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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
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NATIONAL REPORTS ON PARTICIPATION IN THE OCEANOGRAPHIC ASPECTS OF THE WORLD CLIMATE RESEARCH PROGRAMME

This document includes summary of description of national, regional and multinational programmes related to WCRP, presented at the Second Session of the IOC Programme Group on Ocean Processes and Climate (Paris, 10-13 March 1987) and relevant extracts from the report of the Fourteenth Session of the IOC Assembly (Paris, 17 March - 1 April 1987).

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PROGRAMME GROUP FOR THE SOUTHERN OCEANS (PG/SOC)
(prepared by Dr. D. Sahrage,
Chairman of the IOC Regional Committee for the Southern Ocean)

The Fourth Session of the IOC Programme Group for the Southern Oceans was held in Paris in March 1983. The summary report of that meeting is available as document IOC/SOC-IV/3.

The Fifth Session of the Regional Committee for the Southern Ocean will take place in Paris from 9-12 June 1987. The substantive items will be concerned with the following scientific activities, most of which are being promoted during the inter-sessional period:

(1) Status and recommendations for research on the general circulation of the Southern Ocean (Report of SCOR Working Group 74, WCP-108, WMO/TD-No. 86, October 1985).

(2) Recommendations of the Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill, to be held in Paris, 2-6 June 1987. During this Seminar, jointly sponsored by IOC and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), about 35 contributions will be presented and discussed, of which 8 will be directly concerned with ocean and atmospheric processes.

(3) Environment aspects of the BIOMASS Programme and possible follow-up activities. Of special interest will be the results of the BIOMASS/SIBEX Oceanographic Data Workshop, to be held in March 1987 in Cambridge.

(4) Regional, to SOC related components of the Ocean Observing System, including GLOSS, the IGOSS ship-of-opportunity programme, drifting buoy activities and satellite observations in the region.

(5) Possible establishment of an RNODC for the Southern Oceans region, for which facilities were offered by Argentina. A report by the IOCSOC Task Team on Data Management will be considered, and further proposals be developed, during the Twelfth Session of the Working Committee on IODE in December 1986.

2.

JAPANESE OCEANOGRAPHIC ACTIVITIES RELATING OCEAN PROCESSES AND CLIMATE

1. ON-GOING OR PLANNED SPECIAL RESEARCH PROJECTS

1.1 UNIVERSITIES AND BASIC RESEARCH INSTITUTIONS

(a) The Japanese WCRP Programme (the 1st phase)

The programme was endorsed by the Geodesic Council, Ministry of Education, Science and Culture in August 1986, and will be executed for the period from 1987 to 1990. The projects included in this programme are 1) Basic research for construction of atmosphere-ocean combined model, 2) Study of cloud distribution and its effects on climate, 3) Japanese TOGA, 4) Ocean mixed layer experiment (OMLET), 5) Study of interannual variations of atmosphere and sea ice in the Antarctic area, and 6) Study of natural and artificial factors which influence climate. The projects 1), 2) and 4 are intimately related with ocean process studies. In project 3), it is planned to keep one XBT observation line across the equator by using ship-of-opportunity.

(b) Dynamics of Deep Water Circulation Project

This was approved by the Ministry of Education, Science and Culture as one of the Grant-in-Aid for Scientific Research on Priority Project Research, and will be executed for the period from 1987 to 1989. The emphasis is laid on Shikoku or Philippine Basin, and the detailed mapping of the water properties is aimed. Direct current measurements both in Eularian and Lagrangian methods will be also made together with chemical tracer studies.

1.2 ORGANIZATIONS FOR OPERATIONAL SERVICES

(a) The Japanese WCRP Programme (the 1st phase)

The organizations for operational services also participate in the Japanese WCRP Programme. They are expected to improve their systems relating to oceanic monitoring and to data bases in this programme.

(b) The Japan-China Joint Research on the Kuroshio

The project is scheduled to be conducted during the period from 1986 to 1992 under the sponsorship of the Science and Technology Agency. The Japan Meteorological Agency (JMA), the Hydrographic Department (the Maritime Safety Agency) (HD) and the Japan Fisheries Agency (JFA) are participating in this programme. Basically, the project takes a form of reinforcement of the routine observations in Kuroshio area and the East China Sea.

(c) The Japanese El Nino Experiment

The Japan Marine Science and Technology Center sent his research vessel Natsushima for Equatorial Pacific region in February 1987 under the sponsorship of the Science and Technology Agency as the Japanese El Nino Experiment (JENEX-87). XBT, CTD, XCP and serial observations were conducted together with meteorological observations (Fig. 1). There is a plan to execute similar observations for proceeding years.

(d) Studies on the Oyashio

JFA will conduct a special project Studies on the Oyashio during the period from 1987 to 1989. Although the purpose of the project is to study fishery resources and their background, the obtained results would be useful for the programmes on ocean processes and climate.

2. JAPANESE OCEANOGRAPHIC OBSERVATION ACTIVITIES

2.1 ROUTINE OBSERVATION NETWORK

(a) Japanese routine observation network is fairly dense in the seas around Japan. The observation lines conducted by HD are shown in Fig. 2a, those by JMA in Fig. 2b and those by JFA and Prefectural Fisheries Experimental Stations belong to the local governments in Fig. 2c, respectively. The observations along these lines are typically made four times a year.

(b) Long meridional observation lines are occupied along 130°E (once a year) and 137°E (twice a year) by JMA (Fig. 3a), and along 144°E (once a year) by HD (Fig. 3b). In addition, JMA will revive to observation line along 155°E (once a year) from the summer of 1987 (Fig. 3c). Besides, the Icebreaker Shirase conducts oceanographic observations (mainly by XBT) on her way to and from Japanese Syowa Station in the Antarctic (Fig. 4).

(c) JMA operates four ocean data moored buoys in the sea around Japan (Fig. 5). HD is conducting surface drifter tracking. The number of released ARGOS drifters is from 5 to 6 per year, recently. The operation is made mainly in the North Pacific, but they have the plan to operate in the southern ocean (one released from Icebreaker Shirase in winter of 1986-87).

The oceanographic data of these routine observations are currently collected by JODC with some time lag. In addition to these data, the information on surface conditions are also collected by these agencies according to their own duties. In particular, JMA conducts special managements on real-time data for IGOSS.

2.2 TIDAL STATIONS

There is a very dense network of tidal stations, not only around the main Japanese Island but also at offshore Japanese islands. The locations of the stations are shown in Fig. 6, which gives those belonging to JMA, HD and the Geographical Survey Institute. Total number of the stations including other agencies is 462, for which tidal records longer than one year period are available. In addition, JMA operates four ocean bottom pressure-gauges as part of the Earthquake

Prediction Project for Tokai District; one is installed in Enshunada and three off the Boso Peninsula. Besides, a tidal station is working at Syowa Station in the Antarctic (69.0°S, 39.5°E) almost continuously from 1975 as a part of the Japanese Antarctic Research Expedition. These tidal data are also available from JODC.

2.3 NON-ROUTINE OBSERVATIONS

Besides the routine network, the above-mentioned agencies, JMA, HD and JFA, and Japanese university groups are conducting oceanographic observations with specified purposes very frequently in the western North Pacific, and some activities are now extended over the whole Pacific and the southern oceans. As an example, the cruise lines occuped by R/V Hakuho-maru, the Ocean Research Institute of University of Tokyo in the period from 1967 to 1982 are shown in Fig. 6a and 6b. Not all of the non-routine data are collected by JODC, but we have the plan to improve the collection rate for TOGA and WOCE purposes.

3. JAPANESE SATELLITE

Japanese Marine Observation Satellite (MOS-1) was successfully launched on February 19, 1987. The satellite is equipped by Multispectral Electronic Self Scanning Radiometer (MESSR), Visible and Thermal-Infrared Radiometer (VTIR), Microwave Scanning Radiometer (MSR) and Data Collection System Transponder (DCST). Earth Resources Satellite (J-ERS-1) is planned to be launched in 1991.

4. JAPANESE TEMA ACTIVITIES

As one of the activity relating to WESTPAC, the training programme for developing countries have conducted on several Japanese research vessels; R/V Takuyo (HD) in 1985, R/V Hakuho-maru (Univ. of Tokyo) and R/V Ryofu-maru (JMA) in 1986. Also, the Training Course on Oceanic Data Management is held in yearly base by the Japan Oceanographic Data Center (the fifth course in 1986 and the sixth in 1987).

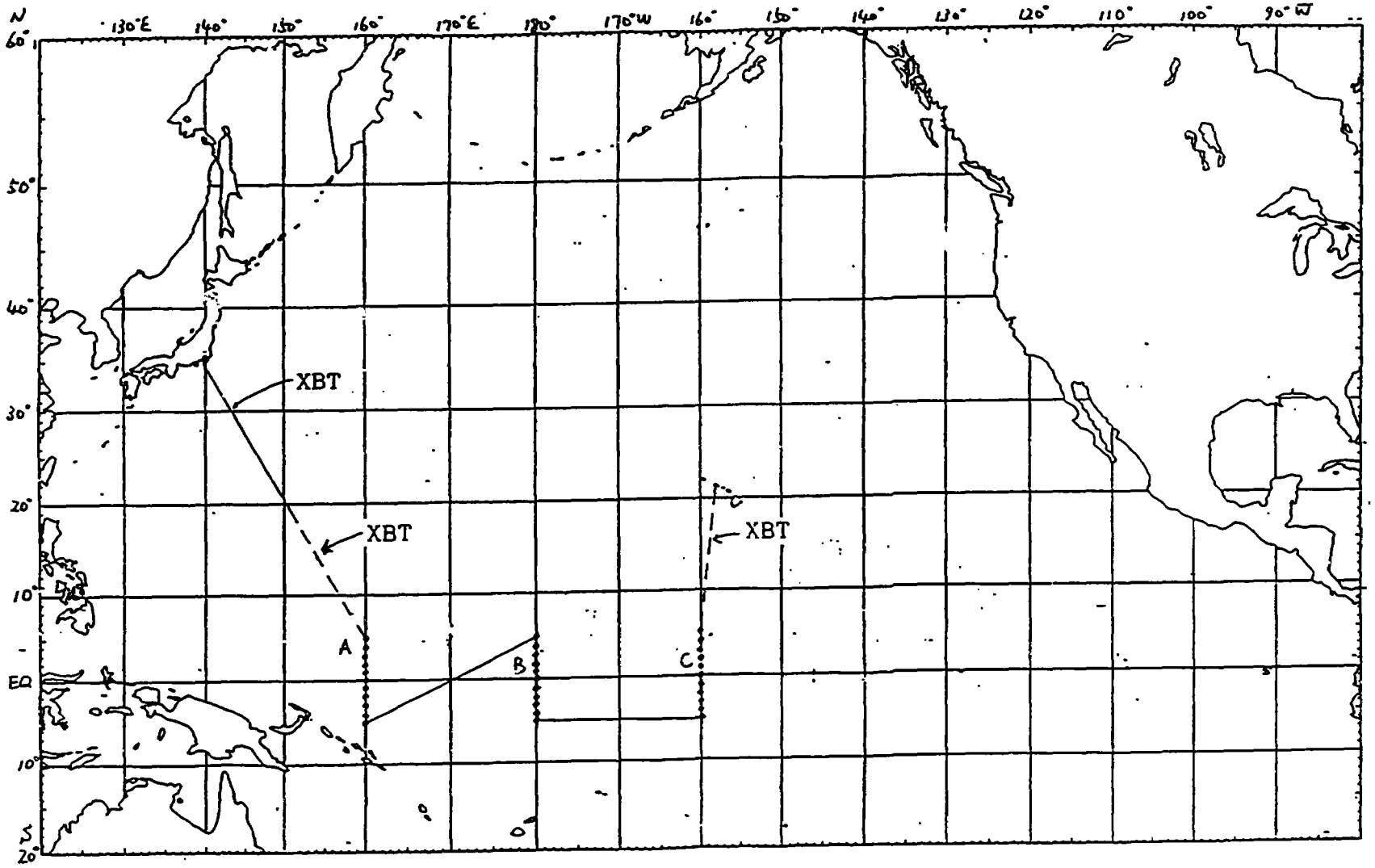
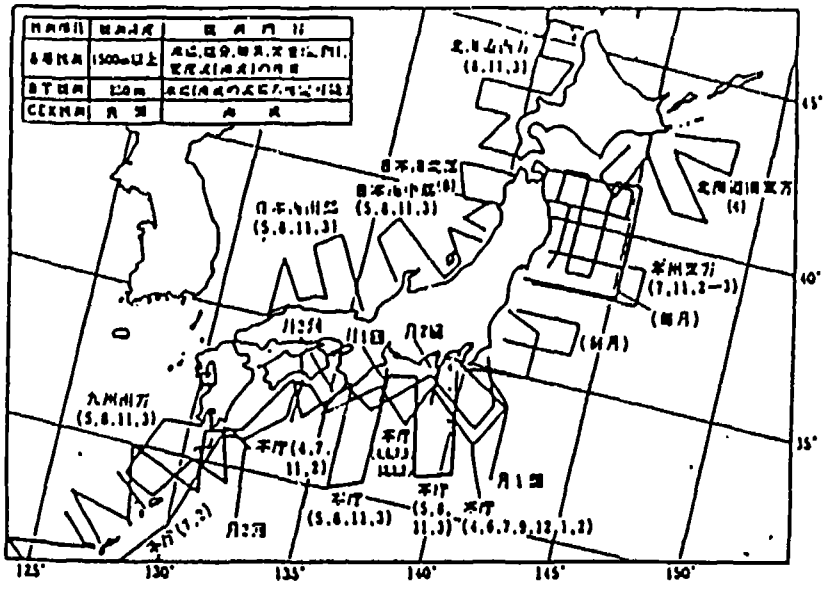
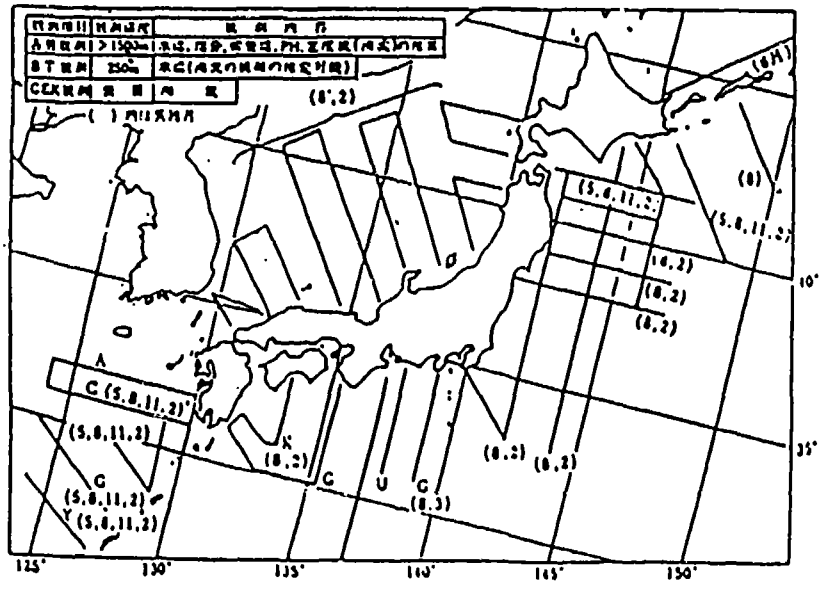


Fig. 1 Observation line in JENEX-87. ● : Serial observation, O : STD,
—— XBT (0.5° latitudinal interval), ---- XBT (1.0° latitudinal interval)



(Maritime Safety Agency)



(Japan Meteorological Agency)

Fig. 2 Routine oceanic observation network around Japan (a,b)

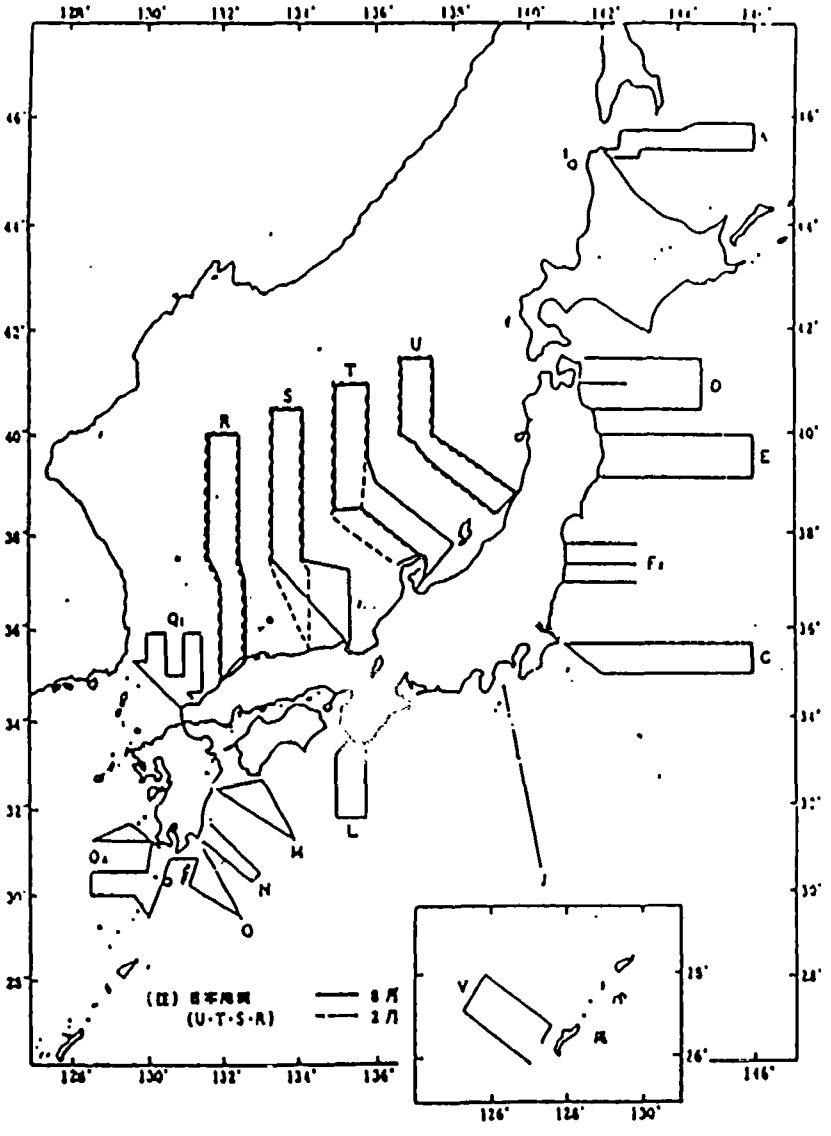


Fig. 2 Routine oceanic observation network around Japan (c)

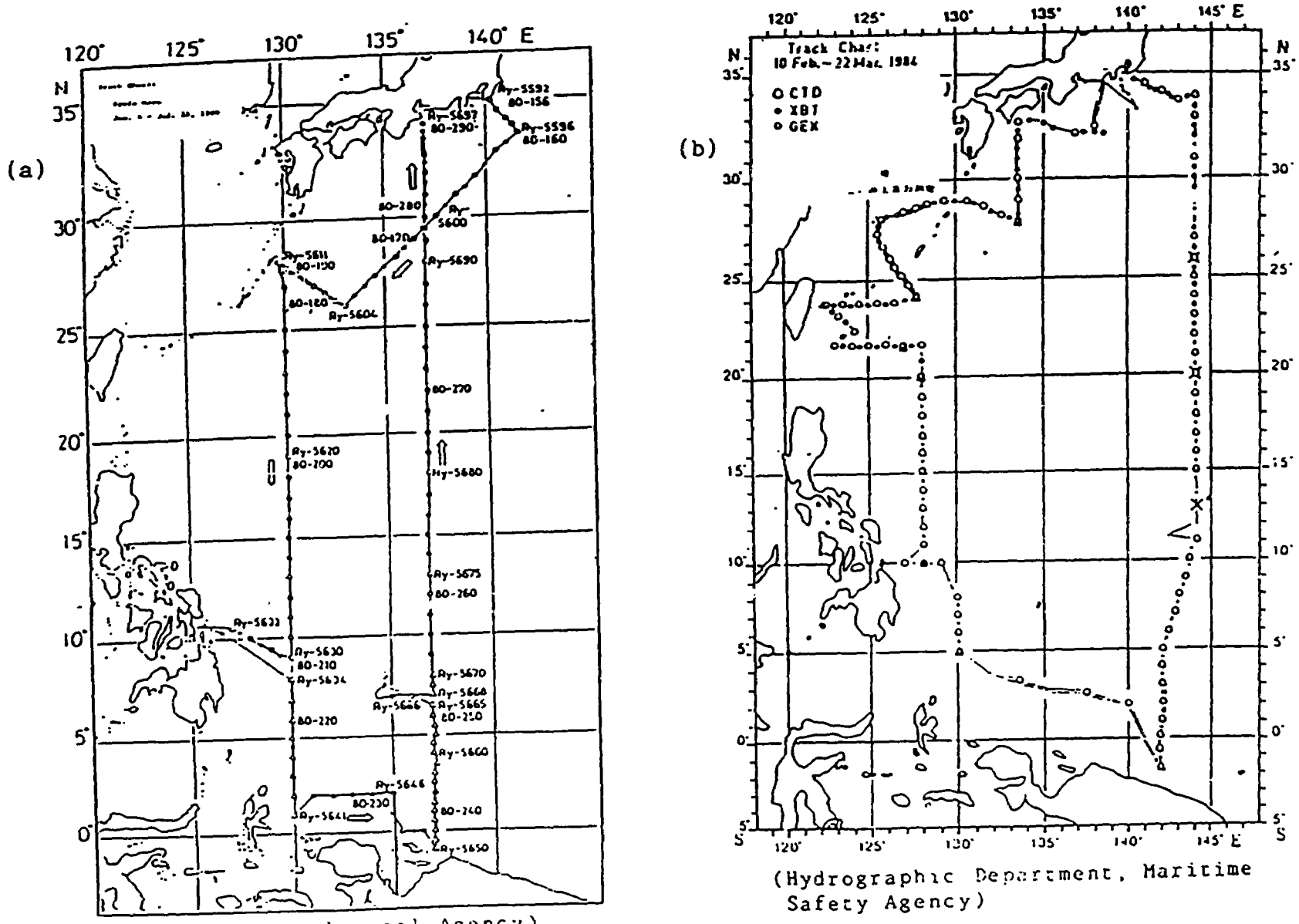
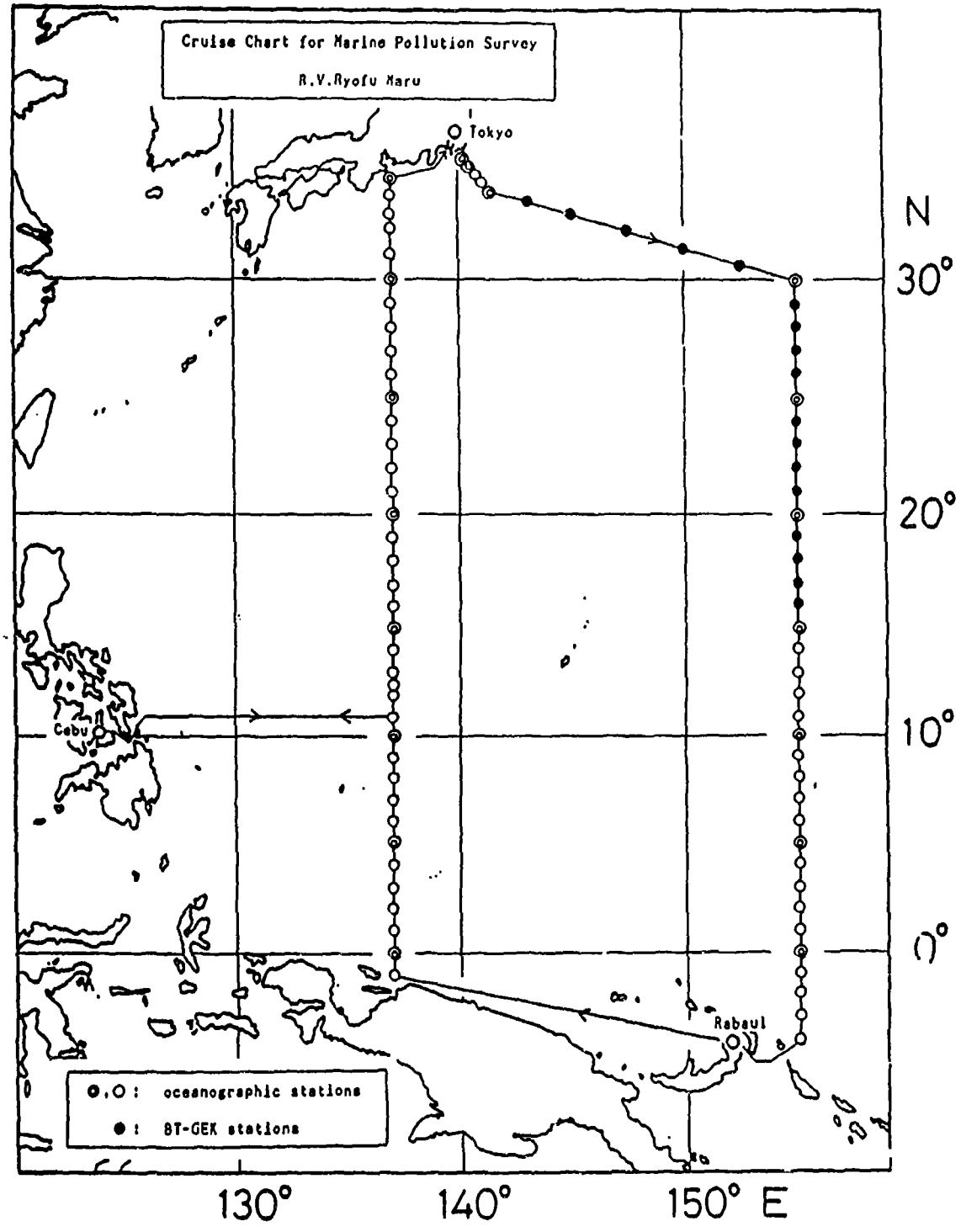
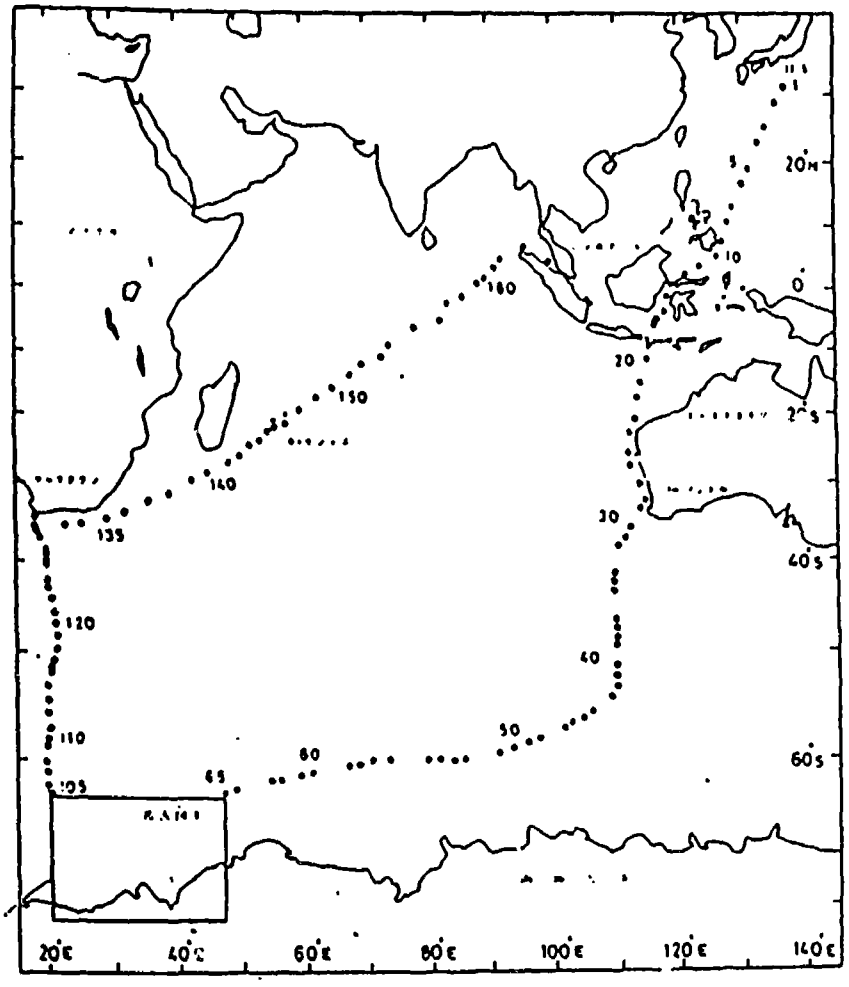


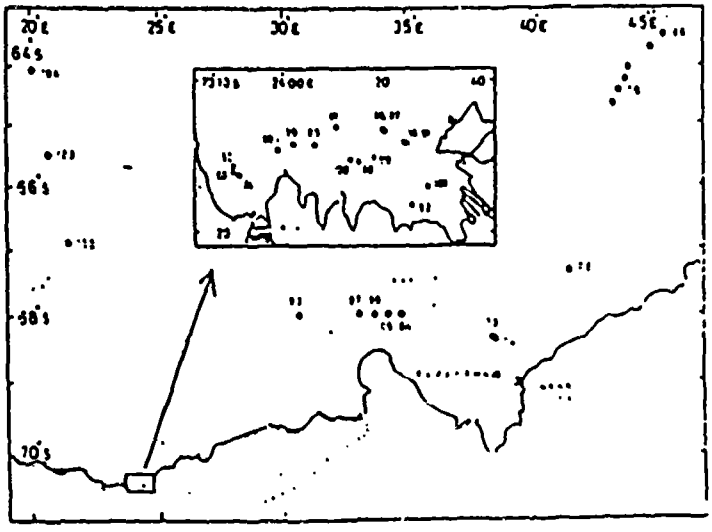
Fig. 3 Long meridional observation lines occupied by Japanese agencies routinely



Schedule of the cruise (June-July, 1987)			
Departure		Arrival	
Tokyo	June 6	Rabaul	June 22
Rabaul	June 25	Cebu	July 7
Cebu	July 12	Tokyo	July 26

Fig. 3c. Scheduled observation line in the summer 1987 (JMA)

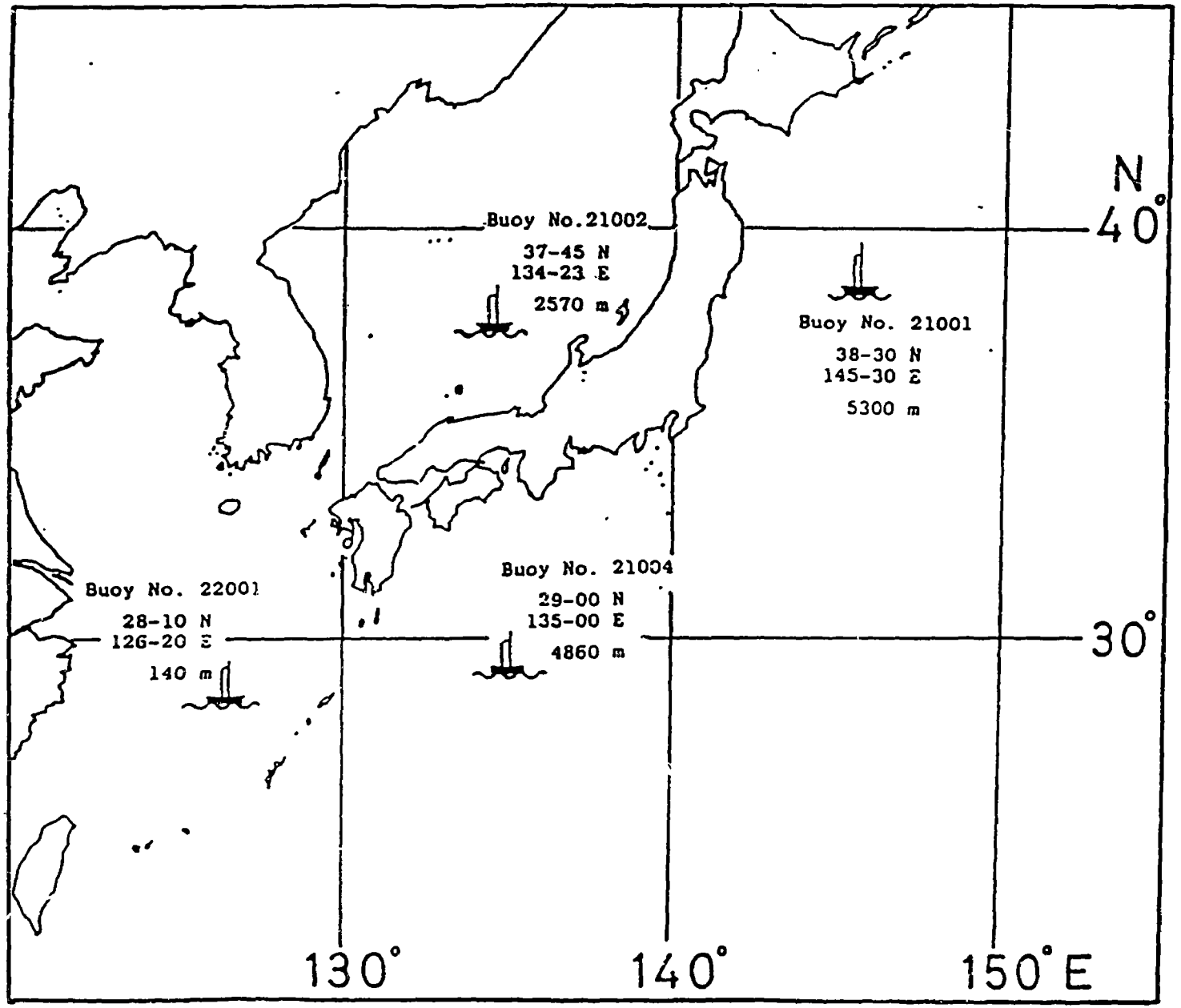




(enlarged)

Fig. 4 Typical Oceanic Observation line occupied by ice breaker Shirase

Fig. 5 Locations of the JMA ocean data buoys



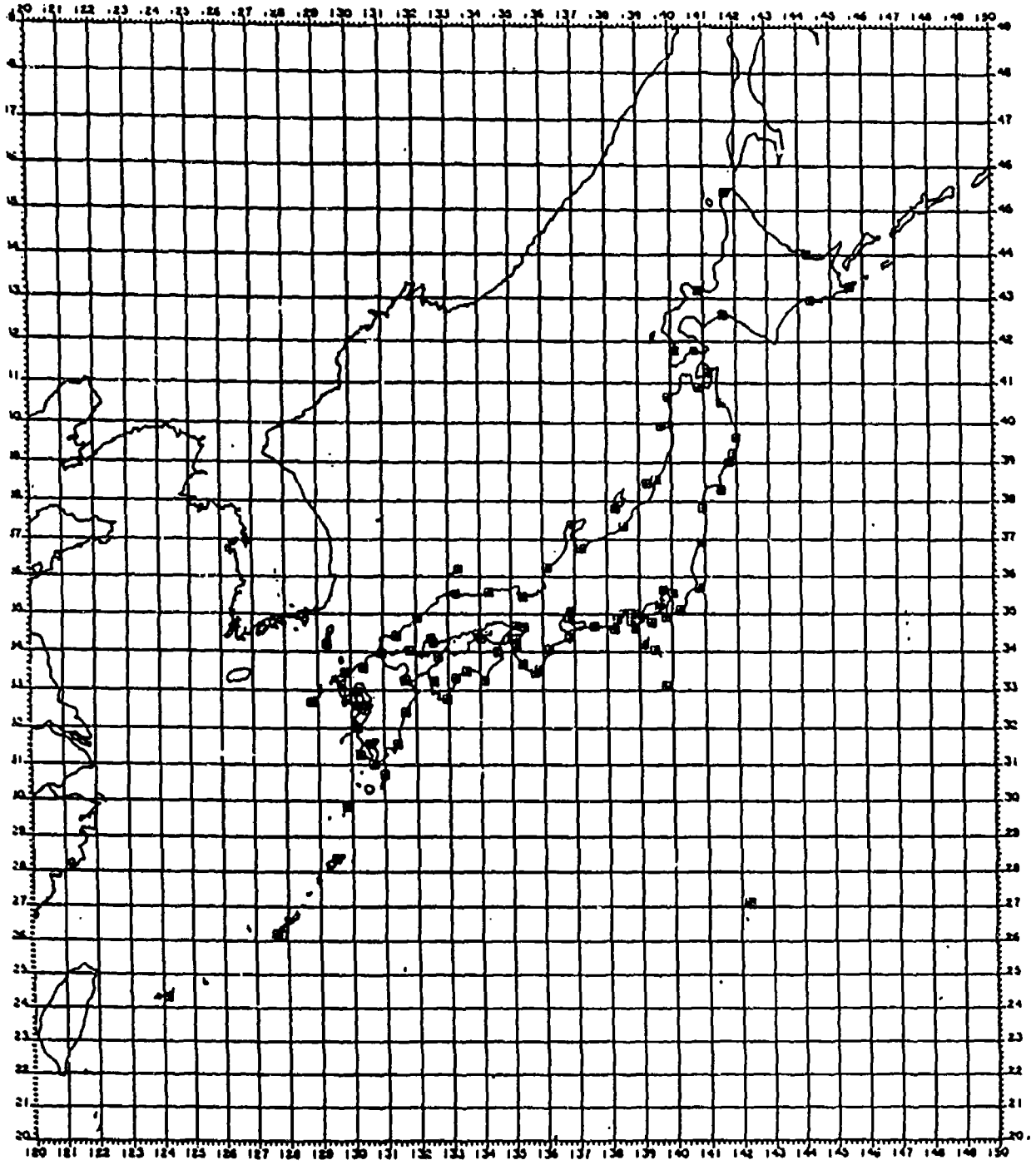


Fig. 6 Locations of the tidal stations operated by JMA, HD and GSI

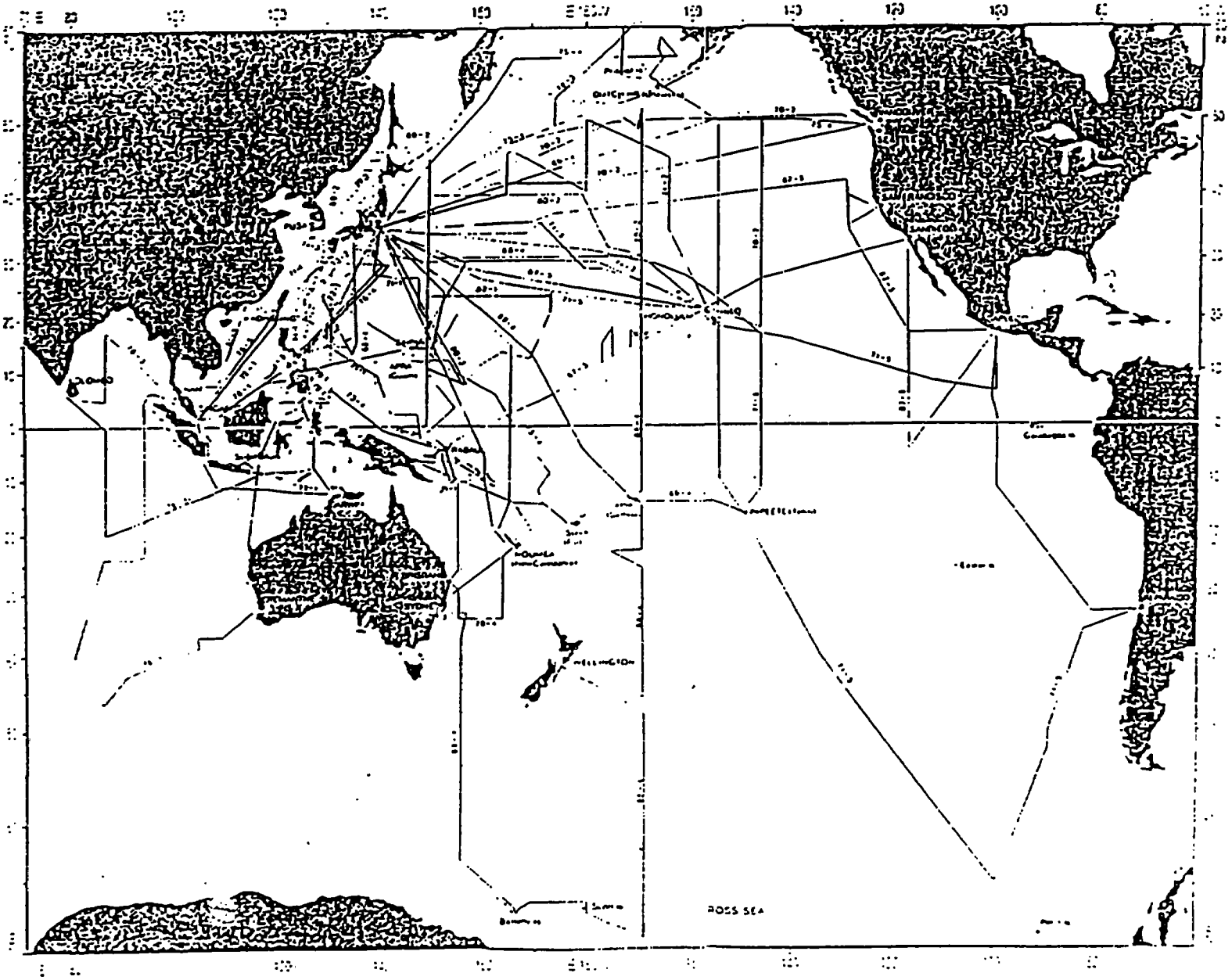


Fig 7a Cruise line of R/V Hakuho-maru, University of Tokyo in the period from 1967 to 1982; long cruises visiting foreign countries

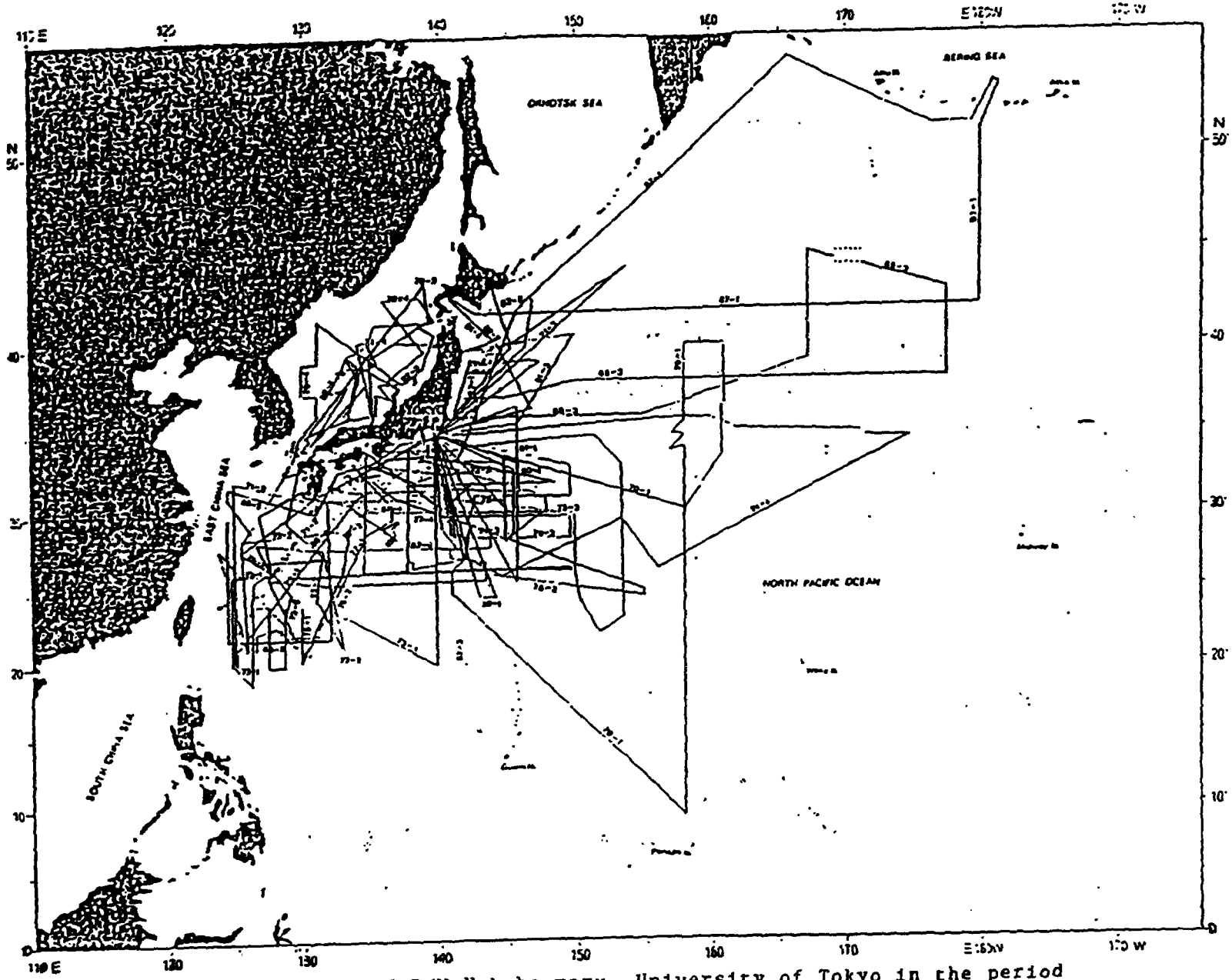


Fig. 7b Cruise lines of R/V Hakuho-maru, University of Tokyo in the period from 1967 to 1982 ; short cruises not visiting foreign countries

3.

SUMMARY OF TOGA AND WOCE PROGRAMMES IN THE FEDERAL REPUBLIC OF GERMANY

TOGA

Modelling activities include the application of the low-resolution version of the ECMWF spectral atmospheric circulation model and of a tropical ocean circulation model by groups at the Max-Planck-Institute of Meteorology and at the University of Hamburg. The atmospheric and oceanic models are run independently with prescribed SST or wind stress boundary conditions, respectively, and in the coupled mode. First experiments have also been performed with an isopycnal ocean circulation model. - The Comprehensive Ocean Atmosphere Data Set (COADS) is being used to provide the input functions for the forcing of models and for the identification of precursors. - The German Weather Service, in co-operation with the TOGA Data Centre in Bracknell, England, is presently involved in preparing the data exchange for the tropical regions in the climatological summary scheme, with the data set confined to the TOGA region. - A physical oceanographer from the F.R.G. has been assigned to the international TOGA data project at the ECMWF, Reading, England, with funding for the position provided by the F.R.G.

WOCE

An F.R.G. WOCE Committee has been established (Chairman: Prof. G. Siedler). The committee is engaged in planning the future field programmes and modelling activities within the international framework. The emphasis of the F.R.G. contributions to WOCE will be on the following topics: Field programmes in the North and South Atlantic, including the Southern Ocean, modelling of the oceanic circulation, including regional and global models, and satellite data assimilation. - A physical oceanographer from the F.R.G. has been assigned to the International WOCE Scientific Planning Office in Wormley, England, starting his work in March 1987. Funding for this position is also provided by the F.R.G.

4.

THE CONTRIBUTIONS OF MAURITIUS IN THE IMPLEMENTATION OF THE WORLD CLIMATE RESEARCH PROGRAMME

Because of the important impacts which the World Climate Research Programme will have on the understanding of climate variability over the globe and in our region of interest in particular, Mauritius is prepared to participate actively within our capabilities in the implementation of the WCRP. Among the Meteorological and Oceanographic activities in which we are engaged in the region, our involvement in the sea-level and XBT programmes pertaining to the Indian Ocean are our most recent contributions.

SEA-LEVEL PROGRAMME

Mauritius (20°S-57°E) and its three outer islands: Rodrigues (19° S-63° E), Agalega (10° S-56° E) and St. Brandon (16°S-59°E) are interesting potential sites for the installation of sea-level gauges. In June 1986, the University of Hawaii offered us two sea-level gauges of the floating type for installation in Mauritius and Rodrigues. With the collaboration of Ted Murphy, a technician from the University of Hawaii, one gauge was installed in July 1986 at Port-Louis, Mauritius. Sea-level data reduction is being done regularly since and hourly and daily data are submitted on a monthly basis to the University of Hawaii which is also the TOGA Sea-Level Data Centre. In November 1986 with the experience gained in the installation of the Mauritius instrument, the Mauritius Meteorological Service set up the Rodrigues sea-level gauge and on the 6 November, the first ever record on a tide gauge chart was obtained. The data is being submitted to the TOGA Centre for Sea-Level. Mean monthly data will be submitted to PSMSL.

Our next target will be the establishment of a bubbler type gauge in Agalega, a station which has been giving high priority in the implementation of sea-level programme for TOGA (Informal Planning Meeting of WCRP, May 1986, Geneva).

On the basis of the experience gained in the setting up of our national sea-level network, Mauritius proposes that it assumes responsibility as co-ordinator for the sea-level network in the South-West Indian Ocean.

XBT PROGRAMME

Analysis of sea-surface temperature which is obtained from VOS plying the South Indian Ocean is being carried out on a regular basis. Fortnightly sea-surface temperature is being published in our Monthly Weather Summaries Publication which is distributed globally.

Within the framework of the XBT Programme of the Indian Ocean, discussions have already been initiated with the French authorities (Dr. Voituriez of IFREMER) about the possibility of Mauritius becoming the focal point of the XBT Programme. We will be prepared to collaborate with India and Australia to establish the XBT lines Mauritius-Bombay and Australia-Mauritius. However, our contribution will be limited, at least for the moment, in the provision of human resources and local facilities.

5.

ACTIVITIES IN BRAZIL RELATED TO TOGA

(Report to the Informal Intergovernmental Planning Meeting of the World Climate Research Programme, Geneva, 12-16 May 1986)

1. INTRODUCTION

The activities being presently carried on and those in planning in Brazil, which could be a contribution to the implementation of the WCRP, are centered around the Tropical Ocean and Global Atmosphere (TOGA) project.

The Brazilian research programme within the scope of TOGA is described in the document presented to the TOGA conference (Paris, September 1984). The following is a report on the status of implementation of the national programme.

2. INTERANNUAL, SEASONAL AND MONTHLY ATMOSPHERIC VARIABILITY

Within this topic, there was progress on the study of large-scale circulation anomalies and on the predictability of droughts in Northeast Brazil.

As analysis of the monthly departure of the relative vorticity and wind fields over the globe was performed for the period 1963 to 1980. Planetary-scale wavelike (teleconnection) patterns were observed in the vorticity and wind deviation fields extending from Subtropical North Atlantic through the North Pole to Eastern Siberia for years of droughts and excessive rainfall over Northeast Brazil (Nordeste). These patterns are sharpest in December January. Of major interest is the phase coherence of the wavelike patterns and the precipitation anomalies of Nordeste, that is, the phase of the patterns is reversed from very dry to very wet years. Such phase coherence and also the emergence and persistence of the wavelike pattern several months preceding the rainy season in Nordeste (March-May), seems to indicate that there might be some predictive potential in these configurations. An index of the existence and phase of the wavelike patterns was developed. It was seen that the sign of the index is highly associated with the sign of the precipitation anomaly in Nordeste for most of the years. A comparison was made between three potential methods of prediction for droughts in Nordeste.

The 1982-83 El Nino/Southern Oscillation (ENSO) was one of the most intense ever recorded and it has affected the climate and weather in South America in several years causing floods in many areas and droughts in others. This work is concentrated on two aspects:

(a) the abnormal dry period during January-February 1983 in central and northern Amazon and the severe drought over Northeast Brazil, from January through June, and

(b) the extensive flooding in southern Brazil, northern Argentina and Paraguay in May-July 1983.

Precipitation analysis for northern South America revealed monthly rainfall values up to 70% below the climatological mean for January-February 1983 in central and northern Amazon and up to 60% below the mean for January-June 1983 (rainy season) in Northeast Brazil. Analysis of the 200 hPa velocity potential charts from December 1982 to February 1983 seems to indicate that the cause of that unusual dry spell was an anomalous Walker circulation. Its rising motion was concentrated over equatorial central and eastern Pacific in the region of very warm sea surface temperature (SST) and increased convective activity. Its sinking branch extended over a broad tropical area covering most of the Amazon, Northeast Brazil and the Tropical Atlantic. The extensive flooding in southern South America in May-July 1983 was caused primarily by excessive rainfall from a few quasi-stationary frontal systems.

A Monthly Bulletin of Northeast Brazil Climate Anomalies is being published. Four issues have appeared (in Portuguese): September to December 1985, January 1986, February 1986 and March 1986. The bulletin includes:

(a) the Inter-tropical Convergence Zone (ITCZ) position and intensity and Tropical Atlantic sea-surface temperature anomalies;

(b) fields of precipitation (on a regional scale), convective activity over the Western Equatorial Atlantic (near the coast of Northeast Brazil);

(c) mean and anomaly analysis of global fields of Out-going Long-wave Radiation, 850 and 200 hPa winds and 200 hPa geopotential height;

(d) other rain-producing mechanisms (upper tropospheric cold penetration of frontal systems and instability lines).

The 1986 rainy season in Northeast Brazil has been very wet. The ITCZ's southernmost position reached about 7°S and it remained south of the equator over the western Atlantic during March and April making it for a plentiful rainy season. The SST pattern in the Tropical Atlantic has been one typical of a rainy year in Northeast Brazil: warmer waters to the south of the Equator and colder waters to the north, which is consistent with the pronounced migration of the ITCZ to the South. Also the teleconnection pattern NAEA (North Atlantic - East Asia) appeared in January and March with the phase indicative of wet years in Nordeste. The Acores trough has been more intense and displaced to the south of its climatological position, which is also another feature typical of wet years in Nordeste.

3. VARIABILITY OF THE COUPLED OCEAN-ATMOSPHERE SYSTEM

A numerical experiment is being planned, with the use of a general circulation model of the Atlantic (G. Philander, NOAA/GFDL) to

simulate the oceanic response (in terms of SST distribution) to an anomalous wind stress forcing as observed in months when the NAEA teleconnection pattern emerges. From the results of such model simulation, it will be possible to validate (or not) the hypothesis that the SST anomalies in the tropical Atlantic are a response to wind stress anomalies at the surface.

4. ATLANTIC OCEAN VARIABILITY

The Brazilian programme includes the study of the meridional heat and mass fluxes and their variabilities in the South Atlantic. This is being conducted as a joint programme with the University of Rhode Island. Presently most of the effort is toward the collection of data in the South Atlantic western boundary current (Brazil current). A section at 23 S across the Brazil current has been surveyed since 1982 twice a year, whenever possible. It is planned to monitor this section at least on a monthly basis. Values of transport based on geostropic calculation, using the level of no motion at 400 m, and Pegasus measurements, agree reasonably ($4.2 \times 10^6 m^3/s$ and $6 \times 10^6 m^3/s$, respectively, in April 1983). The variability data are being processed.

The Brazil current is also being monitored at 31 S, either through geostrophic computations based on XBT data, or through local measurements of the velocity profile. Some results are summarized below.

Direct observation of the vertical structure and transport of the Brazil current have been made near 31 S using the Pegasus profiles. The current was centered over the 2000 m isobath and had a width of approximately 20 km. Maximum speeds were near 80 cm/s directed towards the southwest. The two more inshore stations exhibited flow reversals (flow toward the northeast) below the southward-flowing Brazil current water. Sampling difficulties limited transport calculation to depths less than 800 m, above which a value of $16.7 \times 10^6 m^3/s$ was measured. Computation of geostrophic flow using the Pegasus temperature data and adjusting reference levels by the direct observations yields $17.0 \times 10^6 m^3/s$ above 800 m. Heat flux are presently being computed using Pegasus data.

Two XBT sections performed in April and November 1985 were analysed; the geostrophic computations, using a reference level at 600 m, indicate larger transport during April (9 svendrup), as compared to November (7 svendrup). The southwest-ward heat transport during April and November is around 5×10^{14} W. It is well established that the Brazil current is stronger during the summer.

Comparison of the results across the two sections indicates an increase in the volume transport of the Brazil current towards the South.

In order to learn more about the barotropic transport of the Brazil current over the continental shelf and on the slope, two moorings with current meters at 4 levels will be deployed around 23°S x 041°W. One of the moorings is presently being tested.

Also within the programme of monitoring the Brazil current, a series of XBT sections between Rio de Janeiro and Trindad Island (29°30'S, 029°18'W) are being performed on a bi-monthly basis since October 1985.

Satellite images of the southeast coast of Brazil are being recorded for later processing and analysis.

5. INSTITUTIONAL ARRANGEMENTS

The co-ordination of the national level of the TOGA programme is being made by an ad-hoc committee composed of representatives of the two main research institutions in Meteorology and Oceanography, and of the operational services in Meteorology and Oceanography. Consideration will be given to formalizing this arrangement, if necessary.

Instituto Nacional de Meteorologia
Diretoria de Hidrografia e Navegacao
Instituto de Pesquisas Espaciais
Instituto Oceanografico da Universidade de Sao Paulo

6.

UNITED KINGDOM

The United Kingdom is actively involved in developing and executing its own national activities under the umbrella of both WOCE and TOGA Programmes and in providing support for the international management and development of these programmes.

WOCE

A National Committee for WOCE has met (under the Chairmanship of Prof. H. Charnock) and the formulation of a national scientific programme including shipborne observations, satellite remote sensing and numerical modelling components is underway. The United Kingdom also hosts the WOCE-IPO, located within the Institute of Oceanographic Sciences and provides both scientific inputs and secretarial support for the planning office.

An eddy-resolving community model, the Fine Resolution Antarctic Model (FRAM), is already underway which will make an important contribution to the core project 2 of WOCE and will form part of a major UK effort to understand the oceanography and the climatic importance of the Southern Ocean.

TOGA

Both numerical modelling and observational projects related to the atmosphere/ocean interactions in low latitudes are underway within the oceanographic and meteorological communities building on the pioneering both of the late Dr. Adrian Gill of the Robert Hooke Institute. Indeed a coupled ocean/atmosphere numerical model is already operating with the UK Meteorological Office.

The UK also provides financial support for the International TOGA Project Office.

OTHER WCRP RELATED ACTIVITIES

The UK is active in its support for international programmes such as IGOSS and GLOSS and in the latter has played a major role in promoting the improvement of global coverage of high quality mean sea-level data. These activities are continuing.

The importance of satellite remote sensing of the ocean is providing information on sea-level and ocean/atmosphere fluxes is recognized and the UK will continue to be active in the planning to ERS-I and other ocean observing satellites.

7.

CONTRIBUTION OF FRANCE TO THE WORLD CLIMATE RESEARCH PROGRAMME

1. INTRODUCTION

Having long been aware of the role of climatic phenomena in maintaining the equilibrium of human societies, France set up in 1982 a National Programme for the Study of the Dynamics of Climate (Programme National d'Etude de la Dynamique du Climat, PNEDC). This programme combines the work of the National Centre for Scientific Research (Centre National de la Recherche Scientifique, CNRS), the National Centre for Space Studies (Centre National d'Etudes Spatiales, CNES), the National Meteorological Service (Direction de la Meteorologie Nationale, DMN), the French Institute for Ocean Research (Institut Francais de Recherches sur la Mer, IFREMER), the French Institute for Research and Development in Co-operation (Institut Francais pour la Recherche et le Developpement en Co-operation, ORSTOM) and the French Southern and Antarctic Lands Administration (Administration des Terres Australes et Antarctiques Francaises, TAAF).

PNEDC, whose objectives are substantially the same as those of the WCRP, has led to a number of significant results being obtained during the 1982-85 phase, and has enabled several courses of action to be initiated which are still in progress.

(i) In the field of paleoclimatology, several original results concerning the variations of climatic elements (temperature, CO2, aerosols) during the last 150,000 years have been obtained and much useful progress on the interpretation of these anomalies by means of numerical modelling has been made.

(ii) Several studies on climatic processes have been, or still are, the subject of specific programmes. Thus the NEPHOS programme will enable a more realistic picture to be obtained of the radiation effects of extensive layers of low cloud. In another field the MOBILHY programme, which has since been included in the international HAPEX programme, tackles the study of fluxes at the ground-atmosphere interface for purposes of parameterization in climate models.

(iii) In oceanography, on the one hand, the FOCAL programme on the variability of fluxes transported by the oceanic circulation from tropical regions is to be noted, while on the other hand, there is the TOPOGULF programme on the evaluation of flow from west to east in the Atlantic.

(iv) In the fields of both oceanic and atmospheric numerical modelling, French scientists have obtained many important results in developing simulations of processes, the first stage of ocean-atmosphere interaction and the detection of the climatic "signal in the meteorological noise".

(v) Since 1983 France has also acted as the Satellite Calibration Centre for the ISCCP programme.

In its second phase (1985-88), PNEDC will continue its work within the framework of extended international co-ordination. Its primary objective is the first stream of WCRP, i.e. long-range forecasting. PNEDC will also participate extensively in the TOGA programme (second stream of WCRP) and in the preparation of a contribution to the WOCE programme (third stream of WCRP) in the form of space altimetry. PNEDC will continue its work on paleoclimatology, accumulating documentary evidence and endeavouring to understand the evolution of past climates.

2. THE FRENCH CLIMATE RESEARCH PROGRAMMES

PNEDC is a four-year programme, for which a second phase (1985-1988) was decided upon in December 1984. The scientific aim of the programme is the study of climatic change at the level of experimentation and modelling, with particular emphasis on meteorological long-range forecasting (1 - 2 months). This programme falls under three main headings.

2.1 EMPIRICAL DATA

Paleoclimatology at middle and high latitudes will be devoted to a specific study of the whole of the Southern Ocean, to studies on cores of sediments in a continental environment and to deep-sea core drillings in the Antarctic. New French drilling equipment will be brought into use, enabling cores 4000 m in depth to be obtained and enabling the study of the beginning and end of the last ice-age (0 to 150,000 years ago).

The empirical study of oceanic phenomena will consist of French participation in the international Tropical Ocean and Global Atmosphere (TOGA) programme. Systematic observations will be made in the Indo-Pacific convergence zone by the development of measuring networks provided by merchant ships and a biannual hydrological section along the 165°E meridian. FOCAL data obtained during the preceding plan will continue to be used. Building up an extensive file of oceanic data will make it possible to develop methods for data analysis, enabling the signals corresponding to the response of the ocean to certain influences to be identified and then, in the long term, enabling the principal predictors of climatic variability to be determined.

2.2 PHYSICAL PROCESSES INVOLVED IN THE DYNAMICS OF CLIMATE

The study of the influence of clouds on the earth radiation balance will be continued under the International Satellite Cloud Climatology Project (ISCCP). The French component will enable the methods for calculating the transfer of radiation to be validated and enable our knowledge of the influence of clouds on radiation to be improved by the study of extensive layers of clouds in the upper troposphere (cirrus). Developing algorithms for processing satellite images, enabling cloud amount and cloud type to be determined on a global scale, will be an important part of this branch of research.

The study of modelling the flux of evaporation over the continents will enable another important process for the evolution of climate to be studied. The continental water balance affects the state of the atmosphere, both in the short term by being involved in the energy supply of the atmospheric circulation, and in the long-term by playing a moderating role in the dynamics of semi-desert regions, by warming up the lower layers of the atmosphere. General circulation models should include the parameterization of the water balance which should be as realistic as possible and on the scale of a 100-500 km grid. Since the present models have been developed only for areas of a few hundred square metres, it is important that an experiment on a much larger scale be undertaken, enabling our knowledge of surface hydrology to be improved, methods of parameterizing on various time scales to be tested, and data by remote sensing to be extended. The Modelling the Water Balance project (Modelisation du Bilan Hydrique, MOBILHY) depends on the establishment of a network equipped with instruments over an area of 10 km in southwestern France, supplemented by aircraft measurements. This project was implemented in 1986. The basic network consists of some 15 automatic stations for measuring temperature, humidity, wind, turbulent radiation balance, turbulent fluxes of latent and sensible heat and surface soil moisture. The area also has 59 rainfall stations, 2 meteorological radars and 33 stations for measuring the discharge of rivers. Remote sensing by satellite and by airborne equipment will be carried on simultaneously.

It is proposed to undertake a study of the influence of the distribution of sea ice on climatic changes. Ice has a direct effect by modifying ocean-atmosphere interaction, due to its reflecting, insulating and mechanical properties. During the melting and freezing processes, its thermodynamic properties are of very great importance. In this connection, the results of international campaigns of the Marginal Ice Zone Experiment (MIZEX), and preparations for the French component of the international project for the study of the Greenland Sea (ARCTEMIZ), will be the main basis of the studies.

2.3 MODELS

Atmospheric modelling will be organized around the three streams of WCRP, in particular the first stream. Thus, experiments on sensitivity and predictability will be carried out, based on actual data. As regards sensitivity, research will cover the large-scale influence of anomalies of ocean temperature and the influence of initial anomalies of soil moisture. Concerning predictability, a series of forecasts on a monthly scale will be attempted, in collaboration with the operational services of the National Meteorological Service. The other studies will be on ocean-atmosphere interaction and on desertification.

Oceanic modelling will be concerned mainly with the second and third streams of WCRP. The proceedings will consist in developing models of oceans in the tropics which will have to be validated by available oceanic data or by data from the TOGA programme. The next stage, which will consist of the development of 3-dimensional global models of the ocean, with or without resolution of eddies, will only be achieved by means of WOCE data, which will begin to become available in 1990. However, this important programme will combine the use of satellite altimetric data (TOPEX/POSEIDON experiment), hydrological measurements by geochemical tracers, release of sub-surface floats located by acoustic navigation and the techniques of acoustic tomography. PNEDC will thus have a component preparatory to this programme.

3. OTHER SCIENTIFIC ACTIVITIES

3.1 AEROSOLS

In France, a study of SAGE-II satellite data will enable the profile of temperature in the stratosphere to be obtained, and enable its variation to be studied. It is proposed to validate the model atmosphere developed by the National Meteorological Service by means of the profiles measured by SAGE-II.

In the field of aerosols in the troposphere, work is being undertaken on "Aerosols in the Sahara", in order to study in particular their sources and changes associated with desertification, the energy balance of the aerosol layer, and the study of their trajectories by means of satellites. A campaign of surface measurements and measurements by airborne instruments in the Sudano-Sahelian region of Africa is proposed for the 1990's.

3.2 WATER BALANCE

France is participating in the ISLSCP programme by way of a combination of surface measurements and measurements by means of satellites in Tunisia in a homogeneous area, and in the Sudano-Sahelian area in order to develop models of the water balance.

4. WORLD WEATHER WATCH SYSTEMS

France is aware that the conduct of the whole set of WCRP projects presupposes that the WWW will be operating at least at its present level and even at an improved level as regards certain critical sub-systems. In particular, obtaining consistent sets of global data which are continuous over a long period places considerable demands on the meteorological satellite systems.

In the field of the WWW, France is now prepared to undertake the following.

4.1 METEOSAT SATELLITE WINDS

As a participant in the METEOSAT programme, France will make its contribution to enable the programme to be continued until 1995, in order to obtain the required wind vectors at 00, 06, 12 and 18 GMT, and will encourage other participants to do likewise. In the initial phase, measurements could be made for three of the four synoptic time periods. France also intends to support the development of the next generation of operational satellite systems.

4.2 WIND SOUNDINGS

France will carry out at least one wind sounding per day at key stations for TOGA, which France is responsible for, from the list of stations established by the WCRP, i.e. Atuona, Tahiti, Cayenne and Tromelin. Two soundings per day will be made at Tahiti. At Tahiti, Atuona and Cayenne the soundings also include measurements of temperature and humidity.

4.3 SOUNDINGS FROM SHIPS

France plans to equip four ships with ASAP systems. Part of the route of these ships lies in the tropical zone in the neighbourhood of the West Indies. The SARE (designation of the French system for ASAP) system has been operational since the beginning of 1986.

4.4 SELECTED SHIPS

France plans to maintain its programme of Selected Ships. This programme, which includes 208 ships, provides each year, in the zone 30° N - 30°S, approximately 60,000 observations for the Atlantic, 10,000 for the Indian and 5,000 for the Pacific. Unfortunately this programme cannot be extended because all ships having a radio officer are already participating.

4.5 METEOROLOGICAL BUOYS

France plans to deploy drifting buoys for making meteorological observations. It is at present proposed to deploy approximately ten buoys each year in the North Atlantic, these buoys having been developed from Marisondes-B, which proved to be very efficient during the FGGE. The basic buoy measures atmospheric pressure and sea surface temperature. New types, at present being tested, are equipped for the measurement of wind or deep-sea temperatures.

4.6 ARGOS

France intends to maintain the continuity of the ARGOS system on NOAA operational polar orbiting satellites, including K, L, M (i.e. until about 1995). Recently CNES has reached an agreement with NOAA in this connection.

4.7 OTHER CONTRIBUTIONS

In addition, further possible commitments are at present being studied, but no decisions have been taken. In particular, this applied to:

- meteorological measurements on Clipperton atoll by an automatic station and collection by satellite (at present, experiments are being conducted to determine the extent to which environmental conditions of this atoll permit the making of conventional meteorological measurements by means of an automatic station),

- possible deployment of additional drifting buoys in the southern hemisphere (an analysis of the cost of this project is at present being undertaken), and

- possible installation of wind profile radars in the inter-tropical zone (these radars are at present being developed).

5. PROGRAMME OF OCEANOGRAPHIC OBSERVATIONS

In the field of oceanography, France is involved in four of the six WCRP sub-programmes, Coupled Atmosphere-Ocean Boundary Layer Research, TOGA, WOCE, and Cryosphere Research. No specific action is proposed with regard to the first and fourth of these sub-programmes. Nevertheless, the observational networks which have been set up in France for TOGA, concern the first sub-programme, and France also has suggested carrying out an ARCTEMIZ programme under the Greenland Sea Project. A preliminary ARCTEMIZ campaign is to take place in 1986. The French WOCE programme has not yet been established and a FRANCE-WOCE proposal should be available by the end of 1986. However, as regards oceanographic observations, local action or technological development is being undertaken.

French participation in oceanographic observing systems include sea level, deep-sea measurements, oceanographic campaigns, float programmes, fixed anchorages, acoustic tomography, ice stations, wind measurement and observations from space.

5.1 SEA LEVEL

ORSTOM has set up a network of 11 pressure recording tide gauges in the tropical Atlantic for the FOCAL programme. This network will be maintained for the duration of the TOGA programme. The possibility of real time data transmission is being studied.

The Sub-Antarctic Zonal Anomaly programme (SUZAN) now being carried out, studies the circumpolar Antarctic circulation (WOCE Core Project 2) based on variations in sea level between Kerguelen and Amsterdam. At present British recording tide gauges are being used for this programme.

Provisions are being made to meet the needs of altimetry by satellite (elimination of the tide, reference measurement), by the building of a set of instruments for measuring sea level, in the cases of medium and great sea depths.

5.2 MEASUREMENTS ALONG SHIPPING ROUTES

The USA and Australia have signed an agreement concerning the implementation of an XBT network for the TOGA programme, to ensure that it is maintained for the duration of the programme. In this network, France at present operates three routes in the Atlantic Ocean, one in the Indian Ocean and, jointly with the USA, four routes in the Pacific Ocean. This programme is also scheduled under IGOSS.

The terminal ports are Noumea, Marseille and Le Havre. On each route of the XBT network, surface samples are taken to determine the salinity and chlorophyl content. Besides this, the MESTRA (METEO/ORSTOM) programme provides a much denser coverage of surface measurements (salinity, temperature) in the North Atlantic.

5.3 OCEANOGRAPHIC CAMPAIGNS

In the western Pacific, ORSTOM provides a systematic description of the physico-chemical structure along the 165°E meridian from 20°S to 10°N, twice a year. Provision has been made to maintain this for the duration of the TOGA programme.

The programme of WOCE campaigns has not yet been determined, but under the SUZAN programme, provision has been made for such work to be undertaken on the MARION DUFRESNE of the TAAF in the Antarctic (Crozet, Amsterdam, Kerguelen).

5.4 SURFACE AND SUB-SURFACE FLOATS

France has three types of floats for oceanographic measurements:

- Drifting surface buoys, simply making measurements of surface temperature and tracked by ARGOS.

- Drifting surface buoys equipped with thermistor chains (0-150 metres) and tracked by ARGOS. These buoys will be subjected to experiments in the equatorial Indian Ocean in 1986.

- SOFAR type floats, tracked acoustically, and already widely implemented for the TOPOGULF programme.

The programme for the use of the first two types of floats for TOGA is being examined. The use of SOFAR floats for Arctic programmes, with data transmission via ARGOS, is being tested during the ARCTEMIZ-1 campaign.

5.5 FIXED ANCHORAGES

In addition to the SURTROPAC oceanographic campaigns, one or perhaps two anchorages comprising thermistor chains (0 to 500 m) will be deployed in 1986 and 1987 at 7 N and 10 N along the 165°E meridian. These will supplement the four identical anchorages installed along the same meridian between 5° S and 5° N by NOAA/PMEL. Data from these anchorages are transmitted via ARGOS.

5.6 ACOUSTIC TOMOGRAPHY

Under WOCE, France currently is developing Transmitter, Acoustic Receiver for Tomography (Emetteur, Recepteur Acoustique en Tomographie, ERATO) instrumentation, in order to have, from 1988/1989, a network enabling mesoscale structures to be studied. This instrumentation will be tested in 1986 and two ERATO stations will be included in the network set up at the end of 1987 by the USA in the Gulf Stream (SYNOP programme).

5.7 ICE STATIONS

Systems for the measurement of temperatures at the ocean-ice interface, and transmitting via ARGOS, are now being tested during ARCTEMIZ so that the measurements can subsequently be used in the ocean-ice-atmosphere interaction programmes.

5.8 MEASUREMENTS AT SEA OF WIND AND WAVE HEIGHT (TOSCANE)

The IFREMER TOSCANE project is aimed at having an operational network for measurements at sea of wind speed and direction and the non-directional spectrum of waves. The double network will be operational in 1989 for the launching of the ERS-1 satellite, the measurements of which it will serve to calibrate (scatterometer, altimetry). More generally, it could be used to calibrate wind data.

6. THE SPACE CONTRIBUTION OF FRANCE TO THE OBJECTIVES OF THE WCRP

The WCRP has three main objectives and a plan for the long-term observation of the oceans, all of which rely to a large extent on space

techniques and facilities. CNES, as the national space agency responsible for the development of space facilities, gives particular attention to the consistency of its efforts with the international research programmes and especially WCRP.

As regards ocean observing system, CNES joined with NASA in order to conduct an altimetric satellite project for determining the global ocean circulation, by measuring the topography of the ocean surface to an accuracy of 2-5 cm. Arrangements have been made to launch this satellite, known as TOPEX-POSEIDON in May 1991, which fits in with the timetable for the WOCE experiment. A decision to undertake this programme is imminent. France is also a participant in the European Space Agency ERS-1 oceanic remote sensing satellite mission, to which it contributes, particularly by supplying an ATSR/M hyperfrequency passive radiometer, in addition to the national participation in the ERS-1 programme. CNES also intends to contribute to the implementation of satellite calibration and laser tracking stations comprising recording tide gauges, which are connected to the geodesic network by the DORIS radio positioning system in co-operation with IGN.

In view of the need to determine accurately and independently the geoid, in order to represent fully the oceanic circulation from altimetric data, a study is being made of the gradiometric satellite project (GRADIO). The performance of these satellites is comparable to those involved in the American GRM project, the implementation of which could come under the ASE programmes. CNES benefits from the development of the following new instruments which can be put into orbit and which concern the WCRP, POSEIDON altimeter, ATSR/M microwave radiometer and possibly the AMSU-B sounder in collaboration with the U.K. To these should be added the multispectral (visible and near-infrared) image-producing radiometer having a wide field of view and resolution on the order of one kilometer. This type of radiometer is intended for observing, on a global scale, the vegetation over the continents and the colour of the ocean, and designed to be carried on SPOT-3 and SPOT-4 (1990 and 1994 respectively) satellites. This instrument, of the CZCS class of Nimbus-7, will provide important data on the distribution of phytoplankton and its variations, thus contributing to a better understanding of the carbon cycle and changes in the biosphere. In addition to these very short-term projects (decided upon or about to be decided upon), mention should be made of studies in progress, under Franco-Soviet co-operation, on a radiometer which could be carried on a METEOR satellite for monitoring the radiation balance, beyond ERBE, and on a cloud lidar altimeter.

In the longer term, France is involved in thinking about the future of the polar-orbiting meteorological satellite system in relation to the advent of space stations and, in particular, of several polar stations, one of which might be provided by Europe. Even now, plans are taking into account the need to maintain and extend a meteo-oceanic data acquisition system, which is basic to a research programme on climate and supplemented by a scientific experimenting capability, appropriate to global monitoring of the environment.

7. WCRP DATA PROGRAMMES

France is already participating in the ISCCP and is offering to act as a collection centre for TOGA sub-surface data and to contribute to the oceanographic data collection system, in particular data from satellites.

7.1 IGOSS PROGRAMME

Under IGOSS, the French National Centre is undertaking the archiving, with quality control, of BATHY, TESAC and DRIBU data, transmitted over the GTS. A French offer to undertake the role of a Specialized Centre is at present being studied.

7.2 ISCCP

The Space Meteorology Centre of the National Meteorological Service is the Satellite Calibration Centre (SCC) for the ISCCP (1983-1988). France is committed to continue this task for the duration of the WCRP until 1995.

7.3 TOGA SUB-SURFACE DATA CENTRE

France has agreed to be responsible for the TOGA Sub-surface Data Centre. This will be undertaken at Brest by IFREMER and ORSTOM. The terms of reference of this centre, as proposed in the TOGA International Implementation Plan, were revised at a meeting with the International TOGA Project Office in March 1986. This centre will collect and validate XBT, CTD and surface salinity data for the entire tropical region, archive them and transmit them to the World Data Centres. This centre will suggest and possibly disseminate, on its own initiative, products which, for example, would enable the evolution of the thermal content to be monitored.

7.4 WOCE REGIONAL DATA CENTRE

France is planning to set up, for her participation in WOCE, a data management and processing system, which would have regional responsibility.

7.5 CERSAT

France is working on the implementation of an ERS-1 data archiving, processing and dissemination centre under the auspices of ASE.

7.6 AVISO

The aim of the AVISO project is to make available to scientific users, in 1990, processed oceanographic data from satellites (e.g. the dynamic topography of the oceans by altimetry) and to provide a certain number of scientific products, introducing data from various sources.

7.7 DATA BASE FOR CONTINENTAL AREAS

Under ISLSCP it is proposed to set up a multi-temporal and multi-satellite data base in test areas in France and Tunisia. For its part, the HAPEX/MOBILHY experiment on hydrological processes at the continent-atmosphere interface will produce a data base consisting of in situ measurements (surface and upper air) and also remote sensing data.

8. GLOBAL ENVIRONMENTAL MONITORING

In the field of environmental monitoring, France has an active research programme on the evolution of CO2 in the atmosphere. This programme tackles in a co-ordinated fashion the present and past evolution of CO2 in the atmosphere, through studies of the three sources of carbon: the atmosphere, the oceans and the continental biosphere.

8.1 PRESENT AND RECENT ATMOSPHERE

The station on Amsterdam Island, which forms an integral part of the WMO BAPMoN network, will continue to make continuous recordings of CO2 in the atmosphere, so as to be able to connect the observed variations with major climatic phenomena (e.g., El Nino). Isotopic measurements of Carbon 13 will lead to a better understanding of the origin of variations in CO2. A second station making continuous recordings could be envisaged for Reunion Island.

8.2 PALEO-VARIATIONS

The study of cores of polar ice and the variations of the CO2 content of occluded bubbles of air will be continued in order to obtain a profile extending over the past 150,000 years. A comparison of this profile with the Carbon 13 profiles of marine sediments should lead to a better understanding of the role of the ocean with respect to the CO2-climate system. The APSARA campaigns being conducted on board a ship fo the TAAF will enable necessary samples at high and low latitudes to be obtained.

8.3 THE PRESENT OCEAN

The experiments carried out on board the ship of the TAAF will enable the exchange of flux through the ocean-atmosphere interface to be determined, by measuring the gradient of the CO2 partial pressure. At the same time, by tracking artificial tracers, the penetration of CO2 into the ocean depths will be determined.

Developments using pictures obtained by remote sensing above the ocean, in particular by means of the SPOT-3 satellite, will provide detailed information on the role of primary production in regulating CO2.

9. CONTINENTAL BIOSPHERE

Two studies are being conducted at the present time. First, the study of the role of vegetation and organic matter of soils in the seasonal and annual variations in the fluxes of CO2. This study combines surface measurements and monthly monitoring of the vegetation using pictures obtained by NOAA satellites. Second, the impact of a variation in CO2 content on the functioning of forest ecosystems is also being studied.

8.

CURRENT AND POTENTIAL CANADIAN CONTRIBUTION TO THE WORLD CLIMATE RESEARCH PROGRAMME

1. INTRODUCTION

The following is an outline of current and potential contributions from Canada to the World Climate Research Programme.

2. DATA AUGMENTATION

2.1 WORLD WEATHER WATCH SYSTEMS

(i) Marine Meteorological observations

- Improvement of precipitation measurement by rain gauges on ships
- Evaluation of automated shipboard packages to transmit meteorological and oceanographic (BT) data by satellite (SEAS project)
- Development of system to measure rain using ambient noise
- Development of automatic system to collect radiosonde data from VOS and to transmit data by satellite (ASAP project)
- Recruitment of additional VOS in the North Pacific
- Provision of CMM rapporteur, to upgrade quality of observations
- Possible technology development for shipboard measurement
- Possible contribution of automatic stations

(ii) Marine buoy observations

- Operation of 3 buoys in the North Pacific
- Capability to supply additional buoys for Arctic Buoy Programme

- Development of a self-propelled surface buoy, which is powered by wind
- Development of a low cost anemometer for use on drifting buoys
- Development of a self-propelled buoy, to carry sensors for sea and air temperature, barometric pressure, etc., and to be powered by solar cells
- Operation of an RNODC for drifting buoys on a global basis, utilizing reports from the IGOSS network and data tapes from Service Argos
- Evaluation of Weather Observations Through Ambient Noise (WOTAN) for wind and rain.

2.2 OCEANIC OBSERVING SYSTEMS

(i) Sea level observing system

- Provision of data from Canadian tide gauge network
- Upgrading of selected ice-covered tide stations along the Labrador Coast to provide low frequency data
- Feasibility study of using sea level anomalies to determine if the gauging system is adequate for the Global Sea-Level Observing System

(ii) Mobile ship observations

- Development of dropsondes for use from VOS
- Monitoring of upper layer along a line west of Vancouver Island's "Line Papa"
- Provision of XBT data in the northwest Atlantic and northeast Pacific to the IGOSS system
- Through MEDS, production of charts of SST and upper layer temperature for northwest Atlantic and northeast Pacific

(iii) Precision hydrography and chemical tracer surveys

- Participation in Pacific and Atlantic sections to describe precision hydrography and for chemical tracer studies
- Participation in trans-Pacific section to describe precision hydrography and for chemical tracer studies
- Participation in Arctic Ocean ventilation studies using geochemical tracers

(iv) Surface and deep ocean circulation drifters

- Drifters deployed for coastal studies in northwest Atlantic, cross the Atlantic and data are available for ocean circulation studies
- Surface drifters deployed in northwest Atlantic and the northeast Pacific
- Development of ice beacons for the Labrador Coast and Arctic Ocean
- Support for developmental work on various types of buoys or floats
- Measurement of northeast Pacific circulation using satellite-tracked drifting buoys

(v) Current meter moorings

- Maintenance of array of current meters and bottom pressure gauges to monitor Labrador Current system
- Additional buoys could be maintained in the northwest Atlantic and the northeast Pacific

2.3 EXPERIMENTAL SATELLITE SYSTEMS

(i) Wind stress scatterometer missions

- Provision of expertise for retrieval of surface wind or wind stress values

(ii) Imaging microwave radiometer missions

- Work proceeding on establishment of ground truth for RADARSAT or other microwave emission for measurement of ice type and thickness

(iii) Other satellite instrument development

- Potential SAR and RADARSAT application
- Work proceeding on improvement of scale control to remove distortion from satellite images

3. GLOBAL PROCESSES - WCRP DATA PROJECTS

3.1 INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT (ISCCP)

- Serve as Sector Processing Centre (SPC) for GOES-East (archiving began in July 1984, but satellite failed; replacement launch in May 1986 failed)
- Possible participation as SPC beyond 1988
- Development of algorithms for Arctic cloud climatology
- Possible research on interpreting satellite imagery over polar regions to distinguish between low clouds and ice
- Possible research to develop, validate and interpret cloud algorithms and to apply these to statistical studies of spatial/temporal cloud relationships

3.2 RADIATION BUDGET CLIMATOLOGY PROJECT

- Active development and testing of new codes and verification of current codes
- Participation in intercomparisons

3.3 ATMOSPHERE-OCEAN FLUXES DATA PROJECT

- Possible contribution by provision of sea ice data
- Participation in project HEXOS, an experiment to determine bulk formulas for humidity flux
- Correction of formula for shortwave radiation over ocean areas due to regional cloud types
- Research on response of upper ocean layer to both heat and salt fluxes at Ocean Weather Station Papa

3.4 GLOBAL PRECIPITATION CLIMATOLOGY PROJECT

- Investigations on precipitation gauge designs and on representativeness of shipboard precipitation measurements
- Increased reporting of precipitation in SYNOP reports and for collection and exchange of precipitation totals from rain gauges at climatological stations and other operating rain gauges

3.5 CONTINENTAL WATER RUN-OFF DATA PROJECT

- Provision of hydrometric data and annual updates for Canadian stations to WMO
- Conduct studies of interannual and decadal changes in hydrology regimes

3.6 GLOBAL LAND SURFACE DATA PROJECT

- Develop instrument that measures spectral light information and which can be used to measure vegetative characteristics
- Potential research support from universities

3.7 CRYOSPHERIC PROJECTS

- Observation and modelling of glacier movements in Western Canada
- Thermodynamical study of the Labrador-Baffin Bay ice sheets
- Participation in MIZEX by providing measurements of surface wind stress and heat flux
- Development of statistical description of kinematics of pack ice in the Beaufort Sea
- Improvement of parameterisations of processes of ice growth models
- Observations of tracers and hydrography from ice island in the Arctic Ocean.

4. GLOBAL ENVIRONMENT MONITORING

4.1 ATMOSPHERIC CARBON DIOXIDE

- Monitor weekly/twice-weekly at Sable Island, Alert and Cape St. James; supplementary monitoring at Mould Bay in co-operation with USA and from ships of opportunity in North Pacific
- Monitor air and oceanic CO2 between North America and Australia and Japan
- Conduct research on carbon cycle in upper layer and flux of CO2 to deeper water and sediments

5. REGIONAL PROCESS STUDIES

5.1 LAND SURFACE PROCESS STUDIES (HAPEX)

- Conduct one year field study at a high-latitude/forested,

snow-covered site, preceded by two years of planning and preparation, and followed by two years of analysis and modelling
- Conduct study of land surface climatology of eastern Canada during past 50 years

5.2 OCEAN PROCESS STUDIES

- Develop eddy-resolving, quasi-geostrophic circulation model of the northeast Pacific Ocean with topography included
- Conduct various projects aimed at parameterising diapycnal mixing processes (e.g., double diffusion, internal waves)
- Interpret coastal and island tide gauge data of the Atlantic in terms of interannual variability of ocean circulation
- Interpret trends of annual sea level data in terms of eustatic changes, due to ocean circulation, coastal processes and land movement
- Conduct study of formation of deep water in the Labrador Sea and Greenland Sea
- Conduct research on the variability of the Gulf Stream and exchange between the Gulf Stream and Slope Water

6. ANALYSIS AND MODELLING

6.1 CLIMATE DIAGNOSTIC STUDIES

- Develop climate monitoring system and climate prediction (extended monthly/seasonal forecasts) techniques
- Develop new experimental models and extended forecasting techniques, perform analysis of various models, perform analysis of model response to ocean temperature anomalies, develop 5-year global climatologies
- Make diagnostic calculations of different wave types, using the Canadian Climate Centre GCM
- Implement and test variations of analogue forecasts applied to monthly/seasonal time scales
- Devise experimental models for extended forecasting by numerical techniques

6.2 ATMOSPHERIC CLIMATE MODELLING

- Conduct long-term climate simulations (30 years) and improve computational techniques
- Conduct climate sensitivity experiments (El Nino, sea ice, gases), develop parameterisations, perform intercomparisons of climate models
- Develop analytical and numerical models of atmospheric blocking
- Develop model of mid-latitude atmospheric circulation anomalies forced by anomalous oceanic heat fluxes in the North Pacific

6.3 COUPLED OCEAN-ATMOSPHERE MODELS

- Devise and code simple mixed layer ocean models and thermodynamic ice models
- Design and run preliminary experiments with interactive ocean-atmosphere models (fixed ice), developing interactive ice-ocean-atmosphere models
- Conduct studies of correlation between large-scale wind stress and tide gauge data, and seasonal and annual large-scale variability
- Develop an air-sea CO2 flux model (Pacific) from VOS data

6.4 OCEAN CIRCULATION MODELLING

- Potential area for major support through IOS and the McGill programme
- Construct ocean models for the Labrador Sea, the Arctic Ocean and North Pacific
- Develop ocean CO2 model for the Pacific, incorporating biogeochemical cycling of carbon and CO2 circulation
- Conduct deep water formation studies and modelling (intermittency of deep convection at Ocean Weather Ship B in the Labrador Sea; analysis of seasonal variation in the flow through the Straits of Gibraltar)
- Develop an upper layer (mixed layer plus thermocline) ocean circulation model which includes heat storage, horizontal advection and isopycnal mixing

9.

GERMAN DEMOCRATIC REPUBLIC

Further to the report on contributions of the German Democratic Republic to the WCRP at the Informal Planning Meeting held in Geneva from 12 to 16 May 1986 (see Annex 22), the following Progress report summarizes major oceanographic activities:

Meetings

The Third Co-ordinating Session with Scientific Seminar of the Multinational Programme "Energetically Active Zones of the Ocean (EAZO) and Climate Variability" ("SECTIONS") was held in Rostock-Warnemunde (GDR) from 21 to 25 October 1986 at which IOC was invited to send a representative.

The meeting was attended by 26 scientists of Bulgaria, Cuba, German Democratic Republic, Poland and USSR, 16 scientific presentations were made. A mission report (No. 86/1986) of the IOC provides further information.

Overview on additional national activities related to "Sections" as well as to TOGA and WCRP oceanography

Equatorial dynamics

It has been revealed by a passive tracer technique in the tropical Atlantic that the vertical penetration of small scale turbulence is usually smaller than the mixed layer depth. In this case the actual penetration depth is determined by the energy input through the sea surface due to the wind and the dissipation of kinetic energy within the water column. A quantitative relation has been found between the local wind velocity and the penetration depth of the small scale turbulence in the mixed layer. There is evidence that this relation seems to be independent from the geographical latitude.

Gross features of persistent fronts stretching zonally over large distances, commonly observed in the interior of the oceans, have been modelled by a linear stratified ocean model. According to the modelling results the fronts are generated by east-west oriented wind edges. The ocean responds both with a fast growing highly sheared jet trapped at the wind edge which likely becomes instable and a slowly growing front which likely remains stable and is not dispersed by Rossby wave radiation. The regime of the stable front is characterized by high pressure in the east wind area, low pressure outside the wind area a steplike transition zone of two Rossby radii width. A geostrophically adjusted jet accelerates until it is arrested by the front of long Rossby waves emanating from the eastern boundary.

A theory for the frequency spectra of equatorially trapped waves has been developed. The theory is based on the linear hydrostatic Boussinnsq-equations for a continuously stratified unbounded ocean on the equatorial B-plane. The dissipation is accounted for in terms of Rayleigh friction and Newtonian cooling with the same relaxation parameter. The stratification is described by a constant Brunt-Vaisala frequency (BVF) in the upper layer and an exponentially decreasing BVF below. The model is forced by winds which are considered to act as forces evenly distributed over the upper layer. The wind is sinusoidal in zonal direction and Gaussian distributed perpendicular to the equator. The solution theory is based on a Green's function technique. Good ressemblance is found between the theoretical spectra and spectra of equatorial currents in the eastern Pacific.

Coastal upwelling dynamics

Microscale incisions in the shelf profile intensify locally the upwelling process. This has been studied in the submarine canyon of Nouakchott, Mauritania. The disturbance of the internal pressure gradient causes an increasing transport of South Atlantic Central Water from the undercurrent into the surface layer, reflected by lower water

temperatures and higher phosphate, nitrate, and silicate concentrations near the head of the canyon. The phytoplankton response to this nutrient input was displaced in time and space.

Application of remote sensing

Investigations on the spectral reflectance of sea water and on its relations to dissolved and suspended matter in sea water were carried out in different areas of the Baltic Sea, the eastern central Atlantic Ocean and in the upwelling area off NW-Africa. On the base of these measurements an algorithm for the determination of chlorophyll-a and phaeopigments on the base of colour indices was derived for the upwelling area off Mauritania. A similar algorithm was determined for the Baltic Sea for the period of the spring algae bloom.

Investigations on mesoscale dynamic features in the Baltic were started within the frame of subsatellite experiments in form of case studies. The application of satellite data in the thermal infrared provided additional informations on characteristic spatial and temporal scales.

Oceanographic long-term variations in the Baltic Sea

During the last years further investigations of the long-term variations of oceanological parameters of the Baltic Sea were carried out. Special attention was paid to the current stagnation period of the Gotland Basin deep water.

The period since the last major inflow of salt water into the Baltic Sea towards the end of 1976 is one of the longest stagnation periods in the deep water of the Eastern Gotland Basin of the deep water have decreased considerably. During the current stagnation period the highest hydrogen sulphide concentrations ever observed in the Gotland Basin were measured at the 240 m level. The great decrease in salinity at all depths led to the halocline sinking by 8,5 m and of the isohalines by 14 to 42 m (1977 - 1984). The stagnation period must already be considered at present to be the most important and serious one ever observed in the Gotland Basin.

The GDR carried out four experiments concerning the water exchange between the North Sea and the Baltic Sea. The aim of these complex research programmes was to obtain a more comprehensive understanding of the exchange mechanism by studying in detail the different situations at various times of the year.

The experiments yielded the following general results:

- Subinertial current fluctuations have been observed in the Darss Still Area (Belt Sea) with time scales of 10 - 20 days, amplitudes of 40 cm/s and being coherent over distances of at least 150 km.

- These fluctuations could be observed simultaneously with baroclinic current fluctuations having time scales of 2 - 3 days, amplitudes of 60 cm/s and spatial scales of less than 60 km.

- The low frequency current fluctuations at time scales of 10 - 20 days change between outflow and inflow regularly near the surface and are directed into the Baltic most of the time close to the bottom.

- Evidence for a cross circulation has been found turning clockwise when looking in downstream direction near the surface and being in agreement with the observed upwelling and downwelling patterns near the coasts.

- Transport fluctuation of 1.5 x 10 m /s associated with the current fluctuations of 10 - 20 days determine the mass balance of the Baltic essentially at these time scales.

- The currents at the 10 days time scale in the Darss Sill Area are geostrophically adjusted and are driven by the longitudinal pressure gradient associated with the sea level and density differences between Kattegat and Baltic Sea.

Concerning major inflow of saline water into the Baltic Sea a statistical analysis of the period from 1897 to 1987 was carried out (cf. Figure 1). During the whole period, a total of 90 major inflows took place only between August and April. Their distribution in time shows that a few occur as individual events and a large number belong to inflow groups. Such groups are separated by one to four years without inflows. Various parameters of the major inflows such as the intensity index, frequency, stratification coefficient, mean temperature, and duration of the inflows show characteristic seasonal variations, extreme values being observed mainly between November and January.

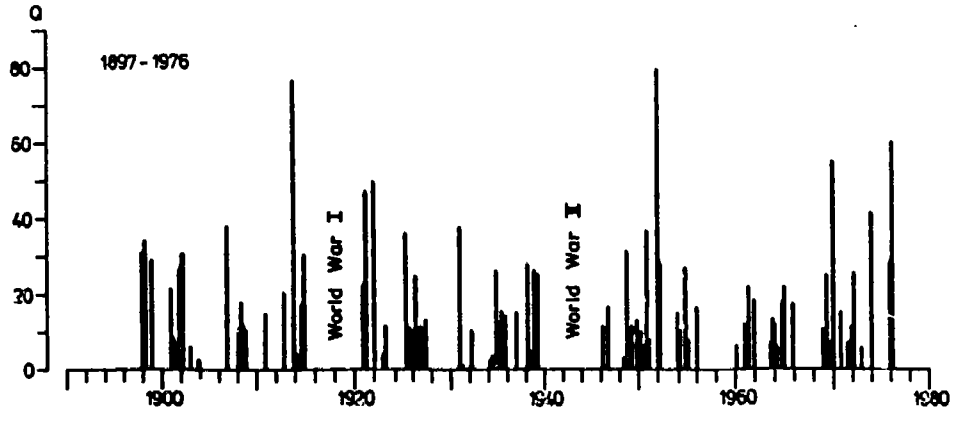


Figure 1 - Major inflows of saline water into the Baltic Sea between 1897 and 1976, characterized by the intensity index Q. (According to FRANCK, H., MATTHAUS, W., SAMMLER, R.: Major Baltic Inflows during this century. - Beitr. Meereskunde No. 56 (1987) (in print).

CONTRIBUTION OF THE GERMAN DEMOCRATIC REPUBLIC TO THE WORLD CLIMATE RESEARCH PROGRAMME

(WCRP Publications Series No. 8,
Annex 22)

1. MARINE RESEARCH ACTIVITIES

During the past three decades, co-operative investigations in the tropical Atlantic have emphasized the conclusions that a considerable interannual variability regularly occurs in this vast marine area and might be predictable, associated with the profound effects on the meridional heat and water transport in the Atlantic as well as on circum-Atlantic land and ocean activities. Since 1981, therefore, the German Democratic Republic has co-ordinated its relevant research activities with the SECTIONS programme of the USSR and other socialist countries and, in 1985, agreed to contribute also to the WCRP Tropical Ocean and Global Atmosphere 'TOGA) Programme.

National marine research activities focus on:

- theoretical and numerical studies on the equatorial and eastern boundary current system in the tropical Atlantic,
- related field observations by the oceanographic research vessel, A.V. HUMBOLDT, including unattended current meter moorings and ships-of-opportunity (VOS) equipped with INMARSAT data communication,
- participation in relevant oceanographic data collection and exchange such as IGOSS and IODE, and
- supporting planned remote sensing studies related to the understanding of relevant ocean processes.

These activities are co-ordinated by the Institute of Marine Research in Rostock-Warnemunde (Director, Prof. Dr. sc. K. Voigt) of the Academy of Sciences of the GDR. Dr. sc. Eberhard Hagen of the same institute was designated as the national oceanographic contact for TOGA.

2. DIAGNOSTIC STUDIES

In accordance with the Scientific Plan of the WCRP, the purposes of diagnostic studies of the climate systems are:

- to gain new knowledge of the natural variability of climate at various time scales,
- to detect the existence of systematic climate trends,
- to discover, on the basis of empirical evidence, the relationships between observed patterns of variation and possible causal factors,

- to quantify the dynamic and thermodynamic processes in the climate system and to test specific dynamic hypotheses (when available, products of quantitative diagnostic studies are an invaluable source of verification data for the development of climate models), and
- to provide the basis for regional and local applications of large-scale climate forecasts, i.e. interpretation of climate forecasts for the sub-grid scale of climate models or climate forecasts.

The climatic record is an incomplete data basis for such studies since long-term series of measurements are available only for a few parameters and a few locations. Nevertheless, reasonable qualitative inferences have been made on the basis of nearly incomplete climatological observations. Research in diagnostic studies in the GDR are concerned with:

- diagnostics of interannual global and regional climate changes with regard to their relations between troposphere and middle atmosphere,
- diagnostics of selected processes with statistical-dynamical models,
- analysis of the interrelationship between ENSO and climate in extratropical regions of the northern hemisphere, and
- analysis of long-term series of several parameters, e.g. ozone.

These activities are co-ordinated by the Meteorological Service of the GDR in Potsdam. Dr. I. Spahn has been designated as the national contact to TOGA for meteorology and climatology.

The GDR is supporting attempts to more intensively investigate and consider the interrelationship between hydrological land surface processes and climate and accordingly, the proposals made at this Informal Planning Meeting, to more strongly reflect this in the WCRP. Long-term research activities in the GDR in the field of investigation and modelling of hydrological processes in river basins are now increasingly oriented towards more direct fulfilment of the demands of climate research, in particular physically based macroscale modelling of hydrological land surface processes with special concern given to a real evapotranspiration. The responsible institution in the GDR which co-operates in this research is the Institute for Water Management, Berlin.

10.

PEOPLE'S REPUBLIC OF CHINA

China sent out two research vessels in 1986, named Xiangyanghong No. 15 and 5, to carry out TOGA and WOCE activities in the equator area of the Pacific Ocean. Two missions have since been conducted. China plans to participate in joint investigations with the United States of America over a period of 4 years. In the last January, the Vessel Xiangyanghong No. 5 took part in the EMEX activities in Australia for a month.

A programme of a fixed buoy network in the sea areas around China has been in operation since 1976 and some progress has been achieved.

A joint Kuroshio research programme in co-operation with Japan is scheduled for the period 1986-1993 with two cruises every year in East China Sea and the sea area in southern Japan. Two cruises were carried out in 1986.

15 standard sections are opened in the sea area around China which are used for cruise observations once in a month. And this programme has been in existence for the past 30 years.

11.

AUSTRALIA

STATUS OF RESEARCH CONDUCTED AT THE CSIRO DIVISION OF OCEANOGRAPHY, RELEVANT TO IOC PROGRAMMES
(March 1987)

Recognizing that the oceans of the Australian region are believed to be of major importance in the regulation of atmospheric climate, the Division is devoting a substantial part of its effort to WCRP related research. The following summarizes the present state of this work, and immediate plans for the future:

1. The Western Equatorial Pacific Ocean Circulation Study (WEPOCS) was conducted in two phases, July/August 1985 and January/February 1986, as a joint experiment between CSIRO, Scripps Institution, U.S.A. and the Universities of Hawaii and Miami. It involved an array of CTD, Doppler Profiler, Pegasus Profiler and Moored Instrument measurement in the Bismarck Sea North East of New Guinea, including sections to 5°N. Analysis of results is proceeding, and has already revealed several important new dynamical features.

2. In collaboration with U.S. NOAA a transoceanic section at 12.5° S in the Pacific Ocean is planned for June 1987, followed by a section of the southern edge of the Solomon Sea.

3. Over the last three years observing networks have been established using Volunteer Observing Vessels plying from Australian ports, with the object of understanding the physics of variability of tropical surface waters of the Pacific and Indian Oceans. Ten ships on six lines are now in operation, deploying about 3500 XBT's per year at roughly one degree latitude interval between 20°N and 20°S. Data are processed and given quality control at the CSIRO Marine Laboratories in Hobart and then archived in Hobart and at the TOGA Subsurface Data Centre at Brest.

4. The foregoing project is augmented by collaborative projects with universities, the Bureau of Meteorology and AIMS to investigate atmospheric forcing and surface fluxes.

5. Tide gauges have been installed at Papua New Guinea (7 stations), Christmas and Cocos Islands, Pelabuhan Ratu, S. Java, Indonesia and Norfolk Island. During WEPOCS (# 1 above) gauges were also placed across the Vitiaz Strait. The gauges are used to monitor long-period changes in circulation and heat content, and to identify the propagation of long period shelf-waves and their influence upon equatorial wave generation.

6. Theoretical work is continuing on simple models of depth integrated wind-driven world ocean circulation, which serve to understand the role of throughflow though major conduits such as the Indonesian region.

7. To understand the dynamics of the Indonesian/N.W. Australian Triangle Drogued, satellite tracked drifting buoys are being deployed in a continuing programme. Three buoys were deployed in 1986 and four more will be used this coming year. Future collaboration with FRG is planned. As an aid to other projects in the Coral Sea four similar buoys were deployed in 1986 and three more will be deployed in 1987.

8. A major series of cruises and mooring deployments (17 moorings and 28 instruments) is underway along the West Coast of Australia. This project, titled LUCIE, is an interdisciplinary study of the seasonal Leeuwin Current which flows Southward from the Northwest Shelf of Australia, and extends as far as Tasmania.

Future WCRP related activity may include:

- Repeated Southward sections from Tasmania, in collaboration with the Antarctic Division.
- Use of the NASA TOPEX/POSEIDON mission to investigate large scale dynamics of the Australia's region and the Southern Ocean.
- Ocean-dynamical projects associated with ERS-1.
- An investigation of turbulent mixing and surface flux in the Western Equatorial Pacific, using a towed microstructure (BUNYIP) vehicle and possibly involving collaboration with US, China, UK and FRG.

12.

UNITED STATES ACTIVITIES SUPPORTING THE WCRP

INTRODUCTION

Due to the diversity of these activities, they are presented here in outline form. Both atmospheric and oceanographic programs are mentioned, although emphasis is on the latter. The United States sponsors many climate-related activities, both atmospheric and oceanographic, that are not directly part of WCRP, and these are not included in this report.

STREAM I

- ISCCP (International Satellite Cloud Climatology Project) - NASA is host to international co-ordination office for collection of cloud cover data
- Modelling activities, in particular Dynamic Extended Range Forecasting models at NMC and GFDL
- Analysis of FGGE data

STREAM II

- Atmospheric Dynamics
  - Monsoon Climate Program (MCP)
  - Equatorial Mesoscale Experiment (EMEX)
- TOGA
  - International TOGA Project Office (ITPO)
    - Currently hosted by USA
    - Continued financial and staff support in new location
  - US National TOGA Project Office
    - Operated by NOAA
    - Supported by NOAA, NSF and NASA
  - Oceanography Program
    - Monitoring
      - Sea-Level Observing System
        - Pacific (in place, expanding)
        - Indian Ocean (in place, expanding)
        - Indonesian Archipelago (started)
      - SST-Satellite observations (GOES)
      - Subsurface Thermal - VOS-XBT lines
      - Instrumented Moorings
    - Data Centers
      - SST Data Center at NMC
      - Sea Level Center at University of Hawaii
      - Subsurface Thermal Structure Activity at Scripps - in co-operation with USNODC and International TOGA Data Center at Brest

Process Studies
TROPIC HEAT - Central Pacific warm pool, air-sea interaction, equatorial current systems
EPOCS - Eastern Pacific El Nino studies, equatorial currents
WEPOCS - Pilot Study of Western Equatorial Pacific Current Sources
Modelling Studies
Coupled Ocean/Atmosphere models at Columbia University, University of Maryland, Florida University, NOAA and NASA
Process-oriented model studies of air-sea interaction on scales of seasons to a few years

STREAM III

- WOCE
US/WOCE Planning Office at Texas A & M University
US/WOCE Scientific Steering Committee
Drafted Plan for US participation in WOCE - consistent with and in support of the international plan
Data Management Systems Development at NODC, University of Delaware
Satellites
TOPEX/POSEIDON - scheduled
NSCATT - deciding on vehicle
WOCE Hydrographic Program - contributing to international plan
Long-lead-time developments underway to prepare US Program for start of WOCE field program

For further information on the activities listed in this outline, please write to: Dr. J.M. Hall, NOAA, 6010 Executive Blvd., Rockville, MD 20852
or Dr. R.B. Lambert, NSF, 1800 G. St. NW, Washington, DC 20500.

13.

MULTINATIONAL PROGRAMME "ENERGETICALLY ACTIVE ZONES OF THE OCEAN (EAZO) AND CLIMATE VARIABILITY 'SECTIONS'"

(Bulgaria, Cuba, German Democratic Republic, Poland, USSR)

The programme "EAZO Sections" is the study of large-scale interaction between the atmosphere and the ocean. Its major objective is to investigate the role of the ocean in short-term climate changes (from a few months to a few years). In short, it aims at finding the answers to the following questions:

- How are the SST anomalies formed?

- How are the anomalous heat sources in the atmosphere formed in response to the ocean anomalies?

- What is the response of the atmosphere to the anomalous heat sources?

It is a multinational programme implemented since 1981 by Bulgaria, Cuba, German Democratic Republic, Poland and the USSR.

The programme includes modelling studies and field investigations in 5 EAZO's: near Newfoundland, Gulf Stream, Norwegian, Tropical Atlantic and Kuroshio regions (Part 1).

Oceanographic observations in EAZO's are carried out four times a year from the surface to 2000 m depth.

During the five-year period from 1981-1985, 28 research institutes and 40 research vessels of the USSR and GDR took part in the programme. 161 ship cruises were made, with a total duration of 13 ship-years. More than 35,000 stations and about 53,000 marine meteorological observations were made.

Preliminary scientific results of the programme were discussed at two scientific Conferences (in 1984 and 1986 in Odessa). International co-ordination is organized through the specially established co-ordinating mechanism and the co-ordinating meetings on the programme "EAZO - Sections". The first two meetings were held in Moscow (USSR) in 1982 and Varna (Bulgaria) in 1984. The third meeting was held in Rostock-Warnemunde (GDR) from 21 to 25 October 1986 at which IOC was represented by an observer.

The third meeting was attended by 26 scientists and specialists of Bulgaria, Cuba, GDR, Poland and USSR. 16 scientific presentations were made at the meeting dealing with the study of ocean thermodynamics in the EAZOs', development of ocean and atmospheric models.

For the period (Part 1) 1986-1990, the following changes in the field programmes have been proposed:

(i) expand the observational programme in the tropical Atlantic to cover the entire tropical belt;
(ii) initiate some regular cruises in the tropical Indian Ocean zone; and
(iii) extend the investigations in the Norwegian EAZO to the ice edge zone near Greenland.

These changes, in fact, came into force in 1986 and the programme will be continued until 2000. The programme considered to be most relevant, by its nature, to the TOGA Programme. The major difference between the "Sections" programme and TOGA is that the former includes investigations, not only in the tropical zone of the ocean, but also in the middle and high latitudes. Nevertheless, the programme "Sections" cannot be considered to be part of TOGA. In this regard, the question of co-ordination and co-operation between TOGA and "Sections" can be discussed.

Since 1982 special series of scientific publications on programme "Sections" has been prepared, which includes, in particular detailed description of the programme, proceedings of the two scientific seminars on the programme, held in Odessa in 1984 and 1986, descriptions of ocean-atmosphere characteristics in EAZOs, requirements for satellite remote sensed data, etc. During the 6-year period more than 300 scientific articles and monographs on the results of investigation on "EAZO - Sections" Programme have been published. Selected bibliography of some of those publications is shown in Part 2.

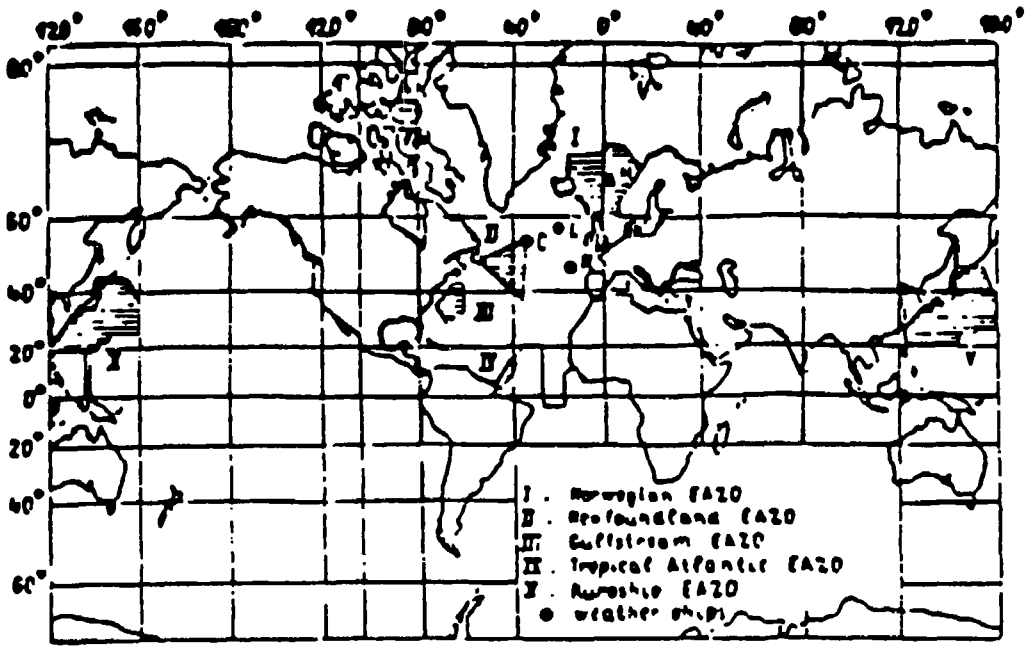


Fig. 1 Areas of field investigations under the Programme "EAZO - Sections"

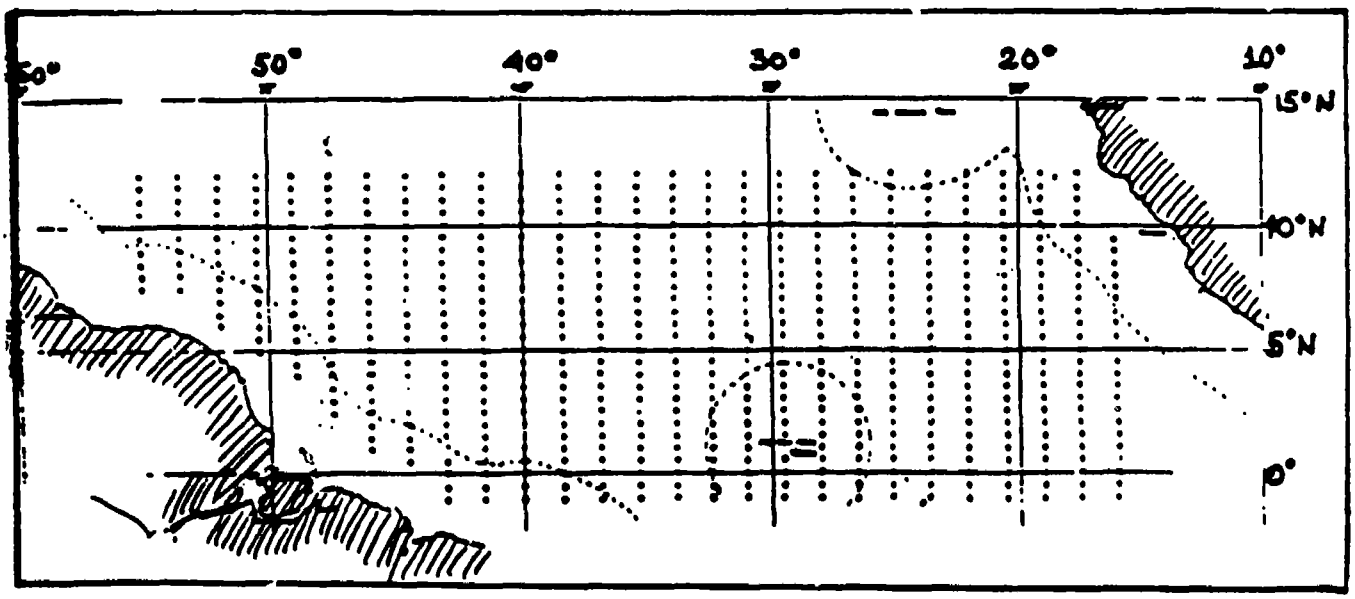


Fig. 2 Expanded area of field investigations in the Tropical Atlantic EAZO

Part 1

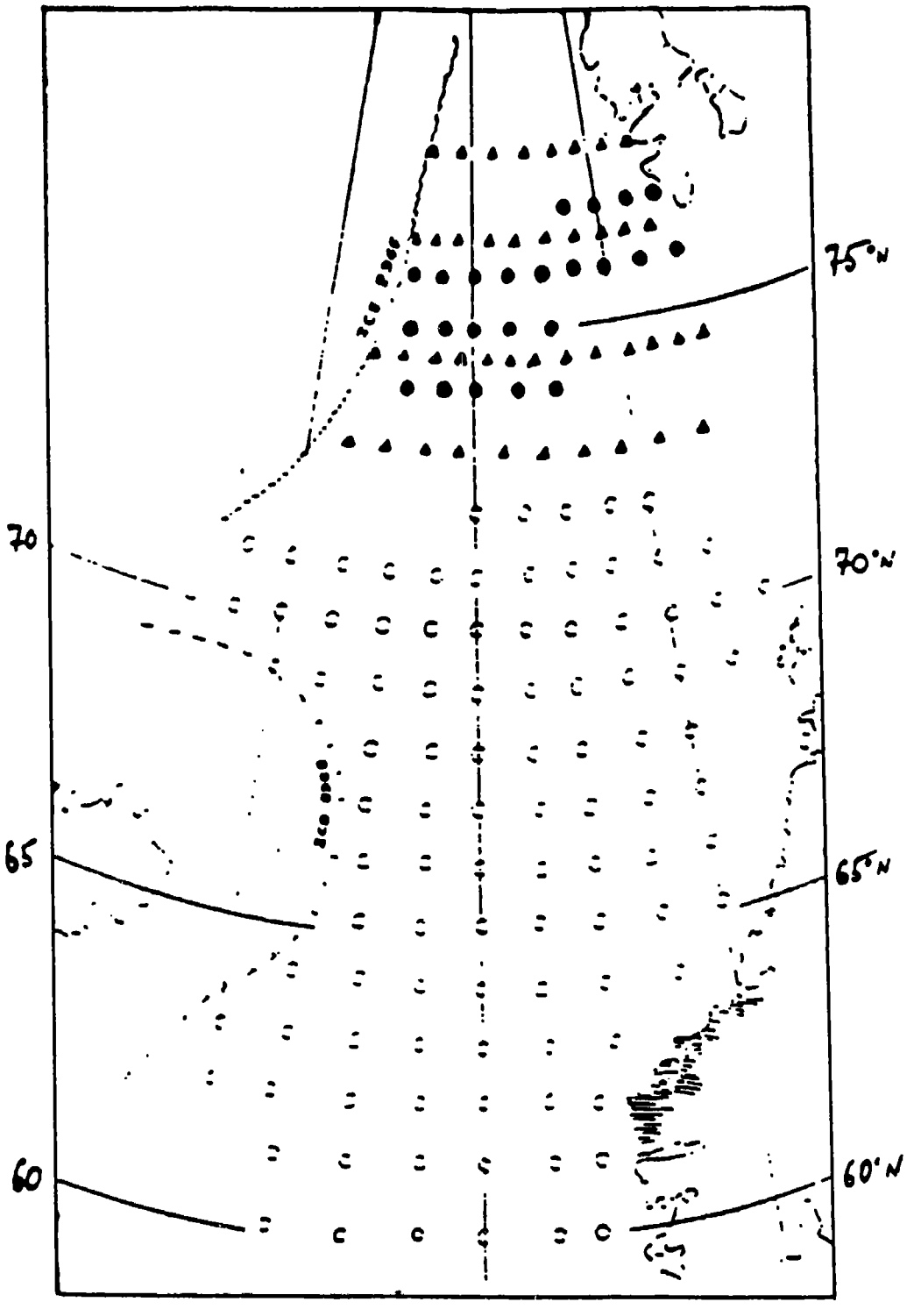


Fig. 3 Expanded area of field investigation in the Norwegian-Greenland EAZO

o stations in the Norwegian EAZO

▲ ▲ ▲ standard sections in the Greenland Sea

● additional stations in the Greenland Sea

Part 2

LIST OF SELECTED PUBLICATIONS ON THE PROGRAMME "EAZO - SECTIONS"

1. Programme "Sections"
Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 1. Moscow 1983.

2. V.P. Dimnikov, G.K. Korotaev, V.Ja. Galin "Satellite information requirements concerning resolution and accuracy for the "Sections" programme". Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 3. Moscow 1984.

3. K.Ja. Kondratjev, V.V. Kozoderov "Anomalies of radiation budget of the Earth and of the heat contents of the active layer of the ocean, as an evidence of energetically active zones". Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 4. Moscow 1984.

4. Hydrometeorological characteristics of the energetically active zones of the ocean: Norwegian, Newfoundland, Gulf Stream, Tropical Atlantic and Kuroshio. Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 5. Moscow 1985.

5. Role of the ocean in short-term climate variations - programme "Sections" part 1: (Diagnosis of the atmospheric climate; adaptation, assimilation and analysis of oceanographic data; modelling of atmosphere and upper mixed layer of the ocean). Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 6. Moscow 1986.

6. Role of the ocean in short-term climate variations - programme "Sections" part 2: (Studies of temporal variability of oceanographic characteristics in EAZOs; application of remote sensed measurements of atmospheric and oceanic parameters for the programme "Sections"; development of data bank for the programme "Sections"; implementation of field oceanographic investigations in the programme). Series VINITI "Itogi nauki i tehniki" "Atmosphere, ocean, space - "Sections" programme", Vol. 7. Moscow 1986.

7. L.A. Kluchnikova etc. "Heat budget in the atmospheric boundary layer on the basis of experimental data". Izvestia AN SSSR, 1984, Vol. 10 No. 6.

8. S.S. Lappo etc. "Energetically active zones of the World Ocean". Dokladi AN SSSR, 1984, Vol. 275 No. 4.

9. S.S. Lappo etc. "Parameterization of integral mean annual heat fluxes between the ocean and atmosphere". Izvestia AN SSSR, series FAO, 1985.

10. S.S. Lappo etc. "Energetically active zones and heat interaction between ocean and atmosphere". Series "Voprosi geographii" No. 125, Publication House "Misl", 1984.

11. "Field investigations in the Norwegian EAZO and adjacent regions of the North european basin". Trudi AANII No. 407, 1986.

EXTRACT FROM THE REPORT OF THE
FOURTEENTH SESSION OF THE IOC ASSEMBLY
(Paris, 17 March - 1 April 1987)

OCEAN DYNAMICS AND CLIMATE

The Delegate of the People's Republic of China informed the Assembly that his country was participating actively in TOGA, by organizing research cruises in the Pacific and joint expeditions with Japan in the Kuroshio area. China is willing to offer shipboard fellowships for scientists from developing countries and to host a CCCO Pacific Ocean Climate Studies Panel Meeting in 1988 or 1989. He emphasized that it will be necessary to strengthen the intergovernmental co-ordination of the oceanographic component of the WCRP.

The Delegate of France informed the Assembly of the planned joint French/USA satellite mission POSEIDON/TOPEX, the establishment of the TOGA Sub-surface Data Centre, in Brest, and France's readiness to take responsibility for a WOCE South Atlantic Centre, should one be recommended.

The Delegate of Mauritius stated that his country is prepared to take an active part in the TOGA Programme and in improving ocean observing systems in the Indian Ocean in support of WCRP. He expressed hope that the CCCO Indian Ocean Climate Studies Panel Meeting, which will be held in his country in April 1987, will make specific proposals on the development of an observational network in the Indian Ocean.

The Delegate of the USA informed the Assembly that his country gives very high priority to WCRP, and particularly to TOGA and WOCE, and urged IOC to give priority to, and focus on, operational support (GLOSS, IGOSS, IODE) and to assist developing countries to participate effectively in the oceanographic activities of the WCRP.

The Delegate of Indonesia noted the importance within the TOGA and WOCE programmes of the study of water mass-exchange between the Pacific and Indian oceans through the Indonesian seas. He stated that his country wishes to participate in the WCRP and recalled that USA and Australia were assisting Indonesia in the installation of sea-level stations.

The Delegate of the USSR informed the Assembly of the implementation of the multinational programme "Energetically Active Zones of the Ocean-SECTIONS" being implemented since 1981 by joint efforts of Bulgaria, Cuba, German Democratic Republic, Poland and the USSR. An international co-ordinating meeting was held in the German Democratic Republic in October 1986 with the participation of a Representative of IOC.

The Delegate of the Federal Republic of Germany informed the Assembly of the activities of his country in support of TOGA and WOCE. He noted that the Federal Republic would collect meteorological data from the South Atlantic and provide it to the TOGA Marine Climate Centre in the UK. His country is making a substantial effort in ocean-climate modelling. It strongly supports GLOSS and is studying water exchanges between the Indian and Pacific oceans.

The Delegate of Japan informed the Assembly that the national programme for WCRP had been adopted in 1986 for the period 1987-1990. Japan is studying cloud distributions, interannual variations in Antarctic sea ice, mixed-layer dynamics (Ocean Mixed Layer Experiment (OMLET)). A new ocean satellite MOS-I was launched in February 1987.

The Delegate of the UK recalled that his country supports the WOCE International Planning Office, located in the Institute of Oceanographic Sciences (IOS), Wormley. The Director of the Office, Dr. G. Needler, was seconded by Canada, and the Federal Republic of Germany has recently seconded Dr. P. Koltermann to the Office. He invited IOC to consider seconding a specialist to the office.

The Delegate of Canada reported on national climate programme activities, particularly on the development of coupled ocean-atmosphere models and regional studies aimed at understanding linkage between global and regional processes.