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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of Unesco)

REPORT ON MEETING, EFFECTIVELY AND EFFICIENTLY, NEW DATA REQUIREMENTS ARISING FROM TECHNOLOGY DEVELOPMENT, REMOTE-SENSING OBSERVATIONS, AND THE WORLD CLIMATE RESEARCH PROGRAMME

The IOC Assembly at its Thirteenth Session requested "the Working Committee on IODE to study carefully and prepare recommendations to meet, effectively and efficiently new data requirements arising from technology development, remote-sensing observations and the World Climate Research Programme and to report on its findings in this field to the next Session of the Executive Council".
This document was prepared by the Chairman of the Working Committee on IODE (Mr. D. Kohnke) and the IOC Secretariat in response to this request.

SC-86/WS/3

1. BACKGROUND INFORMATION ON IODE SYSTEM

IODE system has been established under the guidance of ICSU and IOC to facilitate the exchange of oceanographic data and to provide conditions for long-term data archiving. IODE network, comprised of world and national data centres is a remarkable example of a system for supporting international co-operation in the marine sciences. The network is supported entirely by data servdices in Member States and, through their concerted efforts, it has been possible to serve users in all countries with centrally archived data and computerized data banks.

The IODE system can be subdivided into three operational levels each with specific functions: national oceanographic data centres (NODCs) or designated national agencies (DNAs); responsible national oceanographic data centres(RNODCs); world data centres (WDCs).

RNODCs operate at the second level - reformatting data from national into international standard formats, merging of national data into international general or specialized files, compilation of specialized catalogues, provision of data to participants in international projects, etc. (see Annex II). The incompatibility of national oceanographic data formats, the increasing volumes of data, the complexity of processing of oceanographic data and the emergence of large international projects (such as WCP, GARP, WESTPAC, El Nino, etc.) contribute to the need for such services.

The RNODC scheme is not intended to promote a system of archival centres competing in any way with established National or World Data Centres. One of the main responsibilities of all types of RNODCs is to co-operate closely with the WDCs-Oceanography and to ensure regular shipments to the WDC, at least once a year, of complete data sets for each past year for archiving and distribution so that the sets can be available to users without considerable delay. Description of presently envisaged types of RNODCs (data, specific project, specific region and technical types) and the guidelines used for the operation of RNODCs are presented in the IOC Manual and Guides N° 9 part II, Unesco 1982.

Two WDCs were established in 1958 specifically for Oceanography: the WDC-A in the U.S.A. and the WEC-B in the USSR.
Both operate entirely at the expense of the host countries. They are responsible for collection, storage and provision of oceanographic data, catalogues and other information to data users in different countries.

The regulations concerning the worldwide exchange of oceanographic data are detailed in the Manual on International Oceanogrpahic Data Exchange published in IOC Manual and Guides N° 9, Unesco 1976. A new updated edition will be issued in 1986. The IODE Manual recommends that preferably all data should be made available within one year of their collection for the international exchange.

2. HOW THE IODE SYSTEM MIGHT HELP TO MEET DATA REQUIREMENTS OF THE WCRP

2.1 INTRODUCTION

The Joint CCCO/IGOSS/IODE ad hoc meeting on WCRP Ocean Data Management (October 1984, Paris) critically evaluated the existing data management services system - IGOSS and IODE and identified their major dificiencies as:

IODE - Delays up to several years in availability of data from WDCs;

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

Nevertheless the general conclusions of the meeting was that IODE can adequately function as the archiving mechanism for surface and sub-surface data for WCRP purposes.

This view was shared by the Joint IOC/SCOR CCCO at its Sixth Session which noted that the assessments mentioned above, while critical indicated that IODE is a useful mechanism for the collection, exchange and archival of surface and subsurface data. It should be noted that the identified deficiencies in many cases may be easily overcome if necessary resources are available and data originators strictly follow the agreed upon commitments.

It should be noted that in order for IODE to support the WCRP WCRP must support IODE. This support would involve the submission of data collected by the research community to the IODE system. This is an important issue because of the reluctance of some scientists to make their data available to the international community in the agreed time frame.

The Working Committee on IODE noted with concern that data collected by research vessels were not received by data centres for many years, sometimes not at all. For example, the Report on International Oceanographic Data Exchange for 1984 submitted by the WDC-B, Oceanography contains the following figures of data arrivals from 59 countries for different time periods: (see table 1). This is in spite of the fact that in 1983, 18 IOC Member States declared data from almost 100 cruises open for international exchange.

This may be the result of legitimate time periods necessary to completely process and analyse a data set, or this may reflect the reluctance of some scientists to release data until a publication is completed.

The main concern of scientists to the effectiveness of the IODE pursuant to the delay of products development can be overcome in many countries if time limits identified in data management plans are kept by scientists themselves.

The Meeting of Experts on Climatic Oceanographic Data Management (Beijing, China, 22-26 April 1985) noted that existing data flow management for BATHY/TESAC data (figures 1 and 2) correspond fully to the suggested data flow and time limits for TOGA purposes and recommended a diagram of data flow of BATHY/TESAC data for TOGA in which the place of NOCs/NMCs and SOCs (of IGOSS) and NODCs/DNAs and RNODCs of IODE is clearly identified (figure 3). One may note that if the diagram is accepted, RNODCs-IGOSS may easily take the responsibilities of TOGA Data Centers for this type of data.

Table 1

TOTAL NUMERICAL CHARACTERISTIC OF OCEANOGRAPHIC DATA, RECEIVED BY WDC B1 FROM 59 COUNTRIES

YEARS DATA WERE OBSERVED	PERIODS	CRUISES	OCEANOGRAPHIC STATIONS	BT	CURRENTS SURFACE	CURRENTS ABYSSAL	BATHYMETRY	BOTTOM SEDIMENTS SURFACE	BOTTOM SEDIMENTS ABYSSAL	BOTTOM SEDIMENTS BOTTOM PHOTOGRAPHY	BIOLOGY	GEOPHYSICS MAGNETIC	GEOPHYSICS SEISMOLOGICAL	GEOPHYSICS GRAVIMETRIC	GEOPHYSICS BOTTOM HEAT FLOW
UP TO 1960 (INCLUDING)	A	1720	140734	53563	60462	29893	108	1366	1868	72	22349	229	0	0	25
	B	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	1722	140734	53563	60462	29893	108	1366	1868	72	22349	229	0	0	25
FROM 1961 TO 1965	A	2962	190305	78664	41507	3385	10714	3978	2337	832	28486	12042	11594	15246	106
	B	12	1358	0	0	0	0	0	0	0	0	0	0	0	0
	C	2974	191663	78664	41507	3385	10714	3978	2337	832	28486	12042	11594	15246	106
FROM 1966 TO 1970	A	4032	243641	98884	75998	18171	20332	1204	2153	1256	46586	24236	20903	16839	363
	B	30	3020	497	0	0	0	0	0	0	0	0	0	0	0
	C	4062	246661	99381	75998	18171	20332	1204	2153	1256	46586	24236	20903	16839	363
FROM 1971 TO 1975	A	3598	182809	76792	144575	41405	52985	1054	2852	1070	33664	46410	30340	40336	0
	B	32	1726	21	0	903	6	0	0	0	505	28	34	28	0
	C	3630	184535	76813	144575	42308	52991	1054	2852	1070	34169	46438	30374	40364	0
FROM 1976 TO 1980	A	1228	64122	31002	112375	2873	25022	2138	661	9	15023	22241	81	25599	0
	B	530	41851	22236	18339	99	25	77	3	0	2566	19	0	0	0
	C	1758	105973	53238	130714	2972	25047	2215	664	9	17589	22260	81	25599	0
1981	A	30	2023	412	383	17	0	0	0	0	97	0	0	0	0
	B	99	2345	3113	20612	119	0	0	0	0	1216	0	0	0	0
	C	129	4368	3525	20995	136	0	0	0	0	1313	0	0	0	0
1982	A	13	2241	24	0	0	0	0	0	0	0	0	0	0	0
	B	22	1714	1026	263	0	0	0	0	0	0	0	0	0	0
	C	35	3955	1050	263	0	0	0	0	0	0	0	0	0	0
1983	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	4	149	100	0	0	0	0	0	0	0	0	0	0	0
	C	4	149	100	0	0	0	0	0	0	0	0	0	0	0
FOR ALL YEARS	A	13583	825875	339341	435300	95744	109161	9740	9871	3239	146205	105158	62918	98020	494
	B	731	52163	26993	39214	1121	31	77	3	0	4287	47	34	28	0
	C	14314	878038	366334	474514	96865	109192	9817	9874	3239	150492	105205	62952	98048	494

A - amount of data received by December 31, 1983

B - amount of data received from January 1 to December 31

C - amount of data received by December 31, 1984

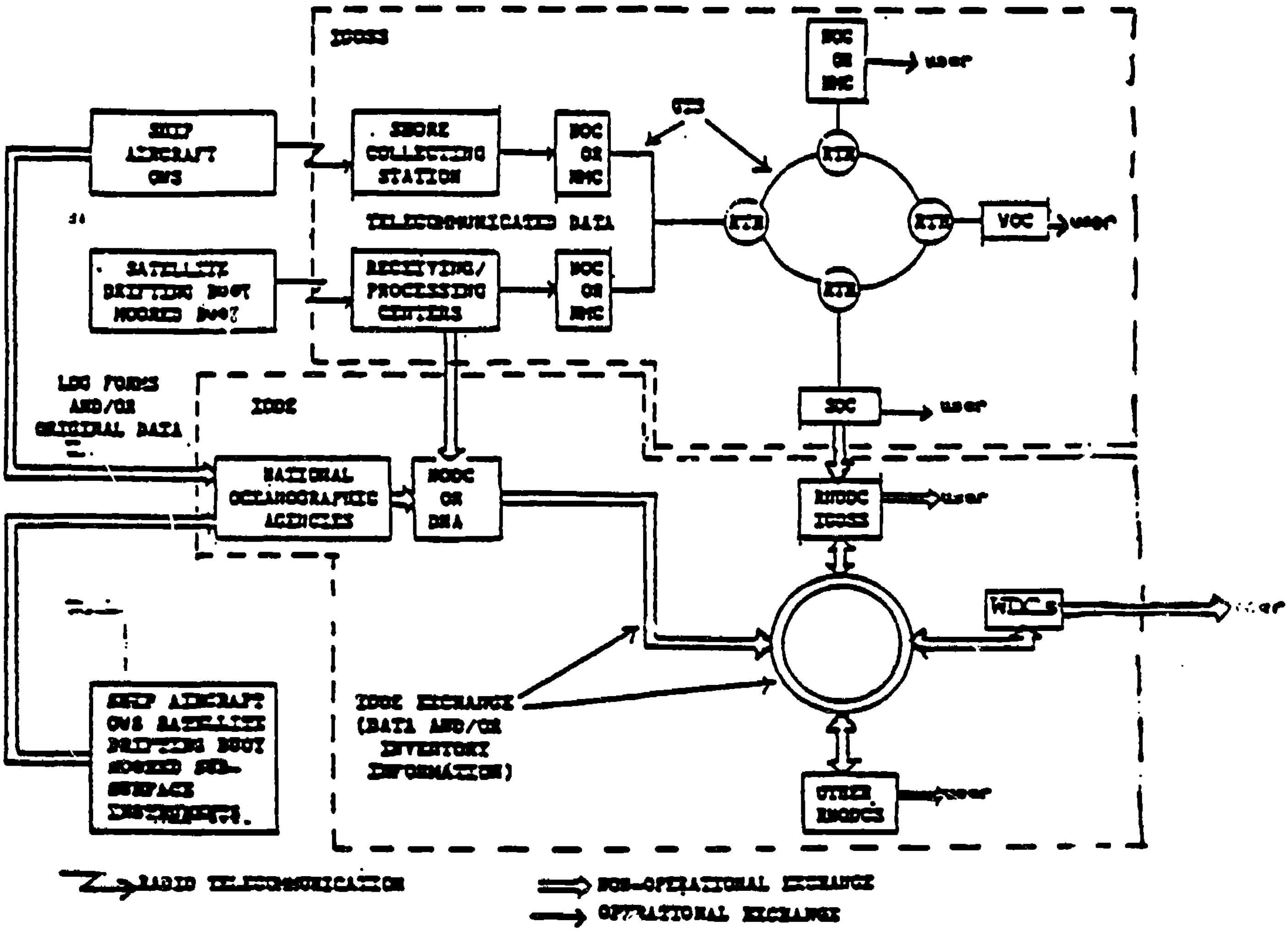

Figure 1 The IGOSS/IODE Data Flow Diagram

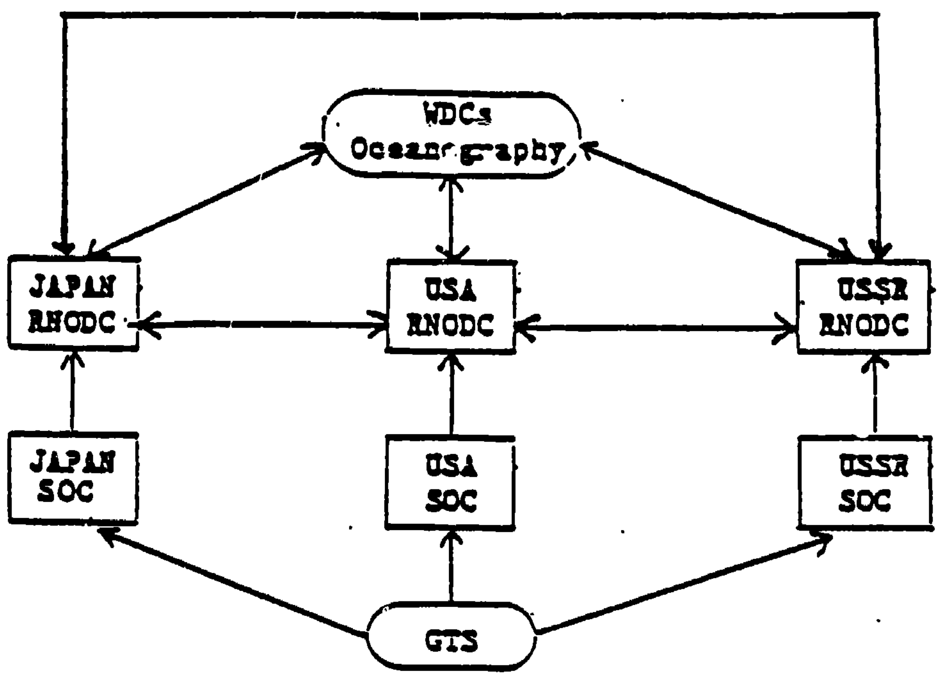

Figure 2 Data Flow between IGOSS-SOCs and IODE-RNODCs

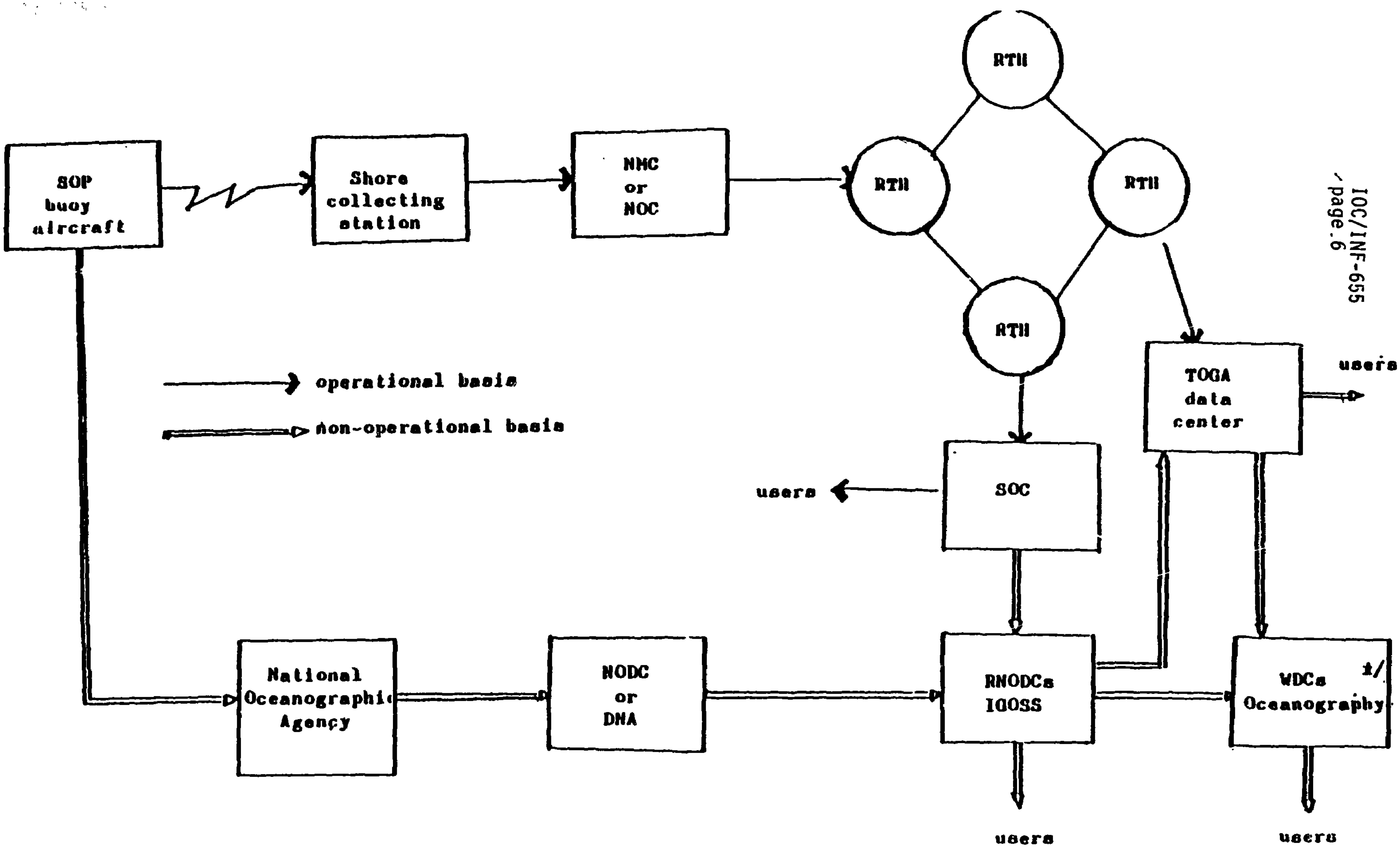

Fig 3 Flow of BATHY/TESAC data for TOGA
(proposal made by the Meeting of Experts on Climate Oceanographic Data Management, Beijing, China, 22-26 April 1985)

*/ WDCs will be requested to maintain a separate TOGA archive

To facilitate IGOSS data exchange and to document procedures to be followed in processing and archiving BATHY/TESAC data in the RNODCs for IGOSS and the World Data Centres for Oceanography, the Guide to IGOSS Data Archives and Exchange (BATHY and TESAC) was published in the IOC series Manual and Guides N° 1 in 1985. It is a very useful document not only for data managers but also for scientists and engineers who wish to use the data and who are not very familiar with the system.

It would be much more complicated to use the IODE system for managing other types of non-operational data at Level IIB. Due to the anticipated time limits of TOGA, only a few NODCs of the IODE system in developed countries will be able to provide the TOGA Data Centre with CTD/STD/Nausen Casts. It might be difficult for NODCs to process large volumes of high quality CTD data within three months. Drifting buoy operational data may arrive directly via GTS and non-operationally via RNODC-Drifting Buoys, which has been established in Canada. Figure 4 gives some idea of the place and role of the IODE centres in the flow of non-operational oceanographic data for TOGA.

Each existing and newly created RNODC should be examined to see to what extent its existing services could be expanded in order to meet the requirements of major international scientific programmes such as TOGA and WOCE. Large merged data sets, basin scale data products and other services generated in a timely fashion may be logically produced from RNODCs rather than by inventing new organizations or responsibilities.

2.2 ROLE OF IODE MEETING WOCE NEEDS

At this stage, schemes of WOCE data flow are very general. Nevertheless it may be foreseen that IODE centres can be widely involved in WOCE data management: RNODCs- IGOSS for international data gathering and quality control of sub-surface data; RNODCs of the IODE system for the creation of Level-II data archives for different types of oceanographic data other than IGOSS data; NODCs for monitoring data submission and for playing a role as an input point for non-operational data submission; WDCs for preparation of permanent data archives and providing a permanent user interface to the archives.

The responsibility for creating final archives will continue to be the function of the WDCs, Oceanography. However it is expected that functions of the WDCs will be expanded to include the provision of datasets to users with a minimum delay. Data archives should include an adequate browse capability. Such a facility would allow the interested user to locate and inspect data sets rapidly and to select those that will be useful for further analysis.

3. IODE DATA MONITORING

An important vehicle for the improvement of timeliness of data submission might be an establishment of data monitoring procedures to control the data flow at different stages.

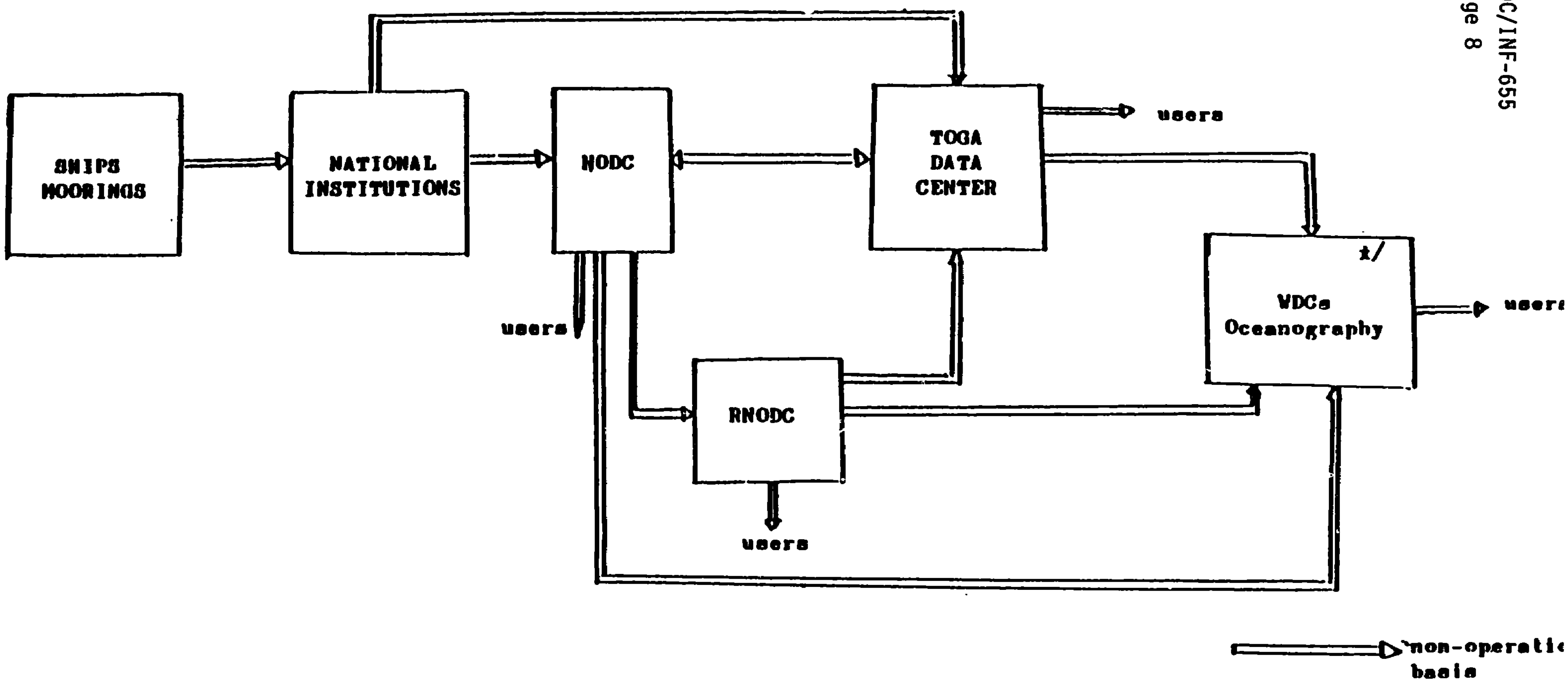

Fig. 4 Flow of non-operational oceanographic data for TOGA (proposal made by the Meeting of Experts on Climate Oceanographic Data Management, Beijing, China, 22-26 April 1985)

*/ WDCs will be requested to maintain a separate TOGA archive

The monitoring of the data flow in the framework of the IODE system should be considerably improved to become highly warranted. Future monitoring procedures should include monitoring of operational and non-operational data coming to the IODE and should be considered in a wide context covering such issues as quality control, delivery and archival formats, etc. Such monitoring should comprise the full range between the data collection on the platform and the final archival at the WDCs. IODE is now reviewing existing use of the ROSCOP and DNP/NOP information bases so as to adopt and upgrade them to provide input to a data monitoring.

As a stepping stone for the improvement of the IODE monitoring procedures all existing RNODCs of the IODE system were requested to submit the following information to the IOC Secretariat: type and amount of data which are archived in respective centres and which have not been submitted to the WDCs (Oceanography); reasons for the delay of data submission from an RNODC to WDCs.

Specific attention to the problems and deficiences of the IODE data flow monitoring will be given at the coming Twelfth Session of the Working Committee on IODE.

4. DEVELOPMENT OF IODE PRODUCTS

It is evident that institutions, scientists and other organizations will only contribute large quantities of data willingly, quickly and accurately to the IODE syste if they perceive clearly that the end product is immediately beneficial to themselves and their community.

The compilation of existing data products at IODE data centres will be completed by the end of 1986 and presented to IODE-XII. If resources permit, a document similar to the ICES catalogue will be prepared. The question of developing services in suport of global oceanographic programmes will be the major item confronting IODE in 1986. All NODCs will be encouraged to produce NODC Users Guides, similar to those published by the US NODC and MEDS of Canada, which contain comprehensive descriptions of data holding, processing procedures and product generation capabilities. RNODCs have been requested to examine in the greatest possible detail the data products which they could produce quickly and regularly and embark on a much larger programme of communicating their services to potential users. In particular each RNODC should prepare easily acceptable inventories and maps of its data holdings and distribute these as widely as possible to universities, institutes and industrial users of oceanographic data. All the products distributed in this way should contain explicit reference to the fact that they were only possible thanks to the contribution of data from data orginators. The community of data centres and RNODCs should be seen to develop the capability for managing the volumes of data implicit in WOCE and TOGA and for producing large scale integrated or gridded data products. Unless the ability to produce the end products is proven and established, orginators will be reluctant to contribute their data.

It was proposed that the Task Team on Development of IODE Data Centre Services in consultation with the IODE Task Team on Ocean Data

Management for Climate Studies would consider the preparation of draft Terms of Reference for future RNODC Data Products and Services. This proposal should consider the technical and computer problems inherent in exchanging large volumes of data electronically between NODCs and RNODCs, in merging of large data sets from different sources and should be related clearly to an IODE objective of creating routine data products on a basin or regional scale.

The Task Team on Development of IODE Data Centre Services is also examining the problems of large-scale, non real-time data management and data product generation. A special paper was prepared which examined implications of merged data sets and estimated magnitudes in terms of data volumes. Special attention has been paid to the generation of an annual ocean climate atlas series in some way similar to the Climatological Atlas of the World Ocean published by NOAA. However it was noted that it might be yet premature to plan gridded data sets at present because neither data availability nor requirements for gridded data are yet known. A major obstacle to routine production of gridded field data products is the normal time delay in receiving the data at the oceanographic data centers.

Another vital obstacle to expanding IODE centers' services to cover timely preparation of products is a failure of national institutions and governments to spend money on oceanogrpahic data management. A prime need is to gain increased national support for NODCs and to this end a coherent overall framework is needed.

5. FORMAT DEVELOPMENT

To expedite the process of oceanographic data management and exchange, to reduce the amount of programming work connected with this, to extend the exchange to other parameters and to react in a more flexible manner to new measuring techniques, the IOC developed a standard format for the exchange of oceanographic data - General Format 3 (GF3). The format is sufficiently general to encode virtually any type of digital data, including physical, chemical, biological, geological, meteorological and geophysical data and is very flexible permitting the user to describe, on the same magnetic tape that carries the data, the exact format he has selected and all codes he has used, as well as to leave ample space for plain language documentation.

During the last year considerable progress has been achieved in the development of standard subsets. They have been completed and deposited with the RNODC-Formats (ICES, Copenhagen) for moored-current-meter data, mean-sea-level data, drifting-buoy data, non-directional wave spectra, digitized contour charts of marine geophysical data, IGOSS BATHY/TESAC data. Guides on the use of GF3 have been published in the IOC Manuals and Guides series. GF3 has reached the stage where it can be widely used for the exchange of a variety of data types. An important effort has been made in the preparation of portable software for GF3, GF3-Proc, which will facilitate reading and writing GF3 formatted tapes. GF3-Proc provides a simple and yet complete software interface for reading and writing data in GF3. It is a collection of FORTRAN subroutines which provides several benefits to users. These benefits and characteristics of the package are introduced in the "User's Guide to GF3-Proc". Three additional documents will be prepared in support of GF3-Proc, i.e., GF3-Proc User's Reference Manual, GF3-Proc User's Reference Sheets and an example programme demonstrating the use of GF3-Proc. Initial distribution of the package and its associated documentation was made to selected IODE centres at the beginning of 1986.

Discussions held during the Third Session of the Group of Experts on Format development (Copenhagen, 16-20 September 1985) supported the belief that the flexibility of GF3, coupled with substantial support of the software package GF3-Proc and extensive documentation all contribute to a system that can significantly assist in managing climate data sets. Data (Level 2 or 3) from satellite sensors, atmospheric sounders, ocean profilers and time series instruments can all be put into one project data set in the GF3 format. The software in GF3-Proc gives considerable power in manipulating data from such diverse sources for scientific purposes. GF3 is well adapted to the description of gridded and geographically sorted data. Within the confines of a character format it is extremely economical.

GF3 format system strikes a balance between flexibility and the economics of nonchanging record structure. The system can be easily used by scientists. A number of independent observers are convinced that GF3 is a most useful product which will significantly assist the free and timely flow of data

It should preferably be in its own uniform series composed of six essential volumes plus a brochure. At present these are either in final stages of preparation on in annexes. Such a series would make the document more suitable to pass on to the wider earth sciences community under the IOC initiative.

6. CAN IODE EXCHANGE NEX DATA TYPES EFFECTIVELY?

So far international oceanographic data exchange is confined to the compilation and archiving of marine environmental observations or measurements which have been made from oceanographic platforms with generally accepted types of instruments and analytical methods widely known and described in the scientific literature. Data of this classification, when submitted for public use, either require no further correction or the corrections are well-known and generally available. Data of this type, although generated by different groups of scientist around the globe, form consistant international data sets and therefore are archived.

Data types which are experimental, or where data volumes are very great, or where the techniques of data reduction are still not agreed (non-standard data types), are generally retained by the originating institution and exchanged only upon request.

Requirements for archiving data from new observation techniques have been expressed by various scientific groups. These techniques which may generate amounts of data up to orders of magnitude larger than the more conventional methods include ground-based measurements as well as remote-sensed data from aircrafts or satellites.

As these data result from non-standardized observation techniques, it is imperative that additional, documenting information, for example, about sensor types, correction techniques, data reduction algorithms are carried along with the data to be archived, in order to give users of the data a chance to estimate their accuracy (reliability).

Recognizing the value of drifting buoy data for the devleopment of climatological summaries of surface currents and temperatures, CCCO requested that steps be taken to establish a central archive for such data. The Canadian Environmental Data Service (MEDS) has applied to become recognized as the Responsible National Oceanographic Data Centre (RNODC) for Drifting Buoy Data within the IOC system. The official accreditation process has been completed.

Archiving of drifting buoy data circulating in the GTS in DRIBU code began on May 3, 1985. As an example of the amount of data being obtained this way, during the month of September 1985 MEDS archived 27247 DRIBU reports from 182 buoys, including some platforms deployed on the Artic.

The real-time processing system is fully operational.The data from the GTS is accumulated for one week, at which time it is processed, quality controlled and updated into the archive data base.

Service Argos sent a letter to all drifting buoy operators requesting their permission to supply their data to the archive (MEDS), but received only a small number of positive replies. As of October 1985, 18 users have indicated unconditional agreement for placing their data in the archive. Drifting buoy data are purged by Service Argos after three months time. Unless they are submitted by Service Argos to the RNODC-Drifting Buoy Data within that period of time they are lost. Therefore, it is regarded desirable that Service Argos, with the firm support of international groups managing larger scientific projects, such as TOGA and WOCE, releases a new letter to drifting buoy owners inducing them to give their permission for the submission of their data to the RNODC within three months time. The buoy operator can be assured that his data will be withheld from exchange by the RNODC for a period of time which he can specify if he wishes to do so.

IODE is fully aware of the urgent need for an international exchange of mooored current meter data and from subsurface drifters. The exchange format for data from moored instruments (a special GF3 subset) is ready; the exchange of Lagrangian current values is being considered by the IODE Group of Experts on Format Development. IOC is endeavouring to find a centre with sufficient expertise and suitable equipment to function as a centre (RNODC) responsible for the processing and archiving of current data.

Larger amounts of CTD/STD data sets are beginning to flow into the WDCs for Oceanography. It was recommended that the WDCs should receive reduced CTD/STD data sets accompanied by the reference data (rosette samplers).

No international agreement was yet been reached upon the compression method, either the traces are to be digitized in ldbar intervals (SCOR recommendation) or at inflection points. Both types of reduced CTD/STD sets are submitted to the WDCs.

Large amounts of data are collected with towed undulating instruments (batfish, Delphin). They produce very high-density data sets of temperature, salinity and for the Delphin fluorescence and sound velocity along a vertical section of the upper 150 m of the ocean. The recording frequency of the Delphin is 8 data cycles/second. After each up-and-down track of the undulating instrument it is reduced to vertical profile(s). With that again the GF3 format is the appropriate vehicle to accomodate the data profiles for exchange. It may even not be necessary to create a new standard GF3 subset. With a slight modification the GF3 subset for CTDs may be applicable.

Very recently a GF3 subset was created for the exchange of sea-beam data. The IOC is negotiating, whether the WDC-A (Marine Geology and Geophysics) will be in a position to finally archive sea-beam data and to prepare certain types of products, for example an inventory of the sea-beam data holding.

There are measuring techniques in an experimental stage, i.e. the acoustic Doppler current profiler (ADCP) and those still in a development stage, such as acoustic tomography. It seems to be too early to make any firm judgement about the mechanisms for archiving acoustic tomographical data in a data centre. However, the W/C on IODE must keep the further development of this measuring technique under continuting review and undertake actions for the establishement of exchange and archiving mechanisms, once the technique has passed its present stage and starts producing useful data sets.

One of the major decisions which has to be reached in the years to come is, what types of satellite-derived and air-borne sensed data are to be archived by IODE data centres for their non-real time use by marine scientific groups. Oceanographic parameters that now can be detected refer to measurements of:

- sea-surface temperature; with a relative radiometric accuracy of 0.1°K, an absolute radiometric accuracy of 0.5°K, and a spatial resolution of about 1x1 Km^2;
- altimeter (ERS 1); precision of over ocean: 10 cm; resulting in ocean currents and, possibly information about thickness of the mixed-layer;
- scatterometer and synthetic aperture radar (SAR); accuracies highly dependent on technique used; resulting into wind and wave data;
- colour of euphotic zone; chlorophyll.

The amount of data generated by satellites is several orders of maginitude higher than data from conventional shipborne techniques. Special software is needed to rectify the horizontal distribution of the observed values and to transform them from engineering units to physical units, applicable for marine scientific purposes. Only specialised centres are able to process the high-density raw data sets and to reduce them to quantities which can be handled by invidals, scientific groups or data centres managing other conventional types of oceanographic data. IODE centres will not be in a position to process the raw data (level-I data). If, however, the satellite data processing centres would agree to prepare, on a regular basis, level-II data sets in physical units, for example gridded data, other than those mentioned above IODE would consider the possibilities to archive such data sets (Report of the Joint IOC/WMO Expert Meeting on Oceanographic Climate Data Management, Beijing, April 1985).

In view of the increasing importance of remotely sensed oceanographic data for marine scientific purposes, especially in global research projects, such as TOGA and WOCE, IODE must undertake steps to make remotely sensed data, in generally accepted units and in suitably compressed forms, available to a wide variety of oceanographic data users. Those steps should include the following actions:

(i) acquire, process, and distribute information about the availability of remotely sensed data from the oceans;

(ii) identify the demands of oceanographic programmes or scientific groups for remotely sensed data, especially relating to:

. data types needed,
. form of data presentation,
. quality and quantity of the data (accuracies and degree of compression, respectively),
. timeliness of the availability of compressed data sets from the archives (IODE centres).

(iii) seek agreement between satellite data processing centres and IODE about meeting the scientific demands under 2), and about a format for the submission of data from the satellite centres to IODE centres;

(iv) acquire, process, archive and retrieve, on request, compressed remotely sensed oceanographic

The CCCO Working Group on Oceanographic Data Management Aspects of the WCRP, at its second meeting (Wormley, August 1985), reveiwed the probable evolution of oceanographic data management over the next five years. The Group, noting that relatively inexpensive microcomputers, communications and storage media offer new perspectives for data exchange, came to the conclusion that a distributed data management system is scientifically feasible and technically practicable.

IODE has already undertaken a first step for a decentralised storage of oceanographic data by establishing its RNODC data centre network. This data centre system is to be expanded as new data management needs are manifested. To date there are no on-line connections between the centres. Both data exchange amongst centres and submission of data requested by users take place by mail.

It is, however, expected that international electronic networks will increase and become faster and cheaper. Those are essential pre-conditions for an increase of on-line transfer of larger volumes of data.

It cannot be assumed that data in distributed data bases are managed in the same manner; the data will be handled on different computers with different operating systems and with different data base management systems (DBMS). The effectiveness of a distributed data management system will essentially depend on how easy it is for a data searcher to find and to retrieve in an on-line mode, from several data bases, the data of interest to him.

The following three prerequisites ought to be met to make distributed data bases efficient:

(i) The data bases must have facilities to be accessed through public telecommunication systems by telephone lines. The transmission rate of the lines must be increazed, when large volumes of data are to be transferred.

(ii) It is anticipated that data searchers are not familiar with the various computer operation systems and DBMSs. Therefore, the the data base manager should offer the data searcher a menu software which guides him through the retrieval procedure.

(iii) It would be ideal, if the data output would be in a generally agreed format(s). That would avoid writing time-consuming data transformation software.

IODE must pay attention that this trend to distributed facilities will continue and even accelerate. It should, in due time, look into this matter and make proposals for internationally co-ordinated efforts which may be ncessary to make distributed data base systems work efffectively. This type of international co-ordination is new and obviously beyond the present scope of IODE activities. The Working Committee on IODE will deal with that matter at its next session in 1986.

7. IODE INVENTORING SYSTEM

At the heart of the data management for an undertaking as complex as WCRP-Oceanography there must be a good inventory system. It will need not only to point to the data sets and their details but also to the progress of individual components (projects) from early planning to completion to allow for more effective collaboration between groups of users at all stages of the programme development.

At a very simple level the ROSCOP (Report of Observations/Samples Collected by Oceanographic Programmes) directory produces a rapid documentation of sea-going programmes actually carried out and summarises the data collected. WDCs-Oceanography publish annual reports which include the list of the ROSCOP inventory forms received from Members States. It thus provides the equivalent of a "current contents" literature survey. The form is suitable for drawing up an inventory of time series data for the WCRP. At present this system is not automated and not heavily used by third parties. Its format is under review at present.

Catalogues associated with data archives published by WDCs-Oceanography frequently do no provide enough information for the interested user to determine whether the archived data will be useful for a particular research projects. Efforts should be made to improve this situation.

To meet the requirements for general worldwide information on the availability of data sets, their content, storage media used and the extent of their validation, on the location and characteristics of marine environmental data, the Marine Environmental Data Information Referral System (MEDI) has been established. The second edition of the MEDI Catalogue was issued in 1985. In order to ensure comparability with other international efforts, MEDI has been designed and developed as the sectorial focal point (subsystem) of UNEP/INFOTERRA system for marine science. A suitable link between MEDI and the WCP Referral System INFOCLIMA is being looked for in order that complementary services can be provided.

Procedures should be established for the exchange of MEDI and INFOCLIMA marine data description in order to minimize the impact on input centres and maximize both the MEDI and INFOCLIMA data bases. The IOC provided a copy of the MEDI data base on a magnetic tape to France and US to make the information available on-line to interested NODCs and DMAs.

A more aggressive focus on data management would involve evaluating and improving the international referral system such as MEDI and assistance of scientists in that regard would be most welcome.

8. CONCLUSIONS AND RECOMMENDATIONS

If national procedures to meet the data submission requirements of the World Climate Programme are improved and data are submitted by originators to the IODE system promptly, the existing data management system could provide in many cases, a rapid service by using the RNODC component.

It has become a scientific tradition that ownership of data belongs to the data collector, or to any third party to whom the data collector has transferred his or her rights. Coupled to this is the right of first publication accorded to the data collector. However today, timely data-sharing opens up such important benefits for the world scientific community that the responsibility of all data collectors for sharing their data without delay, embodies in the concept of "data freedom", needs to become equally a tradition. This is something the scientific commmunity itself can promote by agreeing, within international organizations such as ICSU and IOC, to develop a policy fostering the free exchange of scientific data. Note that this goes against the generally increasing trend to copyright data and to other national and international restrictive measures. Support to such a policy can be given by research authorities; the threat to cut resources such as staff, equipment or ship-time is a powerful incentive to data exchange. Scientific journal editors can help be adopting the aggressive editorial policy "No data easily available? No paper published" suggested by S.W. Bie in the paper "Data Management and Global Change".

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 a given project. Scientists who request the establishment of data bases should be prepared to develop the required commitments for the activity.

It is strongly advised that International TOGA and WOCE Project Offices, jointly with the Working Committee on IODE should identify appropriate NODC and RNODCs to develop the capability for managing the volumes of data implicit in TOGA and WOCE and for producing large scale intergrated or gridded data products.

Experience of FGGE and other international programmes observed that the lack of standarization of data formats may affect the successful correlation of interdisciplinary data and the capability of the scientist to use the data once they have been acquired. In that regard the GF3 format system may be considered on as a very useful instrument for the international exchange and archiving of different types of climate data. Efforts should be made and funds allocated to advertize the formal and market it in a most attractive and informative way.

To attack oceanographic data management problems the highest priority should be given to the improvement of national data management systems through the contrete national support as part of the support for TOGA and WOCE; compilation of data catalogues and inventories; further development of international exchanges of oceanographic data to meet extented requirements; further improvement of international exchange of information on data availability.

It would be useful for TOGA and WOCE to establish schemes for operational (exchanged via GTS) and non-operational data flows of different measured parameters. While carrying this out the proposals described under Chapter II of this document should be taken into account.

Archiving is only important if the archived data can be accessed in a useful form. Scientists should develop requirements for the form of archives and bring them to the attention of the WUCs.

Current mass storage technology is inadequate to store at sufficiently low costs all the data collected in huge volumes. In addition, magnetic tape, the storage medium for the vast majority of data of current archives, has a serious deterioration problem with time and many of the newer technologies have either known a deterioration problem or have not been available long enough to permit an assessment of their potential for storing science data. Special attention should be given to this problem.