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REPORT OF THE CCCO/IGOSS/IODE

AD HOC MEETING ON

WCRP OCEAN DATA MANAGEMENT

(8-12 October 1984, Paris)

SC-85/WS/4

Table of Contents

		Page
1.	INTRODUCTION	1
2.	WCRP OCEAN DATA MANAGEMENT PRINCIPLES	1
3.	GENERALIZED DATA MANAGEMENT SCHEME	3
4.	REVIEW OF WCRP OCEAN DATA REQUIREMENTS AND DATA MANAGEMENT PLANNING	8
	4.1 Study of the Interannual Variability of the Tropical Oceans and Global Atmosphere (TOGA)	8
	4.2 World Ocean Circulation Experiment (WOCE)	14
	4.3 Ocean Observing System Development Programme (OOSDP)	17
	4.4 Oceanographic Data of Interest to the WCRP Obtained from Satellites	21
5.	WORLD CLIMATE DATA PROGRAMME	26
6.	REVIEW OF EXISTING SERVICES SYSTEMS	26
	6.1 Integrated Global Ocean Services System (IGOSS)	26
	6.2 International Oceanographic Data Exchange (IODE) System	34
	6.3 Ocean Surface Data and the World Weather Watch (WWW) of WMO	34
	6.4 Other Selected Services	35
7.	ASSESSMENT OF EXISTING SERVICES SYSTEMS	35
	7.1 Sub-surface Temperature and Salinity Data	37
	7.2 Sub-surface Circulation	38
	7.3 Surface Ocean Circulation	38
	7.4 Tracers	39
	7.5 Completeness of the Data	39
	7.6 IGOSS Data for TOGA	39
	7.7 A WOCE View of Existing Systems	40
8.	XBT DATA FLOW ILLUSTRATION	40
ANNEXES	1. List of Participants	42
	2. Agenda	43
	3. OOSDP Action Items	44
	4. World Climate Data Programme	50
	5. List of Acronyms and Special Terms	55

1. INTRODUCTION

The Ad hoc Meeting on WCRP Ocean Data Management was organized jointly by CCCO*, IGOSS* and IODE* to address the issues raised by CCCO at its Fifth session, December 1983. The specific task of the meeting was to:

1) Consider A) space based and in-situ observations already identified for the TOGA and WOCE experiments as representing activities under Streams 2 and 3 of the WCRP, and B) the requirements for analyses of these data particularly with respect to time scale for turn-around of the data and the extent of quality control.

2) Consider the extent to which existing Data Management, Exchange and processing systems, including IGOSS, IODE and satellite data processing procedures, meet the expectations of the oceanographic requirements of the WCRP.

3) Recommend activities in which the existing oceanographic systems can be focused and developed to the benefit of the WCRP.

4) Identify aspects of data management in which entirely new international initiatives need to be established.

5) Advise CCCO on how best to communicate its needs to IGOSS and IODE.

6) Report back to CCCO for action.

The participants interpreted this assignment to mean they were to critically evaluate the existing data management services systems (IGOSS, IODE, etc.), begin the process of designing and establishing the framework for the WCRP ocean data management activities, and to address, as appropriate, both ocean and ocean-atmosphere interface data. The meeting was aware of the initiatives and data management and data acquisition philosophy being pursued by the Joint Planning Staff for the WCRP. The participants recognized, and wished to impress upon CCCO, that this meeting and their recommendations were only an initial step in a very long and complicated process. The meeting recommended that CCCO provide the means for immediate follow-on activities and ensure continual oversight through a standing group, preferably jointly with the IGOSS and IODE Working Committees.

The participants in the meeting are listed in annex 1 and the Agenda is given in annex 2. Dr. K. Voigt chaired the meeting. Please note that the report is not organized along the lines of the Agenda. While discussing all items, the participants decided its report should address the issues and present its findings in a problem oriented rather than chronological (Meeting minutes) order.

2. WCRP OCEAN DATA MANAGEMENT PRINCIPLES

Principles for scientific data management

The meeting reviewed the concerns of CCCO related to data management as presented in the Summary Report of CCCO-V, Abingdon, December 1983. These were adopted by the meeting as criteria by which existing and new data

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* See Annex 5 for List of Acronyms and Special Terms

management systems could be evaluated. To summarize, the CCCO data management concerns are:

1. Timeliness. Data management systems should provide data to users in a time appropriate to the type of data and the use to be made of them.

2. Formats and exchange. There should be agreement on common formats for data archiving and on mechanisms for efficient data dissemination and exchange.

3. Quality control. Users must be able to appraise the appropriate confidence to give to the data.

4. Products. Close collaboration is needed amongst groups collecting data, data centres, and users to determine suitable products derived from analysis of the data.

5. Completeness. A potential data user must be able quickly to ascertain the address from which to seek data, and when the request is made, the user must be able to get all of the relevant data, together with annotations with respect to quality control.

As a complement to these data management concerns, the meeting took note of the "Principles for successful science data management" presented by the Committee on Data Management and Computation (CODMAC) of the Space Sciences Board of the U.S. National Academy of Sciences (National Academy Press, Washington, D.C., 1982). These principles were prepared in the framework of satellite-derived data, but the meeting felt that they applied generally, with slight modifications, to the management of WCRP scientific data. These principles may be summarized as follows:

<u>Principles for successful science data management</u>

I. There should be active involvement of scientists from inception to completion in order to assure production of, and access to, high-quality data sets. Scientists should be involved in planning, acquisition, processing, and archiving of data.

II. Oversight of scientific data management activities should be implemented through a peer-review process that involves the user community.

III. Data should be made available to the scientific user community in a manner suited to the scientific research needs and have the following characteristics:

1) Data formats should strike a balance between flexibility and the economies of nonchanging record structure. They should be designed for ease of use by the scientist. The ability to compare diverse data sets in compatible form may be vital to a successful research effort.

2) Appropriate ancillary data should be supplied, as needed, with the primary data.

3) Data should be processed and distributed to users in a timely fashion as required by users.

4) Contractual obligations by users to return data to the archive in a modified form should be enforced.

5) Proper documentation should accompany all data sets that have been validated and are ready for distribution or archiving.

IV. A proper balance between cost and scientific productivity should govern the data-processing and storage capabilities provided to the scientist.

V. Special emphasis should be devoted to the acquisition or production of structured, transportable, and adequately documented software.

VI. Scientific data should be suitably annotated and stored in a permanent and retrievable form. Data should be purged only when deemed no longer needed by responsible scientific overseers.

VII. Adequate financial resources should be set aside early to complete data-base management and computation activities; these resources should be clearly protected from loss due to overruns in costs in other parts of the project.

The meeting endorsed these CODMAC principles as a guide in developing an ocean data management system to meet the requirements of the WCRP. It was noted that the principles are very general, and that in order to be useful, they should be applied, as appropriate, to the specific needs of TOGA, WOCE and the OOSDP. The meeting hoped that CCCO would accept these principles and instruct its subsidiary bodies to apply them to the projects in which they are involved.

3. GENERALIZED DATA MANAGEMENT SCHEME

In order to discuss the generalized data management scheme, the following definitions are proposed. They are derived from the FGGE data management plan and it is recommended that CCCO and JSC consider them in developing a uniform set of definitions for the WCRP.

Level I data are instrument readings, normally in engineering units (e.g. volts), that require conversion into meteorological and oceanographic variables specified in the data requirements. The raw data records are to be retained by the participants but not, in general, exchanged as part of the standard data flow.

Level II data are values of the universal meteorological and oceanographic variables either obtained directly from instruments or derived from Level I data, e.g. wind velocity, sea level, SST. These data are subdivided into two classes with different timeliness characteristics.

Level II-a data are WWW, IGOSS and other information required for research and monitoring activities in which rapid data availability is important.

Level II-b data are distinguished from the II-a data by a delayed cutoff allowing the acquisition of a more complete data set and/or the application of further quality control.

Level III data are processed products derived from Level II data by analysis techniques. Typically such data may be internally consistent data fields set in grid point form.

These definitions encompass and extend those adopted for TOGA (Plan for the TOGA Scientific Programme, 1984). In addition for certain data types, particularly satellite data, Level 0 data is defined as raw data, for example, that telemetered from a spacecraft, which requires data processing for conversion to Level I.

A conceptual generalized data flow scheme from the sensor to the permanent data archive centre is shown in figure 1. An important function within the data management flow is that of international data gathering and quality control. This may be organized either on a global or regional scale but preferably on an ocean basin scale and upwards. Data is then passed either directly to a permanent data archive or to a special analysis centre which may also provide an intermediate data archival function. Since centres performing these latter functions are generally project oriented, and hence of limited life span, it is important that all required data eventually reach a permanent archive.

Because of the multiplicity of data centres, data flow paths and archives, there is a requirement for a Data Coordination Group. Functions of this group include:

i) to plan data preparation and flow paths including the coordination of data exchange media and formats.

ii) to inform scientific users as to programme status and data availability, including the preparation of: lists of projects and centres; an inventory of data inventories; pointers to intercomparison exercises and summaries of results.

Data should not flow directly through the Data Coordination Group, although the project information assembled by this group must become a part of the permanent data archive.

Figure 1 does not show the flow of data to the scientific user. It will be necessary for each user to interact with those performing each of the functions shown. This is illustrated in figure 2. Scientists act both as originators of data as well as analysts of their own data and data obtained from other programme components. The main route for the latter data class is by the supply of Level II b and Level III data to the scientist from the permanent data archives. However, there will be many cases in which this route cannot satisfy the criterion for timeliness (that is it is too slow for the scientists' research requirements). The Level II data archives are designed to provide these data in a timely fashion. The scientist may also obtain data direct from the Special Analysis Centres. However, since neither these nor certain of the Level II data archives will have the User Servicing Interface which exists at the Permanent Data Archives, data flow to the user may need to be coordinated or regulated by the Data Coordination Unit.

The importance of the Data Coordination Unit is emphasized by figure 3. This shows the flow of information regarding data within the programme. The scientist needs initially only interface with the Data Coordination Group to obtain information as to the status and availability of data which he does not already hold. However, any actual flow of data to the scientist will be along paths defined in figure 2.

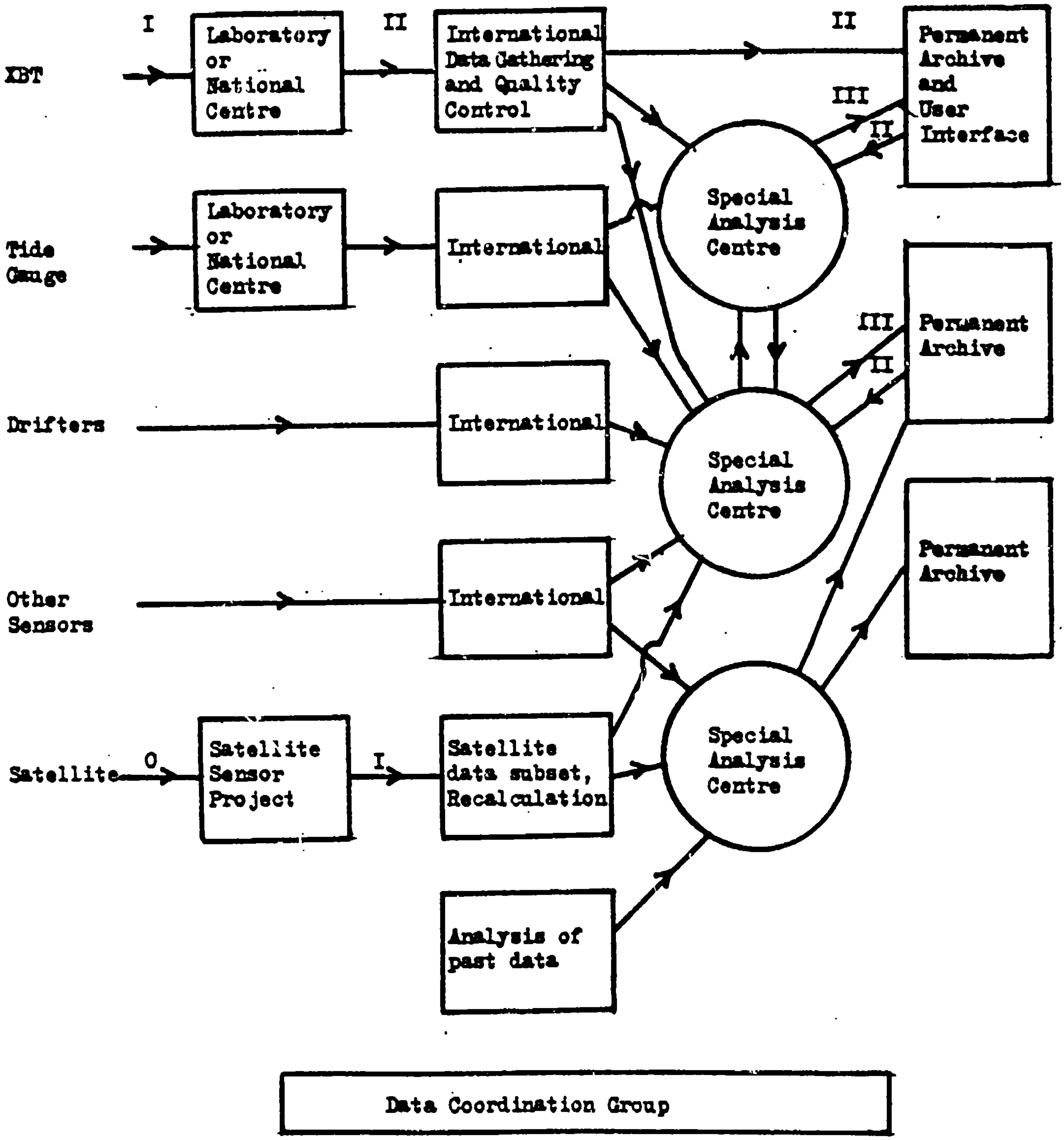


Figure 1. Conceptual data management scheme showing flow of data from the sensor to the permanent archive. Sensor types are named purely as examples. Each box represents a data management function. The number and interconnection of the boxes is shown schematically only.

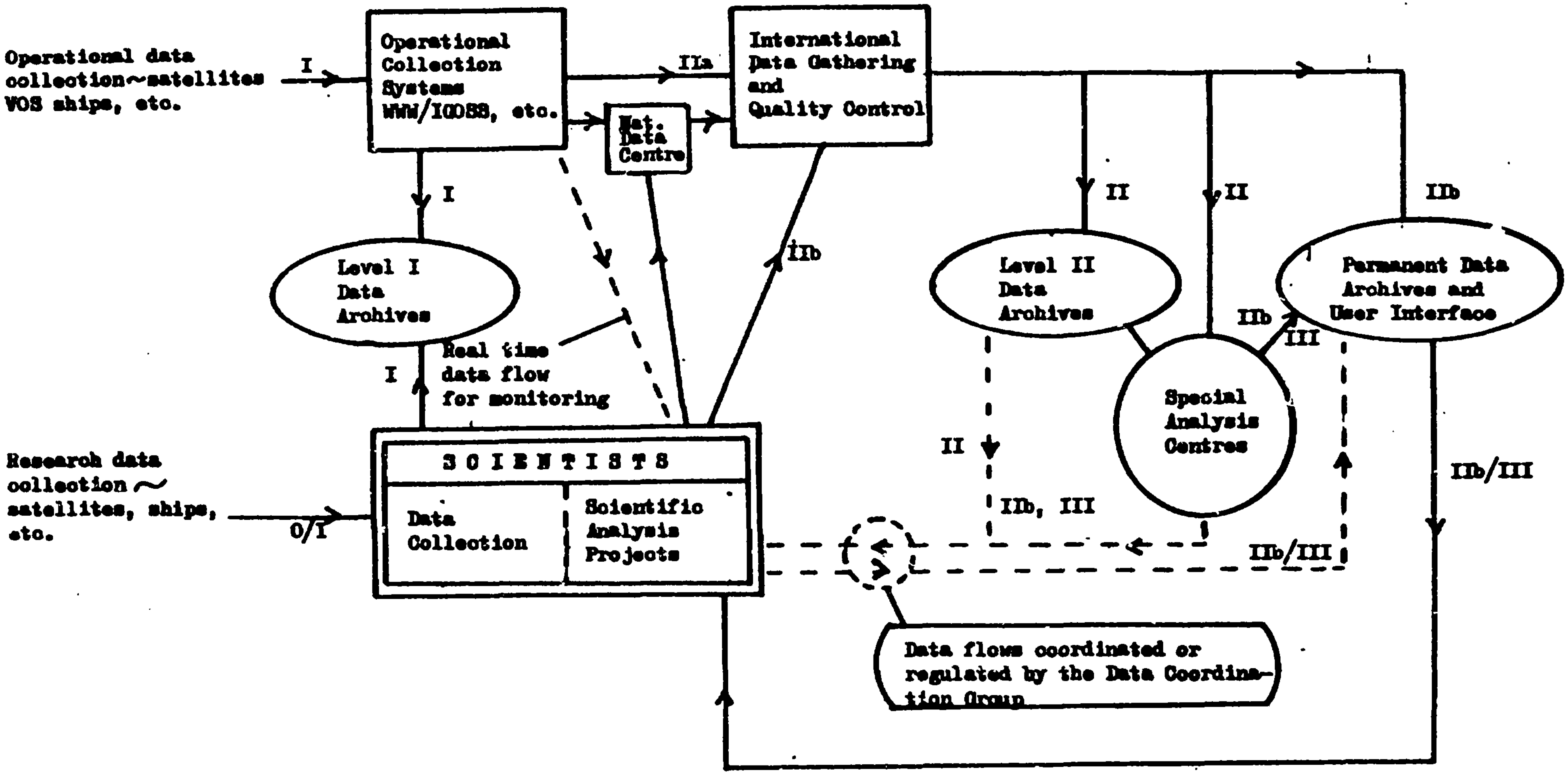


Figure 2. Conceptual data management scheme showing the flow of data to and from the scientific community. Note that each box represents a data management function which may be physically collocated with other functions or split between a number of data management centres.

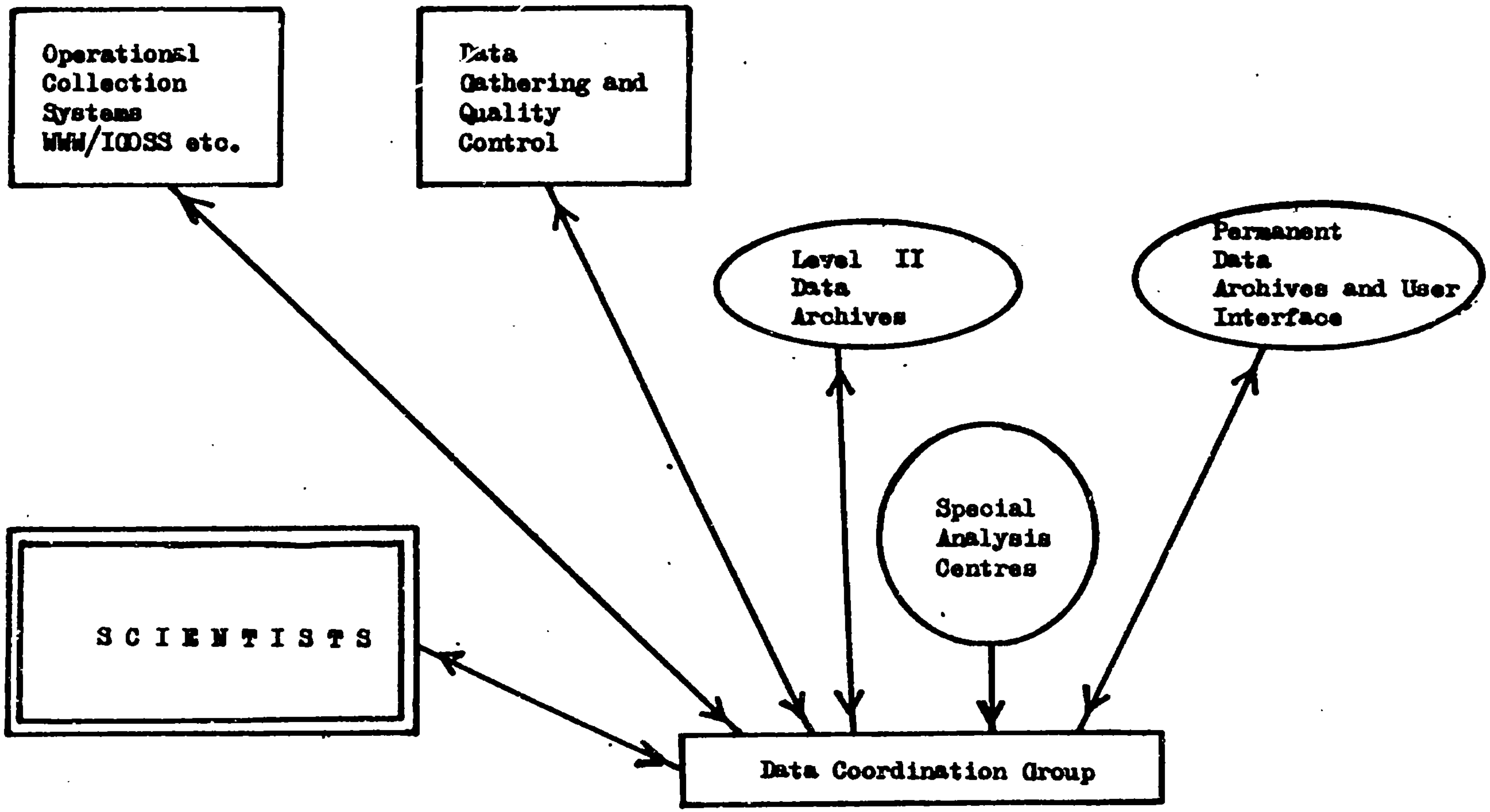


Figure 3. Flow of data management information between programme elements and the scientific community

Whereas figures 1 and 2 are organized in terms of data management functions, the actual flow of data will be optimised through two or more functions being performed within a single centre. Thus, in general, a Special Analysis Centre will also perform the function of International Data Gathering and Quality Control. Similarly, the Level II archive may be collocated with the Permanent Archive with the benefit that the User Servicing Interface will then be available to provide Level II data to the scientists.

For each data type required by the oceanographic activities of the WCRP, the data management functions shown in figures 1, 2 and 3 must be associated with an identified centre or centres. A centre so designated must be capable of meeting the principles of data management given in section 2 with regard to timeliness, format and exchange, quality control, products and completeness. It is the responsibility of the separate programmes, TOGA, WOCE and OOSDP, to insure the centres properly perform these tasks.

An illustration of the Generalized Scheme using the flow of XBT data is given in section 8, after all the issues raised at the Meeting have been explained and the existing systems analyzed.

4. REVIEW OF WCRP OCEAN DATA REQUIREMENTS AND DATA MANAGEMENT PLANNING

4.1 Study of the Interannual Variability of the Tropical Oceans and Global Atmosphere (TOGA)

Dr. Webster reviewed the objectives of the TOGA Scientific Programme, the major scientific issues, the programme components and the TOGA data requirements, based on the Draft Plan for the TOGA Scientific Programme

The TOGA Programme Objectives have been established as:

> Objective 1: To determine to what extent the time-dependent behaviour of the tropical oceans and global atmosphere system is predictable on time scales of months to years, and to understand the mechanisms of this behaviour.
>
> Objective 2: To study the feasibility of modelling the coupled ocean-atmosphere system for the purpose of predicting its variations on time scales of months to years.
>
> Objective 3: To provide the scientific background for designing an observing and data transmission system for operational prediction if this capability is demonstrated by coupled ocean-atmosphere models.

In developing the TOGA Programme, a number of scientific issues have been identified. These include:

a. Observing and analysing:

i) the behaviour of the tropical oceans, the processes of importance, and the reaction of the tropical ocean to wind forcing.

ii) the variability of the atmosphere on seasonal and interannual time scales.

iii) the variability of the total coupled tropical ocean-atmosphere system.

b. Modelling:

i) coupled models of the ocean-atmosphere system, in order to simulate the system and, ultimately, predict it.

ii) atmospheric models must well specify surface wind stress and heat/energy fluxes, in order to force correctly the oceanic circulation.

iii) oceanic models must well specify the surface temperature field and heat content in the upper layer, in order to force correctly the atmospheric circulation.

An improvement in ocean data bases for TOGA is needed:

- Data bases are needed to test models. Over much of the tropical ocean, data are simply not available.

- A special effort to obtain sea level at isolated stations is needed in order to verify model prediction.

- Data are needed, with high priority, to carry out observing-system experiments and to determine the statistics of the variability.

- Oceanic models might be used to specify priorities for data needs.

General requirements by the TOGA Programme for oceanic and atmosheric data include:

- research into key processes

- diagnostic studies

- model development

- model verification

- determining the initial states of predictive models

- watching for the early signs of El Niño and other anomalous events.

The data requirements for TOGA were considered at the recent TOGA Conference. A tentative version of those requirements is given in Table 1.

Table 1

TOGA DATA REQUIREMENTS

	Parameter	Horizontal (Vertical) Resolution	Time Resolution	Accuracy
Atmospheric Data (additional to WWW)				
1.	Upper Air Winds (Sat, AIREPS)	500 km (2 levels)	1 day	3 m/sec
2.	Tropical Wind Profiles	3000 km	1 day	3 m/sec
3.	Sea-Level Pressure	1200 km	1 day	1 mb
4.	Total Column Precipitable Water	500 km	1 day	0.5 g/cm^2 or 10%
5.	Area Averaged Total Precipitation	2^olat x 10^olong	5 days	3 cm/month
Interface Data				
6.	Global SST	5^ox 5^o	30 days	0.5 K
7.	Tropical SST	2^o lat x 10^o long	15 days	0.5 K
8.	Tropical Surface Wind	Identification of centre for analyzed wind stress to be specified separately Store raw data (vectors from each source: VOS, sat, etc.)		
8a.	Surface Humidity	Store raw data		1 gm/Kg
9.	Surface Short-Wave Radiation Flux	2^o lat x 10^o long (long wave flux to be specified also)	30 days	10 $Watts/m^2$
	Oceanic Data			
10.	Tropical Sea Level (coast & islands)		1 day	2 cm
11.	Tropical Ocean Sub-surface Temperature	2^o lat x 10^o long; 5 levels in 200 m (special specification of transects)	30 days	0.25 K
11a.	Salinity	to be specified		
12.	Surface Circulation	2^o lat x 10^o long	30 days	To be specified
12a.	Sub-surface Circulation	Equatorial 40^o spacing 4/5 levels	1 day	

The meeting spent considerable time reviewing the TOGA data requirements to develop a sense of the related data management issues. Oceanic data of particular interest to the meeting were items 6 to 12. Several of the requirements for oceanic data in TOGA have not yet been specified by the TOGA Scientific Steering Group. The meeting recognized that the data requirements in Table 1 were likely to be modified and that such a table necessarily over-simplifies. However, the Table's existence at this stage is of great value in beginning to specify WCRP ocean data management requirements.

Mr. Kaneshige informed the meeting of the data management strategy for TOGA. The programme design of TOGA requires that there be both near-real-time and delayed-time data flows. For example, near-real-time data are required to monitor El Nino events in the Pacific and to watch for the development of extremes in the Southern Oscillation and other persistent anomalies which could lead to significant climate changes throughout the tropics and mid-latitudes. It is planned that the operational flow of meteorological and oceanographic data over the World Weather Watch Global Telecommunications System (GTS) will be augmented by additional real-time data from some of the TOGA Observing Systems.

The TOGA research data set must be as complete as possible and must be sufficiently validated and quality-controlled in order for the scientific goals of the programme to be achieved. The TOGA strategy is to utilize existing facilities wherever possible, to minimize the need for implementing new data management centres. Figure 4 shows the centres that are needed for the purpose of producing specific data products required by TOGA. These are:

1) Tropical Upper Air Wind Data Centre - to provide large-scale, low frequency variations of the tropical atmospheric wind field.

2) Precipitation Data Centre - to provide large-scale precipitation statistics for the 20N - 20S latitude band.

3) Air-Sea Interface Data Centre - to provide gridded fields of surface fluxes at the air-sea interface, for the 20N-20S latitude band.

4) Surface Wind Data Centre - to provide wind stress fields over the ocean surface, for the 20N-20S latitude band.

5) Tropical Sea Level Data Centre - to provide maps of monthly sea level anomalies over the three tropical ocean basins.

6) Global Sea Surface Temperature Data Centre - to provide global fields of mean sea surface temperature.

7) Ocean Subsurface Data Centres - to provide for the centralized collection of quality-controlled Level II-b data (one centre for each of the three oceans).

Comments on TOGA Data Management

1) The meeting recognized that the definition of the data exchange for TOGA is in an early stage and subject to change. At present, inconsistencies appear to exist between the table of TOGA data requirements (as received in amended form at the meeting) and the products to be produced at the TOGA data centres. The meeting urged that in finalizing the TOGA data requirements, care be taken to ensure that the data input needs of the TOGA data centres and of planned and future research activities be fully considered. Data may be required at improved accuracy and better resolution for different parts of the programme and each of these must be considered in designing the overall data management strategy.

2) For each parametre required for TOGA (see Table 1), there should be a specific timeliness need identified, possibly by geographic region or level. Such a need must be known if the data management system is to be designed to meet the user's needs for timeliness of data.

3) Care will have to be taken on several major points when designing the detailed data management plans for each of the proposed TOGA Special Centres (see Figure 4). These points are:

- Mechanisms must be incorporated to provide for the archiving of input data and possibly intermediate data products, as well as the final output products.
- All data and products should be easily accessible to researchers, in a timely manner.
- Suppliers of input data should not have to be required to provide duplicate sets of data to more than one data centre (if at all possible).

The meeting recommended that the CCCO advise the JSC and the JSC/CCCO TOGA Scientific Steering Group of the above concerns, to insure that the further detailed preparation of the data management plan by the International TOGA Project Office take these fully into account.

TOGA DATA MANAGEMENT CENTRES

Centre	WDC's
TROPICAL UPPER AIR WIND CENTRE	WDC's : METEOROLOGY
PRECIPITATION DATA CENTRE	WDC's : METEOROLOGY
AIR-SEA INTERFACE DATA CENTRE	WDC's : METEOROLOGY, OCEANOGRAPHY
INTERIM SURFACE WIND DATA CENTRE	WDC's : METEOROLOGY, OCEANOGRAPHY
TROPICAL SEA LEVEL DATA CENTRE	WDC's : METEOROLOGY, OCEANOGRAPHY
GLOBAL SST DATA CENTRE	WDC's : METEOROLOGY, OCEANOGRAPHY
OCEAN SUBSURFACE DATA CENTRES	WDC's : OCEANOGRAPHY

Figure 4

4.2 World Ocean Circulation Experiment (WOCE)

Mr. J. Crease presented a summary of the WOCE goals, objectives and elements and a preliminary assessment of WOCE data management needs. The objectives of WOCE are:

1) To determine and understand on a global basis the following aspects of the World Ocean Circulation and their relation to climate.

   . The large scale fluxes of heat and fresh water and their divergencies on a 5 year mean, and in addition their annual and interannual variability.

   . The inputs and fluxes of potential vorticity.

   . Components of ocean variability on months to years, megametre to global scale, and the statistics of the smaller scales.

   . Volumes and locations of water masses with ventilation times of 10-100 years.

2) To determine the representativeness of the specific WOCE data sets for the long term behaviour of the ocean, and to find methods for determining long term changes in the ocean circulation.

To achieve these objectives a number of elements compose the experiment. They are:

1) Ocean circulation modelling

2) Altimetric and wind measuring satellites

3) Global tracer surveys

4) Global hydrographic sections

5) Basin scale sub-surface drifter programmes

6) In-situ sea level programme

7) Ships of opportunity and voluntary observing ships

For a fuller discussion of the objectives see the Report of the Second Session of the WOCE Scientific Steering Group, Wormley, January 1984, WCP-81.

WOCE Data Management Factors and Requirements

Some factors relevant to the WOCE data management organizational structure are:

1) WOCE as presently defined interacts observationally with the atmospheric component of the WCRP through the boundary parametres - momentum and heat flux and SST. This is different from TOGA and the earlier "Cage" proposal.

2) The strongest emphasis on data management is on quality and timeliness; timeliness probably does not include 'near real-time' as in TOGA except, possibly, in regard to delivery of in-situ calibration data for satellite systems.

3) WOCE is crucially dependent on non-operational data both satellite and in-situ. TOGA is heavily dependent on operational data.

4) The goals of WOCE emphasize the building and testing of models rather than their initialization. Thus gridded data sets and analyzed fields are the only end-product of an experimental programme.

There appears to be three distinct WOCE Data Management phases:

1) The utility of existing data types should be assessed. This requires sensitivity studies to be made of the utility of these data in achieving WOCE objectives. It would then be possible to assemble a wholly useful sub-set of the historical data for WOCE purposes.

2) The assembly of data sets for the boundary conditions on the ocean models. It is likely that as well as the surface boundary conditions, basin scale boundary conditions will be required in the absence of global models.

3) The assembly of data sets for the critical assessment of theories/models (this is a return to 1 but incorporating data from the WOCE field programme).

By way of example of the complexities of data assimilation, Table 2 lists a number of observations and techniques which yield fairly directly some measure of the ocean currents or transports. It seems likely that each can make a valuable contribution to one or more of the requirements above. The job for a WOCE data management plan will be to identify both the nature of the analysis centres to handle these data and secondly to identify the physical location of the collection and analysis centres.

The WOCE Scientific Steering Group has not yet defined parameter by parameter the data accuracies needed to meet its objectives. One present argument, based on the assumption of a percentage precision (10%?) required to see significant change or test physical significance has been used to suggest criteria such as the ± 10 $W.M.^{-2}$ average heat flux error through the sea surface, 0.35 m/sec for the averaged surface wind-speed. The second figure is of particular interest in the data management in that it highlights a distinct use of the data. The wind-speed data is used in the calculation of the

TABLE 2

Sources of Current Data

Type	Quality	Averaging Space	Averaging Time	Duration	Area	Era	Receiving centres	Processing centre	Archiving centre
1 Ship's drift	Low	400 km	1 day	–	Shipping lanes	Last century	Met.Offices	None	Met.Office
2 Currents (Fixed loc'n)	High	Point	1 hr	1 year	scattered	last 2 decades	Laboratory Projects	Laboratory Projects	NODC's (some)
3 Currents (Drifters)	High	10 km	1 day	1 year	scattered	Last decade	System Argos	Laboratory Projects	None (Canadian offer)
4 Sea level (Satellite)	High? (Med.)	10 km	mins	Years	Global	Seasat Geos.	R.S.centres	JPL	NESDIS !
5 Sea level (in situ)	High	Point	hour	Decades	coastal & scattered	Last century	Laboratory Projects & National Authority	National Authority & IOS	PSMSL & IHB
6 Wind stress (Satellite)	High	10 km	mins	Years	Global	Seasat	R.S. centres	JPL et al	NESDIS !
7 Tomography	High?	100 m vert.	hours?	–	scatterd basin	New	Labs.	Labs.	None
8. Doppler Acoustic Profilers	High? (Med.)	10 m vert.	mins	–	ship lanes +scattered	New	Labs.	Labs.	None
9 Geostrophy	High	km.	hours	Years	Global sparse	Last century	Labs.	Labs.	NODC's

gradients of stress and must, because of differentiation, be known with greater accuracy than would be required of the stress alone. The effort required to up-grade the specification will not be trivial, involving, probably, much more "surface-calibration" than would be required for TOGA needs alone.

4.3 Ocean Observing System Development Programme (OOSDP)

Dr. Voigt and Mr. Thompson introduced this subject by reviewing the objectives, scope and implementation and development projects of the OOSDP (see IOC Technical Series No. 27). The OOSDP is the framework through which routine oceanic climate observational programmes will be either established or, in the case of existing programmes, improved. The OOSDP is intended to contribute to TOGA and WOCE and also to be the basis for long-term monitoring programmes which will be operated under the aegis of intergovernmental bodies, particularly IOC and WMO. The full suite of OOSDP projects is given in Annex 3. Data management associated with the OOSDP will be handled mainly by IGOSS, WWW and the IODE. However, those data obtained through the OOSDP that are to be used by TOGA and WOCE researchers will have to be assimilated in their data management schemes as well. Two OOSDP major programmes, being developed in cooperation with the IOC, are explained in the following sections.

Sea Level Project

The Meeting was informed of the IOC's Plan for a Global Sea Level Network. This network is being developed by the IOC in response to the need for a non-real-time global system of tide gauges to observe sea level changes. The proposed network, (see figure 5) is designed to serve many purposes. It will cover the entire spectrum of time and space from short-lived tsunami to the slow changes related to tectonic processes. Its characteristics include permanence, high vertical precision and stability, and the flexibility to develop as requirements evolve. The network is based upon some 250 sea level gauges and is capable of providing valuable data for both practical and scientific applications. Of the 250 gauges proposed for the network, about 150 are presently in operation but many of them may need upgrading in terms of leveling, accuracy, documentation, telemetry and the time required to obtain the data. The Plan recommends that each gauge in the network record data automatically in a computer compatible format. Sampling sea level at intervals of 15 minutes (averaged over a few minutes to avoid aliasing) is recommended, but in all circumstances the minimum sampling interval should be one hour. The Plan does not address the need for the operational global exchange of such data on a near real-time basis.

Although the network is defined in terms of permanent long-term operation, implementation must largely be completed in time to support TOGA and WOCE. This implies an active period of implementation of perhaps five years, beginning in 1984, during which the development of the network should be given high priority.

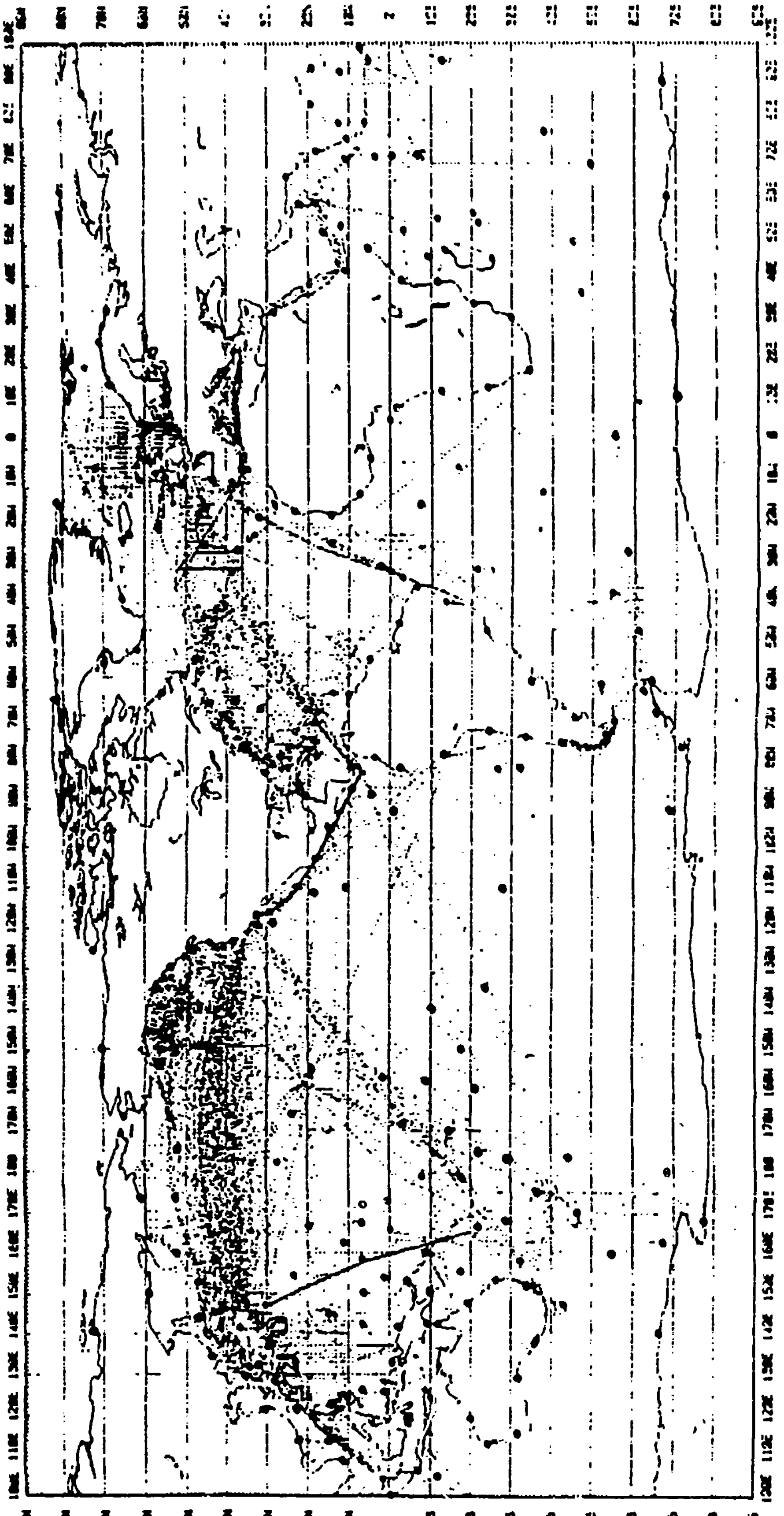


Figure 5: Proposed Sea Level Network

Early priority toward implementing the netework is being given in the CINCWIO (Western Indian Ocean) Region. A survey of training and equipment needs in the Region has been conducted and actions undertaken to address these requirements. To date, two training courses have been held in the U.K. for participants from the CINCWIO Region. However, intergovernmental efforts have been inadequate in providing equipment and supplies to repair existing gauges or establish new sites.

It was also reported that a number of Member States are presently undertaking or plan sea level initiatives in the Indian Ocean in addition to those undertaken by the IOC. These include efforts by Australia/Indonesia, Canada, France, France/Indonesia, Mauritius and Seychelles.

The meeting was also informed of the IGOSS Sea Level Pilot Project (ISLPP) in the Pacific Ocean, which had been developed to address the need to upgrade the sea level data networks in the Pacific Basin in order to obtain a monthly synoptic data set from which products could be produced. The Pilot Project was conceived as a test of the feasibility and usefulness of such an operational network and thus was designed to operate initially over a five year period. During the course of the Pilot Project, additional products will be developed and the need to incorporate different sampling rates or additional parameters will be addressed. Near the end of the five year pilot period a decision will be made concerning termination or making the Project operational, and if it should be expanded to incorporate additional oceanic regions.

An IGOSS Specialized Oceanographic Centre (SOC) for the ISLPP has been established at the University of Hawaii and several monthly sea level anomaly charts have been produced. Data are presently being received from over 20 countries and several additional members have indicated a willingness to participate. The basic parameter being reported is monthly mean sea level. Communications remain a significant problem, especially since many of the tide gauges concerned are located in remote locations.

The Meeting expressed its satisfaction with the development of the ISLPP and noted that it was one of the first intergovernmental projects which had been initiated and developed primarily in support of the Climate Programme. Concern was expressed over the limitation of the Pilot Project to the Pacific and the possible need to begin the implementation of such an effort in the Atlantic and Indian Oceans. However, it was recognized that the need for sea level data on a near-real-time basis from other Basins has not been established. Also, there was no agreement as to the exact data requirements of TOGA and WOCE, as well as other potential users, with respect to frequency of observation, supporting data and timeliness, for example.

<u>The Meeting recommended that a meeting of a group of scientists/users concerned with sea level data be convened through an appropriate mechanism to determine</u>:

a) the global an/or regional need for the near-real-time exchange of sea level data

b) the technical requirements of these data (frequency, averaging, precision, gauge requirements, etc.)

c) density of observing/reporting stations by region

d) need for an internationally approved exchange code, and

e) other related items directly needed to meet the requirements of the WCRP.

Sub-surface Thermal Structure Project

The Meeting reviewed the Draft Operational Plan for the proposed Joint CCCO/IGOSS Sub-surface Thermal Structure (STS) Monitoring Project. The Project is intended to address the operational requirements of the sub-surface Heat Storage element of the OOSDP as well as other programmes having a need for sub-surface thermal data. The Project is designed to increase the quantity and quality of such data by facilitating the establishment of new or expanded ship-of-opportunity lines. It depends upon the co-operation, facilities and services of participating Member States and organizations with co-ordination and intergovernmental arrangements provided by the IOC and WMO.

While there was general agreement that additional ships-of-opportunity lines would be required to support at least some aspects of the WCRP, there was strong reservation expressed regarding the need to establish yet another intergovernmental structure. In particular, it was felt that an overall project manager was not required and that efforts should be directed regionally and based upon the proven management skills and scientific interest of those individuals who have already shown success in establishing such lines. The meeting felt that because of the substantial annual investment (approximately $100K/year) required to operate an average XBT line, it was unlikely that any Member State would agree to release control of the necessary funds, equipment and supplies to an international Project. Finally, it was noted that the proposed Project did not address the problem of gaining access to at least part of the substantional number of XBT, BT, CTD and hydrocast data already being observed but not exchanged.

The Meeting recommended that the development of the STS project should be pursued under the following guidelines:

1) The concept of having an overall Project Manager should be re-thought with the possibility of eliminating the position or incorporating it with one of the Regional Project Manager Positions.

2) The management and operation of the Project must be maintained in the Member States.

3) The Annex of the Plan dealing with Funding, Equipment and Supplies for the Project must be developed in such a manner as to assure potential donor states of the appropriate fiscal and scientific management of their resources; and

4) Additional efforts must be undertaken in order to convince Member States of the need to exchange the data they are presently observing but not reporting; regardless of the outcome of the development of the STS Monitoring Project.

4.4 Oceanographic Data of Interest to the WCRP obtained from Satellites

Data sets from various satellites that provide information of value to oceanography were reviewed. Often the high volume of satellite data is a problem: this can make it difficult to reprocess basic data, to use an improved algorithm or to use basic radiances to calculate a new variable. In programmes such as the International Satellite Cloud Climatology Project (ISCCP) a strategy of averaging and sampling basic radiances from geosynchronous and orbiting satellites was devised that reduces the total data volume by a factor of about 200 for the so-called B1 (nominally 10 km) data, and by another factor of about 6 for the B2 and B3 data (25 to 30 km). These data are useful not only for cloud estimates but also for estimating other variables such as ocean surface radiation budgets and precipitation. Data sets of derived geophysical variables typically have reasonable data volumes.

The Pilot Ocean Data System (PODS) has acquired much of the SEASAT data and has prepared subsets that are easy for users to access. Table 3 shows the volumes of data from several current and future satellites. Level 0 is the basic satellite data, level 2 has the derived meteorological and oceanographic data such as SST and wind.

Table 4 summarizes selected ocean information that is expected from various satellites during the next decade.

Specifications of satellite data requirements

Many requirement documents call for such summarized data as a weekly or monthly analysis by $2^{o} \times 10^{o}$ squares. Since TOGA and WOCE require global or near-global data, we must have satellite derived processed global data sets that have manageable data volumes and yet which still have sufficient time and space resolution to resolve mesoscale structures (samples about each 15 to 30 km). These data sets do not need to resolve small local eddies.

Recalculation of variables

It is important to choose date structures that will permit reanalysis and recalibration of the major subsets of the data in the future. In the case of altimeter data, this means that one should be able to incorporate new knowledge of the earth's gravity field without complete reprocessing. Or, one should be able to recalculate altimetry correction terms as simply as possible. Note: this may often be done on a major subset of basic data instead of on all of it. For example, a 10/second satellite altimeter takes samples about each 0.7 km. If this is reduced to one each 3.5 km and if the average number of stored correction terms is reduced, the relative data volumes are:

Case 1: (each 0.7 km; 10/sec) (20 numbers each point) (16 bits each) = 1.0×10^{11} bits/YR

Case 2: (each 3.5 km) (5 numbers each point) (16 bits each) = 5.1×10^{9} bits/YR

The data set for case 2 would be very easy to use for various recalculations; the case 1 set is so large that reprocessing would be very costly, especially when several years of data (and perhaps more than one altimeter) are involved.

Flags for relative reliability

When calculating SST, sea level, winds, etc. from satellites, it is typically very helpful for the user to include relative accuracy flags that might, for example, indicate:

- This is a SST of the highest quality from this sensor
- This SST is of quality #3 because there were moderate showers in the area
- This wind data is probably affected by land affecting the side lobes

Given such flags (at more quantitative estimates), the analysis programmes can test for biases, assign error estimates, and use optimal interpolation and related methods to prepare analyses.

Data for basin studies

Many ocean research projects will focus on one ocean basin. There should be methods to access the satellite data so that it is not too costly to extract data for one basin, or a defined geographical region. Most laboratories would not be capable of making full global analyses.

Historical Satellite Data

A considerable amount of satellite data exists beginning about 1972 which could be used to derive information about cloudiness and improved SST. Much of these data do not have backup magnetic tape copies and will soon be unreadable if not copied to new tapes.

Satellite Data Considerations

- The data management plans for each of the satellite sensors should include information about:
  - Data volume and space/time sampling rates in the input data stream
  - Volume of basic data after initial processing
  - The likelihood that different algorithms will be developed to calculate variables and, if so, the relative ease of accomplishment. Also, if a subset of basic data is needed to help provide the ability to recalculate variables over a many-year period

. Volume of output data

. Where the data will be archived

. Writeups about satellite data should make it clear how (and why) the calibrations were changed as a function of time. For some types of satellite data (especially earth radiation budget and solar constant), it is important to have overlap between satellites because good "surface calibration" data are difficult to obtain.

. As International data management systems to deliver satellite data to users have not been developed, the practices used in past and ongoing projects should be considered when defining formats for radiances, output variables and analyses, in order to choose formats that are similar if not identical.

. Historical satellite ocean data sets should be reviewed for their importance to the WCRP programme.

. Where the volume of satellite data is such that it must be provided to users in densely packed or binary formats, suitable documentation should be supplied by the providing centre to enable the data to be accessed on the users own computer.

Table 3

ESTIMATED DATA VOLUMES

DATA SOURCE	GEGA-BYTES/YEAR				
	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 2.5	LEVEL 3.0
SEASAT - ALT*	8.4	1.5	0.200	0.150	-
- SASS*	0.42	3.0	2.880	0.350	-
- SMMR*	1.900	3.1	1.440	0.165	-
GEOS 3 - ALT**	-	-	0.300	0.165	-
WEST COAST - AVHRR	20.0	-	-	-	-
CZCS	15.0	-	-	-	-
DMSP - SSM/I	5.0	12.0	12.0	-	0.25***
GEOSAT - ALT	33.5	-	-	-	-
TOPEX - ALT	29.6	39.0	1.0	-	-
NROSS - SCATT	5.0	12.0	2.0	-	0.15
- ALT	34.0	73.0	1.0	-	-
- SSM/I	5.0	12.0	12.0	-	-
ERS 1 - ALT	34.0	73.0	-	-	-
- SCATT	5.0	12.0	-	-	-

* FOR 90 DAY SET
** FOR THREE YEARS OF PARTIAL COVERAGE
*** POLAR DATA ONLY

Table 4

Satellite data expected during the 1984-1995 period

SST

NIMBUS SMMR (still going)
NROSS LFMR late 1989
NOAA series 5 channel vis & IR
ATSR/M on ERS-1 1990 (ESA)

Altimeter

Geosat Alt	late 1985 (Navy) & Late 1987	
NROSS Alt		5 cm
TOPEX/POSEIDON Alt	1991	3 cm
ERS-1		Seasat class
MOS-2 Alt Japan	mid 1990's	

Winds

Speed from altimeters to 2 m/sec
Speed from SMMR to 2 m/sec
Speed & direction from NSCATT. NROSS
Winds aloft from WINDSAT
Speed & direction from scatterometer on MOS-2

Wave Information

Height from altimeter to 50 cm or 10%, whichever greater
From Seasat SAR (wavelenght & direction)
Probably SAR on ERS-1

H_2O Vapor, rain rate, ice

SMMR on Nimbus (still going)
SSM/I on DMSP 1986
on TOPEX/POSEIDON 1990
on NROSS

Color

NIMBUS CZCS (still going)
OCI (color imager) launch 1990
8 channels, 2.5 mbit/sec

5. WORLD CLIMATE DATA PROGRAMME (WCDP)

Dr. Unninayar informed the Meeting of three WCDP projects (CLICOM, INFOCLIMA, CSM) which are relevant to WCRP ocean data management. These WCDP projects are parallel to but distinct from the WCRP data management and data acquisition projects. Further details of the WCDP projects are given in Annex 4, but their associated activities are, in brief, to:

a) promote and facilitate the transfer of technology in climate data processing and management - emphasis on computer system specifications and software, education and training (CLICOM);

b) collect, consolidate, disseminate information on climate data sources - World Climate Data Information Referral System (INFOCLIMA); and

c) collect, consolidate, disseminate information on significant climatic events, fluctuations, changes within (or affecting) the atmosphere-ocean-cryosphere-land surface climate system - Climate System Monitoring (CSM).

The participants expressed keen interest in these projects and suggested several ways by which they could be enhanced in order to provide direct support to the ocean research community. For example, the CSM monthly bulletin of global analyses of anomalies (temperature, precipitation - and soon sea level) should be distributed to all ocean scientists involved in TOGA and WOCE. Several other suggestions are included in Annex 4.

6. REVIEW OF EXISTING SERVICES SYSTEMS

6.1 Integrated Global Ocean Services System (IGOSS)

Dr. K. Huber introduced this item. He gave a brief description of the structural elements of IGOSS and the manner in which ocean data are managed and exchanged within the System.

IGOSS is the international operational system for the global collection and exchange of oceanic data and the timely preparation and dissemination of oceanic data products and services. It is an activity planned, developed and co-ordinated jointly by WMO and IOC. Successful implementation of IGOSS depends upon close co-operation and co-ordination between the oceanographic and meteorological communities at all levels. Although IGOSS is a global ocean services system, it has been determined that implementation may be pursued on a regional basis. It is, however, extremely important that implementation in each region be closely co-ordinated with activities at the global level.

IGOSS consists of three essential elements through which its activities are carried out. Those elements are:

i) The IGOSS Observing System (IOS) consisting of various facilities and arrangements for obtaining standardized oceanographic information from voluntary observing ships, research ships, ocean weather stations, fixed and drifting buoys, aircraft and other platforms;

ii) The IGOSS Data Processing and Services System (IDPSS) consisting of national, specialized and world oceanographic centres, for the processing of observational data and the provision of products and services to marine user groups and for data archiving and exchange activities; and

iii) The IGOSS Telecommunication Arrangements (ITA) consisting of telecommunication facilities of the World Weather Watch (WWW) Global Telecommunication System (GTS) and other arrangements necessary for the rapid and reliable collection and distribution of the required observational data and processed information.

The BATHY/TESAC Operational Programme is the primary element within IGOSS and constitutes the major source of near-real-time surface and sub-surface temperature, salinity and current data which are collected and exchanged on a world-wide basis. The total and daily average BATHY/TESAC reports exchanged through IGOSS from 1975-1983 are given in Table 5.

TABLE 5

BATHY/TESAC Reports for 1975 - 1983

TOTAL REPORTS

	1975 1/	1976	1977	1978	1979	1980	1981	1982	1983
BATHY reports		22,783	24,752	31,846	34,568	31,506	30,544	31,358	32,960
TESAC reports		2,675	7,025	10,839	10,303	919	1,353	1,582	7,724
Total reports	16,500	25,458	31,777	42,685	44,871	32,425	31,897	32,940	40,684
NUMBER OF REPORTING PLATFORMS									
	120	150	190	210	300	260	240	285	

1/ Separate BATHY and TESAC data not available for 1975.

Figures 6a and 6b give plots for BATHY and TESAC reports for January-June 1983 and July-December 1983 respectively, and figures 7a and 7b give separate BATHY and TESAC plots for Sept 1984.

GOSS BATHY & TESAC EXIST PLOT FOR JAN. '83 - JUN. '83 TOTAL 16680

ALL COUNTRY TOKYO - JAPAN

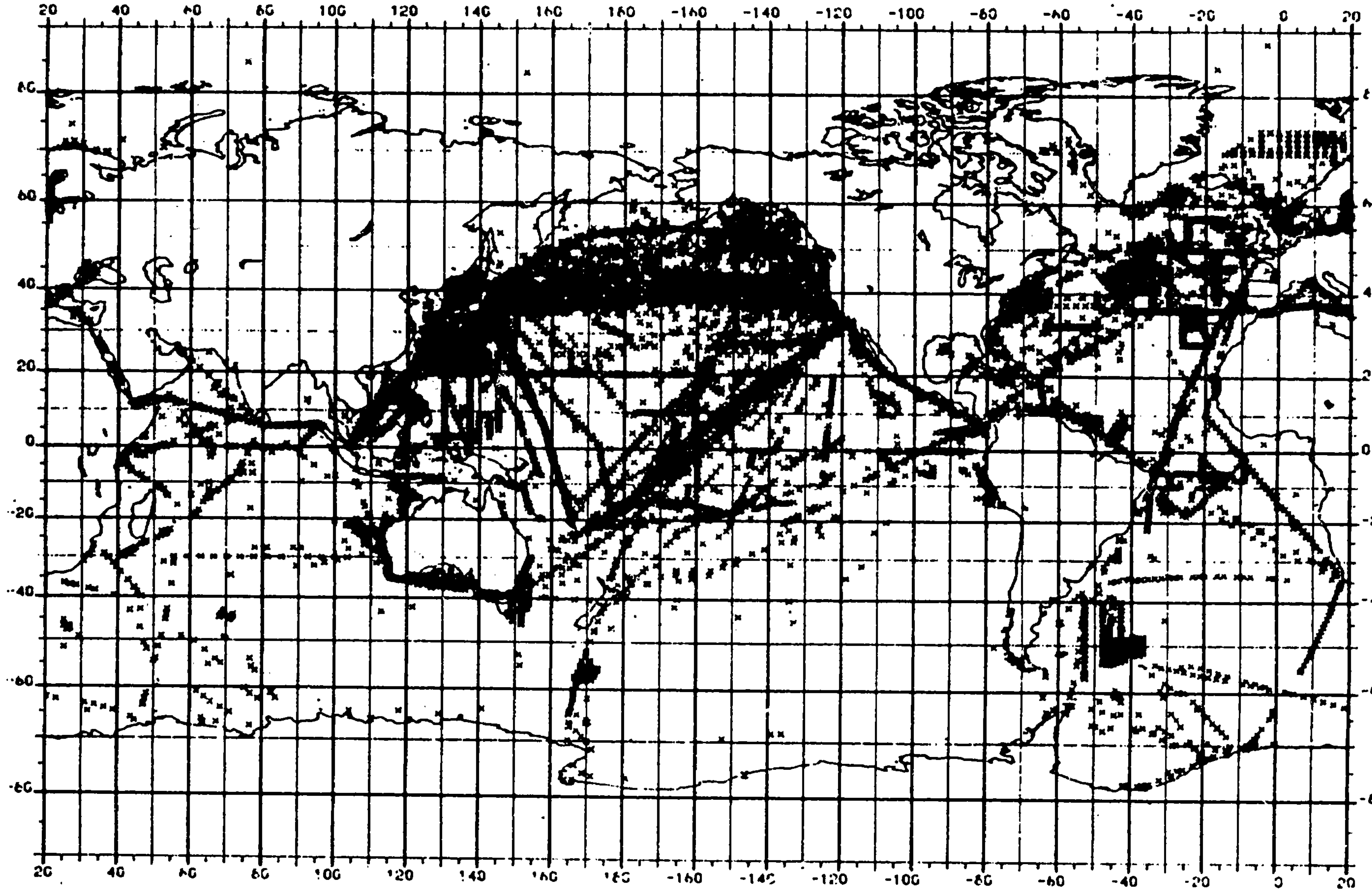


Figure 6a

IGOSS BATHY & TESAC EXIST PLOT FOR JUL.'83 - DEC.'83 TOTAL 16122

ALL COUNTRY TOKYO - JAPAN

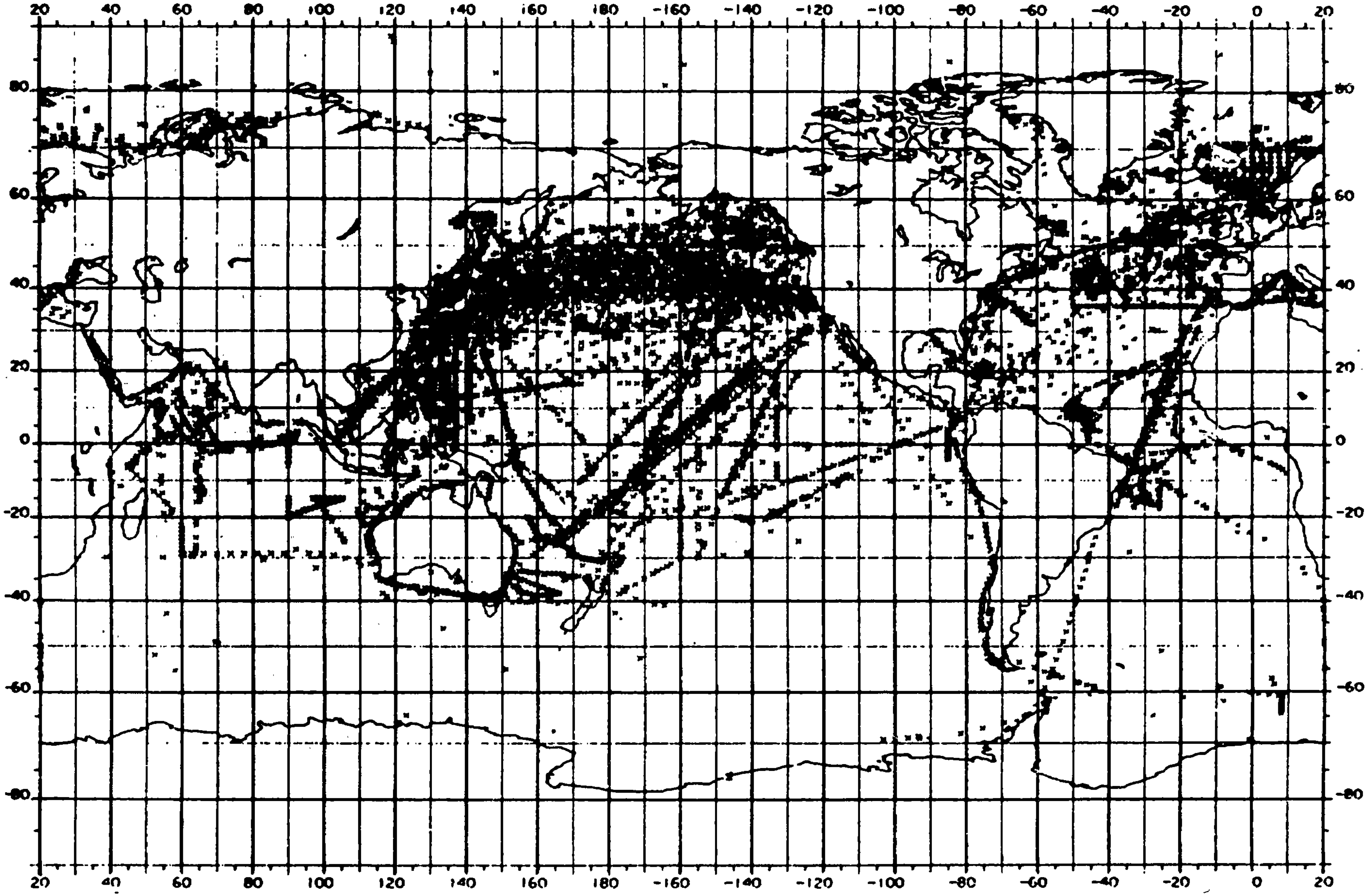
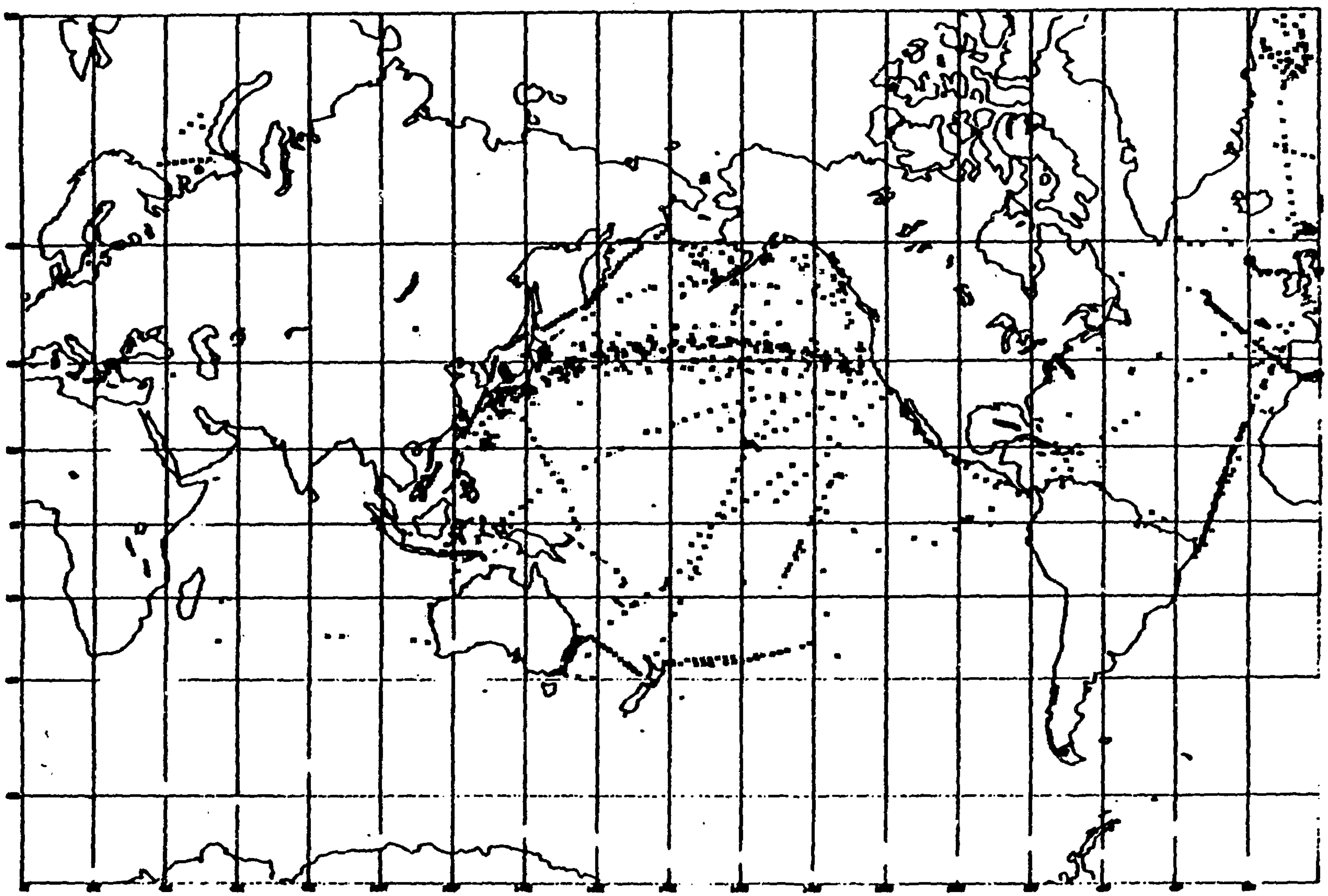


Figure 6b

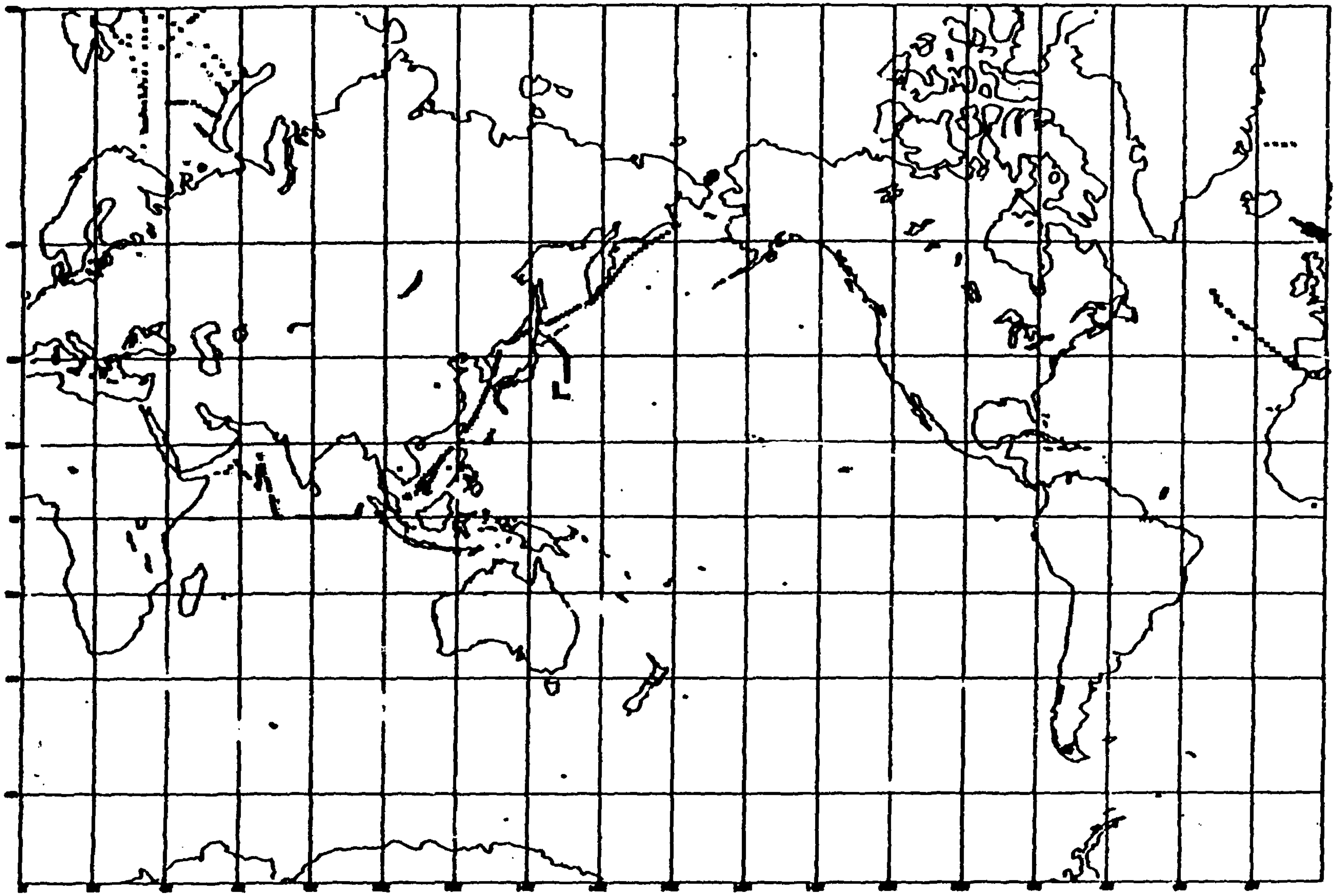


Geographical distribution of BATHY reports for September 1984
(Total amount of data: 1763)

IGOSS SOC for the Pacific Ocean
The Japan Meteorological Agency

Figure 7a

Figure 7b



Geographical distribution of TESAC reports for September 1984 IGOSS SOC for the Pacific Ocean
(Total amount of data: 607) The Japan Meteorological Agency

IGOSS is primarily concerned with operational data. Operational data are defined as those data up to 30 days old from the time of observation and may be exchanged on the GTS. However, the most important factor in dealing with IGOSS data concerns their timeliness. For IGOSS purposes, timely is defined as being within a space of time since the time of observation such that the data are of operational use. The duration of the timely period depends essentially upon the physical phenomenon under consideration. For IGOSS purposes that duration goes from one or two days up to a few months for the complete exchange and processing of the data.

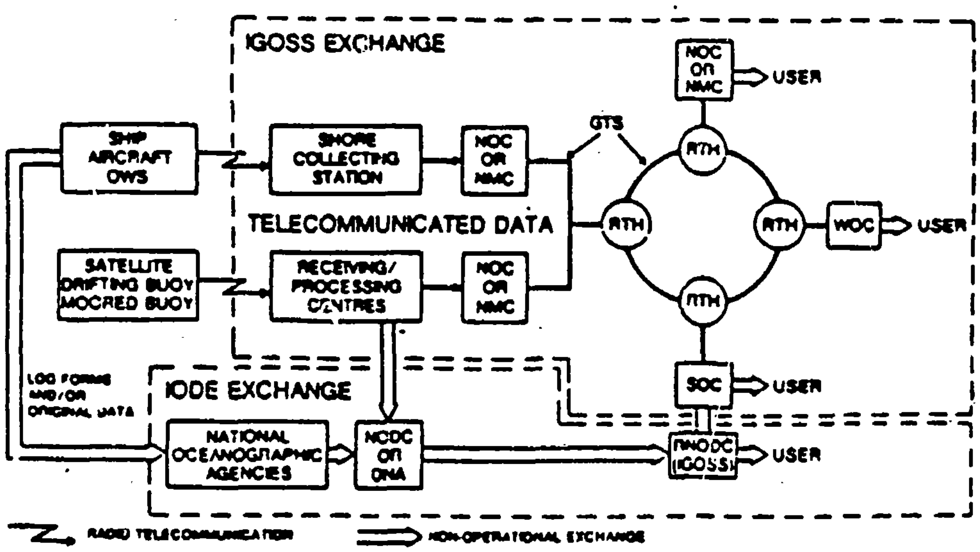
In order to provide the data within operational time as well as to provide long-time archival, the data flow is separated into two components, an operational data flow and a non-operational data flow, as shown in figure 8 below. This figure shows:

i) The IGOSS Exchange (operational data flow). This data flow contains that information which has been radio transmitted. These data are available from IGOSS from one day to less than two months following the time of observation.

ii) The IODE Exchange (non-operational data flow). This data flow contains detailed identification information and other supporting environmental data as well as the basic oceanographic data. These data are available from IODE from many months to years following the time of observation.

Figure 8

Typical IGOSS data exchange flow



Because of the operational nature of IGOSS data, they are generally of a somewhat lower quality than those data contained in a fully quality controlled data archive. However, IGOSS realizes that the value of its data for a user depends essentially upon their quality. Quality control guidelines and procedures have been developed to improve the quality of data at its origin, prior to insertion onto the GTS and for after reception from the GTS. These procedures, as well as guidance on the operational requirements for the collection, encoding and exchanging of BATHY and TESAC data are contained in IOC Manuals and Guides No. 3, Guide to Operational Procedures for the Collection and Exchange of Oceanographic Data (BATHY and TESAC), revised 1984.

The IDPSS is the main international system for operational ocean data processing and analysis, and for the preparation of oceanographic products to satisfy the requirements of participants in support of activities based on or affected by the sea, and as input to national or international oceanographic/meteorological research programmes. The system is intended to provide a common basis for the operation of the IGOSS oceanic data-processing centres, provide for the standardization of ocean products, ensure that the requirements for ocean products of all users are recognized, and minimize duplication.

The IDPSS is a data-management and product-formulation system using telecommunicated data. Its main elements are operational centres which provide a variety of products, some of which are routine in nature while others are designed in support of specific oceanographic and meteorological projects. These centres are:

a) National Oceanographic Centres (NOCs) or National Meteorological Centres (NMCs) with corresponding functions which are the sole responsibility of Member States and provide services in response to national priorities.

b) Specialized Oceanographic Centres (SOCs) which may be established at the request of several Member States or in response to the requirements of international programmes to provide products for designated regions or specific projects. The products of the SOCs primarily address regional requirements.

c) World Oceanographic Centres (WOCs) which are SOCs on the global scale. The WOCs have highly automated facilities and can deal with large volumes of data and use numerical techniques efficiently for the analysis and forecast of large- and planetary-scale phenomena. Their products are usually available to other centres via the GTS in the form of guidance material to be used for the production of specialized products.

IGOSS should be able to make processed operational oceanographic data of certain regions available for WCRP purposes within one to three months of data observation through the SOCs . Additionally, oceanographic data fed by research vessels from their working area in near real-time to the GTS can be processed by an SOC and the products then transmitted back to the ships. This information can be used as an initial survey of the thermal structure and as an aid to logistic planning concerning further measurement strategy. This type of service can materially help scientists at sea, particularly during major international programmes such as TOGA in which many research vessels of many nations may be taking part over an extended period of time.

The primary requirement with respect to the IDPSS in responding to the needs of the WCRP is the establishment of one or more SOCs to collect the IGOSS data from the GTS and other sources, process the data (including quality control and the allocation of quality control flags in accordance with IGOSS Quality Control Procedures) and compile a data set to be delivered on a regular basis to WCRP Special Analysis Centres or scientists working within the Programme. A request for this service must be officially addressed to IGOSS from the CCCO/JSC or one of their subsidiary units including detailed requirements with respect to data to be included, timing, method of delivery, etc. In the absence of such a request, IGOSS can at best attempt to meet the perceived needs of the WCRP which may or may not meet the specific requirement of one of the experiments or the OOSDP.

6.2 International Oceanographic Data Exchange (IODE) System

World Data Centres A & B for oceanography were established during the IGY to provide an archive for the data collected during the Year. Since then, they have continued to serve an archival and dissemination function for oceanographic data, in particular that related to salinity and temperature. Through the development, encouraged strongly by the IOC's Working Committee on IODE, of national data centres, an international framework has been established capable of supporting some of the data management functions envisaged for WOCE and TOGA. In particular, in addition to long-term archival, several national centres have now offered their services to the international community to provide products/services in specifically defined areas of data management. These may be by geographic region, project or parameter. An example of such a centre is the MEDS drifter centre (see Sections 7.1 and 7.3).

It is recommended that when a specific oceanic data management function is identified, and an organization sought, the WC/IODE be consulted as to its knowledge of existing or potential groups in its organization that could be called on to assist.

Recently the WC/IODE has successfully introducted a General Format (GF-3) which, with common software, permits the construction of a wide number of specific formats for the exchange of a variety of data sets. It has the benefit of being largely self-defining and being able to carry calibration data as well as the main data sets. IOC Manuals and Guides No. 9, Annex 1, Pt. III gives an extended description of the general format.

6.3 Ocean Surface Data and the World Weather Watch (WWW)

Data describing conditions at the air-sea interface are required by both atmospheric and oceanographic components of climate experiments such as TOGA and WOCE. Such data are obtained by satellite remote sensing and in-situ measurement by ships and buoys. Many of the data are obtained by Voluntary Observing Ships (VOS) operating within the WWW system. Although satellite derived data are expected to form the future observational basis for variables such as sea surface temperature and surface winds, other variables (for example, surface air pressure and temperature) will rely on in-situ measurement. It has been suggested, both for TOGA and WOCE (e.g. WCP-81, appendix C) that atmospheric models be used to calculate surface fluxes of heat and momentum. However, such models require further development and there is a need for in-situ measurements for model initialisation and verification (WCP-74). Similarly, where satellite observations are to be used, in-situ observations are required to increase the accuracy and coverage of satellite SST observations, for precipitation and surface wind estimates (2nd session WGSOS, Vienna).

In considering the use of WWW in-situ data for these purposes, it must be realised that the WCRP Ocean requirements in terms of sampling, accuracy and timeliness are not, in general, the same as those for the weather forecasting purposes for which the system was designed. A number of specific recommendations concerning modifications to the WWW marine system are contained within the OOSDP plan (IOC Technical Series No. 27). These recommendations, if implemented, would also increase the value of the data to WOCE and TOGA. Many of the recommendations are concerned with the provision of ancillary data needed to allow quality control and calibration of the WWW data to achieve the specific standards of accuracy needed by WCRP ocean activities.

The meeting recommended that the OOSDP action items pertaining to WWW/WMO contained in IOC Technical Series No. 27, prepared by CCCO, be discussed with WMO with a view to timely implementation. Furthermore, this discussion should encompass data management and procedural changes which might be implemented to satisfy the data needs of the TOGA and WOCE experiments.

6.4 Other Selected Services

World Weather Watch Data

Archives are available that have the decoded observed weather reports from the WWW. These include surface land synoptic, marine surface synoptic, rawinsondes, aircraft reports, satellite atmospheric sounders, satellite cloud drift winds, etc. In addition, many gridded analyses prepared by the meteorological centres are archived. These archives, however, are limited to data exchanged in real-time over the GTS and do not contain the delayed mode data.

Data from operational and research forecast models

There are archives of selected analysis and forecast fields from operational and research analysis/forecast models. Certain operational atmospheric forecast models yield such fields as surface winds, surface latent and sensible heat flux for 12 hours and surface radiation terms but do not prepare the data so that it can be readily accessed. The capabilities of the operational centres need to be assessed to reach archival agreements that would help to support ocean research.

River flow

UNESCO prepares publications (Discharge of selected rivers of the world; several volumes) with monthly river discharges for about 150 to 200 major rivers.

7. ASSESSMENT OF EXISTING SERVICES SYSTEMS

Using the earlier reviews both of the international data networks and of the data requirements of the various identified projects of the WCRP, the meeting assessed how existing systems might help meet these requirements. This assessment can only be preliminary and general because the data requirements for each of the projects is incomplete, particularly with regard to the timeliness requirement of the data. The assessment was therefore primarily made on whether the existing systems handle known data sets and how well existing systems meet the general principles for scientific data management.

Two concerns that could be assessed most effectively by the meeting were timeliness and completeness. Each of the parameter and project analyses in the following Sections reiterate the need to satisfy these concerns and identify a number of cases where the services are deficient in this regard. Specific recommendations, findings and conclusions are cited throughout this report. The meetings general conclusions and findings regarding IGOSS and IODE are:

- IGOSS can provide a mechanism for collecting and distributing near-real-time sub-surface oceanographic data for WCRP purposes if certain improvements are made (see paras 7.1-7.7)

  Major IGOSS deficiencies are:

  1) Only a small portion of the sub-surface data obtained by research vessels enters the IGOSS system.

  2) Only a few countries participate in the IGOSS BATHY-TESAC exchange.

  3) Data availability is poor from many regions, particularly the Tropics for TOGA purposes.

- IODE can adequately function as the archiving mechanism for surface and sub-surface data for WCRP purposes if certain conditions are met. (See sections 7.1-7.7)

  Major IODE deficiencies are:

  1) Delays up to several years in availability of data from WDC's.

  2) Sub-surface circulation exchange and archiving methods are not being used effectively.

- IGOSS/IODE do not provide a mechanism for the exchange of data that could be submitted by observers after 30 days and prior to the data's availability from WDC's. This is a major shortcoming of critical importance for TOGA.

- IGOSS has the potential to organize ocean analysis centre support for the WCRP through its Specialized Oceanographic Centres (SOCs).

- TOGA and WOCE must define a time by which each data set must be available to its analysis centres and/or a time in which a particular data product must be available. Such information is absolutely necessary before implementation plans for data management can be developed and in order to define the details of the roles of IGOSS and IODE in the WCRP.

7.1 Sub-surface Temperature and Salinity Data

There are presently three international systems which capture, exchange and archive sub-surface Temperature (T) and Salinity (S) data; IGOSS, IODE and System Argos. All these systems require observing institutions to submit their data into their streams and this raises serious questions concerning the completeness of the data sets which are thereby collected.

IGOSS provides a mechanism by which temperature and salinity at depth data can be quickly distributed to a variety of data centres and users. The data must be coded and entered onto the GTS within 30 days of its collection time. It is intended that all the data entered onto GTS will be quality controlled both when it enters and when it exits the GTS and that this quality controlled data set will be archived. The archived data set will then carry quality control information. This quality control and archiving system is not yet fully operational although tapes of IGOSS data are being saved.

IGOSS can provide a mechanism for collecting and distributing near-real-time sub-surface oceanographic data provided that:

i) vessels, platforms and institutions collecting sub-surface data can be persuaded to provide the human and/or technological support so that quick look T/S data can be entered into GTS within 30 days of collection

ii) the mechanisms for quality control and archiving of the data stream be put in place

iii) a mechanism be developed so that ancillary data associated with an observing platform can be distributed and archived.

IODE provides a mechanism by which quality controlled data is exchanged and archived internationally. The data in the system are presently restricted to XBT's, BT's, hydrocasts and CTD's although exchange formats for other data types are defined. Generally the movement of data from observing platform to WDC takes several years with delays first by the research scientist in releasing a data set, then by the national centre and finally at the WDC. IODE can adequately function as the archiving mechanism for subsurface T/S data provided that:

i) scientists, research institutions, national data centres renew their commitment to exchange their data

ii) nations provide the resources so that data can be quickly processed and exchanged

System Argos is primarily a satellite based data collection and platform positioning system. Data received by system Argos can be passed directly to IGOSS and/or WWW if requested by the investigator controlling the platform. Data received by system Argos from ocean drifters are being archived by the Marine Environmental Data System (MEDS) in Canada. It is not known if the ocean drifter data to be archived by the MEDS will include all Argos derived data or only those data released by individual scientists or observing institutions

There are several types of T/S sub-surface data which are not handled by the existing systems.

a) Profiling towed CTD systems can provide a 0 to 400 M T/S profile every 5 to 10 km along a ship track. Sub samples of such data can be exchanged via IGOSS but no mechanism exists to exchange or archive the entire data sets or processed average data sets.

b) Moored or drifting self recording T and T/S instruments deliver their data too late for inclusion into IGOSS and are not now exchanged for archival through IODE.

The meeting noted a significant problem with respect to the availability of Sub-surface thermal data which are not presently exchanged through IGOSS. Many of these observations are not made available to the general oceanographic community through the existing IODE exchange procedures until well after (many months to years) the time of observation, if ever. The meeting considered that much of these data will be required within two-three months following the times of observation. However, neither IGOSS nor IODE are presently constituted to collect and exchange such data in this time frame.

The meeting recommended that precise requirements for these data be established by the CCCO and that the task of developing a suitable mechanism (if required) to manage the collection and exchange of these data be assigned to either IGOSS, IODE or some other existing system or unit. The meeting expressed concern that in the absence of such an assignment of responsibility the problem would not be adequately addressed or unnecessary duplication of efforts may be expended by the concerned systems.

The meeting also recognized that large numbers of T and T/S observations are being made by numerous research vessels through the world ocean. However, only a small proportion of these data are entered into IGOSS/IODE. Efforts will have to be undertaken by the scientific communities of each Member State to ensure that a greatly increased volume of these data (especially from the tropics and high southern latitudes) are made available in near-real-time to the WCRP.

7.2 Sub-surface Circulation

Sub-surface velocity profiles can be exchanged via IGOSS if they can be entered within 30 days. Unfortunately, most such velocity data will be collected by self recording moored instruments or by SOFAR, RAFOS or pop-up floats and the data will be available only in delayed mode. International and national methods of exchange and archiving this data are not yet being effectively used.

Increasingly, velocity information may be obtained from acoustic profilers mounted on ship-of-opportunity or research vessels. Subsets of such data could be exchanged by IGOSS. Mechanisms to exchange and archive either the entire data sets for suitable averaged products from such sets are not yet in use.

7.3 Ocean Surface Circulation

This is primarily measured by satellite tracked drifters. These data are received by system Argos and archived by MEDS. Some ancillary data concerning the physical characteristics of each platform should be available; however, it is not known if this will be archived at MEDS.

Useful information is also obtained by comparing a ship position expected from ship heading and speed with the actual position. The UK gathers these data. At low speeds, selected large ships obtain accurate data on currents from their doppler logs. An assessment should be made of whether these ship drift data are valuable for TOGA/WOCE and whether the present collection system is adequate. Also, it should be determined whether the doppler log information is valuable and should be collected and archived.

7.4 Tracers

Various chemical constituents are used to trace movement of water masses. Some of these tracer data are archived by IODE; others are not. It is important to establish which tracers can be measured consistently enough by a variety of groups to be exchanged and archived internationally.

7.5 Completeness of the data

The existing systems of data exchange and archiving fail to capture significant quantities of available oceanic data as is evident from the literature. While noting the efforts underway regarding long-time series information by CCCO and ICES, it is recommended that institutions around the world be canvassed to investigate what data exists in those institutions that has not been exchanged, to learn why existing mechanisms have not been used (or, if they were used, why they failed) and to encourage future data exchange.

7.6 IGOSS Data for TOGA

The meeting reviewed IGOSS as a means for collecting sub-surface thermal information in support of TOGA. The collection system for sub-surface temperature data in place appeared capable of meeting TOGA needs in the tropical ocean if sufficient data were submitted by countries. However, the meeting noted that in 1983, only 14 countries submitted data to IGOSS. Of those 14, only 5 submitted significant amounts of data. It was pointed out that in 1983, the strongest El Niño ever observed took place, with intensive study of the phenomenon by many nations. The nature of the El Niño phenomenon requires near-real-time exchange of information for research purposes. In spite of this, not a single data point was submitted to IGOSS in 1983 by any country in the El Niño region.

The meeting agreed that if the IGOSS system is to be of value to TOGA and other experiments of the WCRP, it must be used by Member states. The meeting thus recommended that CCCO alert the IOC and WMO, and through them the appropriate subsidiary bodies, that the submission of data through IGOSS by many Member States is inadequate for WCRP purposes.

7.7 A WOCE view of existing systems

Taken within the framework of the functional diagram for data management in figure 1, the following remarks can be made:

1. WOCE needs for originating, analysis, and data coordination units are not specified but it can said that suitable centres generally will not be found to exist.

2. The IODE system has the potential to meet the long-term archival requirements in association with the WDC's. The IODE Responsible National Oceanographic Data Centre (RNODC) System has the capability of expansion to serve as assembly centres and analysis centres for some particular types of data.

3. The IGOSS system can be utilized to generate data and to provide a mechanism for exchanging data.

4. CCCO or WOCE/TOGA SSG's must identify groups ready to assume global (or possibly regional) responsibilities for analysis and quality control. In general, to meet the WOCE needs, it will be best to co-locate these groups with one or other of the major WOCE/TOGA scientific projects (labs).

5. At present, prototypes of the sort of groups that could grow usefully from the present organizations are:

   i) the Canadian MEDS office to act as an RNODC for drifting buoy data. It is already in touch with Service Argos, Toulouse to acquire the full tapes.

   ii) the IGOSS Pilot Project on MSL in the Pacific which is basing itself on and assisting in the expansion of existing systems.

8. XBT DATA FLOW ILLUSTRATION

The general data management scheme (see section 3) will now be illustrated using the flow of XBT data. Typically, two XBT data sets can be expected: one received via near-real-time radio telecommunications (IGOSS Mode) and the other via National and International data Centres (IODE Mode).

The IGOSS Mode - Ships crews will forward BATHY (XBT Code format) messages (level IIa data) to National Centres for insertion on the GTS within 30 days of observation time. BATHY messages may be forwarded via HF to coastal radio stations, satellite links or in hard copy form after returning to shore. In the latter case, the BATHYs may pass through a laboratory prior to forwarding to a National Centre. Once the BATHYS are on the GTS they may be copied for retention by any participating Member State. In our example, an IGOSS Specialized Oceanographic Centre (SOC - See figure 8) operated by one of the Member States will be responsible for extracting all XBT data in BATHY form from the GTS, providing quality control and producing a level IIa data set for submission to the Permanent Archive. The SOC, in this case, would be acting as the "International" Data Centre in figure 1. The SOC would also provide its level IIa data sets to the Special Analysis Centres. An example of the latter would be a TOGA Ocean Subsurface Data Centre (see figure 4). This Special Analysis Centre could also arrange direct access to the GTS. The

Special Analysis Centres would be responsible for producing level III data (processed products) and providing them to scientists and to the Permanent Archives. Procedures for the IGOSS Mode are described in IOC Manuals and Guides No. 3.

The IODE Mode - All XBT data, including those which have been distributed in the GTS in BATHY form within 30 days must follow the IODE mode. In this mode, the XBT's go through the national laboratories (research institutions, governmental institutions) to National Oceanographic Data Centres (NODCs) or Designated National Agencies (DNA) which are components of the IODE system. The NODCs, DNAs (represented in figure 1 by the box "Laboratory or National Centre") will then forward a quality controlled set (level IIb) to the "International Data gathering and quality control" Centre. In the IODE Mode, these are usually Responsible NODC's (RNODC's). This set will form the Level IIb data set which should be available within a time frame of one year. The RNODC's will provide the IIb data sets to the Special Analysis Centres and to the Permanent Archives. As in the IGOSS mode example above, a TOGA Ocean Sub-surface data centre is a Special Analysis Centre.

In our example, the Special Analysis Centres have received data sets from both the IGOSS and IODE Modes. There is, however, a shortcoming in this system. The Special Centres, which are the primary centres supporting the WCRP scientists, are deprived for many months, perhaps years, of XBT data that does not come through the IGOSS Mode (See Section 6.1). An arrangement must be made so that data older than 30 days can arrive at the Special Analysis Centre sooner than it would through the IODE mode. This is mandatory for TOGA purposes. One solution would be the agreement of a Special Analysis Centre to accept hard copy or other forms of data so that scientists or National Agencies can send copies of their XBT data directly to the Special Analysis Centre as well as through the IODE Mode (see Section 7.1 also).

Annex I

CCCO/IGOSS/IODE Ad hoc Meeting

on

WCRP Ocean Data Management
(8-12 October 1984, Paris)

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Annex II

CCCO/IGOSS/IODE Ad hoc Meeting

on

WCRP Ocean Data Management
(8-12 October 1984, Paris)

Agenda

1. Objectives of the meeting
   Reference CCCO-5, paras. 67-70

1.1 Determination of Data to be addressed

- Marine Scientific Research project oriented data
- Atmosphere/Interface/Ocean
- Data Related to the OOSDP

2. WCRP Ocean Data and Data processing/management Requirements

2.1 Tropical Ocean and Global Atmosphere (TOGA)
2.2 World Ocean Circulation Experiment (WOCE)
2.3 Ocean Observing System Development Programme

3. WCRP Data and Data Processing/management Projects

3.1 *In-situ* Sea-level
3.2 Sub-surface Thermal Structure
3.3 TOGA Projects

4. World Climate Data Programme

5. Summary of WCRP ocean data and data processing/management Requirements

6. WCRP Data Management Strategy

7. Existing Ocean Data Services Systems

7.1 Integrated Global Ocean Services System
7.2 World Weather Watch
7.3 International Oceanographic Data Exchange
7.4 Satellite Data Systems
7.5 Activities in which the existing Ocean Services Systems can be focused and developed to the benefit of the WCRP

8. Identification of Aspects of WCRP ocean data management in which entirely new international initiatives need to be established

9. Action Items for consideration by CCCO and other bodies

10. Mechanism for continuation of the assessment and planning of data management activities

Annex III

OOSDP Action Items
(From the report of CCCO-5)

The following action items were identified by CCCO on the basis of the recommendations contained in the revised Observational Systems Plan. Elaborations of all items can be found in the "Plan" which is available through the Secretary CCCO.

I. INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Sea level (Streams 2 and 3)

(TOGA; global sea level; altimeter validation)

- Maintain existing long-term stations.
- Establish new stations.
- Tie all long-term stations to geodetic net (Stream 3)
- Quality control, including interaction with data collection bodies (with PSMSL)
- Data exchange (with PSMSL)

II. WORLD METEOROLOGICAL ORGANIZATION

Ship meteorological observations (for Streams 1, 2, 3)

(SST for Stream 1, wind, air temperature (wet and dry bulb) for Streams 2 and 3)

- Distinguish bucket, injection and skin SST's in analyses and archives (with IOC through IGOSS and IODE).
- Distinguish day and night air (wet and dry bulb) temperatures.
- Maintain ship ID in all archives.
- Establish ship calibrations for injection temperature, anemometer height.

- Consider reporting ship heading with wind data.
- Improve quality control procedures.
- Monthly mean analysis (with IOC through IGOSS).
- Data exchange.

Pilot project on operational time VOS data transmission and assembly in tropical Atlantic (Stream 1) (forecast droughts in N.E. Brasil, data management) -

- Identify suitable shipping lines.
- Install satellite communications.
- Establish analysis center and experimental forecast procedures.
- Assess utility and design extended programme.

Quality controlled subset of VOS surface data (Streams 2 & 3) (determine biases) -

- Select routes and instrument packages.
- Install packages and communications systems on selected ships.
- Determine installation dependent corrections.
- Compare data with neighboring VOS data.
- Infer biases in historical VOS records.
- Assess potential impact of quality control and operational time communications on system performance.

In-situ radiation measurements (Streams 2 & 3) (calibrate satellite solar flux) -

- Panel of experts on required sampling and quality control.
- Locate or train technicians.
- Observations from research ships of opportunity.
- Intercompare with satellite estimates.

III. INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION AND WORLD METEOROLOGICAL ORGANIZATION

Drifters (Streams 2 and 3)

(Surface pressure in Southern Ocean, surface currents for TOGA, mesoscale eddy energy for WOCE, gyre variability)

- Panels of experts on choice of hull designs and sensors, data exchange and analysis launch sites and frequency (with SCOR and ECOR).
- Maintain existing series in Eastern Pacific.
- Initiate series in Indian Ocean.
- Negotiations of tariff agreement with ARGOS.

IV. INTEGRATED GLOBAL OCEAN SERVICES SYSTEM AND INTERNATIONAL OCEANOGRAPHIC DATA EXCHANGE WORKING COMMITTEES

Sea Surface Temperature (Stream 1)

(Data base for global, seasonal SST climatology and anomaly relaxation analysis, for statistical modelling and routinely as initial conditions)

- Adjust analysis procedures for different kinds of conventional SST data.
- Assess system performance.
- Quality control, including interaction with data collection bodies.
- Data exchange.

Sea Level (Streams 1 and 2)

(Monthly MSL analyses)

- Develop the IGOSS Sea Level Pilot Project (ISLPP) for the Pacific and extend to other oceans as feasible.

Subsurface heat storage (Stream 2)

(For TOGA, pilot study for WOCE)

- Maintain existing XBT ship-of-opportunity network in Pacific.
- Extend network to Indian Ocean and elsewhere.
- Quality control, including interaction with data collection bodies.
- Data exchange.

V. COMMITTEE ON CLIMATIC CHANGES AND THE OCEAN

Sea surface temperature

- Establish anomaly regression formulae (for Stream 1)
- Design and implement long-term calibration system using selected in-situ measurements.

Sea level

- Analyse network performance in terms of variability from altimetry.
- Evaluate the ISLPP.

Drifters

- Recommend Extension for the Equatorial Atlantic, North Atlantic, Pacific.

Acoustic current profiling from merchant ships

(With SCOR)

- Install a small number of instruments on selected ships.
- Exploratory time series in selected regions.
- Characterise variability of near surface currents and profiles.
- Design surface current observing systems.

Subsurface heat storage

(Exploratory time series for Streams 2 and 3)

- Complete analysis of existing data.
- Design extended ship-of-opportunity network.
- Assess system performance.

Sea ice (Stream 3)

(Water mass formation)

- Design long-term calibration and validation procedures.

Assess 4-dimensional assimilation of surface fluxes

(Improved analyses of heat and freshwater fluxes, for all streams)

- Analyse surface heat and moisture fluxes for oceanographic consistency.

VI. JOINT SCIENTIFIC COMMITTEE FOR THE WCRP

Sea surface temperature

- Determine SST accuracy requirements by region and season for atmospheric prediction purposes.

4-dimensional assimilation models for surface fluxes

(Improved analyses of heat and fresh water fluxes for all Streams)

- Analyse mean heat-flux divergencies over continents.
- Compare output maps of surface stress with statistics of input data.

VII. JSC-CCCO WG ON SATELLITE OBSERVING SYSTEMS FOR CLIMATE RESEARCH

Sea surface temperature (for Stream 1)

(Data base for global, seasonal SST climatology and anomally relaxation analysis for statistical modelling, and routinely as initial conditions)

- Update operational satellite algorithms.
- Establish in-situ network for satellite data calibration.
- Quality control (e.g. sensor failure, volcanic dust).
- Data exchange.

Sea level (for Streams 2 and 3)

(Relationship between altimetric fields and in-situ sea level network)

- Analyse (in-situ) data network in terms of variability fields of altimetry.

Cloud winds (for Stream 2)

- Develop automatic rational algorithms to match Wisconsin winds in FGGE.
- Implement highest quality cloud-clearance algorithms.
- Design and implement.

Calibration and validation procedures for Scatterometer (Streams 2 & 3)

- Analyse SEASAT data for apparent biases.
- Support research on retrieval algorithm.
- Design and establish in-situ intercomparison stations.
- Assess scatterometer system performance.

Sea ice (Stream 1)

(Data base for seasonal variation of sea-ice extent climatology and anomaly relaxation analysis, for statistical modelling and, routinely, as initial conditions for Stream 1)

- Actions to be defined.

Annex IV

World Climate Data Programme

1. Introduction

The purpose of the WCDP is to ensure timely access to reliable climate data which are exchangeable in acceptable format to support climate applications, impact studies and research. The Plan for the WCDP defines "climate data"; identifies requirements for climate data organization; critically reviews existing data management systems; and proposes actions required for improvement. Appendix 1 lists the elements constituting "climate data" as defined in the Plan. Appendix 1 represents a definition of "climate data" for broad guidance purposes and is not all inclusive. Appendix 2 depicts the present organization of climate data archives in terms of national, regional and global centres. Depending on the requirements of WCP projects centres may need to be established.

The implementation of defined objectives of the programme necessarily involves all WMO programmes, WMO technical commissions and other relevant international organizations. The WCDP plays a catalytic role in the identification of priority action areas' implement selected target projects; develop plans to achieve a transfer of technology; and support design studies towards a globally cohesive, distributed, climate data management and user service system.

Within special projects of the WCP, it would be important (for implementation purposes) to clearly identify what data types are required; how much (number of stations/observing - space/time resolutions); from where (specific observing point locations); to where (designateed centres to which data should flow); the time frame-work for data exchange; mode of exchange (telecommunications, hard-copy/magnetic tape by mail); and purpose.

2. WCDP Implementation

WCDP activities address the following priority action areas:

a) Review, collect, consolidate data requirements

b) Assist countries to improve, upgrade climate data management systems/services (national, sub-regional/regional, global/international) - including data procdssing, quality control and archiving/retrieval, data inventories/catalogues, user services

c) Promote and facilitate the transfer of technology in climate data processing and management - emphasis on computer system specifications and software, education and training (CLICOM)

d) Collect, consolidate, disseminate information on climate data sources - World Climate Data Information Referral System (INFOCLIMA)

e) Climate System Monitoring (CSM): collect, consolidate, disseminate information on significant climatic events, fluctuations, changes within (or affecting) the atmosphere-ocean-cryosphere-land surface climate system

f) International co-ordination

CLICOM

The CLICOM project of the WCDP is aimed at achieving a transfer of technology (computer hardware, software and training as a package) in climate data management, processing and user services. Currently being pursued is the development and testing of prototype systems. Implementation is expected to begin in 1985, with "donor" country or other international (e.g. WMO/UNDP) support. Included will be training components for countries receiving CLICOM systems; and training seminars/workshops on climate data management and user services at the regional level. Microcomputer - based data processing and exchange (floppy disks) may be applicable to several data management aspects of TOGA (for example).

INFOCLIMA

A primary requirement in national/regional and international projects in climate research, applications and impact studies is the need for concise information on station networks (including period of operation and other basic station history informaiton), and the availability (where and in what media of data sets and data sumaries. Information collected, on the basis of WMO Resolution 15 (EC-XXX), from over 100 countries is presently being summarized in standard format for the preparation of the WMO Inventory of Climatological and Radiation Stations. Based on "test" data set descriptions from a few data centres, a preliminary INFOCLIMA catalogue of climate data sets has been developed (format) and distributed to Members to assist in the preparation of similar summary information as requested through WMO circular letter M/C9, PR-3694 dated June 1984. The input information formats developed under INFOCLIMA for the computerized storage of easily retrievable information will be the basis for a guide to using INFOCLIMA and for developing national referral services. Basic INFOCLIMA catalogues will be published in 1984/85.

It was proposed that similar activities be considered for "ocean" stations (e.g. tide gauge) under the framework of MEDI (IOC). As necessary, the WCDP is prepared to cooperate.

Climate System Monitoring (CSM)

Notable climate system anomalies have occurred over the last several years. The recent 1982-83 El Nino/Southern Oscillation, one of the strongest in the century, was associated with significant economic disruption through floods (and prolonged wet periods) in some areas and droughts in others. A first "experimental" monthly bulletin, prepared by WMC-Washington as a contribution to the WCDP, was distributed by WCDP in June 1984. The bulltein contained global analyses of temperature and precipitation anomalies together with statistics which indicated the persistence of hot/cold, wet/dry spells. Future issues will contain sea-level and SST anomaly analyses, and, aperiodically, time series of selected parameters/indicators. Also envisaged are: the issue of summaries once a year containing simple text and graphical material (analyzed fields and time series of selected indices and area averaged parameters) which provide an insight into the atmosphere-ocean-cryosphere-land surface climate system; and bi-ennial scientific reviews. This CSM activity of the WCDP is aimed at assisting Meteorological Services and other organizations/agencies to obtain information products from large centres (which have the facilities to handle/process/analyze global data fields); and to facilitate the interpretation of anomalous climatic events at the sub-synoptic/regional scale in the context of changes occurring elsewhere. CSM represents an international mechanism whereby normally inaccessible multi-disciplinary data/information can be obtained.

It was suggested to the meeting that the CSM activity of the WCDP may be an appropriate vehicle to carry selected summary information/products which are expected to be generated by (for example) TOGA analysis Centres. It was underscored, however, that for the CSM-Monthly, it was important to limit information to key fields/time series, to avoid clutter.

Appendix 1

REQUIREMENTS FOR "CLIMATE DATA" ORGANIZATION

Elements constituting "climate data"

The elements considered to be directly relevant to the earth-ocean-cryo-sphere-atmosphere climate system, are the following:

Upper air: pressure, temperature, wind direction/speed, humidity/moisture - profiles; upper-air circulation patterns.

Surface terrestrial: precipitation (liquid and snow), temperature, max/min temperature, pressure, wind speed/direction, cloudiness, evaporation, snow (coverage, type, depth/water content), moisture/humidity, sunshine duration, net radiation. Also included are data on hail, frost, thunderstorms, severe weather, gales and gusts, sand storms and maximum wind speeds.

Ocean surface and sub-surface: surface winds, temperature, sea surface, temperature, air-sea temperature differences, heat content, temperature and salinity profiles, sea level, near surface currents, deep ocean circulation, velocity profiles, evaporation, precipitation, pollution by chemicals, oil and petroleum products.

Cryosphere: glaciers and continental ice sheets - size, elevation, movement; ice sheet boundaries, sea-ice boundaries, sea-ice coverage, thickness, melting and drift; snow cover and water content.

Radiation budget: related data on clouds (radiation effect) - cover, type height, thickness/optical depth; planetary radiation budget components, solar constant, solar UV flux, surface albedo, surface radiation, net solar and IR radiation at the surface, land and ice surface temperature.

Atmospheric composition: CO_2, O_3 and other radiatively active gases, N_2O, CFMs, CH4, trace gases, stratospheric H_2O and aerosol, tropospheric aerosol, turbidity, pollution, air and precipitation chemistry.

Hydrosphere: surface water (rivers, lakes, reservoirs - stage, run-off, streamflow, sediment transport/deposition, temperature and physical and chemical properties of water, characteristics and extent of ice cover). Ground water (water level, temperature physical/chemical properties of water).

Land and vegetation: water run-off, evaporation/evapotranspiration, plant water stress, soil temperature/moisture at the surface and at various depths, vegetation cover and changes, phenological data, soil type and changes.

Proxy data: proxy climate data derived from a wide range of biological, geological and geophysical phenomena; ice-cover ocean cores (micro-fauna and isotopes), tree rings, lake varves, pollen records.

Solar data: sun spots and flares, alpha particles, solar magnetic fields.

Appendix 2

Figure 1: Data Management and Archiving Centres

Building Blocks of a Co-ordinated Distributed Climate Data Management System

Data Category	National	Specialized or Regional	Global or International
Synop. Met.: Surf. Marine, Upper-air	NMC/NCC	RMC	WMC
Surface climate Precipitation	Nat. Services, Nat. Agencies		
Oceanography	Nat. Centres	SOC/RNODC	WDC
Marine Met. - Logbook obs.	Nat. Services	Responsible Members (8)	Members
Surface Radiation	Nat. Services Res. Inst.		WMO Centre
Glaciology, Snow and Ice	Nat. Agencies Res. Inst.		WDC, PSGF WGI
Atmos. Comp., CO_2, O_3, Chemistry, Pollution, Aerosol	National BAPMoN		WDC (Ozone) BAPMoN
Hydrology	National and Sub-national		
Agriculture - Meteorology	National and Sub-national		
Agriculture - Agronomy	National and Sub-national		
Land surface, Vegetation, Crops, Soil, etc.	National and Sub-national		
Satellite	Nat. Services Res. Inst.	Regional	
Proxy	Research Groups	Specialized Data Banks	
Solar and extra-terr. radiation	National Services	Specialized Institutes	WDC
Res. Expt. data sets-Meteorology	National Services	Special Centres	WDC
Other types of data: Mean Sea Level, Gravimetry, Earth tides, Ionosphere, Seismology, Tsunamis, Geomagnetism, Paleomagnetism, Volcanology, ..., ..., ..., ...	National Services		ICSU Centres

I N F O C L I M A (not yet established)

Acronyms

International Service for Information on Data Sources

USERS WCRP, WCAP, WCIP

U S E R S, W C R P, W C A P, W C I P

Annex 5

Glossary of Acronyms and Special Terms

AOSB	Arctic Ocean Sciences Board
AXBT	Airborne Expendable Bathythermograph
AIDJEX	Arctic Ice Dynamics Joint Experiment
AGCM	Atmospheric General Circulation Model
CCCO	Committee on Climatic Changes and the Ocean, (of SCOR & IOC)
CAS	Committee on Atmospheric Sciences (of WMO)
CTD	Conductivity-temperature-depth instrument to obtain salinity and temperature profiles
CAGE	Heat-flux experiment proposed in the north Atlantic Ocean, so named for the design of the observing system network
EAZO	Energetically Active Zones of the Ocean
ECMWF	European Centre for Medium Range Weather Forecasting, operated by a group of European meteorological services, located near Reading, UK
EGCM	Eddy-resolving General Circulation Model
ENSO	El Niño - Southern Oscillation
EPOCS	Equatorial Pacific Ocean Climate Studies, USA
ERBE	Earth Radiation Budget Experiment, USA
ERFEN	Estudio Regional del Fenómeno El Niño
ERS	Earth Remote Sensing satellite, being planned by the European Space Agency for launch circa 1988
FGGE	First GARP Global Experiment, conducted November 1978 through 1979
FOCAL	Français Océan et Climat de l'Atlantique Equatorial, France
GARP	Global Atmospheric Research Programme, organized jointly by ICSU and WMO. One of the GARP goals was to provide some information on climatic variability. The World Climate Research Programme arose from considerations of logical follow-on international activities
GCM	General Circulation Model
HAIKU	Heat Advection Investigation in the East Kuroshio
ISLPP	IGOSS Sea Level Pilot Project

ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
IAEA	International Atomic Energy Agency
IGOSS	Integrated Global Ocean Services System
IOC	Intergovernmental Oceanographic Commission
IMO	International Maritime Organization
IODE	Working Committee on International Oceanograhic Data Exchange
IREP	International Recruitment Programme
JSC	Joint Scientific Committee (ICSU and WMO) for the WCRP
MIZEX	Marginal Ice Zone Experiment
MONOC	International Symposium on Global Ocean Monitoring
MOS	Marine Observation Satellite, Japan
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration, USA
NOAA	National Oceanic and Atmospheric Administration, USA
NORPAX	North Pacific Experiment, USA
OGCM	Oceanic General Circulation Model
OHTEX	Ocean Heat Transport Experiment, a Japanese programme south of Honshu
OMLET	Ocean Mixed Layer Experiment, a Japanese programme in the western Pacific/Kuroshio region
PATHS	Pacific Transport of Heat and Salt
PEQUOD	Pacific Equatorial Ocean Dynamics, USA
SEASAT	USA Oceanographic Satellite
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SLAR	Side Looking Aperture Radar
SEQUAL	Seasonal, Equatorial, Atlantic Experiment, USA
SAR	Synthetic Aperture Radar
SPC	South Pacific Commission

SPOT Satellite Pour l'Observation de la Terre, France

SSG Scientific Steering Group

SST Sea Surface Temperature

SECTIONS A USSR programme of close-spaced repeated oceanographic observations along lines traversing regions of the oceans thought to be particularly active with respect to ocean/atmosphere coupling

TOGA Interannual Variability of the Tropical Oceans and Global Atmosphere

TOPEX Topographic Experiment, a programme under study in the USA designed to use a high precision satellite radar altimeter to measure the topography of the ocean

TROPIC HEAT A USA research programme on the Tropical Pacific Upper Ocean Heat and Mass Budgets

TSOM Time Series of Ocean Measurements

TTO Transient Tracers of the Ocean

UNESCO United Nations Educational, Scientific and Cultural Organization

UNEP United Nations Environmental Programme

WCRP World Climate Research Programme

WESTPAC Western Pacific Programme of Oceanographic Observations coordinated through the Intergovernmental Oceanographic Commission of UNESCO

WMO World Meteorological Organization

WOCE World Ocean Circulation Experiment

WOCE-NEG WOCE - Numerical Experimentation

WWW World Weather Watch, the global network of surface, upper air and special meteorological observing systems operated by the meteorological services of the world and coordinated through the World Meteorological Organization

XBT Expendable bathythermograph, launched from ships

XCTD Expendable conductivity-temperature-depth probe, deployed from ships