freely; however, ESA will permit co-PIs to be added to the original proposals and those co-PIs can have access to that data set. All other scientists will be required to obtain their data through the ERS-1 data distribution system at costs that are estimated to be an order of magnitude greater than those charged for GEOSAT.

## 4. ACTIONS FOR INTERGOVERNMENTAL BODIES

(i) Upper Ocean Thermal Data

a. The Fourth Session of the Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes was held in Washington D.C. 1-4 October 1991. The Meeting recommended that the Monthly Ship Visit Report be revised and made to reflect a more meaningful monitoring tool for IGOSS and the WOCE/TOGA programmes. A working group was formed to revise this report. This revised report has been distributed for recommendations, comments and approval.

b. The Joint WMO-IOC IGOSS Committee at its sixth session, Geneva, 17-27 November 91 addressed present oceanographic requirements with regards to the GTS distribution system. The Committee noted that identified deficiencies in oceanographic data dissemination should be remedied where possible through improvements to, and expansion of the GTS, rather than through the establishment or use of alternative terrestrial communications systems and that requirements for the global dissemination of IGOSS data and products are likely to expand substantially over the next decade. It therefore requested its Group of Experts on Operations and Technical Applications to monitor closely these requirements, and to liaise with the relevant bodies of WMO to ensure that such requirements are fully taken into account when improvements to the GTS are being planned and implemented.

The Joint Committee expressed particular interest in the developments with regard the Distributed Data Base (DDB) concept and request-reply as opposed to store-and-foreward methodology to a predetermined distribution which is the approach currently used on the GTS. Store-and-forward is the best approach identified to date, for the rapid distribution of meteorological observations and forecast products. Presently only re-transmission of previously sent messages is permitted on the GTS. A different mechanism is needed so that a GTS node can recognize an ad hoc request, satisfy the request from its own limited database if possible, or forward the ad hoc request to an associated facility for a response. The offering, sometime in the future within the World Weather Watch of a DDB functionality could offer a comprehensive request/reply service to meet ad hoc data requests, incorporating standard interfaces for queries and replies to and from data bases. The Committee noted the rapid development, within the international university and business communities, of new request reply communications networks such as INTERNET. Although by no means globally available as yet, these networks nevertheless have considerable potential for IGOSS applications, especially if some links or commonality with the GTS can be established. The Joint Committee agreed that is should maintain close liaison with the CBS Working Group on Data Management on this topic and instructed the IGOSS Group of Experts on Operations and Technical Applicants to undertake this task.

(ii) WOCE Information

Starting in October 91, the electronic information system OCEANIC has ship schedule data identified. The IOC has made arrangements to enlarge OCEANIC access among IOC and IODE national representatives. IOC member states have also been requested to provide necessary information regarding ship scheduling directly to the WOCE Data Information Unit. OCEANIC is considered an important mechanism for improving IODE data flow monitoring and is complimentary to national oceanographic programmes.

(iii) WOCE Work in Coastal Waters

a. The IOC Committee on Ocean Processes and Climate, Paris, 27 Feb-1 March 1991 endorsed the IWP-I request for the IOC to distribute a statement to Member States regarding WOCE work in coastal waters. Subsequently the IOC Assembly established a WOCE resolution working group which considered the request. It was decided that the distribution of the statement would probably not be effective by itself. The working group suggested an alternative approach would be for the Secretary IOC to assist countries needing coastal access for WOCE related work on a case-by-case basis.

b. The IOC Secretariat received a single request since IWP-I for assistance in obtaining clearances for WOCE work in coastal waters. In October 91, China requested assistance in gaining clearances for a November 91 to December 92 WOCE cruise on

sections PR21, PR22, PR23, PR24 and the western part of section P4 and the south parts of sections PR1 and PR2. This work required access in the coastal waters of the Philippines, Indonesia, and Papua New Guinea.

The IOC Secretariat contacted governmental offices in the Philippines, Indonesia, and Papua New Guinea which included IOC Action Addressees (Philippines & Indonesia) and the Papua New Guinea Department of Foreign Affairs. Requests for assistance to obtain the necessary clearances for the field investigations from these countries were made citing the importance of the coastal observations to WOCE and climate change research. The requests for assistance were also closely coordinated with the respective permanent delegations to UNESCO.

The China WOCE Committee informed the IOC that it had successfully finished its first WOCE cruise and that permission for a port call in the Philippines and clearances from Papua New Guinea and the Philippines had been obtained with the help of IOC. Part of the cruise was cancelled due to unavailability of clearances from Indonesia.

(iv) Time Series Data

The Second Session of the Group of Experts on RNODCs and Climate Data Services, Washington, (24-26 February 1992) considered the request of IWP-I to compile a list of all time series stations that have at least a decade of temperature and salinity data available and are presently occupied. A list will be formulated and provided to the WOCE IPO by December 92.

(v) WMO Voluntary Co-operation Programme and Corresponding IOC Programmes

a. The WMO Voluntary Co-operation Programme (VCP) is managed by an Executive Council Panel on the VCP. In addition, there is an informal meeting each year of major donor countries to the VCP. Both these bodies have been invited to support requests from Member States for assistance to undertake oceanographic programmes in the context of IGOSS, GOOS and GCOS. In addition, Members have been informed of the possibility of such assistance. To date, no formal requests for WOCE related VCP activities have been received.

b. The IOC Committee for Training, Education and Mutual Assistance in Marine Sciences, Fifth Session, Paris 1991 developed new guidelines for the IOC Voluntary Co-operation Programme. Although the organizational infrastructure for the programme is in place, substantial resources are required from Member States to make the programme effective. To date, no formal requests for WOCE related VCP activities have been received.

(vi) IOC and WMO Support

a. The IOC and WMO have worked towards the refinement of global meteorological analyses through the establishment of a WMO-CCCO Voluntary Observing Ships Special Observing Project for the North Atlantic (VSOP-NA) which was completed in June 1991. VSOP-NA was designed to determine the effect of Voluntary Observing Ship (VOS) data of different instrumentation and observing practices in meteorological analyses. It is noted that present knowledge of the marine climate is based primarily on meteorological observations from the VOS programme, yet little information is readily available to the climatologist on the nature of the VOS fleet or on the observing practices which are used. The pilot study developed a clear set of recommendations that will lead to improving the quality of VOS data on which meteorological analyses are based. The recommendations are the result of an international VOS Special Observing Project for the North Atlantic (VSOP-NA) completed in June 1991. The project examined instruments, measurement practices, and ship types of the VOS fleet to identify and quantify systematic biases that exist in the repeated data. The output from the analysis phase of the U.K. Meteorological Office Fine Mesh atmospheric forecast model was used as a standard to compare one ship observation with another. Important results include detection of the effects of model characteristics, of biases due to the different types of instrumentation used, and an assessment of the value of the additional data groups reported [see WMO/TD-No. 455][1]. A summary of ship characteristics and catalogue are contained in WMO/TD-No. 456[1].

b. The IOC and WMO continue to actively promote and improve ongoing services and activities of importance to WOCE (e.g., WMO-IOC IGOSS, IOC IODE, WMO-IOC DBCP, and IOC GLOSS).

---

[1] Copies are available from the Secretary SCOR-IOC CCCO, UNESCO/IOC, 7 place de Fontenoy, 75700 Paris, France.

ANNEX IV

# WOCE PROGRAMME GAPS (1991)

## 1. SOUTHERN OCEAN CHOKE POINT SECTIONS

**What is the issue**

Measurement of the Antarctic Circumpolar Current through the three 'choke point" sections (in Drake Passage and south of South Africa and Australia) is a major element of WOCE and Core Project 2. It is the Antarctic Circumpolar Current that links the circulation of the Pacific, Indian and Atlantic Oceans and provides the connections that transform the oceanic heat flux from a regional to a global phenomenon. The SSG has given the same priority to measurements at the "choke point" sections as at the heat flux sections in each ocean basin.

Obtaining accurate fluxes through the "choke point" sections is a difficult problem that will can only be addressed by a concerted effort using a suite of instruments. While some support has been provided by nations, there is a need for additional selected commitments in order for the programme to be effective. These commitments are required for field programmes and equipment during the next 3 years in order to allow co-ordination with commitments already made and to provide needed simultaneity of measurements at all three "choke point" sections and with, to the extent possible, WHP sections in the Southern Ocean.

**What is WOCE doing about it**

A working group met in the fall of 1990 to plan the measurements on the "choke point" sections. Commitments were assessed and a strategy proposed that would enable an effective if not optimal programme to be put in place. It was noted that although pressure gauges are to be deployed for 4 years starting during the 1991-92 austral summer across all the "choke point" sections, none of the required repeat hydrography has been committed for Drake Passage. In addition, the working group noted that commitments to the direct velocity measurements specified in the Implementation Plan are minimal, and limited to the section south of Australia, although additional measurements are being planned in the gap between the Crozet and Kerguelen Plateaux. The Working Group recognized the need for additional commitments for current meter moorings and recommended that they be concentrated on the section south of Australia in order to obtain the best estimate possible of the total flow on at least one of the "choke point" sections.

**How can National Agencies help**

Nations are asked to make commitments for 4 sections across Drake Passage using a ship with an ADCP before the 1995-1996 austral Summer. Additional commitments are sought for current meter moorings to be co-ordinated with those already committed and deployed on the section south of Australia by early 1993.

## 2. CORE PROJECT 3

**What is the issue**

Core Project 3 is that part of WOCE that will study one ocean basin in sufficient detail that it will be possible to make major advances in models for that ocean basin that can be extended to models of the global ocean. It was developed with the recognition that the global measurements of Core Projects 1 and 2 will be unable to resolve the details of the basin- and gyre-scale variations of the deep ocean circulation with time scales of weeks to years and to relate those variations to changes in the surface forcing. The gyre- and basin-scale measurements of Core Project 3 are therefore essential to the fulfillment of the primary goal of WOCE to "develop models for the prediction of climate change and to collect the data to test them".

Recent consideration has been given to the design of ocean observing systems for the collection of data for the initialization of models for the prediction of climate change. Through TOGA an understanding is being developed as to the data set which is necessary for ENSO prediction. The basin- and gyre-scale measurements of Core Project 3 are essential if WOCE is to provide an understanding of the sensitivity of the coupled ocean-atmosphere system to changes in the full depth ocean circulation at all latitudes. An assessment of the extent to which inter-decadal climate change is predictable and the design of a full global ocean observing system for climate prediction await this understanding.

The field components of the basin- and gyre-scale components of Core Project 3 remain seriously under-committed. Substantial resources are required in addition to those already committed to the Deep Basin Experiment, the Subduction Experiment, the Tracer Release Experiment and to other experiments being carried out at present.

**What is WOCE doing about it**

The Core Project 3 Working Group has re-examined the experimental design of the basin- and gyre-scale measurements as proposed in the Implementation Plan and found the approach to be basically sound. Some suggestions are being examined that would allow alternate combinations of standard instrumentation to measure temporal changes of the full depth circulation. The requirements for floats, drifters and the VOS XBT programme remain unchanged.

When setting the priorities for WOCE and the co-ordination of Core Project 3 with Core Project 1, the SSG has emphasized the importance of pursuing the basin- and gyre-scale measurements of Core Project 3 in the North Atlantic in the period 1993-97.

**How can National Agencies help**

Nations are requested to make a commitment to find resources to carry out the basin- and gyre-scale measurements during the period 1993-97. It should be noted that some elements of the programme, for example VOS lines, can be carried out by coastal nations using limited resources. Time series measurements should be started as soon as possible.

## 3. RAPID DELIVERY SEA LEVEL DATA ASSEMBLY CENTER

**What is the Issue**

One of the goals of the WOCE sea level network is to supply *in situ* observations for calibration and validation of satellite altimeter data coming from the present ERS-1 mission and the future TOPEX/POSEIDON mission. The altimeter data will be distributed to the scientific community within short delays, of the order of two months. Among the 67 WOCE sea level stations distributed over the world ocean, it is likely that at least 40 will be operating in a real time data transmission mode. Many of the telemetering gauges are working with US support, especially in the Pacific Ocean, and the data are collected by US teams. But other stations are operating under the control and responsibility of the United Kingdom, France and a few other countries. It is necessary that a data collection, processing and transmission system be ensured such that the sea level data can be made available to the scientific community with delays compatible with the delivery of the satellite altimeter data, i.e., of the order of 2 months. The WOCE-SSG strongly urged that this system be upgraded immediately to fulfil the needs of WOCE.

**What is WOCE doing about it**

Responsibility for the WOCE Sea Level Data Assembly Center has been jointly vested in the University of Hawaii and the Proudman Oceanographic Laboratory in Bidston. Bidston serves as the databank for the delayed mode sea level data set. The University of Hawaii has expressed its willingness to operate the fast delivery center. It already collects Pacific data rapidly and operates an online sea level service allowing the access to several of their monthly sea level products for the Pacific Ocean, through the INTERNET computer network. Confirmation of the UK and USA commitment to support these Centers was given to IOC by the appropriate National Agencies.

**How can National Agencies help**

A commitment to expand the rapid delivery responsibility of the Hawaii Center to meet WOCE objectives is needed immediately, particularly with the present need associated with ERS-1 and with TOPEX/POSEIDON soon to follow.

## 4. STAFFING OF WOCE FACILITIES

**What is the issue**

The infrastructure established to carry out the planning and implementation of WOCE consists of the Scientific Steering Group (SSG) and its technical committees and operational units. The latter include the International Project Office (IPO), the Hydrographic Programme Office (WHPO), Data Information Unit (DIU), and Data Assembly (DAC) and Special Analysis (SAC) Centers. These units require various levels of staffing and overall require a minimum of 30 Full-Time Equivalent (FTE) posts. At present the manning level is 23 FTEs. The staff shortages are, however, concentrated in a few critical areas. They are: the WHPO, IPO and Sea Level DAC (see separate note). Those facilities operating at present at sufficient levels are: Drifter, Mooring, Atlantic and Pacific Upper Ocean Thermal (UOT) and Float DACs, the WHP SAC and the DIU.

In addition to its permanent staff, the WHP Office utilizes Data Quality Experts (DQEs) to assist in its data quality assessments. DQEs are scientists knowledgeable and interested in a specific data type or region who assist in ensuring that the data are achieving the quality standards set for the WHP. These experts are expected to review both the one-time survey and repeat hydrography data. For example, IPO expects that data sets from 39 Atlantic repeats will require DQE review by the end of 1992. Thus far, the availability of DQEs to assist WHPO for repeat hydrography is nil.

In view of the length of the WOCE planning and implementation phases (almost two decades), there is a continuing need for new, or replacement staff. Scientists recruited for these tasks have given up valuable research time but cannot be expected to give up careers. Recruitment is therefore an on-going task faced at all levels and must be kept in mind at all times by Nations when considering out-year funding.

**What is WOCE doing about it**

With the support of Nations and IOC, the SSG has been able to put the basic operational infrastructure in place. All offices and centers are operating at some level. The commitment of Nations to the infrastructure includes personnel and facilities. The IPO has issued vacancy announcements and SSG has worked directly with Nations to obtain secondments. The IOC has negotiated with Nations as appropriate to solicit commitments. The WHP Planning Committee is assisting the WHPO in obtaining the necessary DQE support.

**How can National Agencies help**

Nations are requested to support the staffing of the WOCE infrastructure in one of several ways. They are: by seconding fully funded persons to the international offices; providing funds (full or partial) to support persons available but not funded; and identifying qualified persons available without funding. The most urgent needs at the moment are to fully staff the WHPO, IPO and the Indian Ocean UOT/DAC in Australia.

Nations are requested to include support of WHP quality assessments by DQEs in their programmes. Two months of effort per year per expert is required for the latter. The WHPO is seeking 10 additional DQEs.

## 5. HIGH DENSITY XBT SECTIONS

**What is the issue**

XBT programmes from merchant vessels traditionally provide a sparse sampling of the oceanic upper thermal field. In the North Pacific and the tropical Pacific and Atlantic Oceans, they provide monthly and bimonthly information on the extent and structure of thermal anomalies. When coupled with estimates of winds, air sea fluxes and SST, they form the basis of the operational models currently being run in the tropical Atlantic and Pacific Ocean. Such observations typically involve the officer of the watch launching an XBT from the bridge two to four times each day.

Sixteen to twenty launches/day are required if one wishes to estimate the volume and heat transport through a section. This level of activity generally requires an assigned technician on the vessel. These programmes are more expensive to operate, both in terms of probes and also in terms of personnel salary and travel costs. Such sections also require the active participation of a scientist in order to carry out the analysis from a temperature section to a mass and heat transport estimate.

WOCE has designed a high density XBT sections network in the Pacific which, together with the repeat hydrography, satellite altimetry, surface drifters and mid depth floats should describe the seasonal and interannual variability of its circulation. These should be occupied at least four times each year over several years to allow a seasonal signal to appear out of the mesoscale and interannual signals.

High density XBT sections are also required for the meridional heat flux sections in the Atlantic and Indian Oceans and of the choke point sections in the Southern Ocean. These sections should be occupied at least four times throughout the year; preferable during the period that moored instruments are measuring the major current systems through the section.

**What has WOCE done about it**

Groups in Australia and the US have started or are committed to starting high density XBT sections. By 1993, the high density XBT network in the northern and southwestern Pacific will be largely in place although most sections are to be occupied only twice/year rather than the four or more times that is really required. Similarly, groups are prepared to start the Atlantic.

An automatic carousel has been developed by Scripps to permit a number of probes to be launched sequentially from the stern of a vessel by remote command from the bridge; however the carousel still needs to be reloaded one or more times each day. Fewer probes are lost through breakage of the wire when launched from the stern; this system may be useful for conventional XBT programmes as well.

**How can National Agencies help**

Existing groups need greater resources or we need two or three more nations or groups to begin to do this type of work. Our particular needs on various lines are as follows:

***Atlantic***

| | |
|---|---|
| AX7, AX16 | US to start high density in 1992 but frequency not yet known. The priority in 1992 should be to get 4 occupations of AX16. AX7 will have its highest priority in the 93-95 time frame. Without this frequency of repeats we will have little information of the variability of the heat and mass transport associated with the entire subtropical gyres of the North and South Atlantic. |

***Indian***

| | |
|---|---|
| IX2 or IX21, IX15 | Priority time frame is in 1994-96 when moorings and the rest of the Indian Ocean hydrography is being done. Need at least 4 occupations throughout the year to estimate the variability within a year of the heat and mass transport between the Indian and Southern oceans. |

***Pacific***

| | |
|---|---|
| PX12A or PX12, PX29 | Require 4 repeats of this heat flux section in the 92-95 time frame. Prefer a routing that remains in the latitude band 25 to 40°S. No HD commitment at present for this work, its lack will mean that we will have no estimates of the seasonal variability of the heat and mass exchange between the Pacific and Southern oceans. |
| PX14 | No commitments for HD sampling along this section. Without this section, we will not be able to estimate the variability of the heat and mass transport into and out of the eastern boundary regions. This information is required for an assessment of the role that eastern boundary processes might play on the structure of the upper ocean. |
| PX5, PX10 PX37, PX38 PX44 | Require the additional resources to increase the sampling of these sections to 4 times/year. It is difficult to see how one can estimate the variability of the circulation of an entire ocean if some parts are sampled twice a year and others four times/year. Our experience with model simulations in the Atlantic suggests that quarterly sampling is the minimum required. |

***Southern***

| | |
|---|---|
| PX36 | Require an Antarctic scientist to try the technique on this section between New Zealand and Antarctica to determine whether it can provide an estimate of the transports in the circumpolar current systems. Will need probes every 10-15 miles and an Acoustic Doppler Current Profiler because of the large barotropic component and small horizontal scales of the current structure. |

**Figure** [See Fig. 1]

World chart of high density XBT sections and Repeat Hydrographic sections required at least quarterly.

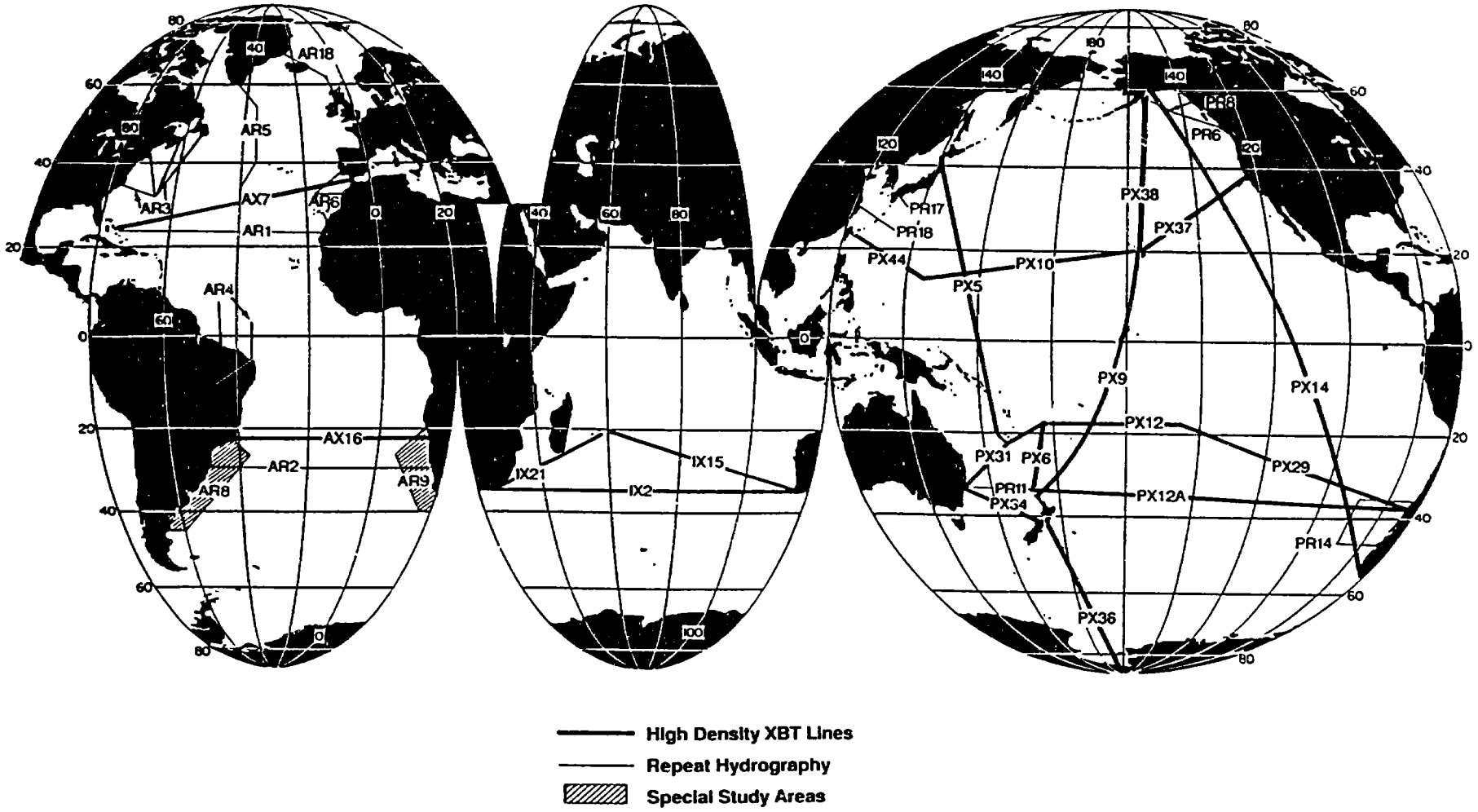



Fig. 1: World Chart of high density XBT sections and Repeat Hydrographic sections required at least quarterly

## 6. SOUTH PACIFIC WHP LINES

**What is the issue**

The southern ends of the meridional lines in the Pacific are an important element of WOCE and Core Project 2 because they connect the interior of the Pacific with the southern boundary of the WOCE one-time survey which is defined by the zonal section along 65°S (S4). These sections cross the Antarctic Circumpolar Current (ACC) and extend into the gyres south of the ACC. They define the circulation of the ACC which links the Pacific, Indian and Atlantic Oceans and contribute to the understanding of the pathways and northward flux of Antarctic Bottom Water.

Understanding of the dynamics of the ACC and the regions south of it requires the completion of all lines of the Pacific one-time survey to a latitude of at least 65°S (the latitude of the zonal S4 section). Presently, only the eastern sections are planned to be extended far enough south to intersect with S4. There are presently no commitments for the southern ends of the WHP lines in the western Pacific (P14, P15). This gap leads to serious problems in the understanding of the circulation in the southern Pacific, especially in view of the fact that only few high quality hydrographic data and basically no tracer data exist for this region from previous studies.

**What is WOCE doing about it**

The importance of the southern ends of the Pacific lines for the interpretation of the Pacific hydrographic and tracer data was pointed out by the Core Project 2 Working Group and by the Geochemical Tracer Scientific Panel. The SSG has given high priority to these measurements. The USSR and USA are co-operating to complete S4 (Pacific) in 1992. They have been requested to consider utilizing any extra time to occupy P14S.

**How can National Agencies help**

Nations are asked to make commitments for the unsubscribed lines in the western South Pacific (P14 and P15) and to extend their commitments for the sections in the eastern Pacific to latitudes as far south as possible, but at least to the latitude of S4 (about 65°S). WOCE requirements would be met best using ice-breakers that could do sections into the Antarctic Coast.

## 7. INTERMEDIATE DEPTH FLOATS

**What is the Issue**

The intermediate depth float programme is considered to be one of the high priority components of WOCE. This is the case both globally, Core Project 1, and in the Atlantic, Core Project 3. These floats will provide a unique set of measurements that can be used to provide a reference level to give total transport from hydrographic data, and define the spatial distribution of eddy kinetic energy and eddy diffusion.

According to latest estimates, 70-75% subscription of the global Core 1 coverage is expected. This estimate includes previous SOFAR float deployments in the North Atlantic which contain data taken from 1972 to 1988. A large fraction of this total are either proposed, but not yet funded, or intended work. The coverage for Core 3 in the Atlantic falls well short (30-50%) of that required. Although there is interest in the scientific community to obtain the necessary float coverage, the financial support is not secure.

**What is WOCE doing about it**

Two types of floats, ALACE and RAFOS floats, are being used to make these WOCE measurements. The ALACE float has made the transition from prototype to an operational instrument, so that it can be used by groups other than at the Scripps Institution of Oceanography where it was first developed. Similarly there is now a version of the RAFOS float developed for use in WOCE that is available from commercial sources. Initial ALACE float deployments in the South Atlantic (January 1990) and Eastern Pacific (1991) are performing well.

**How can National Agencies help**

Given the maturation of the float technology, National agencies are urged to find support and to recruit participation of institutions and float groups in float work to achieve the necessary coverage. The immediate priority is to support the CP1 global coverage. Emphasis should be given to support for Atlantic CP3 studies starting in 1994.

## 8. WESTERN AND NORTH PACIFIC WHP LINES

**What is the issue**

A key element of WOCE Core Project 1 and 2, is the occupation of a set of trans oceanic, eddy resolving, full depth hydrographic/tracer sections throughout the global ocean to modern analytical standards. This data set will provide a description of the present state of the three dimensional ocean circulation and form the basis of the ocean climate models that are to be developed over the next decade. If we are to achieve a uniform global description, it is essential that the sampling standards be maintained on all WHP one time survey lines.

There are, at present, serious shortfalls in the commitments to WHP sections in the western and northern North Pacific. According to our present information, the ship time scheduled for some sections is inadequate to allow the required (30 nm) station spacing to be achieved. The institutions and/or vessels committed to these sections are also lacking a rosette capable of carrying the 10 litre bottles as required for the small volume tracer programme. The problem is further compounded by the fact that few nations running sections have tracer laboratories that would produce the measurements.

The sections for which there are serious concerns are: P1, P2, P8, P9, P11N, P25, P26, P27, P28, P29 and P30.

If nothing is done to improve the situation, our knowledge of the circulation of the North Pacific at the end of WOCE will be significantly less than that of the rest of the world ocean. Given the size of this ocean basin, this will clearly reduce our ability to model the global ocean for climate purposes. Because work has already started in the Pacific, it would be most valuable if these improvements could be made and the sections run in 1993 or 1994.

**What is WOCE doing about it**

The WHP Office is continuing to collect information concerning the capabilities of the vessels and institutions that are planning to carry out these sections. It has informed nations and institutions about their deficiencies. It has produced documents and manuals outlining the required standards. It has participated in regional meetings in which it has urged the nations and institutions to look for means to solve these problems co-operatively.

**How can National Agencies help**

First, national agencies should see if they can find the resources to provide the necessary equipment or ship time to allow their scientific teams, or scientific teams from other nations, to meet WHP standards on these sections.

Second, national agencies could come together to jointly fund and train a team that could provide the necessary rosette and analytical capacity for several of these sections.

If the resources could be made available for the necessary equipment, WOCE would be able to assist in making arrangements for the necessary training. Resources such as berths on cruises, travel and living support in foreign institutions or travel and living support for trainers would be required from national or international agencies.

## 9. CONTINGENCY FUNDING FOR WOCE

**What is the Issue**

International WOCE is running a global programme involving tens of different research groups and organizations in nearly as many countries with its own resources as well as those of the national agencies directed towards particular preplanned research grants, projects, cruises, meetings, etc. As the field work is being implemented, international WOCE is being approached increasingly by principal investigators and its own WOCE committees with problems requiring a few thousands to a few tens of thousands of dollars to solve. Often these problems are related to a particular cruise or situation and if not resolved within a period of a few months then a cruise goes to sea missing a key measurement or instrument or without necessary training, etc.

IOC and other international agencies have programmes for development and assistance; however, these are designed to build up a nation's capability over several years. They have been and will continue to be an excellent mechanism to provide the long term facilities in coastal states such as sea level and time series stations and support for XBT programmes.

**What is WOCE doing about it**

WOCE has already dealt with a number of such problems on an *ad hoc* basis. Some successful examples are as follows:

(1) Soviets provided port costs for Ioffe by USA.
(2) Travel, freight and direct costs of a nutrient chemist to participate in German South Atlantic WHP cruise.
(3) Funding for Standard Seawater Lecture associated with Vernadsky WOCE intercomparison/training provided by IOC and WHOI.
(4) Monitor placed on a Soviet vessel by Canada to restore computing environment.
(5) IPO has provided interim funding for communications (telemail) to allow individuals to participate more fully in WOCE implementation.
(6) Purchase of special flasks by US/PMEL for shipping gas for CFC intercalibration.

A number of situations have also arisen which have not been resolved.

(1) Rosette required by Chile for PR14.
(2) Academia Sinica, PRC, requires CTD and rosette - replacement.
(3) Argentina requires support for conducting XBT programmes on AX18.

**How can National Agencies help**

Firstly, we would like the international and national agencies who finance the operational budget for WOCE to permit WOCE to retain some small percentage of that budget (10%) as a contingency fund. This would permit WOCE to solve several problems each year at the 1-5K$ level. WOCE will reduce the meeting schedule of its bodies to create this surplus within a existing funding levels; however, we would not want to see the agencies then remove such funds.

Secondly, we would like to establish a network of contact points in national agencies might be able to respond to emergency requests for additional resources. We need to find out what sort of assistance various agencies might be able to provide; what sort of restrictions might apply. We need information on availability of funds for travel or training, loan of equipment, transport of equipment, etc.

## CO-ORDINATION OF INDIAN OCEAN FIELD WORK BETWEEN WOCE AND JGOFS

**What is the Issue**

Both WOCE and JGOFS are planning major expeditions in the Indian Ocean during 1994 and 1995. Germany and the USA are both planning such expeditions; France, South Africa and the United Kingdom have also plans for WOCE related cruises during this time frame. The Soviet Union had plans for Indian Ocean work during the earlier 1991-1992 time frame.

WOCE has held preliminary Indian Ocean planning meetings and has developed a plan by which a substantial part of the one time hydrography and small tracer work can be completed within a period of less than two years. These meetings have not yet addressed details of how to co-ordinate with JGOFS to the benefit of both programmes.

When the original implementation plan was created for the Indian Ocean, it was recognized that the tropical and subtropical circulations, especially north of the equator would change with the monsoon season. The sections in this region were specified to be occupied at least once in each of the two monsoon seasons. The desire of the German and US JGOFS communities to carry out an extensive programme in the Arabian Sea should provide the opportunity to schedule the WOCE sections in this region to get an appropriate sampling of the seasonality.

**What is WOCE doing about it**

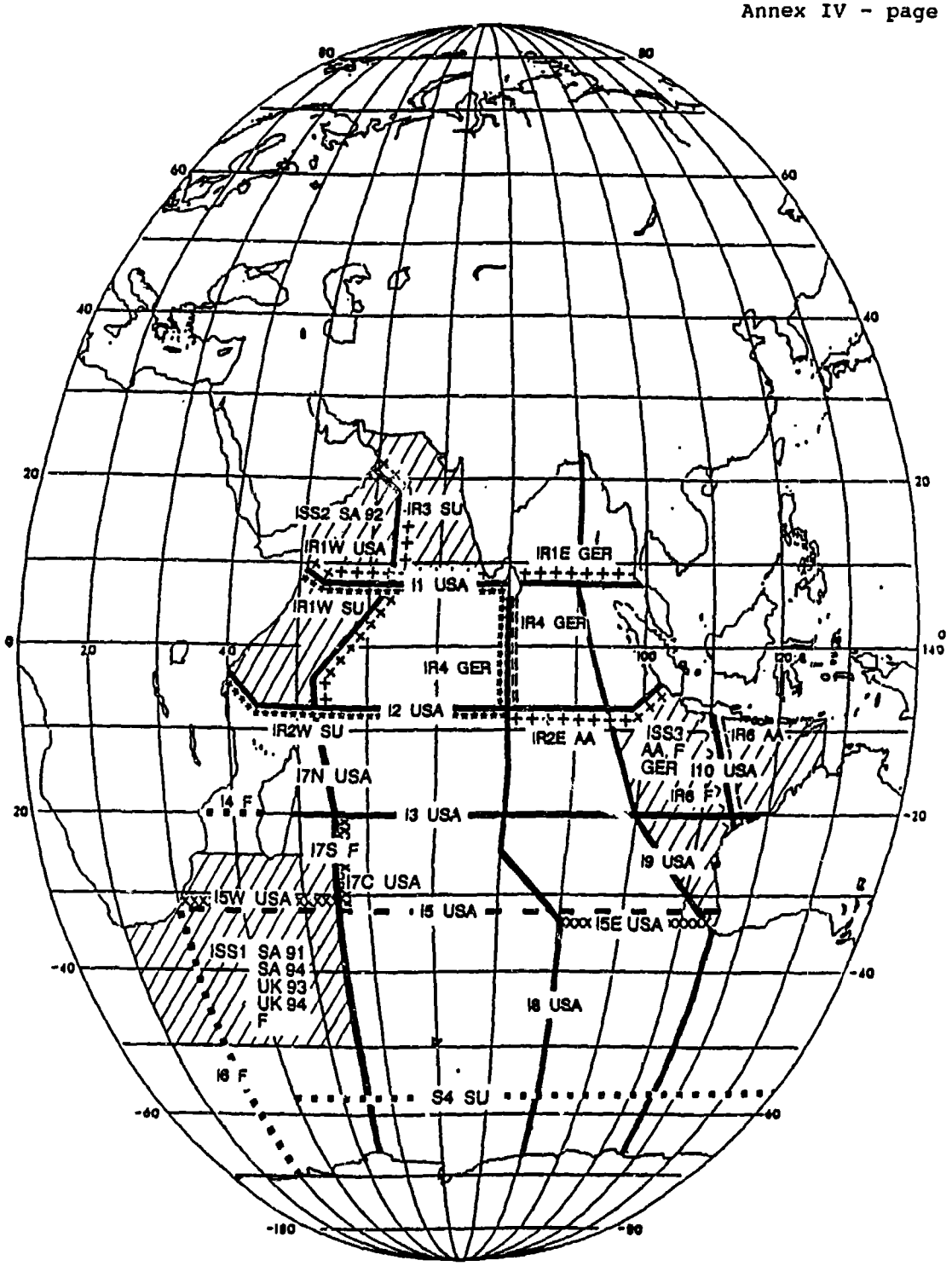
The WOCE IPO is co-operating with national WOCE committees in developing firm dates for the planned programme in the Indian Ocean and is trying to ensure that nations are aware of each others plans and of the scientists involved. The IPO will provide a document for the CCCO Indian Ocean Panel detailing the latest information on WOCE plans in the region to further co-operation with the larger scientific community.

**How can National Agencies help**

We ask that national agencies who are sponsoring both WOCE and JGOFS cruises in the Indian Ocean in 1994/95 take steps to ensure an early dialogue between the WOCE and JGOFS scientists on questions of the timing of the various elements of the work. We would like a mechanism by which the international co-ordination of the efforts of various nations can be taken into account when each nation is making its own ship scheduling decision.

**Figure** [See Fig. 2]

Indian Ocean chart of the WOCE one-time survey sections and Repeat Hydrography.




**LEGEND**

**One Time Survey Sections:**

- 1987
- 1993
- 1995
- 1995 (Interest Expressed)

**Repeat Hydrography:**

- 1990
- 1991
- 1992
- 1995
- No Date

Fig. 2: Indian Ocean chart of the WOCE one-time survey sections and Repeat Hydrography

ANNEX V

# SUMMARY OF NATIONAL STATEMENTS

## A. AUSTRALIA

### 1. APPROVED PROJECTS

### 1.1 THE SOUTH PACIFIC OCEAN

The transport of the East Australian Current is being estimated at the western boundary current moorings (PCM3) at a latitude of about 30°S on the East Australian shelf. The array was deployed from R.V. Franklin in November 1991. The array is to be recovered and redeployed in September 92 and finally recovered in early 94. (PIs are J. Church, G. Meyers, M. Tomczak and F. Boland.)

Sections have been completed on PR11 and PR13 (from Australia to New Zealand only) in August/September 1989 and in February/March 1990. These sections will be done four times in one year in 1993/1994 by combining Australian and New Zealand resources. (PIs are J. Church, G. Meyers and M. Tomczak.)

In November 1991, CTD/ADCP/nutrient sections were completed from the Australian coast at 30°S east to 30°S, 170°E, from northern New Zealand to New Caledonia and from New Caledonia west to Australia. Oxygen and nutrients only were measured. These sections are a repeat occupation of the western end of P6 and P21 and an occupation of PR11. (PIs are J. Church, G. Meyers, M. Tomczak and F. Boland.)

The hydrographic section along 156°E (P11) from Papua New Guinea to 43°S will be completed on RV Franklin in June 1993. The remainder of P11S, from 43°S to Antarctica, will be completed on Aurora Australis in April/May 1993. CTD, ADCP and nutrients will be measured. International collaboration is needed to measure other tracers. (PIs are Rintoul and Church.)

### 1.2 EQUATORIAL REGIONS

A joint surface mooring, with the Japanese, in the western Pacific warm pool was to be maintained to the end of the TOGA COARE intensive observing phase to observe the equatorial current and thermohaline structure. Repeated vandalism of this mooring means it has been discontinued (PI is J. Butt.)

A programme on the direct measurement and calibration of remotely-sensed measurements of heat fluxes into the oceans has been supported. Two cruises to the Western Equatorial Pacific have been successfully completed and two more are planned in conjunction with TOGA COARE in late 1992 and early 1993. (PIs are J. S. Godfrey, F. Bradley and M. Nunez.)

### 1.3 THE SOUTHERN OCEAN

The repeat section from Tasmania to Antarctica (SR3) for study of the Antarctic Circumpolar Current and its interannual variability is being

occupied. The first section was in October 1991. The ship (Aurora Australis) did not have an ADCP for this section but CTD/nutrients/freons were measured. Further repeats will be completed in March 1993, January 1994, October 1994, April 1995, August 1995 (reduced station density only) and March 1996. On one of the occupations of this section, we hope for international collaboration for the full WHP set of tracers. (PI is S. Rintoul.)

The portion of S4 not being completed by the Russian sections (i.e., we will occupy only the section between 120°E and 170°E) will be occupied in March 1995. The section will be closed off on the east by completing the section southwestward to the continental shelf. We expect to measure CTD/ADCP/nutrients only and welcome collaboration to make other tracer measurements. (PI is S. Rintoul.)

As stated in the Pacific section the P11 section will be occupied to Antarctica in May 1993. (PI is S. Rintoul and Church.)

A single current meter mooring was deployed on the SR3 section at the location of the subAntarctic Convergence in October 1991. This mooring will be replaced by an eddy resolving array in March 1993. The array will stay in place for at least two years. US collaborators are seeking to add extra instruments to this array. (Australian PIs are Rintoul and Church.)

We expect to deploy an eddy resolving array east of Macquarie Island near SCM11 in 1995. The array will be deployed for two years. (PIs are Rintoul and Church.)

An Antarctic sea ice study is being carried out with drifting buoys and satellite imagery for use in both forecasting and climate global circulation models.

1.4 WOCE VOS XBT PROGRAMME

Existing low-density XBT sampling of the Indian and Pacific Equatorial Current System will continue.

High resolution XBT sections four times per year are being done to close the southern end of the Tasman Sea control volume during the period 1991 to 1993 and perhaps beyond (PX34 HD). The high-density line from Fiji to Australia (PX31) is being done in conjunction with D. Roemmich of Scripps. (PI is G. Meyers.)

We are presently planning to implement repeat XBT/XCTD eddy-resolving sections between Hobart and Antarctica, and between Hobart and Macquarie Island. If funding permits, we will occupy these sections at least three times per year. (PI is Rintoul.)

1.5 SURFACE DRIFTERS

Ten surface drifters were deployed in the Tasman/Coral Sea during 1991 and we expect ten to be deployed in 1992. For 1993 and 1994, we expect to deploy ten/year in the eastern Indian Ocean. (PI is G. Cresswell.)

1.6 OCEAN MODELLING

A programme to develop ocean models is funded. One of the initial areas of interest is the East Australian Current. A Southern Ocean modelling

programme is just about to commence. We also have ongoing expertise in inverse models. (PIs are J. S. Godfrey and J. Wilkin.)

1.7 SEA-LEVEL MONITORING

An upgrading of the tide gauge network around the Australian continent is underway. Of the dozen new acoustic gauges to be installed about half are operating at this stage. All gauges report in near real time. (PI is G. Lennon.)

Eleven acoustic tide gauges are in the process of being installed on a number of South Pacific Islands. (PI is G. Lennon.)

## 2. PROJECTS EXPECTED TO BE COMPLETED BUT FOR WHICH THERE ARE NOT YET APPROVED PLANS

2.1 INDIAN OCEAN

The transport of the Leeuwin Current is to be estimated at 20°S by moored current meters and short hydrographic sections. (Repositioned ICM6.) (The deadline for ship-time proposals for R V Franklin for cruises in 1995 is June 1993). (Likely PIs are M. Tomczak and J. Church.)

The throughflow from the Pacific to the Indian Ocean is to be estimated by completing the Java to Australia repeat section (IR6) twice during 1995. This will require Indonesian approval and collaboration. (PI is G. Cresswell.)

The Indonesian throughflow is expected to be measured in an ASEAN-Australia Economic Co-operation Programme using moorings for a year in approximately 2000m of water in the Makassar and Molucca Straits north of the equator. (PIs are G. Cresswell and A. Ilahude.)

A detailed dynamical study in a control volume that is large enough to average over the meso-scale eddy field, but is small enough to adequately resolve the lateral property gradients is to be undertaken. This study will be combined with a pair of subduction cruises in the southeastern Indian Ocean. (Likely PIs are McDougall, Rintoul and Tilbrook. International collaborators are needed for the small-volume tracer work.)

Surface drifters are to be deployed in the northeastern Indian Ocean to study the Equatorial Current system. This will also be an area of particular study using R.V. Franklin (ISS3).

2.2 WOCE VOS XBT PROGRAMME

High resolution sections will shortly be proposed for the Fremantle to Sunda Strait route. (IX1). (PI is G. Meyers.)

2.3 DATA CENTERS

The Division of Oceanography, Australian Oceanographic Data Centre and Bureau of Meteorology have informally agreed to set up a regional WOCE data centre (for XBT data). It is focusing on data from the Indian Ocean and the Southern Ocean waters to the south of Australia and New Zealand. Quality control of the 1990 delayed-mode data set is being done at AODC under the supervision of CSIRO oceanographers. If this arrangement proves satisfactory, the data centre will continue.

## 3. PROJECTS IN WHICH THERE IS INTEREST FROM AUSTRALIAN OCEANOGRAPHERS BUT FOR WHICH FUNDING HAS NOT YET BEEN SECURED

### 3.1 THE INDIAN OCEAN

The northward flow of bottom water in the West Australian Basin is to be estimated by moorings and hydrographic sections (SCM4, at the entrance to this basin 105°E, 35°S). The viability of this proposal will depend largely on the availability of current meters. (PIs are T. McDougall and J. Toole.)

It is likely that ship time will be available to do a repeat line in the Indian Ocean. There is Australian interest in doing the eastern half of the repeat section IR2 in 1995 or possibly 1996. Another collaborator would be needed to do the western half of this repeat section.

## 4. PROJECTS IN WHICH AUSTRALIA NEEDS INTERNATIONAL ASSISTANCE OR CO-OPERATION

The above pages list several projects in which Australia needs expertise from other nations, or which may only happen as a collaborative project between two or more nations. These are brought together in the following list.

### 4.1 TRACER MEASUREMENTS

4.1.1 International collaboration is needed to measure the full suite of tracers on the WHP One-time lines P12, P11, P11S, and S4 (part Indian sector).

4.1.2 International collaboration is needed to measure the small-volume tracers in a control volume study in the southeast Indian Ocean.

### 4.2 MOORINGS

4.2.1 More moored current meters are needed on SR3. US scientists have expressed interest.

### 4.3 XBT LINES

4.3.1 Australia has an interest in proposing the eddy-resolving sections IX15/IX21. An international consortium of collaborators will be needed to occupy this section at least twice per year.

### 4.4 REPEAT SECTIONS

4.4.1 It is likely that Australia would do the eastern part of IR2 if another nation did the western part of this repeat section.

## B. BRAZIL

Within the context of the World Ocean Circulation Experiment (WOCE), and following the general guidelines established by the Brazilian WOCE/TOGA Committee (BWTC), Brazilian scientists have developed the following activities:

### 1. DYNAMICAL OCEANOGRAPHY WOCE COURSE

The course was held at Instituto Oceanográfico da Universidade de São Paulo (IOUSP), located in the city of São Paulo, from October 15 to December 15, 1990. Physical oceanographers from several countries in Latin America attended the course with a total of 19 students originating from:

- Argentina (4)
- Brazil (9)
- Chile (2)
- Costa Rica (1)
- Ecuador (1)
- Mexico (1)
- Peru (1)

Topics covered in and invited professors to the course were the following:

- Geophysical Fluid Dynamics. E.J.D. Campos and B.M. Castro (both from IOUSP, Brazil);
- Ocean Circulation. T. Jensen (Colorado State U., USA), D.B. Olson (U. of Miami, USA), E.J.D. Campos (IOUSP, Brazil) and L.B. Miranda (IOUSP, Brazil);
- Numerical Modelling. W. Holland (NCAR, USA) and J.A. Lorenzzetti (INPE, Brazil);
- Air-Sea Interaction. C. Nobre (INPE, Brazil);
- Satellite Oceanography. Y. Sugimori (Tokay U., Japan);
- Data Collection and Analysis. T. Müller (IFM Kiel, Germany) and L.B. Miranda (IOUSP, Brazil);
- Ocean Tides. J. Harari (IOUSP, Brazil).

### 2. CONDUCTIVITY, TEMPERATURE, PRESSURE (CTD) CALIBRATION CENTER

A CTD calibration center is being installed at IOUSP. The calibration center will meet WOCE standards for hydrographic data accuracy. The center should start operating regularly on October/November 1992.

Funding for the calibration center has been made available by CIRM and by FAPESP.

### 3. RESEARCH PROJECT: OCEANIC CIRCULATION IN THE WESTERN REGION OF THE SOUTH ATLANTIC (COROAS)

COROAS will be a joint project between scientists from IOUSP and from INPE. Funding for the project will come through a grant from FAPESP.

The general objective of the COROAS project is to estimate seasonal means of mass and heat transports due to the western boundary currents (Brazil Current [BC] and Antarctic Intermediate Water Flow [AAIW] along the southeastern coast of Brazil, 25°S.

The specific objectives are the following:

(i) To estimate the baroclinic and barotropic components of the circulation along the Southeastern coast of Brazil, including the shelf break and the continental shelf regions;

(ii) To monitor continuously the velocity field and the heat and mass transport due to the BC and the AAIW along the Southeastern coast of Brazil;

(iii) To determine the importance of meso-scale Brazil Current eddies in the heat and mass transport; and

(iv) To study the deep circulation in the Brazil Basin, including its interaction with the Argentine Basin.

The data collection part of the project will include the following activities (name of the principal investigator in charge of each part is presented):

3.1 HYDROGRAPHY

Three seasonal cruises aboard the IOUSP R/V Prof W. Besnard are scheduled: January 1993, July 1993 and January 1994. Each of the cruises will have two legs:

(i) **Meso-scale experiment** : Seven hydrographic sections from 40m to 2000m (E. Campos, IOUSP).

(ii) **Large-scale experiment** : Two hydrographic sections, one extending from Santos (SP) to the Vema Channel, and the other extending from the Vema Channel to the Brazilian coast, along the latitude 30°S (Y. Ikeda, IOUSP).

3.2 MOORING LINES

Three current meter moorings along the radial from Santos to Vema, on the 100m, 200m and 1000m isobaths (M100, M200 and M1000 respectively) (B. Castro, IOUSP).

3.3 TIDE GAUGES

One tide gauge will be installed near Santos, on the coast, and a deep water tide gauge will be deployed together with the M200 mooring (B. Castro, IOUSP).

3.4 METEOROLOGICAL BUOY

One meteorological buoy will be deployed in the mooring M200 position (M. Stevenson, INPE).

3.5 DRIFTERS

Four WOCE standard, low cost drifters will be released during each seasonal cruise, near the shelf break, on the northernmost transect of the meso-scale phase of the study. The position of the drifters are to be

calculated and transmitted periodically via satellite to INPE (M. Stevenson, INPE).

3.6 ACOUSTIC CURRENT PROFILING

Measurements with a Pegasus Acoustic Profiler, in collaboration with Dr Kevin Leaman of the University of Miami (L. Miranda, IOUSP).

3.7 REMOTE SENSING

Thermal images from NOAA-N satellites for the area of study will be recorded at INPE, during the realization of the project (J. Lorenzzetti, INPE).

**4. RESEARCH PROJECT: A NUMERICAL STUDY OF THE TROPICAL ATLANTIC CIRCULATION WITH AN ISOPYCNIC-COORDINATE CIRCULATION MODEL (NUSTRAC)**

The objective of the NUSTRAC project is to study, in a numerical framework, the dynamic and thermodynamic processes governing the oceanic circulation in the tropical Atlantic. The model to be used is the thermodynamically active version of the Isopycnic Coordinate Model developed at the University of Miami, whose main advantage in this context is the elimination of numerically-induced vertical heat diffusion. A comprehensive study of the oceanic response to atmospheric thermodynamic forcing is envisioned. Of particular interest will be the main interannual and decadal variability signal, commonly referred to as the "Atlantic SST dipole".

The project is being submitted simultaneously to the Conselho Nacional de Desenvolvimento Científico et Tecnológico (CNPq, Brazil) and the National Science Foundation (NSF, USA) by E. Campos and R. Bleck.

## C. CANADA

The most substantial change in the Canadian programme for WOCE since the last IWP meeting has been the decision of the Canadian government to fund a climate research programme of CAN$ 85 million over the next five years. Included in this programme is about CAN$ 2-3 million for WOCE. The major part of the funds are for a modelling programme which will include ocean models. Details of the programme are not available at present but it is hoped that a Canadian contribution to the WOCE modelling objectives will be possible.

Nationally, the Marine Environmental Data Service is providing a WOCE global facility for Drifting Buoy Data and is contributing extensively to the GSTPP and the co-ordination of the near real-time sea level network for the Atlantic Ocean. A contribution of $20K was arranged to assist in the funding of the IPO. The Canadian National Committee for WOCE is producing a WOCE brochure which should be available in the spring of 1992.

In the Pacific Ocean, a concern has arisen over the Canadian commitment to the one-time hydrographic survey of P15. A re-organization of the Canadian research fleet has left the Institute of Ocean Sciences with only one major vessel. Several options are presently being considered, including discussion with Russian colleagues on possible joint programmes. Other WOCE commitments in the Pacific are being met. In the Atlantic Ocean, Canada continues to meet its commitments to occupy AR7W each spring throughout the WOCE period. It

is also committed to provide estimates of the transport and T/S characteristics of the Labrador Current through the same period. It has also occupied AR5 during 1991. Plans have been made and funds obtained to provide the microstructure component of the WOCE tracer release experiment, hydrographic and modelling components of control volume experiment AR13 and its associated North Atlantic current array ACM6. Canada is co-ordinating the overall design of AR13 through its contacts with scientific groups in Russia and the United States.

## D. CHILE

### 1. WOCE HYDROGRAPHIC PROGRAMME

Chile carried out the first repeat cruise PR14 during October-November 1991 on board the R/V Yelcho, between 38°S and 48°S at 82°15'W.

The basic programme along the transect PR14 consisted of 18 CTD profiles with additional vertical profiles of temperature, salinity, oxygen nutrients and primary productivity. Seven additional oceanographic stations were carried out just using Nansen bottles since we lost the CTD.

Ship time is available to provide two cruises per year during the next 3 years; it seems possible to extend the ship time to 5 years. The cruises are open to foreign scientists and can include deployment and maintenance of moored arrays and current meter system (for instance, PCM 4).

We are considering the possibility to provide ship time in the Drake Passage during the austral summer for deployment and maintenance of current meter system and CTD observations.

### 2. SEA-LEVEL MEASUREMENTS

The Chilean Navy provides data on sea-level stations included in the GLOSS programme.

### 3. VOLUNTARY OBSERVING SHIPS

Chile intends to recruit new voluntary observing ships using XBT provided by international programmes.

### 4. REQUIREMENTS

We are buying a CTD for the next May cruise. International assistance is needed to obtain a Rossette.

## E. CHINA (PEOPLE'S REPUBLIC OF)

### 1. CHINA'S FIRST WOCE CRUISE

The ocean plays a vital part in regulating and controlling global climate, and its behavior has a decisive effect on the climate change in decades. In order to improve the understanding of global climate change and the weather forecasting model, IOC, WMO, ICSU as well as SCOR initiated the international scientific programme --- World Ocean Circulation Experiment (WOCE) --- as a major programme of the World Climate Research Programme (WCRP). As a contribution to the WOCE programme, China established the China WOCE Committee in Beijing in August 1989 with a view to organizing and co-ordinating China's WOCE activities.

After the establishment of the China WOCE Committee, the Group of Experts made up the China WOCE Programme according to the target and task of the international programme. As scheduled, the Chinese experts and scientists will focus on the observation in the Tropical Western Pacific, Kuroshio area, South China Sea and part of the Southern Ocean. The Chinese programme includes several sections set up by the international programme, such as PR1, PR17, PR18, PR21, PR22, PR23, PR24, SR1, P8, P12, P24, P25, P26, P17, P18, P29, P30, CP4 (the part of P4 west of 165°E), and CP13 (the part of P13 between 20°N and 20°S).

According to China's WOCE Programme and the working plan of the State Oceanic Administration (SOA), the scientific research vessel *Xiangyanghong No. 5* carried out its first comprehensive investigation for WOCE programme in the Western Pacific Ocean from 12 November to 25 December 1991. It covered large water areas located between 116°E, 141°30'E and 23°N, 3°S and lasted for 45 days with a distance coverage of 7,800 nautical miles. The cruise was organized by the State Oceanic Administration (SOA) and conducted by its South China Sea Branch. A crew of 67 and 58 scientists participated in the cruise. The chief scientist was Prof Pu Shuzhen from the First Institute of Oceanography of SOA.

The investigation followed ten section including four complete sections of the international WOCE programme (PR21 to PR24), part of the international sections of PR1 and PR3. Another section was closed to the international section P4. Along all the ten sections, CTD, $CO_2$, $SiO_3$, $NO_3$, $PO_4$ were sampled at 90 points, ADCP measurement along the whole cruise and meteorological observation four times a day were conducted, 147 XBT were launched and 6 drifting buoys were deployed. Sampling of trace elements as $H_3$, $C_{14}$, $O_{16}$ and experimental sampling of CFN were carried out. 6,100 samples of primary productivity, planktons and microorganisms were obtained. In addition, observation of aerosols, precipitation and sea surface flux at 5°N, 141°30'E for 48 hours were also conducted.

During the cruise, a great deal of valuable data were obtained in the Western Pacific where data were rare. To ensure accuracy of the field observations, CTD/$O_2$, observations were conducted at all depths and nutrients analyzed using RFA-300 (an automatic nutrient analyzer produced by ALPKEN), and the data collected on temperature (T), salinity (S), pressure (P), dissolved oxygen ($O_2$), silicate ($SiO_3$), nitrate ($NO_3$), and phosphate ($PO_4$) all satisfy the international WOCE requirement. Other data are now under quality-control and examination. The major goal of the international WOCE programme is to obtain detailed and high-quality oceanographic data, particularly that on world ocean circulation and energy exchange, and this goal was achieved in

China's first WOCE cruise, which reflects China's preliminary contribution to the international WOCE programme.

Apart from the important data obtained during the investigation, some phenomena of interest to oceanographers and meteorologists were also discovered. It was observed that there was a strong water exchange from southeast to northwest along the section PR24 and the section along the equator and a warm water area induced by El Niño was moving eastward.

In the following five years, China will repeat the investigation of some of the sections covered in the first cruise and will expand its observation areas to cover more sections of the international WOCE programme, so as to make more contribution to WOCE. We would like to express our appreciation to IOC Secretariat and countries concerned, particularly the Philippines and Papua New Guinea for their support and convenience in enabling China's first WOCE cruise a success.

## 2. DATA OBTAINED FROM CHINA'S FIRST WOCE CRUISE

CTD measurement: 83 station-time, max. depth 4150m
XBT: 147
ADCP measurement: 710 hours
Drifting buoy: 6
Nutrient analysis: 82 station-time, samples 1600
Dissolved oxygen measurement: 82 stations time, samples 900
Salinity measurement: 76 station-time, samples 760
Plankton sampling: 80 station time
Chlorophyll sampling: 80 station-time, samples 600
$C^{14}$ sampling: 10 station-time, samples 10
$O^{18}$ sampling: 80 station-time, samples 120
$H^3$ sampling: 55 station-time, samples 77
CFM sampling: 5 station-time, samples 38
$CO_2$ sampling: 36 station-time, samples 36
Ca sampling: 36 station-time, samples 36
pH sampling: 36 station-time, samples 36
$TCO_2$ sampling: 64
$PCO_2$ sampling: 64
TOC sampling: 42
Air sampling: 64
Deep water $TOC_2$ sampling: 10 station-time, samples 10
Mooring observation: 14 times
Microorganism sampling: 32 station-time, samples 600
Alkalinity sampling: 36 station-time, samples 36
Flux observation: 15 times
Aerosol observation (KB-120) samples: 27
Precipitation sampling: 5
Rainfall observation: 10 times
Meteorological observation: 174 times
Wave observation: 54 station-time
*In situ* weather forecasting: 31 times

## F. FRANCE

### 1. OBSERVATIONS IN THE ATLANTIC OCEAN

The Atlantic component constitutes the largest component of the French *in situ* effort in the WOCE.

#### 1.1 CITHER

As a part of the Woce Hydrographic Programme, five one-time survey lines are planned: sections A6 (7°30N) and A7(5°S) will be completed in early 1993, while A17 (35°W) will be occupied in 1994 and lines A13 (9°W) and A14 (5°E) are presently scheduled for 1995. Scientific goals include the heat and water mass transport across the equatorial region. (PI: M. Arhan, LPO, Brest.)

#### 1.2 ROMANCHE

ROMANCHE aims at measuring deep water masses fluxes in the Chain and Romanche fracture zones. These aims pertain to the eddy statistics objective (ACM11) of CP1 and to those of the Deep Basin Experiment component of CP3. This project, which has started in 1991 and ends in 1994, includes moorings deployment along with hydrography and tracers measurements. (PI: H. Mercier, LPO, Brest.)

#### 1.3 SAMBA

SAMBA's goal is to collect 500 float x years of subsurface floats data at a given level in the Brazil Basin. This is in order to construct an absolute reference level (CP1 objective) along with a map of eddy diffusivity (as such, it is a component of the Deep Basin Experiment of CP3). The present expectations are to deploy 25 floats in 1993 and 75 in 1994. (PI: M. Ollitraut, LPO, Brest.)

#### 1.4 CONFLUENCE

This component is focusing on a boundary current study (CP3 and AR8 of CP1) in the confluence region between the Brazil and Malvinas currents. Measurements will include moorings, fine-scale hydrography and tracers ($CO_2$ and freons). First deployments will start in 1993 and instruments retrieval is scheduled for 1995. (PI: C. Provost, LODYC, Paris.)

#### 1.5 ETAMBOT

The field programme is scheduled for 1994-1995 and will rely on hydrography, tracers, acoustic tomography and moorings, to monitor meridional fluxes of heat and properties in the Western Equatorial Atlantic: AR4 of CP1 and Tropical Programme of CP3. (PIs: C. Oudot, ORSTOM, Brest; Y. Desaubies, LPO, Brest.)

### 2. OBSERVATIONS IN THE INDIAN OCEAN

#### 2.1 CIVA

This project is a part of the one-time surveys programme of the WHP. It comprises sections I10 (occupied in 1989), I6 (30°E) to be completed in 1993, I7 (60°E) in 1995, and southern portions of I6, I7 and I8 in 1994. As

a subpart of CIVA, a times series station (IRS1 of CP2) will be occupied monthly, 60 miles south of Kerguelen Island. (PI: A. Poisson, LPCM, Paris.)

2.2 JADE

Boundary currents transports measurements (CP1 objective) and the monitoring of the throughflow in the Indonesian Straits, have been completed in co-operation with Indonesia. Moorings were deployed in 1989-1990 and for 1991-1992. Other measurements include hydrography, tracers and ADCP. (PI: M. Fieux, LODYC, Paris.)

## 3. VOS NETWORK

The TOGA network is maintained through the WOCE period (present funding is secured until the end of 1994). XBT lines between 30°N and 30°S along the following lines form the network:

- Atlantic Ocean : AX11, AX15, AX20
- Indian Ocean : IX3, IX6, IX10
- Pacific Ocean : PX5, PX17, PX18, PX31

## 4. SEA LEVEL MEASUREMENTS

Besides the TOGA network in the Equatorial Atlantic Ocean (Lome, Sao Tome, Dakar, Praia, Cayenne) other pressure tide gauges with DORIS beacons will be located at Kerguelen and Amsterdan Islands in 1992. Additional sites, to be added in 1993, are at Crozet Island, North of Crozet Plateau (34°S) and Dumont D'Urville, and those will equipped with ARGOS data transmission systems.

The aim of the Antarctic Ocean gauges is to monitor the time variability of the AACC. (PI: C. LeProvost, IMG, Grenoble.)

## 5. MODELLING

The MOCA (Modelling of Ocean Circulation in the Atlantic) project focuses on the Atlantic Ocean, on account of its anomalous interhemispheric heat flux. A progressive strategy has been designed to improve the understanding of key physical processes which need to be taken into account in models of the large scale circulation of the Atlantic. Moreover, since the major component of the French field programme is being held in the Atlantic, special care will be devoted to building data base of initial fields and forcings which will be compatible with model dynamics. The present programme comprises two parts:

(i) The first part, which is under the responsibility of the oceanography group at IMG, Grenoble, aims at a realistic modelling of both the basin scale coarse dynamics of the whole South Atlantic Ocean (CP1) and the eddy-resolving regional scale of the Confluence region (boundary currents objective of CP3). Moreover, the influences of boundary fluxes and topography will be assessed for the whole South Atlantic Ocean.

(ii) The second part concentrates on process studies aiming at a better parameterization of surface fluxes and vertical diffusivity in ocean models. This part is led by the modelling group at the LPO, Brest. Special emphasis is put on the mechanism of MODE water formation and

seasonal cycles in the upper layers of the ocean on the one hand and on the impact of deep equatorial dynamics on thermohaline and interhemispheric circulations on the other hand.

The common code to the two modelling groups is the SPEM (semi-spectral primitive equation model) and validation and numerical dewelopments are made in collaboration with the international SPEM Users Group.

## G. GERMANY

The German WOCE programme is continuing according to plan. Staying at about the same funding level for 1992-93 as compared to the initial phase 1990-91, three projects were taken up additionally: investigations of the Eastern Boundary Current region AR6/16, participation in the Deep Basin Experiment AR15) with mid-depth floats and establishment of the Canary Island time series station, jointly with Spain. The activities within the different WOCE components for the period 1991-93 are as follows:

### 1. OCEAN MODELLING

Data from the eddy-resolving modelling of the North Atlantic (CME, Kiel) and the Atlantic sector of the Southern Ocean (Bremerhaven) are compared to observational results for selected regions. Large-scale geostrophic models (Hamburg) are used to improve data assimilation techniques, estimate surface fluxes from assimilating hydrographic data and to determine the model sensitivity to changes in surface forcing.

### 2. WHP ONE TIME SURVEYS

Sections A21, A9 and A1E were completed in 90-91. A12 will be conducted in late 92, A10 in early 93.

### 3. WHP REPEAT HYDROGRAPHY AND TIME SERIES STATIONS

AR7/E partly completed in winter 91, next coverage are scheduled in September 92 and October 93. AR6/16 done in spring and autumn 91; further work in February and September 92. AR4 covered in October 90 and June 91, next effort for November 92. AR15 was worked on in December 91/January 92, to be continued in December 92. SR2 will be done late 92, SR4 was done in late 90 and will be repeated late 92/early 93. IR4 was completed in January 91. Activities on the Canary Island time series station were started in January 92.

### 4. WOCE XBT LINES

AX3 is continuing with 12 coverage p.a., using T5/T7 probes p.d. Presently first coverage using XCTDs are performed. AX11 and 17 are operational as before.

### 5. MOORED CURRENT METER ARRAYS

A contribution to ACM8 consists of 6 full depth moorings along AR7E. It is in the water since September 91, will be replaced in August 92 and is expected to be maintained until 95. 7 moorings are deployed in the AR6/16 area for the period 1991-92. ACM19 is operational since 1979 and will be kept

going with instruments at 6 levels. ACM7 consisted of 3 moorings, taken up in 1989 and terminated in 1991. ACM3 (3 moorings) and ACM12 (3 moorings) are deployed for the period 1991-92. JCM7 presently consists of 20 moorings which were deployed in late 90 and will be recovered late 92/early 93. IR8 (3 moorings) was deployed for the period January 91 to March 92.

6. **FLOAT PROGRAMME**

The German contribution consists presently of 26 RAFOS floats in the AR6/16 area (deployment 91/92) and 30 RAFOS in the AR15 area in conjunction with the DBE.

7. **SURFACE DRIFTERS**

Drifter releases were done/will be done in the Southeastern South Atlantic (Benguela Current/Circumpolar Current) as follows:

| Year | No. of drifters |
|---|---|
| 1990 | 35 |
| 1991 | 45 |
| 1992 | 35 |
| 1993 | 35 |
| 1994 | 35 |

8. **CONTRIBUTION TO WOCE FACILITIES**

IPO : Dr Ilse Hamann to start Spring 92
SAC : Support workshop on 91, North Atlantic data in November 92 in Hamburg

National organization of WOCE still resides with the National WOCE Committee (present chairman: J. Meincke, Hamburg).

## H. JAPAN

A WOCE-related programme of the Science and Technology Agency (STA) was started in 1990 by the Special Co-ordination Funds for Promoting Science and Technology and will continue at least for five years. This programme is being conducted through interagency co-operation among national research institutes, universities, etc., and a summary is given in items 1 to 7 below.

1. **WOCE HYDRGRAPHIC PROGRAMME**

Hydrographic observations on repeat lines of PR2, PR3, PR4, PR17, PR18 and PR19 were successively conducted by the Japan Meteorological Agency (JMA) in 1991. As for the heat flux section P2, the Hydrographic Department (HD) of the Maritime Safety Agency made preliminary observations from the coast of Japan to off Hawaii in October 1991. The observation of full P2 section is now under consideration to be conducted by HD in 1993. JMA is preparing observation resources to conduct P9 in 1994 and P24 in 1995. The Japan Marine Science and Technology Center (JAMSTEC) is in charge of conducting repeated lines of hydrography of PR1, PR23 and PR24 as well as the hydrography of the adjacent area of the ocean which may contribute to the understanding of the dynamics of the low-latitude boundary current of the Pacific Ocean.

## 2. SURFACE DRIFTER PROGRAMME

HD deployed 15 drifters in the North Western Pacific and 17 drifters in a tropical region of the Pacific in 1991. JAMSTEC deployed 10 drifters off Mindanao in the research of the Indonesian Through Flow.

## 3. SUBSURFACE FLOAT PROGRAMME

Two ALACEs were deployed by JMA in the North Western Pacific in January 1992. JMA will deploy six RAFOS floats after the summer of 1992 when the sound sources system will be provided by US scientists.

## 4. VOLUNTARY OBSERVING SHIP PROGRAMME

High-density-XBT-sampling-line of PX5 has been maintained by JMA since 1989. With the help of fishing boats in the extensive area of the Pacific Ocean, XBT sampling programme of the Fisheries Agency is under operation. By use of the voluntary ship passing in the Northern Pacific, JMA will start the programme of the high-density-XBT-sampling of PX26 (TRANSPAC) from spring of 1992.

## 5. MODELLING

JMA constructed numerical models of general circulation of the North Pacific Ocean for (1) climatic change of the surface wind-driven and thermohaline circulation and (2) structure of the abyssal circulation driven by the Southern Ocean bottom water. Preliminary study of the North Pacific Mid-depth circulation was made by the University of Tokai with an inverse/diagnostic model using Levitus data set.

## 6. REMOTE SENSING

By use of specific humidity and wind speed estimated from SSM/I data of the Defense Meteorological Satellite Programme (DMSP) for 1987-1990, JMA has completed the map of latent heat flux over the Pacific Ocean.

In 1992, STA will start a new research project to elucidate ocean processes by SAR and a scatterometer of ERS-1 and an altimeter of TOPEX/POSEIDON which is to be launched in July 1992.

## 7. DATA MANAGEMENT

The fourth session of the WOCE Data Management Committee hosted by JODC was held in Tokyo in October 1991.

The first Japan WOCE Forum was held in Tokyo, 6-7 February 1992. Preliminary results and related research topics were presented in this meeting by principal investigators of the project including lectures by four oceanographers invited from the international WOCE community.

A WOCE-related programme of the Ministry of Education, Science and Culture (Monbusho) is under way by Grant-in-Aid for scientific research and some programmes will be carried out using various funding systems of Monbusho.

Other Japanese contributions to WOCE are seen in the IWP-I Report.

To respond to WOCE programme gaps, only some specific contributions will be stated:

- One-Time WHP

JMA will undertake P9 in 1993 and P24 in 1994. Although efforts are being made towards satisfaction of one-time WHP standard, the large volume sampling and some tracers will not be measured. Details of P9 observation plan will be finalized in a few months.

HD will undertake P2 in 1993. HD is trying to upgrade P2 observations to meet one-time WHP standards except for the large volume sapling and some tracers. Top priority will be on spacing to get better hear flux estimate. A final observation plan will be prepared in half a year.

- Moored Current Meters Array

A university group under Monbusho will definitely undertake PCM-5 in 1993 and 1994, to complete the heat flux measurement along P2.

## I. NETHERLANDS (THE)

In the Netherlands support to climate-oriented research has increased in recent years. This also relates to the research of the role of the oceans in the climate system. A programme has been developed for extra funding of climate-oriented ocean studies, and most of this work will be related to WOCE. A national WOCE committee exists since a couple of years that stimulates and co-ordinates this development.

The present Netherlands WOCE-related research involves theoretical and modelling studies, studies on the application of remote-sensing techniques (altimetry, scatterometry) and observational programmes. An altimeter team has been established around the Netherlands ERS and TOPEX/POSEIDON principal investigator.

Where relevant, the research programmes are done in co-operation in a European framework. The Netherlands support the EUROWOCE activities.

As the main points of interest can be indicated the North Atlantic (work in the framework of Core Project 3) and the Southern Oceans.

In the following the development of the observational programme is summarized:

1. In summer 1990 and spring 1991, cruises were made in the North Atlantic, south of Iceland, incorporating work along the AR-7 (east) repeat section. This section was run twice, but one section could not be fully completed. The programme furthermore involves 4 current meter stations and drifter releases (4 drifter still active).

2. For 1994 and following years, plans are being developed for further contributing to the Core Project 3 programme in a similar way.

3. In the intermediate years, drifter release will be continued in the area.

4. A programme has started for high-density mode XBT work between the Netherlands and the Antilles with co-operation of the Navy, as a contribution to the AX-5 section. Both T-7 and T-5 probes are being used.

5. The Netherlands with other European participants developed plans for the establishment of European tracer analysis facilities (EUROTRACER) and submitted these plans for support in the framework of the EEC-MAST 2 programme. Netherlands institutes are equally prepared to take part in the EUROFLOAT programme.

6. The WOCE group works in close contact with the JGOFS group in order to optimize the use of sea-going facilities.

## J. NEW ZEALAND

New Zealand is involved in two WOCE experiments at this point in time. Invitations to participate on US WOCE hydrographic lines P14C and P6 are being considered in regard to personnel availability.

### 1. PACIFIC DEEP WESTERN BOUNDARY CURRENT MOORED ARRAY : PCM-9

To monitor the transport of Antarctic Circumpolar Deep Water into the deep Pacific, a two year current meter mooring array, involving 24 moorings with an average of 3 current meters each was deployed from RV Rapuhia (ex Meteor) in February 1991.

The array cuts the known (western intensified) part of the current east of the Kermadec Ridge north of New Zealand and makes an L shape, with 20 U.S. moorings along 32.5S from the Kermadec Ridge at approximately 178.5W TO 168.5W and four N.Z. moorings "upstream" to the south. As well as current meter moorings, hydrographic (CTD) and tracer ($O_2$, nitrate, nitrite, phosphate and silicate) measurements were made on the mooring deployment cruise along 32.5 and 34.33S.

Three U.S. institutions are involved with principal investigators Tom Whitworth and Worth Nowlin from Texas A&M University, Bruce Warren from Woods Hole Oceanographic Institution, Dale Pillsbury from Oregon State University and Mike Moore from N.Z. Oceanographic Institute, DSIR.

The moorings will be recovered from RV Rapuhia in the period between November 1992 and February 1993 at which time the hydrographic and tracer sections will be repeated.

### 2. TASMAN SEA REPEAT HYDROGRAPHIC LINES : PR-11

At this time proposals are in preparation for a joint N.Z./Australian series of cruises to obtain repeat hydrographic (CTD) sections across the Tasman Sea at 30S and 43S in order to assess the heat flux and variability associated with the east Australian Current and the Tasman Front. The cruises will probably be two aboard RV Rapuhia in March and September 1993 and two aboard RV Franklin (Aust.) in June and December 1993. RV Franklin will carry an acoustic doppler current profiler and several current meter moorings will also be deployed in support of this experiment. The details are not finalized

but probably two Australian moorings will be deployed either side of the Tasman Front and several N.Z. moorings will be deployed in a line north of N.Z. along 168E. The deployment duration will be March to December 1993.

The Australian principal investigator is John Church (CSIRO, Hobart) and the N.Z. principal investigators are Basin Stanton and Steve Chiswell (NZOI).

## K. RUSSIAN FEDERATION

A National WOCE Implementation Plan was prepared two years ago by joint efforts of several former Soviet oceanographic research institutes that formed the National WOCE Committee.

Due to big political and economic changes in our country, we have some difficulties in implementing our WOCE activities. Financial support for research had been reduced by two to three times. Nevertheless, we are making efforts to implement our commitments within WOCE. National WOCE Committee defined oceanographic research as the first priority in our activities for WOCE. Special financial support for this purpose has been received from the Russian Ministry of Science.

In 1991, a research cruise of R/V Academician Vernadsky was carried out within the WOCE Hydrographic Programme for comparison of oxygen and salinity measurements and training exercise from 27 June to 8 July. Participating groups included the Woods Hole Oceanographic Institution (USA), Institute of Oceanographic Sciences (UK), Spanish Oceanographic Institute, Marine Hydrophysical Institute (Ukraine) and State Oceanographic Institute (Russia) on the R/V Vladimir Parshin.

In April-May 1991, observations wer made by R/V Passat along the section AR13 according to repeat HP jointly with R/V Hudson along B10 section.

Joint USA-Russia expedition is being implemented aboard R/C Academic Ioffe along section S4 in the Pacific Ocean. Chief scientists are Dr M. Koshlyakov (Institute of Oceanology) and James Richman (Oregon State University).

Joint cruises are organized with Canadian scientists in the North Atlantic aboard R/V Academic Shuleikin (sections AR13, A3) and R/V Hudson.

Russian scientists co-operate with American scientists in developing drifters to be used in WOCE.

We would be willing to continue our activities within WOCE if some modest support will be given for Russian research vessels particularly to ensure port calls.

## L. SPAIN

Several oceanographic activities in which Spain will take part are listed below. Some of them are directly related to WOCE, others can be of relevance in a higher or lesser degree to it.

### 1. SECTION A-5 (24°N) WOCE CP-1

Present status: To be effected this year

Date : 15 July (Cádiz-Spain) - 25 August (Miami, USA)

Cruise track : From 24°N, 16°25'W to 24°N, 74°20'W

If there is spare time, an additional section will be made across the Strait of Florida.

Stations between the African coast and 20°W will be separated about 20 nm or less. The rest of them until the end of the section will be separated some 32 nm. The total number of stations is 110.

The Strait of Florida section will have about 10 stations, separated around 6 nm.

Presently, we are expecting to move the section up to 24°30'N for better comparison with 1957 IGY and 1981 Wunsch and Roemmich's cruises that were accomplished on that latitude.

Vessel : B.I.O. Hespérides (Spain)

Chief Scientist : G. Parilla (Inst. Esp. de Ocean., Spain)

Co-Chief Scientist : H. Bryden (WHOI, USA)

Parameters and principal investigators:
**Sal., Temp.** - G. Parilla and H. Bryden
**Nutrients** - A. Cruzado (CEA, Blanes, Spain), J. García-Braun (I.E.O., Tenerife, Spain)
**Oxygen** - J. Escánez (idem)
**Chlorophyll pigments** - J. García-Braun
**pH, Alkali.,** - A. Fernández (Inst. Invest. Mar, Vigo, Part. Org., N Spain)
**Inorg. Total C, $CO_2$ pressure** - F. Millero (RSMAS, Miami, USA)
**Freon, Trit.** - R. Fine (idem)
**Metallic tracers (Al, Ni)** - J. Hernández (Fac. C. Mar, Las Palmas, Spain)

### 2. EUROPEAN STATION FOR TIME SERIES IN THE OCEAN - CANARY ISLANDS

Present status : Proposal submitted to MAST II

Proposers : G. Siedler (IFM, Kiel, Germany), G. Weier (U. of Bremen, Germany, R. Molina (Inst. Esp. Ocean., Tenerife, Spain), O. Llinas (Cent. Tecnol. Pesquero, Taliarte, Spain), J.J. Hernández (Fac. C. Mar, Las Palmas, Spain)

Site : 29°20'N, 15°40'W

Objectives : Long-term changes of stratification and circulation on seasonal and interannual scales. Biogeochemical cycles. To provide a focus for ocean studies by Europeans and other research groups in the Canaries region. Contribution to WOCE and JGOFS.

Methodology and Parameters : Monthly occupation. CTD, nutrients, $O_2$, $CO_2$, chlorophyll-a, primary productivity, particulate matter, current meters, ADCP, XBT, sediment traps, satellite.

## 3. MULTIDISCIPLINARY OCEANOGRAPHIC RESEARCH IN THE E. BOUNDARY OF THE N. ATLANTIC (MORENA)

Present status : Proposal submitted to MAST II

Proposers : A. Fiuza (Grupo de Ocean., Dept. Fisica, U. Lisboa, Portugal), J.M. Cabanas (Inst. Esp. de Ocean., Vigo, Spain), F. Fernández (Inst. Invest. Mar, Vigo, Spain), Johnson (U. of East Anglia, UK), Sherwim (U. of Bangor, UK), Road (Nansen E.R.S.C., Norway)

Subproposers : Costa-Duarte (U. of Aveiro, Portugal), Robinson (SUDO, Southampton, UK), P. Davies (U. of Dundee, UK), Johnson (College of London, UK), Savidge (Queen's U., UK)

Area of work : 40°-43°N, Iberian coast - 11°W

Objectives : The general objectives of the Project are the improvement of the knowledge of the physical, chemical and biological phenomena which take place in the Iberian region of the eastern boundary layer of the North Atlantic, and the development of a quantitative understanding of the processes which dominate the transfer of matter (salt, particulates, nutrients, organic compounds, biomass), momentum and energy across and along the continental shelf, the shelf break and the slope in that region.

Methodology and parameters : CTD (4 samplings in one year), Rosette, nutrients, moorings at 41°N and 43°30'N (5 moorings per latitude, one year).

## 4. EUROFLOATS

Present status : Proposal submitted to MAST II

Proposers : W.J. Gould (IOSDL, Wormley, UK), A. Colin de Verdière (LPO, Brest, France), A. Cantos-Figuerola (AINCO, Madrid, Spain), W. Zenk (IFM, Kiel, Germany).

Area of work : NE Atlantic Ocean (from approx. 22 to 55N and from 30W to the west European continental margin):

**UK** - Iberian Basin and subpolar gyre
**Germany** - Canary Basin, Mediterranean water outflow and plume
**France** - Biscay area and eastern boundary
**Spain** - Eastern boundary on Iberian peninsula

Main scientific objectives : The proposal calls for the use of ALFOS and/or RAFOS neutrally buoyant float technologies to investigate a number of aspects of the water mass circulation of the NE Atlantic. The project focuses initially on three features:

- the Mediterranean water plume
- the North Atlantic current
- the poleward eastern boundary current

The measurements will be important in their own right in providing a new view of the circulation of the area but they will be of key importance when combined with measurements of other components of other national and international experiments such as WOCE, MORENA, etc., in shedding new light on the importance of the NE Atlantic in the global ocean circulation.

The technology to be used will be the most advanced available and will make a significant contribution towards re-establishing in Europe a technology that originated here.

The project will transfer familiarity with this technology to Spain and the data set collected by Eurofloat will be available to investigators from Spain, Portugal, Netherlands and the Nordic nations who have expressed interest in the project but will not require funding as part of MAST II. The measurements will also be used to test ocean circulation models of the area.

## 5. PLAN NACIONAL DEL CLIMA (National Climate Plan)

Several Spanish research institutions and universities, led by the Instituto Nacional de Meteorología, are preparing an interdisciplinary project to study the climate. Within this project, the ocean is obviously considered one of the main components.

The project in its final version will be submitted this year for the approval by the Comisión Interministerial de la Ciencia y Tecnología (CICYT), the main Spanish funding agency for the research.

If it gets approved, and the chances are very good, it will become a national plan with its own funding.

The outcome will be to bring climate studies to the forefront in the Spanish research community and to open another source of funding for ocean studies.

## M. UNITED KINGDOM

The UK contribution to WOCE covers the three Core Projects and also addresses the second goal of WOCE. Areas of expertise that existed in the UK prior to WOCE have shaped the balance of the UK effort. However, the requirements of WOCE have also led to new projects, new staff and new directions for the UK oceanographic community. This statement outlines the UK contribution to WOCE by Core Project and summarizes the administration, funding and management structure.

The funding for UK WOCE is through the natural Environment Research Council (NERC), the Meteorological Office, the MAFF Directorate of Fisheries Research, the BNSC and the SOAFD Marine Laboratory. Financial support is also obtained from the UK Ministry of Defence under the MoD/NERC joint grant scheme. NERC funding covers its laboratories IOSDL, DML, POL and PML and, through a Special Topic scheme, Higher Education Institutes. NERC also supports a Capital Fund for the purchase of major items of equipment for the UK WOCE community.

### 1. UK STRATEGY: MODELS, OBSERVATIONS AND REMOTE SENSING

The UK strategy for its contribution to WOCE is to combine the expertise, skills and resources in the areas of models, observations and remote sensing. Two primary geographic regions will be observed and modelled, the North Atlantic and the Southern Ocean. Models will be used to maximize the information that can be extracted from surface forcing fields and *in situ* observations in those two regions, and the observations will be used to develop the models.

#### 1.1 MODELS

The Meteorological Office, the Hadley Centre for Climate Prediction and Research and the Robert Hooke Institute are at the forefront of developing and running coupled dynamic global atmosphere-ocean models. The recently completed FRAM Community Research Project produced an eddy-resolving model of the entire Southern Ocean, and the expertise of the IOSDL core team will be used to spin up a global eddy-resolving ocean model, OCCAM, at the Robert Hooke Institute from April 1992. An isopycnic-coordinate model of the North Atlantic is being run from the James Rennell Centre on the Cray supercomputer at the Hadley Centre.

#### 1.2 OBSERVATIONS

UK laboratories have considerable experience of making high quality observations at sea, both in deep hydrography and in underway measurements of the upper ocean. The expertise in deep hydrography will be used on WHP lines A11 and A23, and in contributions to WOCE ISS1 such as ADOX and Swindex. Expertise in upper ocean research, and in merging upper ocean surveys with deep hydrography, will be used on seasonally repeated surveys of the North Atlantic from 1994. The UK also has the ability to make accurate measurements of air-sea fluxes, and monitoring systems will be deployed on all UK WOCE cruises. Other observing techniques such as neutrally buoyant floats, surface drifters, bottom pressure recorders and purposeful tracer release are and will be used in the UK WOCE programme.

### 1.3 REMOTE SENSING

UK scientists are committed to using satellites to study the ocean during WOCE. Teams at institutes and HEIs are actively involved with satellite altimetry, sea surface temperature, ocean color and scatterometer measurements of wind and wave fields.

## 2. CONTRIBUTION OF NERC SHIPS AND SHIPTIME

The Natural Environment Research Council also supports WOCE through providing shiptime on vessels managed by the Research Vessel Services. Highly graded proposals are allocated shiptime, which for UK WOCE cruises will be predominantly on RRS Discovery and RRS Charles Darwin. Shorter cruises as part of the long-term monitoring programme take place on RRS Challenger and the SOAFD ship Scotia.

The needs of UK WOCE for extra scientific accommodation, a greater endurance and a more stable working platform were major factors in the decision to rebuild RRS Discovery, at a cost of £13M. Now 30 years old, the vessel is being lengthened by 11 meters and will be fitted with new machinery, to provide, in effect, a new ship with a life expectancy of 15 years.

Shiptime proposals for UK WOCE may also lead to cruises on the new British Antarctic Survey vessel RRS James Clark Ross.

## 3. THE JAMES RENNELL CENTRE FOR OCEAN CIRCULATION

The James Rennell Centre for Ocean Circulation was established by NERC in 1990 to manage and support the UK contribution to WOCE. Based in Southampton, the research programme of the Centre will extend over the seven year period of WOCE and will continue for a further three years to establish the UK version of the international WOCE data set.

### 3.1 THE UK WOCE PROGRAMME

The aims of UK WOCE and an outline of the UK programme were published as a color booklet in February 1991. *Ocean Circulation and Climate* has been circulated widely both nationally and to the international WOCE community. It has also been circulated to funding agencies and senior decision makers. It is in demand as a guide to the UK programme and as a basic tutorial on the role of ocean circulation in the earth's climate system.

A newsletter is published by the JRC three times a year to inform the UK WOCE community on current science activities, plans and news. *Sigma* is also distributed to the chairmen of all national WOCE committees and to other key individuals and marine science laboratories world-wide.

## N. UNITED STATES OF AMERICA

A summary of the status of the U.S. WOCE programme is provided by a brief resumé of some of the main U.S. components. A commentary on financial support available and a more detailed analyses of changes in each component, together with results from funded projects, is given in the main body of the document, *U.S. WOCE Implementation 1991, U.S. WOCE Implementation Report No. 3, 84 pp.*[1]

### 1. WOCE HYDROGRAPHY PROGRAMME

U.S. WOCE provided support for scientists and sampling on the German WOCE cruise in the South Atlantic along WOCE Hydrography Programme (WHP) lines A21/S1 and A12 in early 1990. This cruise was a co-operative effort between WOCE and the South Atlantic Ventilation Experiment. The U.S. contribution to the WHP one-time survey began in February 1991 with the sampling of P16N from 19°N to Alaska. Tracer measurements included chlorofluorocarbons (CFCs), helium/tritium, nutrients, oxygen, and carbon dioxide. Sampling along central portions of P16, north from 40°S, and P17, between 36°N and 33°S, will begin in June 1991. Through a joint U.S. and German effort, WHP line A9 was completed in March 1991, with the U.S. providing scientists and support for nutrient sampling.

Operating as part of the WHP repeat hydrography programme, the time-series station north of Hawaii has been occupied approximately monthly throughout the year. A data report chronicling the first year of operation, 1988-1989, was released in November 1990. Researchers found surprising variations, over short periods of time, in the temperature/salinity structure of the North Pacific Intermediate Water. A short article describing this finding was published in *WOCE Notes, 3(1)*.

### 2. MOORED MEASUREMENT PROGRAMME

Three moored current meter arrays have been deployed as part of the WOCE Moored Measurements Programme. PCM9 was deployed successfully northeast of New Zealand in February 1991 to obtain estimates of transports by the deep western-boundary current east of the Kermadec Rise. In the Atlantic, the moored array, ACM1, was deployed in 1990 as part of the Western Atlantic Thermohaline Transport Study. A goal of this array is to determine the variability of the North Atlantic western boundary current. ACM3 was deployed in 1991 as part of the WOCE Deep Basin Experiment (DBE) to measure the meridional heat transport in the western South Atlantic. The U.S. supported a portion of the array in co-operation with the Germans. ACM25, part of the WOCE Tracer Release Experiment (TRE), has been approved for funding. Also funded and scheduled for 1992 deployment is the current meter array that is part of the Kuroshio Extension Regional Experiment (KERE) of the Office of Naval Research (ONR) and the Naval Oceanographic and Atmospheric Research Laboratory (NOARL). It may fulfill the goals of PCM7 in the northwest Pacific region.

---

[1] Copies of this report may be obtained from the U.S. WOCE Office, Department of Oceanography, Texas A&M University, College Station, TX 77843-3146, USA.

## 3. SUBSURFACE FLOAT PROGRAMME

Results from the first full-scale test of the subsurface float, ALACE, were made available. The test used a resolution 1/20 of that recommended for use in the actual WOCE Velocity Measurements Programme. Global subsurface float deployments will commence in the Pacific with the start of the U.S. WHP where ALACE floats will be deployed along P16C and P17C. RAFOS float deployments, funded by ONR as part of KERE, will provide support for the global survey in the northwest Pacific region. Most floats in the global survey will be deployed from WHP lines. Thus, achieving the desired resolution for the global subsurface float programme depends largely on the progress of the WHP.

## 4. SURFACE VELOCITY PROGRAMME

The U.S. WOCE Surface Velocity Programme began in March/April 1991 with the deployment of ten drifters in the eastern North Pacific. Two important issues for the programme have developed during the last year. First, the target resolution for drifters was planned to be 500 km by 500 km. However, low funding levels have forced a de-scoping of the programme to a resolution of 600 km by 600 km -- a reduction in resolution of some 30%. This problem is exacerbated by a second, more critical issue that recently has arisen. Drifters deployed to date have demonstrated lifetimes significantly shorter than predicted. The implication is a need for substantially more drifters than planned to achieve the goals of the drifter programme. This situation has led to the re-examination of the surface drifter programme by international WOCE.

## 5. VOLUNTARY OBSERVING SHIP PROGRAMME

Sampling on the first U.S. WOCE Pacific Voluntary Observing Ship (VOS) lines began in 1987 with an experiment that developed and tested the automatic XBT launchers and demonstrated the scientific value of high-resolution XBT data. Based on the success of the experiment, seven U.S. lines contributing to the Pacific VOS programme have been recommended for support by NSF starting in 1991. These lines all should be operating by 1993 with at least two repetitions per year. The number of repetitions, however, must be increased to provide the required resolution of four per year. The addition to the U.S. Pacific VOS contribution of two to six more lines is planned when appropriate voluntary observing ships are identified and funding allows. The WOCE automatic XBT launchers continue to deploy XBTs successfully. Two units are operational and three others are ready to be installed on the ships. Additional launchers will be built as needed.

The Pacific high-resolution, repeat sampling project was designed on the assumption that low-resolution, broadcast XBT grids would continue in place. These low-resolution grids, being operated by TOGA and the Trans-Pacific Experiment (TRANSPAC), are still both operating. However, there appears to have been a considerable decrease in the number of probes released north of 30°N and in the southeast Pacific during the last few years. It is imperative that these low-resolution programmes continue throughout WOCE to provide the necessary background data for the high-resolution sampling and to allow the upper ocean variability to be mapped at basin scale.

The WOCE Atlantic VOS programme has begun. This programme deploys XBTs in a low-resolution mode. The U.S. will be operating five lines by the end of 1991. These are AX4, AX7, AX8, AX10, and AX12. Line AX12 will be

partially supported by the United Kingdom. Nearly all other planned Atlantic VOS lines are operational with funding from European nations.

## 6. PROCESS STUDIES

The successful deployment in January/February 1991 of the moored array ACM3 began the U.S. participation in the Deep Basin Experiment (DBE). This array was deployed in conjunction with current meter deployments and a hydrographic cruise by the Germans. *WOCE Notes, 3(2)*, provides additional information on these deployments and the cruise. NSF has funded 150 of 300 U.S. DBE floats needed for deployment in the North Atlantic Deep Water and Antarctic Bottom Water. A preliminary modelling study, using direct velocity measurements and tracer fields to constrain inverse models of the general circulation of the western North Atlantic, has been funded to provide the framework for a similar study of the DBE results. Additional U.S. components of the DBE are expected to be funded in the near future.

The Subduction Experiment, supported by ONR, will commence in mid-1991 in the North Atlantic with deployments of Bobber floats and surveys of the hydrographic and tracer fields. U.S. WOCE's third process study, the Tracer Release Experiment, will begin in spring 1992 in the same area as the Subduction Experiment. The two process studies will have an overlap in their measurements and are designed to complement each other. Both have been funded, and preparations have been underway during the last year. The WOCE-developed tracer injection system for the TRE was tested in December 1990 in the northwest Atlantic Ocean. The injection sled, which releases sulfur hexafluoride on an isopycnal surface, met the required TRE performance goals by maintaining its depth within the target density levels.

Efforts are underway to place the IMET packages, developed as part of the U.S. WOCE air-sea flux programme on several vessels of the University National Oceanographic Laboratory System fleet and on ships operating as part of the VOS fleet. One IMET buoy was deployed successfully as part of the ONR Surface Wave Dynamics Experiment in fall 1990. IMET will be deployed as part of the Subduction Experiment and will be used in TOGA's Coupled Ocean-Atmosphere Response Experiment (COARE) in the western equatorial Pacific in 1992/1993. Testing of pressure sensors deployed on surface drifters is expected in 1991/1992. These sensors will extend the limited data base on sea surface pressure measurements.

## 7. AIR-SEA FLUX ESTIMATES PROGRAMME

Several WOCE programmes designed to advance model-based air-sea flux estimates have begun. In 1990, NSF funded the Special Analysis Center for Surface Wind/Wind Stress and Derived Air-Sea Flux Fields to provide improved ocean surface flux fields of momentum and heat for WOCE. Using all available surface wind and heat data, both remotely-sensed and *in situ*, the center will produce five-day mean global wind fields from 70°N to 40°S on a one-degree grid and will produce monthly mean values of net solar radiation, net long wave radiation, and sensible and latent heat fluxes on a five-degree grid for the Community Modelling Effort region in the North Atlantic (15°S to 65°N). In 1989, NOAA's National Meteorological Center (NMC) started a successful visiting scientist programme in which experts evaluate and improve the air-sea fluxes generated by the NMC operational atmospheric models. NMC and the Goddard Laboratory for Atmospheres (GLA) of the National Aeronautics and Space Administration (NASA), together with scientists from NSF and the Department of Defense, continue to investigate improved methods for assimilating

satellite surface wind data into operational models. They also continue to test alternative methods for data assimilation and parameterization of the physical processes of air-sea interaction. These programmes promise to improve model-based flux estimates substantially and to provide the needed flux estimates over the entire globe.

ANNEX VI

# GLOSSARY OF ACRONYMS AND SPECIAL TERMS

| | |
|---|---|
| AAIW | Antarctic Intermediate Water Flow |
| ACC | Antarctic Circumpolar Current |
| ACCLAIM | ACC Levels from Altimetry and Island Measurements |
| ADCP | Acoustic Doppler Current Profiler |
| ADEOS | Advanced Earth Observing Satellite |
| ADOX | Antarctic Deep Ocean Experiment |
| AIM | Atlantic Isopycnic Model |
| ALACE | Autonomous Lagrangian Circulation Explorer |
| ALFOS | Long-life, multi-cycle, pop-up RAFOS floats; a combination or "hybrid" of the ALACE and RAFOS float systems |
| AODC | Australian Oceanography Data Centre |
| ARGOS | A satellite location and data collection system |
| ARISTOTELES | A satellite system for precise determination of the geoid |
| ASCEND | Agenda of Science for Environment and Development |
| ASEAN | Association of Southeast Asian Nations |
| BC | Brazil Current |
| BNSC | British National Space Centre |
| BWTC | Brazilian WOCE/TOGA Committee |
| CCCO | SCOR-IOC Committee on Climatic Changes and the Ocean |
| CEC | Commission of the European Communities |
| CEOS | Committee on Earth Observation Satellites |
| CFC | Chlorofluorocarbon |
| CICESE | Center for Scientific Research and Higher Education of Ensenada (Mexico) |
| CMM | Commission for Marine Meteorology (WMO) |
| COARE | (TOGA) Coupled Ocean Atmosphere Response Experiment |
| COROAS | Oceanic Circulation in the Western Region of the South Atlantic (Brazilian research project) |
| CP | Core Project |
| CSIRO | Council for Scientific and Industrial Research Organization (Australia) |
| CTD | Conductivity, Temperature, Depth |
| DAC | Data Assembly Center |
| DBCP | Drifting Buoy Co-operation Panel |
| DBE | Deep Basin Experiment |
| DDB | Distributed Data Base |
| DIU | Data Information Unit |
| DML | Dunstaffnage Marine Laboratory (UK) |
| DSIR | Department of Scientific and Industrial Research (New Zealand) |
| DQE | Data Quality Expert |
| DMSP | Defense Meteorological Satellite Programme |
| E | Evaporation |
| ECMWF | European Centre for Medium Range Weather Forecasts (UK) |
| EEC | European Economic Community |
| EEZ | Exclusive Economic Zone |

| | |
|---|---|
| ENSO | El Niño Southern Oscillation |
| ERS | Earth Resources Satellite |
| ESA | European Space Agency |
| FRAM | Fine Resolution Antarctic Model |
| FTE | Full Time Equivalent |
| GCOS | Global Climate Observing System |
| GEOSAT | Geodetic Satellite Mission |
| GEWEX | Global Energy and Water Cycle Experiment |
| GLA | Goddard Laboratory for Atmosphere (of NASA) |
| GLOSS | Global Sea-Level Observing System |
| GOOS | Global Ocean Observing System |
| GPS | Global Positioning System |
| GTS | Global Telecommunications System |
| GTSPP | Global Temperature Salinity Pilot Project |
| HD | High Density |
| ICSU | International Council of Scientific Unions |
| IFREMER | Institut Français de Recherche pour l'Exploitation de la Mer (France) |
| IFM | Institut für Meereskunde (Germany) |
| IGBP | International Geosphere Biosphere Programme |
| IGOSS | Integrated Global Ocean Services System |
| IMET | Improved Meteorological Measurements from Buoys and Ships |
| IMG | Institut de Mécanique de Grenoble (France) |
| INPE | Instituto de Pesquisas Espaciais (Brazil) |
| IOC | Intergovernmental Oceanographic Commission (of UNESCO) |
| IODE | International Oceanographic Data and Information Exchange |
| IOSDL | Institute of Oceanographic Sciences - Deacon Laboratory (UK) |
| IOUSP | Instituto Oceanográfico da Universidade de São Paulo (Brazil) |
| IPCC | Intergovernmental Panel on Climate Change |
| IPO | (WOCE) International Project Office |
| ISSI | Indian Ocean Special Survey Area |
| IWP | Intergovernmental WOCE Panel |
| JAMSTEC | Japan Marine Science and Technology Center |
| JGOFS | Joint Global Ocean Flux Study |
| JMA | Japan Meteorological Agency |
| JOI | Joint Oceanographic Institutions Incorporated (USA) |
| JRC | James Rennell Centre for Ocean Circulation (UK) |
| JSC | (WMO-ICSU) Joint Scientific Committee for the WCRP |
| KERE | Kuroshio Extension Regional Experiment |
| LCPM | Laboratoire de Physique et Chimie Marines (France) |
| LODYC | Laboratoire d'Océanographie Dynamique et de Climatologie (France) |
| LPO | Laboratoire de Physique des Océans (France) |
| MAFF | Ministry of Agriculture, Fisheries and Food (UK) |
| MAST | Marine Science and Technology (CEC Framework Project) |
| MOCA | Modelling of Ocean Circulation in the Atlantic |
| MOD | Ministry of Defence (UK) |
| MORENA | Multidisciplinary Oceanographic Research in the East Boundary of the North Atlantic (Spanish research project) |
| MOU | Memorandum of Understanding |

| | |
|---|---|
| NASA | National Aeronautics and Space Administration (USA) |
| NERC | Natural Environment Research Council (UK) |
| NCAR | National Center for Atmospheric Research (USA) |
| NIOZ | Netherlands Institute of Sea Research |
| NMC | National Meteorological Center (NOAA) |
| NOAA | National Oceanic and Atmospheric Administration (USA) |
| NOARL | Naval Oceanographic and Atmospheric Research Laboratory (USA) |
| NSCAT | NASA Scatterometer |
| NSF | National Science Foundation (USA) |
| NUSTRAC | Numerical Study of the Tropical Atlantic Circulation (Brazilian research project) |
| NZOI | New Zealand Oceanographic Institute |
| ONR | Office of Naval Research (USA) |
| OOS | Ocean Observing System |
| OOSDP | CCCO-JSC Ocean Observing System Development Panel |
| OPC | Committee on Ocean Processes and Climate (IOC) |
| ORSTOM | Office de la Recherche Scientifique et Technique Outre Mer (France) |
| P | Precipitation |
| PI | Principal Investigator |
| PMEL | Pacific Marine Environmental Laboratory (NOAA) |
| PML | Plymouth Marine Laboratory (UK) |
| POL | Proudman Oceanographic Laboratory (UK) |
| PRC | People's Republic of China |
| PSMSL | Permanent Service for Mean Sea-Level |
| RAFOS | A form of "pop-up" sub-surface float (SOFAR in reverse) |
| RNODC | Responsible National Oceanographic Data Centre (IODE) |
| RSMAS | Rosenstiel School of Marine and Atmospheric Science (USA) |
| S | Salinity |
| SAC | Special Analysis Center |
| SAR | Synthetic Aperture Radar |
| SCOR | Scientific Committee on Oceanic Research (ICSU) |
| SOA | State Oceanic Administration (China, People's Republic of) |
| SOAFD | Scottish Office Agriculture and Fisheries Department (UK) |
| SOFAR | Sound Fixing and Ranging float |
| SPEM | Semi-spectral Primitive Equation Model |
| SSG | Scientific Steering Group |
| SSM/I | Special Sensor Microwave Imager |
| STA | Scienceand Technology Agency (Japan) |
| SVP | Surface Velocity Programme |
| SWINDEX | South West Indian Ocean Experiment |
| T | Temperature |
| TOGA | Tropical Ocean and Global Atmosphere Programme (WCRP) |
| TOPEX/POSEIDON | Joint US/French Ocean Topography Experiment |
| TOR | Terms of Reference |
| TRANSPAC | Trans-Pacific Experiment |
| TRE | Tracer Release Experiment |
| UN | United Nations |
| UNCED | 1992 United Nations Conference on Environment and Development |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |

| | |
|---|---|
| UOT | Upper Ocean Thermal |
| VCP | Voluntary Co-operation Programme (WMO) |
| VOS | Volunteer Observing Ship |
| VSOP-NA | Voluntary Observing Ships Special Observing Project for the North Atlantic |
| WCRP | World Climate Research Programme |
| WHOI | Woods Hole Oceanographic Institution (USA) |
| WHP | WOCE Hydrographic Programme |
| WHPO | WOCE Hydrographic Programme Office |
| WMO | World Meteorological Organization |
| WOCE | World Ocean Circulation Experiment |
| WWW | World Weather Watch |
| XBT | Expendable Bathythermograph Instrument |
| XCTD | Expendable Conductivity, Temperature, Depth Instrument |