Intergovernmental Oceanographic Commission

Workshop Report No. 127

IOC Regional Workshop for Member States of the Caribbean and South America - GODAR-V (Global Oceanographic Data Archeology and Rescue Project)

Cartagena de Indias, Colombia
8-11 October 1996

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SUMMARY REPORT

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1. BACKGROUND AND OBJECTIVES OF THE GODAR PROJECT

Data archaeology and rescue activities were begun at the three World Data Centres for Oceanography in Washington (USA), Obninsk (Russian Federation) and Tianjin (China), as well as at the ICES Secretariat in Copenhagen, Denmark and at the Japan Oceanographic Data Centre, Tokyo, following the decisions of the Workshop held in September 1990 at the US National Oceanographic Data Centre (NODC) in Washington DC.

An international Workshop (Greenbelt, Maryland, USA, 18-21 February 1992) on Ocean Climate Data, sponsored by the IOC, CEC, ICES, WMO and ICSU, noted the progress achieved in data archaeology during 1991 by a few Member States and international organizations and recommended expanding this *ad hoc* multi-lateral effort into an international data rescue and recovery project (IOC Workshop Report N$^{o.}$ 78, 1992).

This is how the experience gained by the above-mentioned activities laid the foundation for the Global Ocean Data Archaeology and Rescue project, known as GODAR, which was given strong endorsement by the IOC Committee on IODE at its Fourteenth Session (Paris, France, 1-9 December 1992)

The GODAR Project Proposal received full support of the IOC Assembly at its Seventeenth Session (Paris, France, 25 February -11 March 1993). In response to the recommendation of IOC-XVII, the Secretary IOC appointed Dr. S. Levitus, Director WDC-A, Oceanography as the Project Leader.

The above project is ambitious but is essential to bridge the gaps in the long time-series of ocean observations which are of the utmost importance especially for climate change studies. Efforts in the context of the preparation for UNCED, including assessments of the state of environment, the SWCC, the IPCC activities and negotiations for the FCCC have shown very clearly the need for long time-series of quality data. Governments and scientists are now recognizing the value and indispensability of historical ocean data for scientific research and for national decision-making. Vigorous ocean data archaeology efforts will help to significantly enhance the ocean data record from past decades. These efforts will rely on data exchange of the IOC/ICSU IODE and the WDC systems.

The Project, which now is in operation for over 5 years, is endeavouring to augment the historical oceanographic digital data archives by seeking out and recovering manuscript and ocean data not yet included in the ocean databases accessible to the world research community. The term "data archaeology and rescue" refers to this two-part process of first identifying and locating data and then performing the steps required to merge them into a digital database.

The GODAR Workshop for IOC Member States of the Caribbean and South America held at Cartagena, Colombia was the fifth in the series after 4 held at: Obninsk Russian Federation (17-20 May 1993) for Member States of Central and Eastern Europe; Tianjin, China (8-11 March 1994) for Member States of WESTPAC; Dona Paula, Goa, India (6-9 December 1994) for Member States of the Indian Ocean and Malta (25-28 April 1995) for Member States of the Mediterranean Sea.

The purpose of the current Workshop was to identify relevant data in the region and to consider the steps necessary to make this data available to the wide international marine science community thus adding to the global oceanographic data archive. These archives are valuable for different fields of application, including global change and climate studies, world ocean research and global ocean monitoring.

The Workshop included an assessment of the state of data holdings in the region, an identification of common goals and problems with data preservation and resulted in recommendations on implementation steps and approaches to solve the problems identified. The Workshop can also be considered as a starting point for a major upgrading of the entire regional ocean data management

system, an important step in the development of a region-wide ocean data system modernization programme.

The present report contains a summary of the scientific papers (key presentations), a full presentation of the national reports presented at the sessions of GODAR-V as well as the conclusions and recommendations of the Workshop.

2. OPENING AND WORKSHOP ARRANGEMENTS

The Workshop brought 14 national experts, mostly from Member States in the Caribbean and South America and 12 key speakers both from Member States in the region and from other parts of the world, to the city of Cartagena, Colombia. The List of Participants is included as Annex II.

The Workshop started with the national anthem of Colombia. Then Mr. S. Levitus welcomed the participants and wished them an outstanding meeting.

In his welcome speech Dr. I. Oliounine, on behalf of the Executive Secretary IOC, Dr. G. Kullenberg, referred to the earlier 4 successful GODAR meetings. He complimented Mr. Levitus for his efforts in managing the GODAR project and the staff of WDC-A, especially Ms. M. Conkright-Gregg, for their impressive contributions to GODAR-V arrangements. He described the potential value of GODAR for the countries of the region and underlined the special role of Colombia for IOC and of IOC for Colombia, which was illustrated by the fact that the IOCARIBE Secretariat is housed in Cartagena. All activities of IOC in the region are co-ordinated from this Secretariat. He wished the participants a useful and pleasant meeting.

In his welcome speech, Dr. A. Arzayuz, representing the Governor of Bolivar (which is the province where Cartagena is located) referred to the importance of this international workshop for the whole region. In this context, he specifically mentioned the relevance of phenomena such as climate change and air-sea interaction for the economy of Colombia. The choice of Cartagena as the venue for GODAR-V - a project aimed at historical ocean data - was obvious to him in view of the history and treasures of this city. He hoped that the workshop would bring forward new perspectives and initiatives. He ended his speech by wishing the participants, as the ambassadors of the global marine science community, a successful meeting.

Contralmirante E. Romero Vasquez, Commander of the Atlantic Navy of Colombia, in his welcome speech, considered the contribution of Colombia to the programmes of IOC. He also mentioned specifically the activities related to data collection and management of the CIOH - the marine research institute at the Naval School in Cartagena, of the oceanographic centre in Tumaco, as well as of the marine science faculties at various universities and the Colombian Commission on Oceanography, CCO. Large amounts of data have been collected during different national activities and a project called INFOMAR was started to improve the access to these data. This is one of the reasons why GODAR was very timely for Colombia. In his speech he also indicated the importance for Colombia of general and specific training, such as on data management, as well as of the acquisition of adequate technology to cope with the current and future challenges in marine science and management. He then formally declared GODAR-V open and wished the participants a nice stay in Colombia.

Capt. C.N.S. Velandia Rocha, General-Secretary of the CCO, as the local organizer, thanked IOC for selecting Cartagena as the venue for GODAR-V. He informed the participants on local arrangements and joined previous speakers in wishing the Workshop every success.

The Chairman, Mr. Levitus, indicated that it would be needed to appoint a Rapporteur for this Workshop and invited the Workshop for proposals. Dr. A. Duncan proposed Dr. P. Geerders for this task.

The proposal was seconded by Dr. R.R.L. Rojas. With general agreement, the Chairman invited Dr. Geerders to carry out this task, which he accepted.

The Chairman then invited the participants for a round-table introduction. Then the workshop proceeded as scheduled in the Workshop Programme. This programme is included as Annex I to this report.

3. SUMMARIES OF KEY PRESENTATIONS

3.1 IOC REGIONAL ACTIVITIES

IOCARIBE - Capt. C.N.S. Velandia Rocha
El Niño - Cdf. E. Cabrera
SOC - Dr. I. Oliounine

Capt. Velandia presented the history of IOCARIBE in which the CICAR project (Co-operative Investigations of the Caribbean) played a major role. When the IOCARIBE Regional Sub-Commission was set up in 1975, it was the first regional body of its kind, born from the experience of collaboration in the region and its surroundings. Through its thorough knowledge of the local and regional requirements IOCARIBE supports the implementation of IOC programmes in the region such as: OSLR, OSNLR, GEBCO, GLOSS, ITSU, GOOS and, of course, IODE and its GODAR project. He noted the plans for a national component of GOOS in Colombia, GOOS-COL. IOCARIBE contributes to the implementation of the IODE activities in the region through the Colombian national oceanographic data centre.

He noted that a recent evaluation of IOCARIBE has shown that still much capacity building needs to be done in the region, especially for the smaller countries. This element is included in the medium-term plans of IOCARIBE since it is the most urgent need of the countries in the region. Capt. Velandia closed his part of the presentation by indicating the support that IOCARIBE can provide to Member States in the process of setting up national infrastructures related to marine sciences.

CdF. Cabrera presented the activities in the region related to El Niño. There exists more than 20 years of experience and collaboration in this region concerning the studies of the El Niño phenomenon. However, and in spite of all efforts by the countries themselves, UNDP, IOC and WMO - the local and regional capabilities and resources are still not sufficient for a comprehensive study of this phenomenon. The ERFEN programme was formulated to achieve this objective. The tasks of the ERFEN programme include research, prediction and verification of El Niño. The programme relates to several specific areas in the Pacific and along the South American West coast. ERFEN is based on a co-operative network of 16 research centres, which communicate mostly through e-mail and Internet.

Training, education and capacity building are still much needed to improve the exchange of oceanographic information and data. Although some co-ordination exists with respect to procedures, products and bulletins, still more needs to be done.

In his presentation, Dr. Oliounine referred to the Southern Ocean Programme of IOC as a regional programme with a high relevance to global studies of climate and environmental change. He indicated the Terms of Reference of this programme and briefly evaluated its achievements and problems. He noted that the envisaged goal has not always been reached, partly due to the lack of funds, partly due to the overlapping interests of the many international organizations active in the region which do not always collaborate in an effective way. He then described the activities of SCAR, SCOR, ATCM, CCMLR, FAO/ACMRR, WMO, UNEP, IWC and many others in the region. They include WCRP, IGBP, GIPME, GEBCO, GLOBEC, IGOSS, GLOSS, DBCP, IODE, GOOS, BIOMASS (1974-1991) and many others. This indicates the complexity of and urgent need for establishing and maintaining co-ordination. He focused on the existing mechanisms under the Southern Ocean Programme for exchange of data and

information, which are already in place but are not being used to their full capacity and in an efficient manner.

Dr. Oliounine presented the deliberations and conclusions of the Southern Ocean Forum held in Bremerhaven, Germany in September 1996. The Forum discussed items of great concern such as climate and global climate change, preservation of marine living resources, marine pollution research and monitoring, GOOS (in relation to data and information management), legal and other issues which may become important areas of future collaboration. The Forum agreed that a synthesis should be made of the current knowledge gaps and that new research needs should be identified. The Forum stressed that co-operation with other international organizations and the Antarctic Treaty System has to be pursued, and if possible, increased. This approach was supported by specific recommendations of IOC/SOC-VI, held after the Forum also in Bremerhaven.

3.2 IOC-IODE PROGRAMME - BENEFITS FOR BEING A PARTNER, Dr. I. Oliounine

Dr. Oliounine started by saying that this was an excellent opportunity to refresh awareness on IOC and especially on IODE. The IODE activities are aimed at exchange and management of ocean data and information. He explained the structure and various elements of the IODE system, the data and information flow and some of the services and products. The data handled within IODE range from observations of temperature and salinity to remote sensing satellite data. Services provided and products developed differ from centre to centre of the IODE system. He also indicated as a successful element, the IODE activities related to training and education both in oceanographic data and information management (MIM element of IODE).

The cornerstone of IODE is a free and open access to ocean data. Such data are highly needed for climate monitoring and prediction purposes as well as for operational ocean monitoring (GOOS). It is recommended that ocean data be submitted to the IODE system within one year after acquisition, following the standardized procedures developed by IODE.

IODE provides data management services for data collected within WCRP and IGBP. Based upon its experience IODE contributes data management criteria to international programmes, e.g., through workshops, different Manuals and Guides and other publications. IODE makes data and information available to developing countries as a basis for the assessment of their resources. New aspects of the IODE activities include the integration of text and numerical data through new computer-based infrastructures such as Internet. It was noted that the standardization of data exchange and archival formats pursued by IODE still forms an essential aspect for interoperability and efficient communication.

Dr. Oliounine described in detail successful elements of IODE's activities which include the Global Temperature and Salinity Project (GTSPP), OceanPC (a modular software package for ocean data processing), GODAR, MIM (Marine Information Management) and publication of the series of Manuals and Guides. In view of the growing importance of ocean observations and ocean data management, Dr. Oliounine stressed the need for an increase of resources for IODE. Especially more should be invested in the application of new technology and TEMA activities. He showed what benefits may have developing countries by joining the IODE system and getting access to the huge data holdings and valuable experience gained by the IODE partners in oceanographic data and information management.

3.3 IOC-IODE GLOBAL OCEANOGRAPHIC DATA ARCHAEOLOGY AND RESCUE PROJECT (GODAR) - FOUR YEARS OF EXPERIENCE, Mr. S. Levitus

In his presentation, Mr. Levitus defined 'data archaeology' as "*the process of seeking out, restoring, evaluating, correcting and interpreting historical datasets*" and 'data rescue' as "*the effort to save data at risk of being lost to the science community*. These form the key elements of the GODAR project. He highlighted the history and some of the recent achievements of GODAR including the declassification of naval ocean profile data by various countries. In the near future, some large datasets

can be expected from Russia (Navy and State Committee for Science and Technology) and the UK (Hydrographic Office and Plymouth Marine Laboratory).

GODAR has generated a series of publications, both in printed form and on CD-ROM (see Annex IV). The next major product will be the Global Ocean Data Base 1997 (GODB97) which will contain considerably more data than World Ocean Atlas '94 as well as more parameters.

He mentioned various reasons for building global, historical *in situ* oceanographic databases:

- The international scientific community advises national and international bodies on such issues as climate change. Historical data are required to support such studies. To determine the role of the ocean as part of the earth's climate system the international scientific community must have access to the most complete oceanographic databases possible. These databases must be accessible in digital form and available internationally without restriction.

- Ocean measurement programmes are expensive. Scientists planning such programmes should have access to all available data in order to make the most efficient use of scarce scientific data collection resources such as ships.

- Pollutants flow across boundaries. The international community should have access to all historical data for pollution transport studies. This is particularly important for studies of the coastal environment and natural variability versus anthropogenically induced changes.

- Statistical forecasting and hindcasting studies require historical ocean data to develop and improve long-range weather forecasts.

He finally emphasized that *in situ* data cannot be replaced by satellite data; on the contrary, satellite data require *in situ* data for calibration and validation.

3.4 STATUS OF THE ARCHIVAL CLIMATE HISTORY PROJECT, Dr. M. Baker

The Archival Survey for Climate History (ARCHIS) has as its main objective to help to extend backwards in time our knowledge of the Earth's climate by bringing together professional archivists and climatologists in a search for information that is not in the Global Historical Climate Network database.

The ARCHIS project brought together systematically for the first time archivists and climatologists. Two intergovernmental bodies, UNESCO and the World Meteorological Organization (WMO), and 2 non-governmental bodies, the International Council of Archives (ICA) and the International Council of Scientific Unions (ICSU) launched the Survey which started with a pilot project in Europe (with 10 archivists from France, Germany, Italy, Spain and the U.K.) to examine the feasibility of obtaining such information and of its utility.

A scientific evaluation of the data obtained was carried out by ICSU, UNESCO and WMO which found that the pilot project "*is very useful for completing the climate record ..... and should be expanded and made operational*". After discussions with climatologists about possible priorities and regions it was decided to concentrate the next phase on Latin America and the Caribbean.

After a preliminary survey in co-operation with archivists from several Latin American countries 2 searches were begun in Mexico and Cuba in 1994. The preliminary phase of the search brought to light very significant amounts of data such as in Mexico, where a long-term dataset was located that provides daily data from the late 18th Century, and in Cuba where a century-long time-series was found for the Havana region as well as a 5-century record of the occurrence of cyclones. The data from Mexico are currently being digitized and will then be sent to the National Climate Data Centre, USA for quality

control and later incorporation in the GHCN database. For Cuba the digitization of the data discovered is about to begin prior to their transmittal to the GHCN database.

Efforts are currently being made to extend the survey to other countries in Latin America and the Caribbean and later to other regions and also to increase co-operation with other national and international organizations collecting historical information so as to improve our knowledge of climate change and variations and help to mitigate some natural hazards.

3.5 SCIENTIFIC RESULTS MADE POSSIBLE BY GODAR, Mr. S. Levitus

In this presentation, Mr. Levitus showed a number of examples of data collected through the GODAR project. These are all included in the World Ocean Atlas (WOA). He indicated the serious problem of merging datasets of various resolutions in time and space. However interesting phenomena and anomalies can be detected by various methods of processing and presentation, such as time-series. Also a presentation of the data in a GIS form allows for a new and different way to present data and establish relations between different data sets. GODAR provides the basic data to carry out this type of analysis. He also noted the importance of ship log data and of the observations included in these. He finally indicated that the next version of the WOA will include some software to access and present the data.

3.6 HISTORICAL OCEANOGRAPHIC DATA: THE BASIS FOR INTEGRATED COASTAL ZONE MANAGEMENT, Dr. P. Geerders

Dr. Geerders started out with presenting an example of environmental management illustrating the various types of knowledge and data needed as a basis for management and decision making. He noted that coastal zone management should not be limited to one of the traditional environmental compartments (water, air, land) but that a true integration should be sought between oceans, atmosphere, land and society.

Observations of the coastal environment (including the human environment: society) converted into data and information form the basis for knowledge and understanding of the relevant processes and phenomena. This data can originate from *in situ* measurements, from models and from remote sensing: an integration of these is required. Such knowledge also can be used to generate laws and regulations as well as set the priorities. Finally knowledge, legal aspects and priorities will join in a decision-making process which is the core of coastal zone management.

Most of the questions asked relate to: what if? what are the trends? what will happen if such and such measure will (not) be taken? In this context he showed some screens of the COSMO software package to demonstrate the capabilities of software to assist in pursuing different scenarios for coastal zone management.

Historical data on relevant environmental compartments, such as those identified and preserved by GODAR form the only way towards knowledge and understanding which in turn forms the essential basis for responsible integrated coastal zone management.

3.7 NATIONAL AND INTERNATIONAL SCIENTIFIC INITIATIVES OF THE WDC-A FOR PALEOCLIMATOLOGY AND THE IGBP PAST GLOBAL CHANGES PROJECT Dr. D. Anderson

Paleoclimate data complement the GODAR goal to create a long baseline of ocean climate observations by offering a means to reconstruct climate backwards in time before the instrumental period. Paleoclimate data can help to reveal the full amplitude of natural climate variability and also help in understanding the slow physics of the system. For example, changes in ocean circulation that occur over decades to centuries can be observed in the paleoclimate record. To construct the database needed to

provide this paleoclimate perspective, the WDC-A for Palaeoclimatology co-ordinates its efforts with and supports the goals of several international science initiatives, including the Past Global Changes Programme (PAGES), a Core Project of the IGBP, the Paleoclimate Intercomparison Project sponsored by NATO, the CLIVAR programme of the World Climate Research Programme, and the International Marine Aspects of Global Changes Programme (IMAGES) of PAGES. Each of these programmes outlines a set of scientific questions or objectives and recommendations for data collection that are useful in helping the WDC-A for Palaeoclimatology organize its data management activities. More information on these international scientific initiatives, including science plans and workshop reports, is available from the WDC-A for Paleoclimatology via mail and via URL link:
http://www.ngdc.noaa.gov/paleo/paleo.html

3.8 IMPROVING HISTORICAL DATA FOR ASSESSING COST/BENEFIT OF EL NIÑO PREDICTION, Dr. P. Lagos

Dr. Lagos stressed that climate research programmes have indicated that there is a need to construct a comprehensive climate-related database to conduct multi-disciplinary research on climate variability and change.

He noted that this task will address the issues of improving the rescue of historical oceanographic and other climate-related data including socio-economical data. He further discussed the rationale behind the initiation of a national climate database showed how this might be implemented and identified the problems that might arise. A second item he discussed was the procedure that has been initiated to apply a cost-benefit analysis to the El Niño prediction programme in Peru.

His conclusion was that there is some evidence that the benefits generated by applying the El Niño forecast are several times more than the cost of the programme.

3.9 SCIENTIFIC RESULTS OF THE BIOMASS PROGRAMME AND SOME DATA MANAGEMENT LESSONS, Prof. S. El Sayed

The BIOMASS programme grew out of the concern of the scientific community for the conservation of the marine living resources of the Southern Ocean. It was realized that the unwise and unregulated past exploitation of marine resources (e.g., of seals and whales) should not be extended to krill and fish populations, which were experiencing impending exploitation. As a result, SCAR established a Group of Specialists which was charged with the planning and implementation of a scientific, co-operative international programme which became known by its acronym, BIOMASS.

The objective of the BIOMASS programme was to gain a deeper understanding of the structure and dynamic functioning of the Antarctic marine ecosystem as a basis for the future management of potential living resources.

The contributions of the BIOMASS programme to our understanding of the living resources of the Southern Ocean are wide ranging. However, one of the crowning achievements of the programme was the establishment of the BIOMASS Data Centre. The history, objectives and accomplishments of the centre were discussed in the presentation.

The lessons learnt from the problemswhich the BIOMASS Data Centre has faced were also discussed. It was shown that the BIOMASS programme was innovative and revolutionary, both in how it carried out cooperative scientific research and also in how it managed the massive data collected during its life span.

3.10 ESTABLISHMENT OF AN NODC: A CASE STUDY, Dr. I. Oliounine

National Oceanographic Data Centres (NODC's) constitute the backbone of the entire IODE system. The principle purpose of an NODC is to provide, on a long-term basis, quality controlled and in a user friendly arranged manner, oceanographic data and information to different user groups in the most applicable form. Such a data centre plays the role of a national focal point for accessing and disseminating oceanographic data and information, and for arranging the international flow of these data. Dr. Oliounine described activities of some NODC's, presented scientific, educational and informational roles of these centres. He emphasized that NODC's contribute to the capacity building of a country by providing data for applied research and economic development.

Finally, he presented a case study of NODC establishment. As an example, procedures established and followed in Ireland were described, which included the compilation of a national inventory of oceanographic data holdings and a thorough study of national needs and requirements. He called on the participants to follow the experience gained by Ireland in a critical manner by adjusting recommended procedures to their own conditions and needs.

3.11 ANALYSIS OF NUTRIENT AND CHLOROPHYLL DATA FOR THE SOUTHERN HEMISPHERE, Dr. M. Conkright

The Ocean Climate Laboratory is currently updating the WOA94 to produce the GODB97 which will expand on the number of oceanographic parameters from 6 (temperature, salinity, oxygen, phosphate, nitrate and silicate) to 26 parameters and associated metadata. Also included in the metadata is the name of the investigator responsible for making the measurements.

As a result of GODAR the OCL database has increased by 33,088 phosphate profiles, 22,242 nitrate profiles and 27,566 silicate profiles. Due to an emphasis on compiling and rescuing biological data, there are now 89,905 chlorophyll profiles and 93,974 plankton tows.

Results were presented showing the seasonal distribution of phosphate based on the data published in the WOA94. There are major gaps in the coverage of nutrient data in the Southern Hemisphere which is hoped can be filled through the GODAR project for the next release of the FOC/GODAR GODB97.

Current work was just initiated in the quality control and analysis of chlorophyll data. In addition to standard checks such as headers (position, time, date), depths (duplicates, inversions), duplicate checks (based on position, time, date, measured values), range checks and statistical analysis, the objectively analyzed chlorophyll annual mean fields can be compared to ocean colour satellite images. These different datasets agree in the general distribution of low and high chlorophyll areas. Some differences are observed which may be due to: i) lack of quality control of the chlorophyll data; ii) the satellite data used (CZCS) spans from 1978-1986 whereas the *in situ* data spans from the late 1950's to 1990; iii) seasonal bias in both the satellite and the *in situ* data. There are several issues to be resolved in working with chlorophyll data but the most important issue is that chlorophyll is a seasonally dependent parameter and currently it is not possible to do any seasonal analysis due to the lack of data.

In support of the GODAR digitization efforts, the Ocean Climate Laboratory developed a format for the digitization of physical, chemical and biological data. The same format is used for any type of data (CTD, XBT, bottle) and the only difference is in the dictionary of recognized terms or lexicons. This format can be used in combination with any spreadsheet programme such as Microsoft Excel, Lotus 1-2-3, etc.

As part of GODAR, the WDC-A, Oceanography (USA) has begun an inventory of the manuscript data in its archives. From this inventory the part on biological data (chlorophyll, primary productivity,

plankton) from the different countries represented in GODAR-V was shown. This effort is not completed and therefore not all data are included in this inventory.

3.12 ATLAS OF SURFACE MARINE DATA AND OCEAN SURFACE OBSERVATIONS 1994, Mr. S. Levitus

In this presentation M. Levitus introduced the Atlas and described its contents:

- monthly anomaly fields of sea surface marine parameters for each month in the period 1945-1989;

- climatological monthly mean fields for each parameter;

- monthly fields of inter-annual standard deviations of the individual monthly anomaly fields.

He indicated the wide range of 35 parameters presented in this Atlas, including directly observed quantities, heat and momentum flux quantities, fresh water flux quantities and miscellaneous derived quantities.

He especially noted the valuable contribution that the GODAR project has provided to the compilation of this Atlas.

3.13 VARIABILITY OF CARBON DIOXIDE AND OXYGEN IN THE SURFACE WATERS OF THE GULF OF MEXICO, Dr. P. Makkaveev

Investigations of the variability of the hydrochemical composition of the waters of the oceans form one of the main directions of chemical oceanography today.

For the study of variability it is desirable and important to examine the longest time-series of observations possible. These can be extracted from archived data. However, using archived data implies comparing and merging into one dataset data acquired at different times, by various methods, using different standards and different scales. Large problems are caused by data of poor quality and by errors.

The variability of the hydrochemical composition of the ocean waters can have periodical, as well as more or less random components. Currently the main features of the seasonal variability are well known. The next step is the investigation of the daily variability. Estimating the daily changes in the hydrochemical composition is considerably hampered since in the majority of cases these changes are hidden by variations of other time-scales and by non-tidal changes. The range and peculiarities of daily variations change both with place and season. It is obvious that in the period of active photosynthesis the daily variations will be larger than in other periods, and their character in the high latitudes will considerably differ from the tropics.

The correlation of seasonal and daily variability of dissolved inorganic carbon and oxygen was illustrated by an example of data collected during the 30th voyage of the '*Academician Mstislav Keldysh*' vessel (IO RAS) in the Gulf of Mexico, January-April 1993.

The data showed the clear seasonal variation of pH, of total dissolved inorganic carbon and of oxygen values during the period from winter to summer caused by spring blooms of phytoplankton. Practically in all samples which were taken in the morning the content of total dissolved inorganic carbon is higher than in the evening samples while the content of oxygen is lower. A definite regularity can be observed in the difference between the morning and the evening samples. This difference reaches its maximum values in the beginning and in the initial period of the plankton bloom. Outside this period the difference between morning and evening samples becomes immaterial and often changes sign to the

opposite. The values of the decrease of CO_2 in the euphotic layer (0.5-1.5 gC/m^2 daily) are in good comparison with the likely values for this region's quantity of primary production.

3.14 PALEOCLIMATE RECORD OF SOUTHERN CHILE, Dr. D. Anderson

Dr. Anderson started out by indicating the problems of palaeoclimatology: the changes are too slow and the instrument age is too short. Only long, very long time-series can help to understand the slow physics of the climate system. And only then we will be able to understand what is behind the changes we observe today: human made or natural variability.

He showed records of CO_2 both from measurements (recent) and ice cores and indicated that in the past changes of similar size as at present seem to have occurred.

He mentioned the different relevant international programmes active in this field and described their specific aims.

4. NATIONAL REPORTS

4.1 ARGENTINA

Scientific research in the South Atlantic Ocean just began in the second half of the 18th Century when ships were dispatched at sea almost exclusively to assess the biological riches of the Southern Seas and to discover new lands.

During the past century renowned naturalists carried out voyages on ships under German, British, or French flags, among others. Scientists such as Darwin, Fitz Roy, and Weddell; ships like the *R.V. Albatross*, *Challenger*, and *Gazelle* sailed along the Patagonia coasts from the Plata River to Antarctica, hunting whales, studying the marine fauna, performing meteorological, magnetic and astronomical observations.

By the end of the last century, a new stage began in the era of discoveries. The European powers sent large expeditions towards Antarctica, studying at the same time the Argentine coasts. Almost simultaneously Argentina made, through its Navy, its initial steps in oceanic research with the schooner *Rosales*. In 1879, the Naval Central Hydrographic Office was established and several cruises were performed between the Plata River and Tierra del Fuego, getting across the Weddell Sea up to latitudes of 74° South.

In the beginning of the 20th Century, Germany dispatched the *R.V. Deutschland* in order to obtain biological samples and data on currents in the Argentine continental shelf. The British *R.V. Endurance* reached the ice barrier at the southeastern boundary of the Weddell Sea. During the 1920's, the cruises of Germany's *Meteor* stand out, beginning a study on the physical and chemical properties at different depths between the latitude of 20° North and Antarctica. The eminent Prof. Merz planned this two and a half year expedition. In the 1930's, in connection with whale hunting, the British ships *R.V. Discovery* and the *R.V. Scoresby* explored the South Atlantic Ocean.

In the 1940's, there was an intensification of Antarctic activities, with the first international expedition by scientists from Norway, Great Britain and Sweden. The decade of 1950 marks, in fact, the beginning of the most important stage in oceanographic research, with performance of continuing systematic studies of the South Atlantic, of its water masses from surface to bottom, together with actual meteorological conditions. Argentina starts an intensive biological project with oceanographic observations, named *Merluza Project*.

But it was from the moment when specific tasks were placed under Argentinean responsibility, on the occasion of the International Geophysical Year (1957-1958), that the Naval Hydrographic Service performed many projects (*Nivel Medio, Atlántico Sur, Meridiano, Drake, Cuenca, Malvinas*) in order to study the behaviour of the water masses: their circulation, surface and deep water conditions as related to their physical, chemical and biological aspects, as well as the morphological characteristics of the seabed and surface meteorological conditions. As regards Antarctic activities during that period, Argentina commissioned a new unit, fit for sailing in the Weddell Sea ice, namely, the icebreaker *San Martín.*

The Argentine Navy worked together with the Antarctic Institute and reached the 78° South parallel. A series of annual cruises was implemeted which constituted an important contribution of Argentina to the International Geophysical Year.

During the 1960's, oceanographic and fishing projects were developed in co-operation with international organizations. Through these joint efforts, Argentina completed an oceanographic survey intended to perform a systematic study on the circulation and the properties of the water masses and also to link the continental geological characteristics with that of the adjacent seas. Tasks were carried out jointly with Lamont-Doherty Geological Observatory (*Vema-Cánepa* Project), with Uruguay and Brazil (*Trident* Project), with Texas University (*Productivity* Project), and as part of a fishing research project with the Food and Agriculture Organization of the United Nations (*Pesquerías* Project). As regards Antarctic activities, physical, chemical, water mass behaviour, hydrological and biological studies were intensified and joint cruises were also performed with the US National Science Foundation (*Weddell* Project).

In 1974, the National Science Foundation Office for the International Decade of Ocean Exploration (IDOE) approved the "International Southern Oceans Studies" (ISOS). Argentina, represented by the Naval Hydrographic Service and his Antarctic Institute, co-operated through joint cruises with Lamont-Doherty Geological Observatory, Texas University, and Woods Hole Oceanographic Institution. The objectives of this programme were the study of ocean current systems in Antarctica, oceanic dynamics, Southern Oceans air-sea interaction, and the study of the convergence of the Malvinas and the Brazil currents and its influence on the Southwest Atlantic ocean (19 cruises of *R.V. Islas Orcadas*). Also in that decade, Argentina signed the Agreement on Co-operation in Fishing with Germany and Japan, and carried out cruises on board the *R.V. Walter Herwig* and *Shinkai-Marú* for research on fishing resources of commercial interest, as well as in general oceanography in Argentine and adjacent waters.

In the 1980's and the 1990's, Argentina carried out joint cruises in support of the World Ocean Circulation Experiment (*WOCE Programme*) with the participation of international organizations to study the variability of the Southwest Atlantic Subtropical Convergence. Later, Argentina implemented coastal research cruises for research in oceanography and living resources, in co-operation with other countries in the region.

Research intensification initiated in the 1950's forced the creation of new institutes dedicated to marine sciences. The large volume of data collected by the institutes, resulted in a need for establishing central mechanisms, furnished with the adequate equipment and personnel, and with the mission to provide services and generate products required by various users.

In 1974, the Argentine Oceanographic Data Centre (CEADO) was established as a consequence of such need and under the sponsorship of the National Council for Scientific and Technical Research and the Naval Hydrographic Service. Its mission was stated as follows: "*The CEADO accomplish the mission to provide a supporting service to the investigations and developments in the Marine Sciences, by furnishing oceanographic data and information to the domestic and the international scientific communities and to any other public and private users which may require of this service for the development of their activities.*" The main objectives, then, were to develop, operate, and maintain its

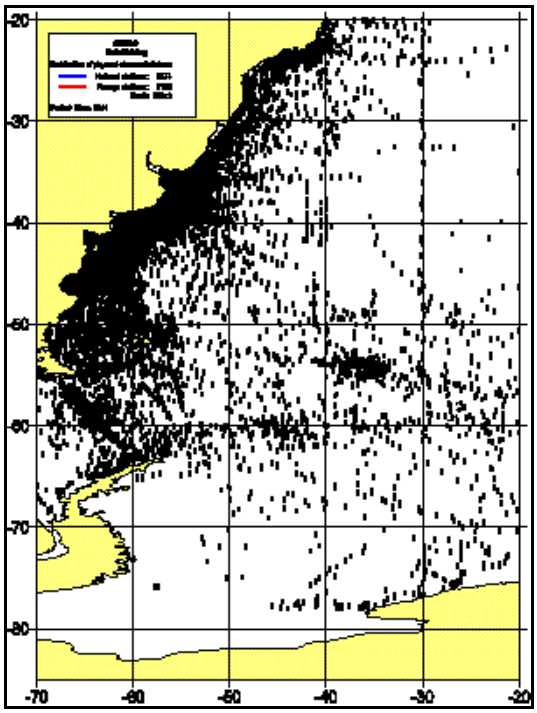
databases and information files through continuous exchange with other International Data Centres and with National Institutes devoted to research of the marine environment.

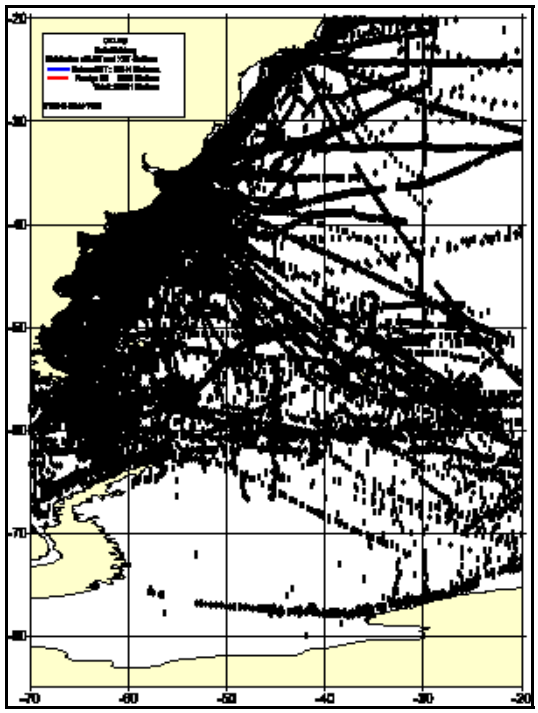
Data Holdings

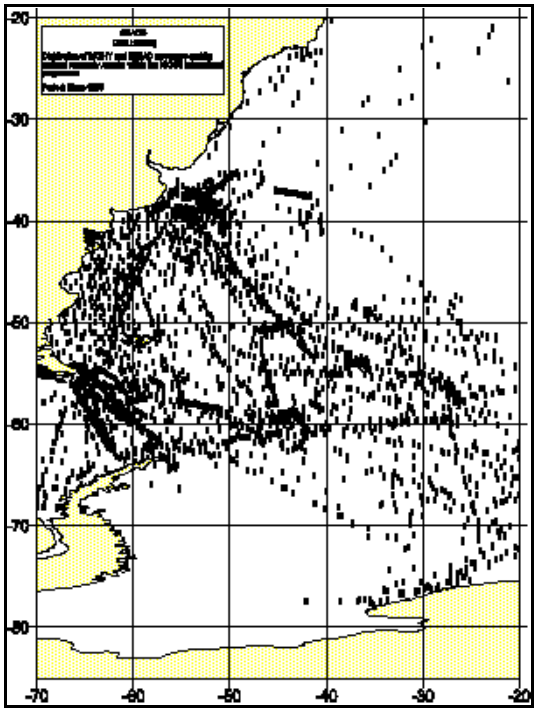
The following graphs demonstrated the distribution of the oceanographic stations, CTD, bathythermographic observations and BATHY/TESAC messages held by CEADO from the area of the Southwest Atlantic Ocean, and of which the corresponding data are being kept in its files.

NANSEN AND CTD DATA	
Total Stations:	13.272
Nationals:	5.074
Foreign:	8.198
Period:	1911/96

BATHYTHERMOGRAPHIC DATA	
Total Observations:	24.021
Nationals:	15.941
Foreign:	8.080
Period:	1953/95



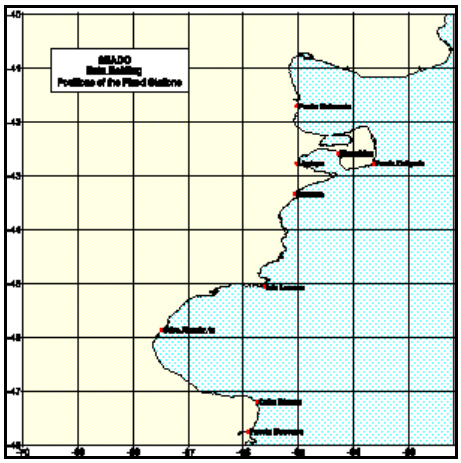


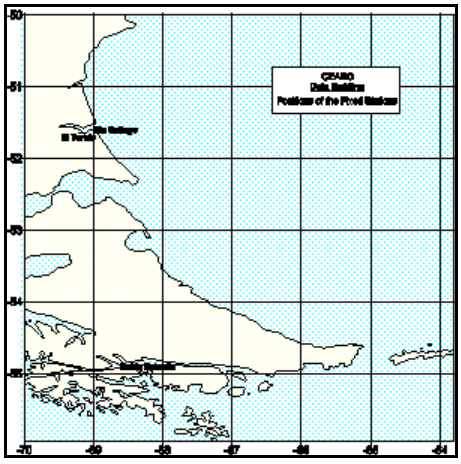


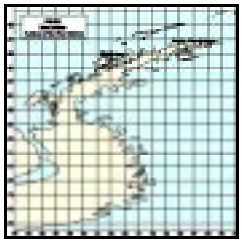
BATHY/TESAC MESSAGES	
Total Messages:	2.906 (all performed by national vessels)
Period:	1975/96

TIDE AND ATMOSPHERE DATA (automatic tide gauge)	
Mar del Plata:	184.330 observations
Ushuaia:	189.641 observations
Esperanza:	84.936 observations
Period:	1992/95

Although those databases are the most important as regards the information volume, they are not the only available at CEADO. Surface temperature and salinity data from 32 Fixed Coastal Stations, located as shown in the next graph, are also held in a database.







In Argentina, biological data are mainly stored in the National Fisheries Research and Development Institute (INIDEP), in the Natural Science Museums and in the Antarctic Institute. On the other hand, the Naval Hydrographic Service manages a wide range of data archives on different disciplines. Upon the user's requests, the CEADO acts as a referral centre providing information where to apply for obtaining data which are not stored in its own files.

It must be pointed out that the Argentine government took the decision of declassifying 7,100 bathythermographic profiles in support of IOC and ICSU's policies and submitted these data to the World Data Centre "A" during 1995; this is considered as a valuable contribution to GODAR project.

An important source of data is CD-ROMs which the centre receives from the international institutions and which contain large amounts of different oceanographic data. The following figure shows the oceanographic parameters that we can reach through the CEADO CD-ROM's library.

CEADO - OTHER SOURCES DATABASES (CD-ROMS)

TITLE	DATA TYPE	INSTITUTE	YEAR
GLOSS STATION HANDBOOK	SEA-LEVEL	NODC-USA/IOC/BODC	1996
GLOBAL OCEAN TEMPERATURE & SALINITY PROFILES	TEMP. & SALINITY	NODC/NOAA	1992
MARINE CLIMATIC ATLAS OF THE WORLD	CLIMATIC	U.S. NAVY	1992
WORLD OCEAN ATLAS 1994 CD-ROMS DATASETS	TEMPERATURE, SALINITY & NUTRIENTS	NODC/NOAA	1994
GLOBAL RELIEF DATA	COAST LINES, GLOBAL IMAGES, GRAVITY	NGDC/NOAA	1993
GEBCO DIGITAL ATLAS	BATHYMETRIC	BODC/IOC/IHO	1994
MONTHLY MEAN DISTRIBUTIONS OF SATELLITE-DERIVED SEA SURFACE TEMPERATURE AND PIGMENT CONCENTRATION	TEMPERATURE & PIGMENTS	NASA	1992
GREENHOUSE EFFECT	ENVIRONMENTAL	GEDEX/NASA	1992
OCEAN CURRENT DRIFTER DATA	BUOY TRAJECTORIES	NODC/NOAA	1995
TAXONOMIC CODE	TAXONOMICS	NODC/NOAA	1993
GEOSAT	WIND & WAVE	U.S. NAVY/NODC	1994
GEOSAT	ALTIMETRY	U.S. NAVY/NODC	1994
OCEAN DRILLING PROGRAMME	GEOLOGICAL	NSF	1992
GEODAS	GEOPHYSICS	NGDC/NOAA	1993
SMMR POLAR DATA	RADIANCES	NASA	since 1990

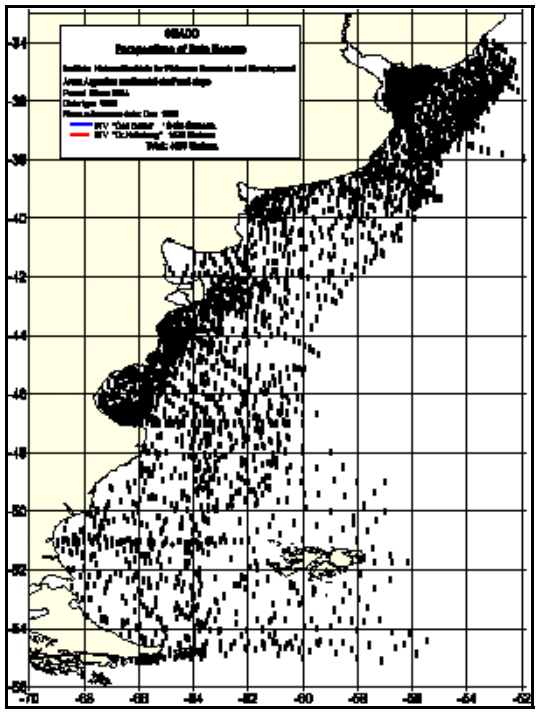
Perspectives of Data Rescue Operations

Data acquired from different sources which CEADO intends to include in its archives in the future that our Data Centre intends to include in its archives in the future are presented in the following graphs:

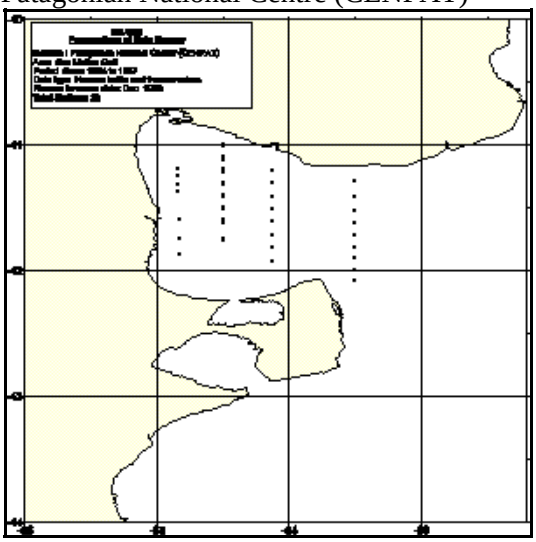
National sources:

Institute: National Institute for Fisheries Research and Development (INIDEP)

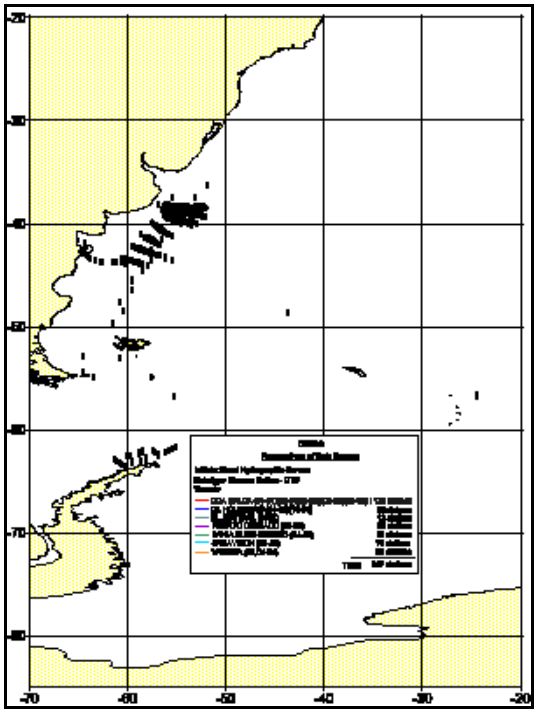
Type of data: Temperature and salinity
Instrument: CTD
Number of stations: 4,155
Area: Argentine continental shelf and slope
Period: Since 1984



Institute: Patagonian National Centre (CENPAT)



Type of data: Physical and chemical
Instrument: Nansen bottles and thermometers
Number of stations: 32
Area: San Matías Gulf
Period: 1984/87



Institute: Naval Hydrographic Service (SHN)

Type of data: Physical and chemical
Instrument: Nansen and CTD
Number of stations: 227
Area: SW Atlantic
Period: 1991/94

Type of data: Bathythermographic
Instrument: XBT
Number of observations: 796
Area: SW Atlantic
Period: 1983/95

Institute: Argentine Antarctic Institute (IAA)

Type of data: Physical and chemical
Instrument: CTD
Number of stations: 27
Area: Southern Ocean
Period: 1994/95

Type of data: Bathythermographic
Instrument: XBT
Number of observations: 45
Area: Southern Ocean
Period: 1994/95

Data Exchange

Data exchange among Brazil, Uruguay and Argentina has increased as a result of the Sub-Regional Programme of the Upper South Western Atlantic. This agreement was signed by the 3 countries within IOC/IODE framework in 1993.

Last year data were received from the Brazilian Federative Republic corresponding to 97 cruises carried out by that country between 1966 and 1992, in the area extended from about 20° to 40° South latitude, with a total of 4,045 stations (Nansen and CTD) and from Uruguay 29 XBT traces obtained by the ship Vanguardia during 1993. Those data are still in the process to be included in the CEADO holdings.

Summary of Data Rescue Activities

The type and total number of data to be included in the CEADO archive during the next few years for the Southwest Atlantic Ocean will be the following:

a) Argentinean origin
Nansen and CTD: 4,641 stations
Bathythermographic: 841 observations

b) Foreign origin
Nansen and CTD: 4,045 stations
Bathythermographic: 29 observations

The final balance shows that, while more than 21,000 physical, chemical and bathy-thermographic national stations are already included in the database (excluding BATHY-TESAC data) there are still 5,482 pending to be entered. The explanation for this backlog is the lack of resources (human and material) for digitizing these data which became dramatic during the last years, both in some national institutes and in CEADO.

RNODC/SOC Experience

One activity CEADO voluntarily has undertaken within the IOC/IODE system is that of a Responsible National Oceanographic Data Centre for the Southern Ocean (RNODC/SOC). During the Twelfth IOC/IODE Technical Committee Meeting held in Moscow in 1986, the Recommendation was adopted on the RNODC/SOC accreditation. This Recommendation was approved by the IOC Assembly in its Meeting in Paris in 1987, with the following Terms of Reference:

a) To acquire the physical and chemical data obtained by international scientific community in cruises and research programmes carried out in the Southern Oceans; control their quality, and store them in standard format, as well as distribute, upon request, the information stored in its files; and

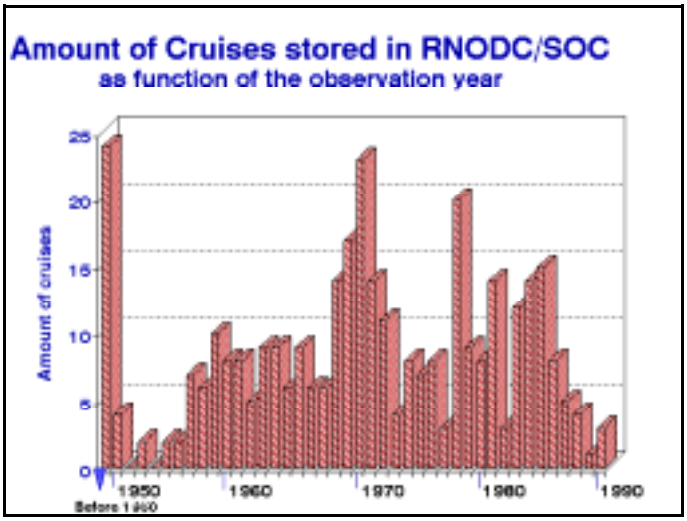
b) Co-operate closely with the World Data Centres in Oceanography by sending regular shipments (at least once a year), free of charge, of a complete set of physical and chemical data stored, as well as inventories, data summaries and other products related with the physical and chemical data from the Southern Oceans.

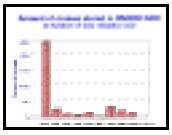
The initial data acquisition was started in 1988 through a request for the information stored in the historical files of the World Data Centres, Oceanography "A" and "B" and of the 24 National Data Centres in the countries which had carried out research cruises in the area between 50° South and Antarctica.

In the 8 years of RNODC/SOC existence, historic data have been retrieved or acquired from publications, magnetic tapes, diskettes, CD-ROMs and FTP. The task was and yet is to retrieve these data and its metadata and to convert them into a standard format (conversion of units, conversion of conductivity or salinity, conversion of depth/pressure, etc.)

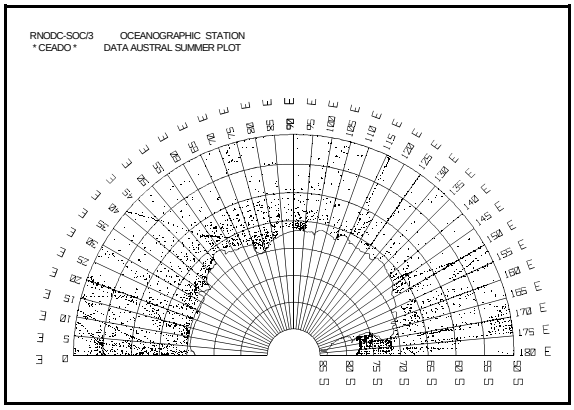
As a part of its general responsibility, RNODC/SOC sends data once a year to the 3 World Data Centres, Oceanography (A, B and D), publishes an Annual Report and disseminates information via the RNODC/SOC Home Page in the WWW, as well as responds to requests from different users.

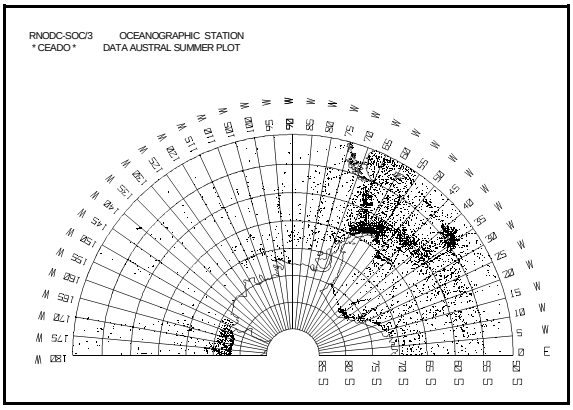
RNODC/SOC regularly exchanges physical and chemical information obtained through IOC/IODE programmes. Exchanging data the RNODC/SOC contributes to its dissemination within the scientific community and their data are included in publications and in the Southern Ocean Atlas published by the Alfred Wegener Institute in 1992. The growth of the RNODC/SOC physical and chemical databases can be observed in the following figures.

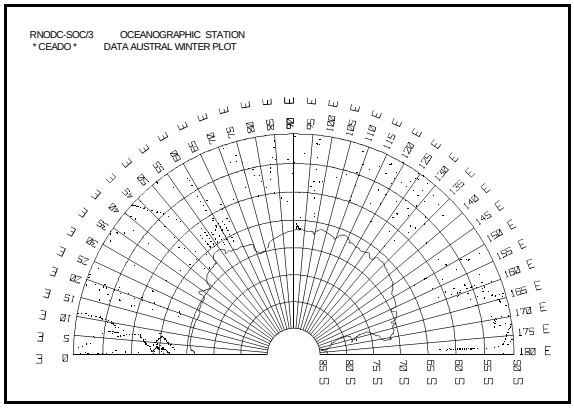


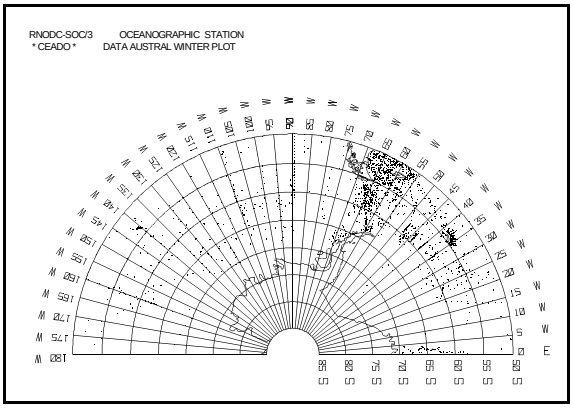


Along the 8 years of development, information on 13,919 oceanographic stations from 348 cruises of 19 countries was accumulated with the following geographic distributions in summer and winter time.

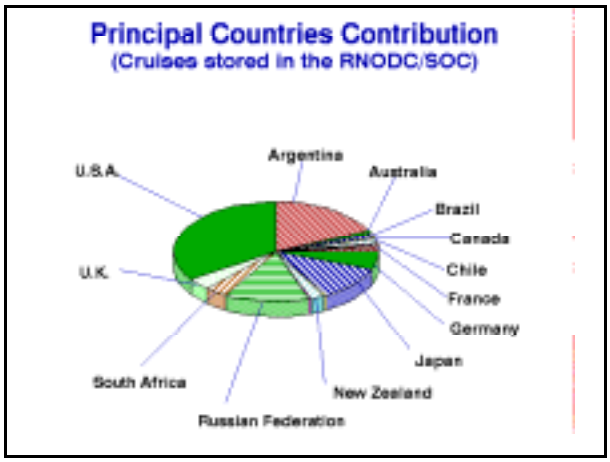








The following figure and its graphic distribution shows the contribution of different countries to the RNODC/SOC data archive.



COUNTRY	TOTAL CRUISES	TOTAL STATIONS
Argentina	063	1,352
Australia	003	0099
Brazil	004	0114
Canada	002	0169
Chile	006	0220
China	001	0035
Denmark	001	0003
Ecuador	001	0023
Finland	001	0014
France	006	0147
Germany	020	1,293
Japan	038	0890
Norway	002	0105
New Zealand	007	0086
Poland	001	0073
Russian Federation	047	2,434
South Africa	012	0508
United Kingdom	013	1,821
U.S.A.	120	4,517

During 1996, data from 4 Japanese cruises were received on diskettes and 9 Australian cruises via FTP. These are in process of being entered into the RNODC/SOC Archive. From June of this year a Home Page offers the information on data and its metadata to the international scientific community via Internet: http://www.conae.gov.ar/~ceado/rnodcsoc.html

The flow of data to the RNODC/SOC was not as good as it could be. In order to improve the flow of data and to obtain a greater density of information not only contributions are required from the IODE System Centres but also from the Antarctic Institutes, which are the natural depositaries of this type of oceanographic data from the Southern Ocean.

4.2 CHILE

CENDOC is the National Oceanographic Data Centre (NODC) within the IODE system and a National Oceanographic Centre (NOC) within the IGOSS system. It is a Service of SHOA, the Hydrographic and Oceanographic Service of the Chilean Navy (Servicio Hidrografico y Oceanografico de la Armada de Chile). CENDOC started in 1968 with the basic aim of gathering the oceanographic information collected by national and foreign research vessels in Chilean waters.

CENDOC constitutes the national and international focal point on data exchange matters in Chile. Its main mission is to maintain an oceanographic database for the national areas of interest, in order to be able to provide information to the national community for research and development.

Marine Research Infrastructure in Chile

CENDOC is an active member of the chilean marine science community, which is co-ordinated by the National Oceanographic Committee (CONA). CONA is also located at SHOA and its main

function is to advise and co-ordinate the many institutions in Chile that carry out oceanographic research. This Committee is composed of the following institutions, from governmental to private and universities.

Permanent Members

* Subsecretaria de Pesca
* M.RR.EE.
* Servicio Nacional de Geologia y Mineria (SERNAGEOMIN)
* Servicio Nacional de Pesca (SERNAP)
* Comision Nacional de Investigacion Cientifica y Tecnologica (CONICYT)
* Servicio Hidrografico y Oceanografico de la Armada (SHOA)
* Servicio Meteorologico de la Armada (SMA)
* Direccion Meteorologica de Chile
* Instituto Antartico Chileno (INACH)
* Instituto de Fomento Pesquero (IFOP)
* Pontificia Universidad Catolica de Chile
* Universidad de Valparaiso
* Universidad Catolica de Valparaiso
* Universidad de Concepcion
* Universidad Catolica del Norte
* Universidad Austral de Chile
* Universidad Catolica de la Santisima Concepcion
* Universidad de Chile
* Universidad de Antofagasta
* Universidad Arturo Prat

Collaborators

* Universidad de Los Lagos
* Universidad Maritima de Chile
* Museo Nacional de Historia Natural
* Servicio de Salud
* Empresa Nacional de Petroleo (ENAP)
* Minera Escondida S.A.

The Committee, among other activities, co-ordinates marine research at the national level, designates Task Teams to solve specific problems (pollution , air-sea interaction, remote-sensing, marine geology , El Niño, and others) and distribute the results through a yearly journal. Through these activities CENDOC has been able to collect during the last decade most of the oceanographic data from national sources.

Computing Facilities and Data Management Structure

CENDOC makes use of the computing facilities of the Informatics Department of SHOA (main frame IBM9370) and also owns PC computers (486 & Pentium). At present, a general renovation is taking place at SHOA. The IBM9370 will be replaced by a complete network linking all departments at SHOA. There will be 4 servers (type COMPAQ Proliant 1500,166 MHz Pentium, 4.3 MB HD) one of them exclusively for INTERNET connections, which will make SHOA and CENDOC reachable URL nodes. WEB pages are being prepared to fulfil this task. During 1996, in the process of making inventories and catalogues of the oceanographic data held at CENDOC, a new edition of the Oceanographic Atlas of Chile (Volume I) was finished and is available to users.

Databases of classical oceanographic data are being built at CENDOC using Visual-Basic.

National and International Data Exchange

At the national level, CENDOC answers the data requests made by the Chilean marine science community, especially for time-series data (SST and Sea-level) and other data for research purposes. Some institutions that turn in data to CENDOC need to give permission before CENDOC can release their data to other users.

Concerning the international exchange, sea-level data are sent on a regular basis to PSMSL and SOC-Hawaii, also SST and sea-level data are sent monthly to the Hydrographic Service of the Peruvian Navy in order to produce a bulletin on Regional Climate Warning for the Permanent South Pacific Commission (CPPS). The lack of personnel hampers to accomplish all the duties related to an NODC. However, CENDOC plays an important centralizing role in collecting data and information obtained

under the umbrella of global programmes such as WOCE, IGOSS, JGOFS, GLOSS and other programmes having a component in the eastern Pacific.

Data Holdings

At present CENDOC is the depository of the following oceanographic data:

Classical hydrocast stations:

DATA TYPE	T,S & O_2	XBT (IGOSS)	MET & SHIP
Number of stations	16,816	5,877	5,602
Data since	1930	1987	1989
Manuscript	originator	no	data logs
Digitized	yes	yes	yes

Time-series data:

DATA TYPE	SEA-LEVEL	SST	CURRENTS	WAVES
Number of stations	16 permanent	16 permanent	35 time-series	20 time-series
Data since	variable (oldest 1945)	variable (oldest 1945)	1987	1977
In analog form	recording roll	recording sheet	no	no
Digitized	yes	yes	yes	yes
Rec. interval	hourly	daily	hourly	raw data (10 min)
Location	along Chilean coast	along Chilean coast	specific locations	specific locations

There are other types of oceanographic data that are being collected by investigators or research programmes from many institutions in Chile which are not in the possession of the NODC. Most of the universities and governmental offices through the development of institutional programmes collect biological data (zoo and phytoplankton, ichtyoplankton, chlorophyll, fisheries and other), pollution data (Polycyclic Aromatic Hydrocarbons, pesticides, heavy metals and waste organic matter). The area where these data are collected is mainly located near the coast, but meridionally encompass all over the country (from the northern part, central, southern channels and down to Antarctic) .

Due to the limited resources allocated to the projects, the archiving of the data is not arranged in a proper way (only in analog or manuscript form, no standard formats) and there is a risk of losing this data. CENDOC is making efforts to approach those institutions and scientists in order to make inventories and eventually become the depositary of that data. However, additional staff and corresponding training will be required to extend further efforts on data archaeology and rescue in Chile.

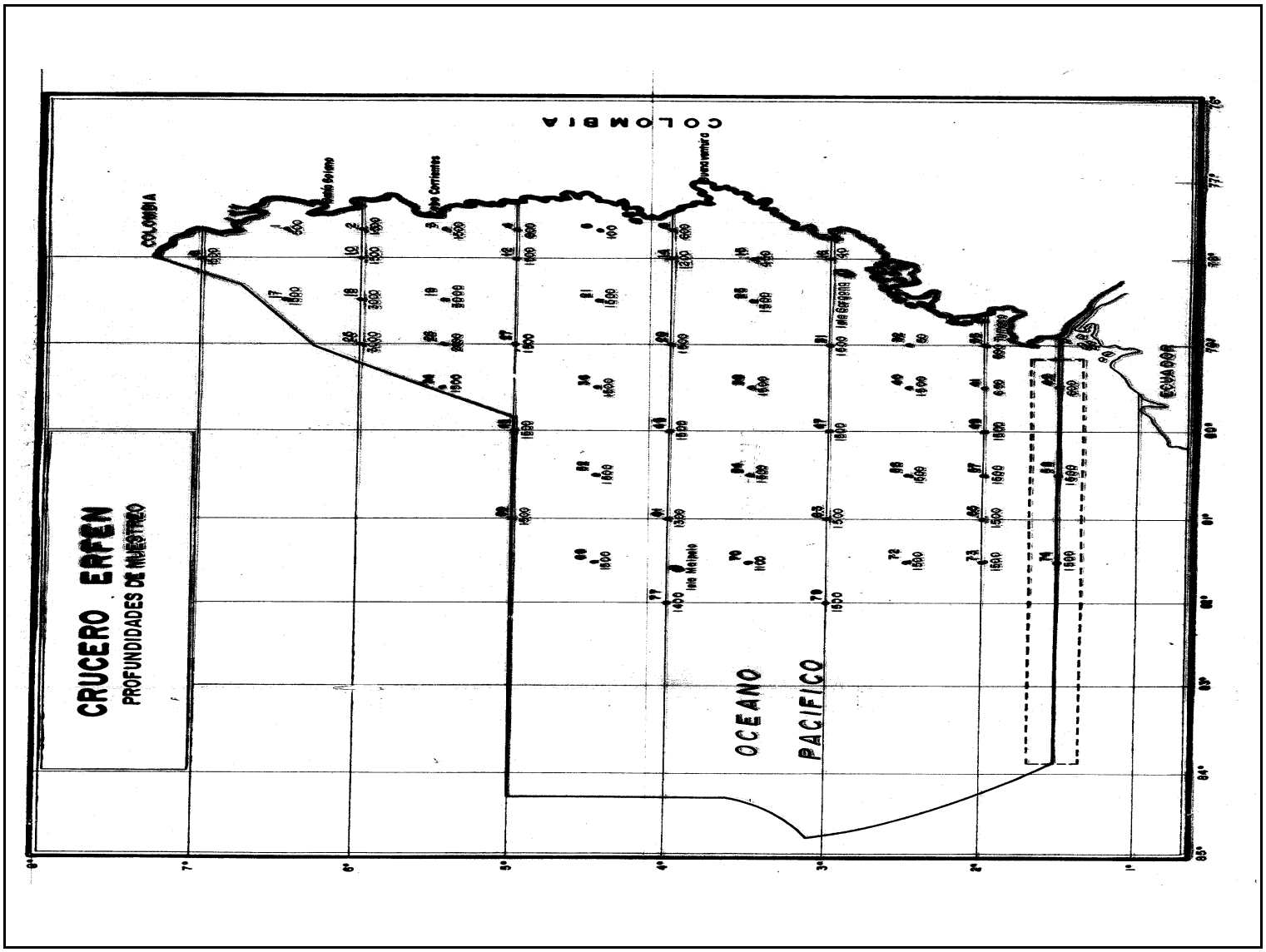
4.3 COLOMBIA

The General Maritime Directory through its centres (CIOH, CCCP) carries out monitoring and research programmes, as a part of the regional ERFEN programme and supports these activities and the related entities with its platforms for scientific investigation.

Up to now 42 cruises have been carried out by the National Navy in which different types of studies were included: physical oceanography, chemical oceanography, marine biology, meteorology and geology.

The continuity in the development and follow-up of observations of physical oceanographical phenomena is hampered by the lack of continuity of the personnel specialized in this field.

Below are included some graphical presentations indicating areas of data acquisition.



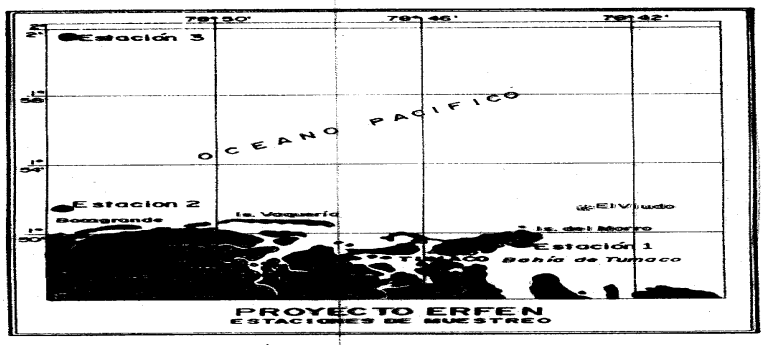
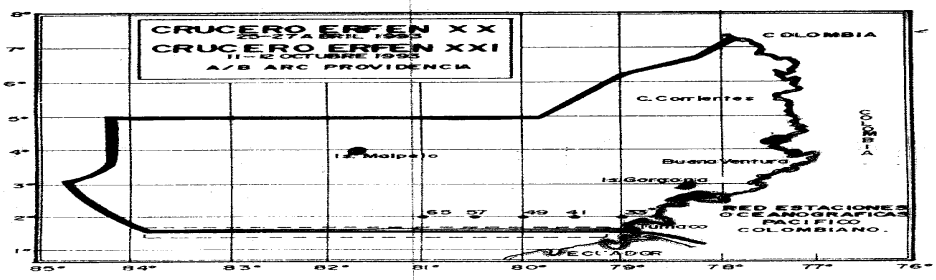
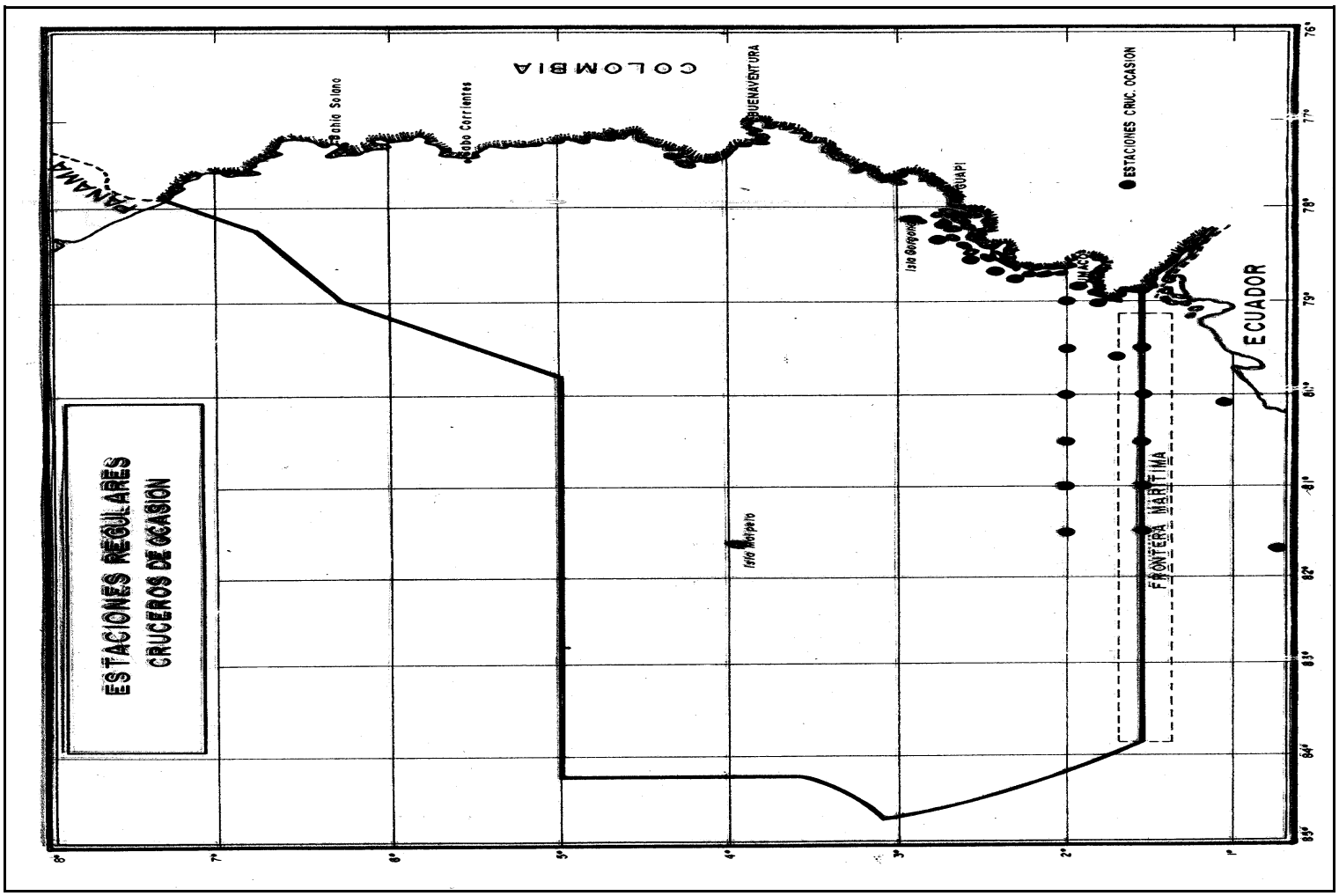


Figura 2. Estaciones Costeras

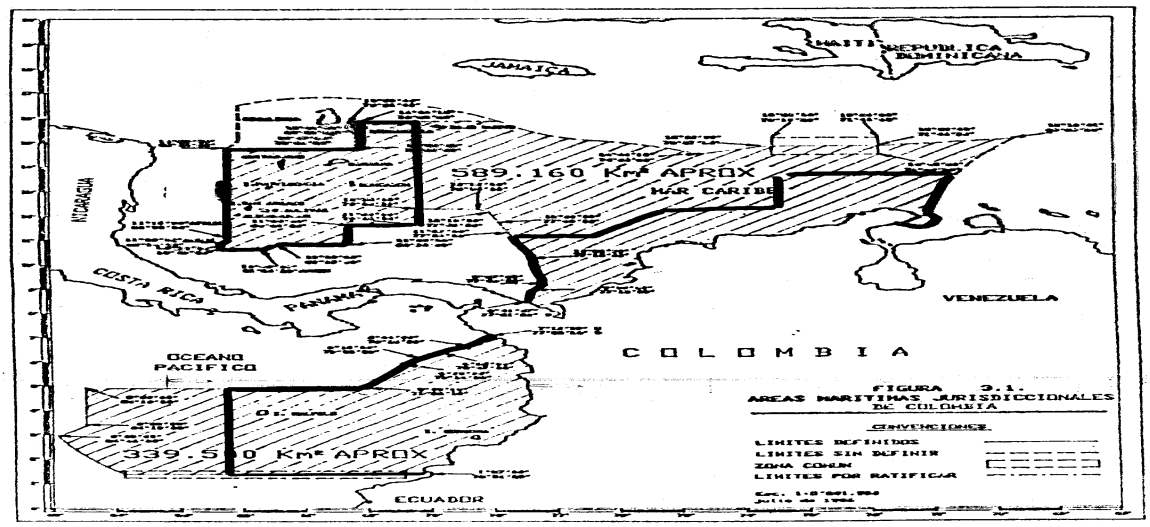


Estaciones Oceánicas

Figura 3.


COLOMBIA
PANAMA
ECUADOR
Bahia Solano
Cabo Corrientes
BUENAVENTURA
GUAPI
Isla Gorgona
Isla Malpelo
ESTACIONES CRUC. OCASION
FRONTERA MARITIMA
ESTACIONES REGULARES
CRUCEROS DE OCASION

JURISDICCION DIMAR



4.4 COSTA RICA

General

Costa Rica is a small tropical country with few resources for scientific data collection and analysis in the oceans. Data are collected and processed locally in 2 national universities that implement coastal oceanographic research: the University of Costa Rica and the National University .

Areas of research are: physical, biological, geological and chemical oceanography.

Data Structure

Data are presented mostly in printed, non standardized format. There are exceptions to this rule concerning data on tides, waves, winds, currents, some of which are in digital form stored on mini-diskettes or hard disks. There are some 4 years of tidal data and some sparse short duration (hours) current data dating back to 1955. Tidal heights are predicted for all Costa Rica's shores and are distributed as tide tables.

Recently directional wave data have been collected and analyzed and are archived in a textual (ASCII) format. At present there are 2 months of wave data for Limon on the Atlantic Coast of Costa Rica, sampled every 3 hours when wave amplitudes were minor (i.e., less than 1m in significant amplitude Hs) and each hour when high waves are have been observed (i.e., Hs > 1m).

Current data are processed and presented in the form of current reports to the local national harbour authorities. Wave data are processed with the Endeco Adaptive Package and published for local purposes in the form of wave data reports. There are also data generated by 1D, 2D (vertical) and 2D (vertical-horizontal) numerical models on hydrodynamic variables and dispersion. Water quality models also produce estimates of residence times and regenerative capacity of coastal inner water bodies.

4.5 CUBA

Infrastructure for Marine Research

Marine research in Cuba is funded by the Cuban State through programmes for scientific research and several national and international projects. The main sources of oceanographic data in Cuba were created after 1960.

The main centres of the country dedicated to marine science are:

- Oceanological Institute: manages databases on hydrophysics, hydrochemistry, marine geology, ecology, taxonomy, biodiversity, monitoring of beaches, heavy metal concentrations, and others;

- GeoCuba: acts as a data centre for GeoCuba data with databases on hydrophysics, hydrochemistry, marine meteorology, marine geology, geodesy, tides, currents, bathymetry and others;

- Centre for Engineering and Environmental Management of Bays and Coasts: a start is made to organize data on phytoplankton, primary production, hydrochemistry and heavy metal concentrations. The main part of these data are in the hands of individuals and are not digitized;

- Centre for Fisheries Investigations: with data on hydrophysics, hydrochemistry, marine meteorology but the data are not organized in a database management system;

- Centre for Marine Research: available information is not digitized;

- National Aquarium: available information is not digitized.

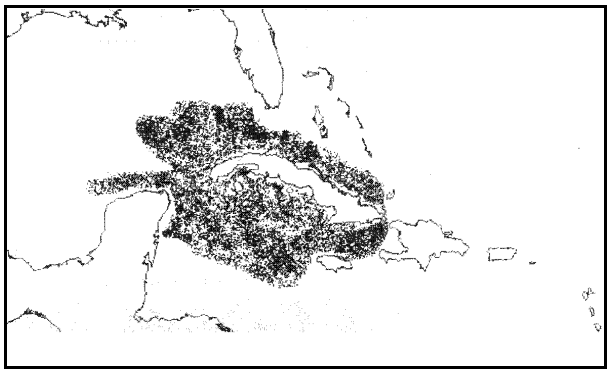
From this list is appears that only two of the country's institutions dedicated to the study of the sea manage the data from their own research as well as from other related institutions in a continuous and planned way.

Infrastructure for Data Handling and Management

Many of the institutions dedicated to marine research have local networks with computers IBM-PS/2 or compatibles with MS-DOS and Windows 3.11/95/NT as operating systems. The main databases use MS-Access 2.0 which allows for an easy conversion in any other format. The data is recorded on floppy discs, hard discs, cassettes, analog forms, catalogues, etc. The management of the databases is done mainly with software designed and developed by experts from the different institutions although some work has started using commercially available Geographic Information Systems.

Data and its Availability for International Exchange

The institutes devoted to marine research in Cuba possess a large amount of valuable data collected from the middle of this century until now concerning the following areas: the Cuban shelf, the Gulf of Mexico and the northern part of the Caribbean Sea (Marsden squares 07, 43, 44, 45, 80, 81, 82, 115 and 116). Much of this data was obtained in collaborative activities between national and foreign institutions.



Area from which most data was collected during 1964-1996

As yet Cuba has no National Oceanographic Data Centre (NODC) and no standardized formats have been implemented for the archival and exchange of the data. It is difficult to assess the total quantity of data still to be digitized and which runs the risk of being lost. However, this quantity is certain to be much larger than the amount of data being managed at present.

From an inventory done in the country it appears that the available data can be divided into 4 different groups:

- *Physical and Chemical Data*

(i) Hydrophysical and hydrochemical data (acquired in the period 1964-1996): depth soundings, temperature, salinity, 0_2, PPO_4, NNO, SiO_3, pH, total nitrates, total phosphorus, and others.

The following table presents the number of stations per parameter

PARAMETER	NUMBER OF STATIONS
temperature	8822
salinity	4633
dissolved oxygen	1519
oxygen percent saturation	670
phosphorus	940
nitrate and nitrite	870
nitrate	188
nitrite	180
silicate	904
pH	256

The following parameters are automatically calculated from the data above: pressure, practical salinity, density, sigma-T, specific volume, soundspeed, adiabatic time delay, potential temperature, and others.

(ii) Marine meteorology (data from 1978-1996): wind, air temperature, atmospheric pressure, waves and cloud cover.

(iii) Currents: data series from 1978-1992.

(iv) Tides: data series from 1966-1996.

- *Geological Data*

(i) Marine geological data (1965-1995): granulometry, chemical composition of sediments, organic composition of sediments with more than 476 geological cores, 50 basic geological profiles, 200 superficial sediment samples from the Cuban shelf.

(ii) Monitoring of the Cuban beaches: data series from 1978-1995.

- *Ecological Data and Data on Biodiversity of Marine Species*

The data includes: taxonomic classifications, synonyms, description or diagnosis, habitat, geographical distribution, bibliography, comments, keywords, photos and drawings.

Main databases:

DATABASE	NUMBER OF SPECIES
Neritic sponges of Cuba	190
Alpheus of Cuba	24
Current catalogue of present molluscs of Cuba	1501
Fish reported in Cuba	908
Echinoderms of Cuba	360
Syllidae of Poliquetos family	30
Fishes of the Caribbean	457

- *Pollution Data*

Concentrations of chemicals such as: sulphuric acid, dissolved oxygen, total solids, ammonia, silicate, pH, aluminum, calcium, cadmium, cobalt, chromium, copper, iron, manganese, nickel, led and zinc.

Conclusions

The awareness in Cuba of the value of the data management generated by sea-going investigations increases. This has led to the implementation of a data management scheme for some data.

On the other hand, the economical situation in the country has led to the need for a better and faster organization of the data. The development of databases and the usage of new computing systems has considerably increased. This has created the necessary conditions for the selection of an entity to become a National Oceanographic Data Centre and to acquire development projects which will permit to work in a joint and well organized way with all information generated by the institutes dedicated to marine research in the country.

The collaboration in the exchange of information has to be increased, both nationally and internationally. Also, a large national programme needs to be developed to assess the amount of information still to be digitized and which is currently archived by the various institutions of the country, as well as by individual scientists. Much of this data is at large risk to be lost.

4.6 ECUADOR

The Oceanographic Institute of the Navy, INOCAR, by law has obtained the position of technical organism of the state for advice to the government on all matters related to oceanographic research and to security of navigation. INOCAR includes 3 main departments related to its basic functions:

- Assistance to Navigation aimed at the maintenance, rehabilitation and modernization of all lighthouses and buoys of the Republic;

- Department of Hydrography to carry out nautic charting;

- Department of Marine Sciences carrying out investigations in the fields of physical oceanography, marine biology at primary levels, chemical oceanography, marine geology, marine meteorology and coastal zone environment.

Apart from INOCAR in Ecuador there is the National Institute for Fisheries that is related to the Ministry of Industry, Commerce, Integration and Fisheries and which carries out research on marine flora

and fauna. On the Galapagos Islands the Scientific Station Charles Darwin is located carrying out several oceanographic projects. Other institutions such as the University of Guayaquil and the Polytechnical School of the Littoral are dedicated to education and training of professionals in marine sciences.

Both the National Institute of Fisheries and the Charles Darwin Station are obliged to provide information to the director of INOCAR on the projects and research plans that are being carried out. Moreover, a proposal has been submitted to the Government on the establishment of the Ecuadorian Oceanographic Commission, in which INOCAR will be the leading organization.

The wide range of research areas of INOCAR and the thousands of observational data available within the institute has led to the establishment of the National Oceanographic Data Centre (CCONDO) in August 1985. This centre started with a minicomputer model IBM/S36. In July 1993, INOCAR published a technical report indicating some alternatives for modernization, which included the introduction of the UNIX operating system and a local area network of PC's. This approach will realize a full connectivity between the information systems of INOCAR and will facilitate the implementation of large data handling projects aimed at setting up hydrographic, cartographic and oceanographic databases which require a rapid, efficient, focused and integral handling of data from different kinds. This upgrading process will soon be finalized with the implementation of a relational database (either ORACLE or INFORMIX).

CONDO of INOCAR manages the data from oceanographic and hydrographic campaigns, ships of opportunity, fixed stations, etc. since 1949, including:

- *Tidal Data*

The information is stored in different files for each mareographic station along the coastline;

NAME OF STATION	PERIOD	VOLUME MB
Bahia Caraquez	1980-present	2
Baltra	1972-present	2.5
P. Bolivar	1970-present	3
Santa Cruz	1978-1990	1.5
Data Posorja	1983-1993	1.5
Esmeraldas	1979-present	2.0
Capitania Guayaquil	1976-present	2.5
La Libertad	1948-present	5.0
Manta	1973-present	2.5
P. Maritimo	1975-1995	3.5
Posorja	1984-1995	1.5
Puna	1980-present	2.5
Rocafuerte	1983-present	1.5
San Cristobal	1976-1990	0.5

- *Oceanographic Data*

Only physical data (temperature, salinity, depth) collected during oceanographic cruises have been digitized, the digitization of the chemical parameters have not yet been done.

Oceanographic cruises 1972 - 1994: 35.0 MB
Monthly means: 1MB

Bathythermographic information provided by ships of opportunity exists in the S/36. Digitized data included in the conventional archives exist only for 1982-1983. No updating was done because of the lack of personnel to handle this type of data.

Bathythermographic data 1982 - 1983: 0.5 MB
XBT 1982-1983: 0.5 MB

Current information is available from the Salinas and Jaramijo stations since 1991. These are stored on tape (S/36). At the stations Salinas and Manta since 1991 until present a CTD station is in operation collecting data on a monthly basis.

- *Meteorology*

The meteorological information is obtained daily, three times a day from various fixed meteorological stations along the Ecuadorian coastline.

NAME OF STATION	PERIOD	VOLUME MB
Bahia de Caraquez	1952-present	3
Baltra	1988-present	1.5
P. Bolivar	1954-present	5.5
Santo Domingo	1952-present	1.0
Esmeralda	1949-present	5
Guayaquil	1972-present	4.5
Manta	1948-present	5
Puna	1948-present	5
Salinas	1951-present	4.5
San Cristobal	1953-present	4.5
San Lorenzo	1953-present	4.5
Santa Cruz	1965-1993	
TOTAL		44.0

- *Geology*

The geological information is obtained in oceanographic cruises or by samples at different locations of the Ecuadorian territorial waters.

Bottom sediments 1973-present: 5 MB
Granulometry 1976-1994: 1 MB

Conclusion

The data archived at INOCAR could be of great value for regional oceanographic analysis, specifically related to the El Niño phenomenon. These data could be shared with the international scientific community through mechanisms such as IODE and its GODAR project. However, support in the form of resources and equipment will be required to effectively implement this collaboration.

4.7 JAMAICA

The Meteorological Service of Jamaica has been involved in the monitoring and analysis of atmospheric phenomena with the aim of interpreting these for purposes of warning or climatological data management.

Up to recently the observation or collection of oceanographic data by the Service has been almost solely confined to the prediction of tides. However, the Climate Branch of the Service is in the process of developing a Plan of Action which includes marine meteorology and oceanography.

Recently, the Meteorological Service was appointed as the focal point for the Intergovernmental Panel on Climate Change linking several other entities in the country with a scientific interest in this subject such as: the Water Resources Authority (initially involved solely with underground water management but now extended to the oceans), the Natural Resources Conservation Authority, the Jamaican Defense Force through its Coast Guard and the local campus of the University of The West Indies (UWI). For several years UWI has conducted marine research at its Marine Laboratory. The Defense Force has been collecting oceanographic data at specific points along the Jamaican coastline.

In spite of a steady though limited collection of oceanographic data over the years in Jamaica, no single body as yet is responsible for archiving these data in a standardized format or for exchanging them with national or international centres.

However, the IPCC related discussions have identified entities which would be given responsibility for a preliminary project aimed at the establishment of a co-ordinated approach to data gathering, control, archival and distribution. This includes the establishment of an oceanographic or coastal zone database. Especially with the consistently restrictive budget of the central government, particularly with respect to scientific or research related matters, it is essential to create awareness at high levels on the benefits of marine data and of the information that can be derived from them. The support of international organizations was also solicited, firstly to set up a preliminary consultative project team, and secondly to provide financial assistance to initiate a full data management project.

Much of the Jamaican oceanographic instrumentation was lost in the great hurricane of 1988. Therefore, there has been a dramatic decline in the capabilities of Jamaica to collect marine data.

4.8 MEXICO

The knowledge about available marine resources in Mexico is limited. However, during recent years large amounts of data were acquired from the Exclusive Economic Zone but this was done in a disperse way and without a proper mechanism to assure its quality, completeness and timeliness. Still important information is lacking which is required to develop oceanography and marine-related products and services.

INEGI, in accordance with the tasks given to it by LIEG, is currently investigating the possible establishment of adequate technical and administrative mechanisms for the development and implementation of a National System for Oceanographic Information. This activity is carried out with the participation of the institutions and departments related to oceanographic activities (acting both as originators and as users of data).

Infrastructure for Oceanographic Research

In the country more than 10 institutions for research and advanced training in the field of marine sciences form the main sources of oceanographic data in Mexico:

CICESE	:	Centre for Scientific Investigations and Advanced Training B.C.
ICMYL/UNAM	:	Institute for Marine Sciences and Limnology, UNAM with stations in Mazatlan, Sin, Puerto Morelos, Qna. Roo; Tuxpan, Ver; and Cd. del Carmen, Campeche
IIE	:	Institute for Electrical Investigations, CFE, Cuernavaca. Mar
CINVESTAV	:	Centre for Advanced Investigations and Studies, Unidad Merida, Yuc.
IMTA	:	Mexican Institute for Water Technology
IMP	:	Mexican Petroleum Institute
IOM/SM	:	Oceanographic Institute of Manzanillo, Col, Oceanographic Institute of Veracruz, Ver.
IIO	:	Institute for Oceanological Investigations, U.A.B.C.

Furthermore there are 17 CRIP centres (Regional Centre for Fisheries Investigations of INP/SEMARNAP) and 17 SETMAR centres (Marine Technology Centres depending of SEP).

Ships

Mexico operates the vessels *Puma* and *Justo Sierra* of the UNAM which since 1982 have been used to carry out investigations (one in the Pacific with its base in Mazatlan, Sin and the other in the Gulf of Mexico with its base in Tuxpan, Ver). S.M. operates 4 ships dedicated to oceanographic research and INP operates 2 ships: the *Onyuko* and the *Humbolt* as well as 8 smaller vessels for fisheries investigations.

Infrastructure for Data Management

Most of the institutes dedicated to oceanographic research have local networks with computers PC 486 (IBM compatible), Pentium and workstations type HP, VAX, IBM, SUN with operating systems MS-DOS, Windows 3.11/95, UNIX, VMS, etc. Mostly relational databases are used to facilitate access and conversion into different formats. The data are recorded on floppy discs, hard disks, Exabyte tapes, etc. In general, the management of the data banks is carried out with commercial software, including GIS systems. Most institutions have access to Internet which facilitates the exchange of information.

Data and its Availability

The institutes and research centres in Mexico manage valuable information on the Mexican sea areas in the Gulf of California, the west coast of the Baja California peninsula, the tropical Pacific, the Gulf of Mexico and the Caribbean. Much of this information was collected in joint activities with foreign institutions. Nevertheless, a large part of this information is not available in a digital form. Only during the last few years some institutions have started to manage their data in a systematic and planned way. Agreed standards for archival and quality control - which would facilitate exchange of data - have hardly been implemented. It is difficult to estimate the amount of work needed to avoid the loss of the available data and information.

INEGI has started to recompile the information of the Mexican EEZ existing in other data centres with the aim to make this information available for national institutions and to stimulate interest in this activity.

The following tables present the information held in the oceanographic databank of INEGI.

TYPE OF DATA	PARAMETER	VOLUME (rec.)	SOURCE	FORMAT	AVAILABILITY
geophysics (1940-1994)	Bathymetry	1,278,446	Lamont	MGD77	corrected & Mercator
	Gravity	716,019	WHOI	MGD77	raw
	Magnetism	641,720	NOAA	MGD77	raw
	Seismicity	2,243	USGS	MGD77	raw
			Oregon St. Univ.	MGD77	raw
			Soest	MGD77	raw
			US Navy	MGD77	raw
			Univ. of Texas	MGD77	raw
			SIO	MGD77	raw
			Univ. Rhode Is.	MGD77	raw
			UK	MGD77	raw
			Texas A&M Univ.	MGD77	raw
			USSR	MGD77	raw
			DMA	MGD77	raw
			Min. Mang. Serv.	MGD77	raw
			France	MGD77	raw
			Univ. of Tokyo	MGD77	raw
Digital coastline of Mexico	WVS		NGDC/DMA	x,y,z	raw

National Institute for Statistics, Geography and Informatics
General Directorate of Geography
Sub-directorate of Oceanography

TYPE OF DATA	PARAMETER	VOLUME	SOURCE	FORMAT	AVAILABILITY
Temperature/ salinity 1900-1980	IBT	759 kb		GF3	raw
	MBT	2074		GF3	raw
	SUM	66		GF3	raw
	SD2	2,226		GF3	raw
	XBT	3,481		GF3	raw
Temperature data 1960-1993	MBT 1960	227,880 kb	JODC		raw
	MBT 1970	525,954	JODC		raw
	MBT 1990	9374	JODC		raw
	XBT 1970	463,554	JODC		raw
	XBT 1980	8,354	JODC		raw
	XBT 1990	11,211	JODC		raw
	XBT 1993	1,773	JODC		raw
	DBT 1990	319	JODC		raw

Bathymetry

CVE	INSTITUTION	SURVEYS	NAUT. MILES	BATH MGD77 recs
1	Lamont (LDGO)	32	36846.8	45,096
2	WHOI	3	3669.4	6,067
3	NOAA	17	21671.9	67,321
6	USGS	23	32196.7	230,769
7	Oregon State Univ.	21	55366.2	72,575
8	Soest	17	16303.1	51,752
9	US Navy	21	61720.7	183,930
10	Univ. of Texas	56	63333.9	109,558
15	SIO	140	142714.0	320,787
17	Univ. Rhode Island	4	1475.7	10,682
19	UK	3	483.4	303
23	Texas A&M Univ.	3	2436.3	11,355
29	USSR	2	4756.9	3,259
35	DMA	10	17421.3	23,800
60	Min. Mang. Serv.	3	14964.6	83,099
67	France	9	10268.7	56,363
J4	Univ. of Tokyo	2	3130.6	1,730
	GRAND TOTALS:	366	488760.1	1,278,446

Seismicity

CVE	INSTITUTION	SURVEYS	NAUT. MILES	MGD77 recs
15	SIO	1	1225.5	2,243
	GRAND TOTALS	1	1225.5	2,243

Magnetism

CVE	INSTITUTION	SURVEYS	NAUT. MILES	MAG MGD77 recs
1	Lamont	29	33269.1	34,845
2	WHOI	2	2216.0	2,517
3	NOAA	5	9146.9	7,165
6	USGS	11	21065.5	75,208
7	Oregon State Univ.	18	54440.6	72,092
8	Soest	15	15952.4	62,080
9	US Navy	6	6393.9	9,816
10	Univ. of Texas	35	46855.2	127,663
15	SIO	114	133391.3	196,430
23	Texas A&M Univ.	1	475.8	2,667
67	France	9	10035.6	49,535
J4	Univ. of Tokyo	2	3080.8	1,702
	GRAND TOTALS:	247	336323.1	641,720

Gravity

CVE	INSTITUTION	SURVEYS	NAUT. MILES	GRAV MGD77 recs
1	Lamont	30	56085.3	62,695
2	WHOI	2	2216.0	2,426
3	NOAA	4	10650.5	6,927
6	USGS	10	13799.2	75,417
7	Oregon State Univ.	20	62038.5	78,105
8	Soest	13	31934.0	85,880
9	US Navy	16	31673.7	165,160
15	SIO	13	37090.8	135,492
29	USSR	2	6866.3	5,224
67	France	7	13104.9	98,659
	GRAND TOTALS:	117	265459.1	718,019

4.9 PERU

Oceanographic investigations are performed mainly by 2 institutions: the Marine Institute of Peru (IMARPE) and the Direction of Hydrography and Navigation of the Navy (DHN).

Marine research activities in Peru are funded by the government, the Ministry of Fisheries (percentage of catches), the National Council for Science and Technology (CONCYTEC), through international co-operative programmes as the VECEP-project (Venezuela, Ecuador, Colombia, Peru) of the European Community, the South Pacific Permanent Commission with funding from the IOC (Intergovernmental Oceanographic Commission) and UNEP (United Nations Environmental Programme) and by foreign universities (Alfred Wegener Institute).

IMARPE's Observational System: Two Levels

Macro- and mesoscale:

- Oceanographic cruises;
- Oceanographic Monitoring for El Niño Forecasting (MOPFEN);
- Cruise of Evaluation of Spawning Biomass of Anchovy and Sardine (MPH method);
- Cruise of Evaluation of Pre-reclutes;
- Cruise of Evaluation of Pelagic Resources;
- Cruise of Evaluation of Demersal Resources;
- Cruise of Evaluation of Coastal Resources;
- Cruise of Evaluation of Giant Squid (Docidicus Gigas);
- Cruise of Evaluation of deep prawn;
- Cruise of Evaluation of deep cod.

Microscale:

- Oceanographic and Fisheries Monitoring in selected areas (MOPAS);
- Bio-oceanographic monitoring at 2 fixed stations in northern Peru (AWI);
- Hydrochemical Variability Monitoring along the shores of Callao and at Callao fixed station;
- Monitoring of Marine Environment quality;
- Evaluation of the Effects of Marine Pollution and Microbiological Quality;
- Inventories of marine invertebrates;
- Specific operations for fisheries applications.

DHN's observational system for on-going marine research includes oceanographic cruises and hydrographical operations.

Research Vessels

- BIC/Humboldt	(IMARPE)	: 76,2 m
- BIC/SNP-1	(IMARPE)	: 32,6 m
- BAP/Carrasco	(DHN)	: 38,0 m
- BAP/Cerrillo	(DHN)	: 25,0 m
- BAP/Melo	(DHN)	: 25,0 m
- BAP/Macha	(DHN)	: 15,0 m
- E/E Huamanga	(CEP/Palta)	: 15,2 m

Data Management Infrastructure

Most scientific institutes and universities in Peru are connected to INTERNET through the Peruvian Scientific Network.

Some of the institutions, especially IMARPE and DHN, have developed their own data and information systems and do not share a unique database. The data are archived in electronic sheets (Q-PRO, EXCEL) and databases (DBASE-III, FOXBASE).

IMARPE envisages to develop a Global Integrated Information System for Oceanography based on ORACLE in order to increase the efficiency of data exchange between researchers, institutions and international organizations. In addition, IMARPE maintains a database of publications, journals and papers related to its investigations in the Peruvian sea such as: "Informe Progresivo", "Informe" and "Boletin". The Direction of Oceanography is editing a Weekly Bulletin of Sea Surface Temperature of Coastal Stations and a Monthly Report of Oceanographic Conditions and Executed Moorings, both accessible through Internet since October 1996. DHN edits the (seasonal) Oceanographic Bulletin.

There is an NODC (National Oceanographic Data Center) in Peru, however, there is no-nation wide marine data archaeology and rescue programme. In 1996, preliminary inventories of available data have been prepared. These present information on the volume of existing data such as the type of data and the data format.

The available data are divided into 4 different groups: time-series data (currents, sea-level, winds and waves, temperature profiles); classical hydrocast data (meteo data and sea-surface conditions, T, S, O_2, nutrients); pollutant data (organic and inorganic) and biological and fisheries data. More than 66% of the data are archived in IMARPE.

Critical Gaps in Data, Resources and Expertise

- large volumes of marine data are scattered between different Peruvian institutions, laboratories and private companies,

- archiving of these data is not standardized and largely not digital (electronic sheets, databases, hard copy data, manuscripts, rolls, sheets, tapes, analogue records, geological and biological samples).

- consistent application of standard quality control procedures is not implemented.

- data from 1925-1965 are scarce, non consistent and discontinuous; Peruvian MBT data from 1950-1960 have already been lost.

- international software for data handling is not available.

- climate change studies require long-term data of well known quality. In Peru, there is a lack of this kind of data; the longest time series are from the stations Chicama (since 1925) and Lake Titicaca (since 1903).

- systematic archival of historical and actual data is not carried out.

- the lack of financial and staff resources prevents further activities in the field of data archaeology and rescue.

- there is a lack of expertise in handling of oceanographic data and information.

Critical Needs

- implementation of an IOC Seminar on management specifically of historical biochemical oceanographic data,

- organization of fellowships and individual training opportunities in the collection, validation, statistical processing and management of oceanographic data,

- support in the development of a Geographical Information System based upon the concept of a relational database,

- provision of powerful PC computers with CD-ROM readers and graphic printers to the relevant institutions.

Oceanographic data from Peru may be internationally exchanged under the condition that the data have already been published by national institutions. No restrictions are applied to exchange and availability of data collected in the framework of co-operative projects.

4.10 TRINIDAD AND TOBAGO

The Institute of Marine Affairs was established by Act of Parliament N°. 15 of 1976 (Chap. 37:01 of the Laws of the Republic of Trinidad and Tobago (1980)) following negotiation of an agreement signed in 1974 between the Government of Trinidad and Tobago and the United Nations through its Executing Agency, the United Nations Development Programme (UNDP). The Institute was mandated to collect, analyze and disseminate data relating to the economic, technological, environmental, social and legal development in marine affairs generally and to formulate and implement specific programmes/projects to achieve the overall objectives.

Current areas of research include:

Marine Fisheries
Aquaculture/Mariculture
. Marine Geology/Sedimentology
. Environmental Impact Assessment
. Pollution Monitoring
. Oceanography
. Satellite Remote Sensing
. Marine Policy and Planning.

IMA is Trinidad and Tobago's Designated National Agency (DNA) for oceanographic data and information within the International Oceanographic Data and Information Exchange (IODE) system of the Intergovernmental Oceanographic Commission (IOC) of UNESCO. IMA is also an Associated Centre of the UNESCO Sub-Regional Network for the Exchange of Information and Experience in Science and Technology for Development in the Caribbean Region (CARSTIN).

The work programmes and activities in which IMA is involved generate a large quantum of data and information in a range of disciplines relating to economic, social, technological, scientific, environmental and legal developments in the marine areas and coastal zones of Trinidad and Tobago, the Caribbean and adjacent regions.

In addition to data generated from its activities, the Institute obtains information through collaborative work with ships of opportunity conducting research in the Caribbean region, as well as by way of exchange with the World Data Centre-A (Oceanography) in Washington, DC. The data are archived, and disseminated to a wide variety of users.

Declared National Agencies or similar institutional structures for the management of oceanographic data and information are lacking in many of the small island developing states in the region. A regional oceanographic database has been established at the IMA, with funding assistance from UNESCO, to serve the needs of CCOSNET. The database incorporates the CD-ROM datasets from the WDC-A (Oceanography), as well as data collected by ships of opportunity conducting research in the region.

The contribution of the Atlantic Oceanographic and Meteorological Laboratory (AOML), Miami to the regional databank and in particular, the cruises of the NOAA Ship *Malcolm Baldrige*, is gratefully acknowledged. The Sea Education Association (SEA) Inc., has also added to the data collection through cruises of their vessels, *viz*., the SSV *Westward*, and the SSV *Corwith Cramer* during the last few years. These ships are actually conducting student oceanographic research projects in the waters of the Caribbean.

The Information Centre provides access to Internet allowing electronic transfer of data and information, including electronic mail. IMA launched its Home Page on the World Wide Web in June 1996, through the support of the IOC and the University of Prince Edward Island, Nova Scotia, Canada which mirrors the site in North America. The URLs for the IMA Web sites are respectively:
http://www.unesco.org:80/ioc/states/trinidad/IMA.HTML
http://www.upei.ca/siin/ima.htm

IMA has been collecting oceanographic and other marine and environmentally-related data and information since the Institute became operational in late 1977. The data include CTD casts, current time-series (one-month period during wet and dry seasons), tidal data, waves and hourly wind data for selected stations in the coastal waters of Trinidad. Oil pollution data, including beach tar and floating tar have also been collected. At IMA, a complete dataset of the IOCARIBE marine pollution research and monitoring programme, CARIPOL is held. A database of oil fingerprints (fluorescence) of crude and refined oils which transit the Caribbean Sea has also been established.

Data collection and processing at IMA has been the responsibility of individuals and projects. During the last 5 years however, a concerted effort has been made to centralize the archival, retrieval, dissemination and exchange of these data and information. The Institute's Board of Governors has approved an Information Policy, and an Information Centre has been established. However, the human resources required to effectively implement policy decisions remain inadequate.

Apart from the lack of human resources, there are additional constraints to the effective management of ocean data and information at IMA. These include:

- various datasets are collected, stored and managed by individual agencies of the State (e.g., Ministry of Energy and Energy Industries) and by the private sector;

- there is no single source where a user can find out what marine data and information is available and where it can be accessed, even within organizations;

- there is a lack of standardization in the full data handling process including acquisition and quality control so it is impossible to use the data to establish trends and correlations;

- there is a lack of horizontal integration of information;

- there are insufficient financial resources.

In Trinidad and Tobago (but equally valid for the majority of the other CCOSNET member States) there is an urgent need to:

- identify the Government ministries, agencies and institutions that systematically collect ocean-related data;

- prepare inventories including short descriptions of these datasets;

- validate, process, organize and archive these data;

- create meta database(s) of datasets in the region;

- explain the benefits of participation in the IODE system to the relevant authorities.

It is expected that the GODAR-V Workshop would provide the necessary guidance and direction to enable IMA and the other CCOSNET Member States to effectively manage their marine environment related data and information resources.

4.11 VENEZUELA

Introduction

In Venezuela, the collection of oceanographic data is mainly carried out by universities and governmental entities, each organization is specialized in the collection of a specific type of oceanographic data. The following table presents a list of the main entities.

ENTITY	TYPE OF DATA
Oceanographic Institute of Venezuela (University de Oriente)	physical, marine biological, chemical, sediments and aquaculture
National Geographical and Cartographical Service	tides
Navy, Directorate of Hydrography and Navigation	bathymetry, physical, sediments, marine meteorology
Institute for Tropical Zoology (Central University of Venezuela)	marine biological, pollution
Francisco de Miranda University	marine biological, pollution, aquaculture
Institute for Marine Technology (Simon Bolivar University)	marine biological, pollution, sediments, ecology
La Salle Foundation	physical, chemical, marine biological, geological, aquaculture
O.N.G.	marine biological, pollution

The geographical area of interest comprises the Caribbean Sea and a part of the Atlantic Ocean. For the research in these areas a fleet is available including one oceanographic vessel with ocean-going capabilities, 2 hydrographic launches and 3 smaller vessels for coastal work.

More than 70% of the data collected in the above areas is archived in the data centre of each institution on forms. Therefore, even when the data are available for scientists they are difficult to handle. The usage of the data is therefore mostly limited to the entities themselves.

Inventory of Historical Data

In correspondence with an existing inventory at the Directorate of Hydrography and Navigation, below an overview is presented of the historical data that up to now has not been archived in digital form.

The Directorate of Hydrography and Navigation is responsible for maintaining 7 coastal meteorological stations making first order synoptic observations. These are:

NAME OF STATION	TYPE	HEIGHT	LATITUDE	LONGITUDE	PERIOD
Cagigal Observatory	S,C1	1035 m	10°30'N	66°55'W	1891-1996
La Orchila	S,C1	3 m	11°48'N	66°11'W	1959-1996
Puerto Cabello	S,C1	2 m	10°29'N	67°59'W	1962-1996
Naval School of Venezuela	S,C1	81 m	10°35'N	67°02'W	1968-1996
Punto Fijo	S,C1	22 m	11°39'N	70°13'W	1976-1996
Carupano	S,C1	20 m	10°40'N	63°15'W	1976-1996
Isla de Aves	S,C1	8 m	15°40'N	63°36'W	1980-1996

The stations continuously record the following parameters:

- minimum temperature
- maximum temperature
- rainfall
- atmospheric pressure
- windspeed
- wind direction
- evaporation (sunlight)
- evaporation (shadow)
- dewpoint
- cloud cover
- visibility
- hours of sunshine
- direct and diffuse sun radiation
- relative humidity

The total volume of data (number of recordings) from these meteorological stations amounts to more than 50 million, of which 20% is archived in digital form. The following table presents the distribution of the data and the percentage digitized.

STATION	VOLUME (millions)	PERCENTAGE DIGITIZED
Cagigal Observatory	12.70	15
La Orchila	4.47	20
Puerto Cabello	4.11	20
Naval School of Venezuela	3.38	20
Punto Fijo	2.41	20
Carupano	2.41	20
Isla de Aves	1.93	20

With regard to bathymetric data the Directorate of Hydrography and Navigation is responsible for nautical charting in Venezuela and although since 1994, the bathymetric data is processed and managed in a digital way, still more than 70% of this data is archived in 'sounding books'.

Along the Venezuelan coast the National Geographic and Cartographic Service operates 6 tidal stations. From the table below the volume of available recordings can be observed; all recordings are analog and on forms.

STATION	PERIOD	TYPE OF RECORDING	VOLUME OF DATA
La Guaira	1948-1996	form	414,720
Amuay	1953-1996	form	371,520
Maracaibo	1964-1996	form	276,480
Punta de Piedra	1971-1996	form	216,000
Cumana	1949-1996	form	406,080
Carupano	1967-1996	form	250,560

Non-digital information from oceanographic campaigns is available from 1961 onwards corresponding to 126 cruises, distributed in the following way:

INSTITUTION	NUMBER OF CAMPAIGNS
La Salle foundation	58
Oceanographic Institute	54
Directorate of Hydrography and Navigation	14

The available information from these cruises contains more than 3,000 oceanographic stations with the following specifications:

TYPE OF INFORMATION	QUANTITY	INSTRUMENT
Profiles of temperature and salinity	3,087	Nansen bottle
Temperature profiles	983	XBT
Basic chemistry	3,087	Nansen bottle
Sediments	315	grab, piston corer

Concerning marine biological data it is planned to compile an inventory to assess the amount of existing biological data in the various institutions that carry out this type of work. However, from preliminary investigations it can already be concluded that the amount of existing data of this type is much larger than of other types of oceanographic data.

Data Centre

Every institution has its own small data centre which allows to record both the historical data and the data from new oceanographic campaigns in a digital form. In 1990, the Directorate of Hydrography and Navigation has started the process of acquiring the necessary hardware and software to set up a database with sufficient capacity to manage all data available in the various institutions. This process is hampered by the current economical situation. Nevertheless, in July 1996, the development of the database (based upon ORACLE) was completed. This Oceanographic Data Base is the linking element of the Hydrographic Information System which has the following sub-systems:

- oceanography;
- nautic charts;
- mapping;
- hydrographic management.

The Oceanographic Data Base is a formal structure upon which will be based the management, updating, handling, processing and maintenance of the oceanographic information from the territorial

zones, as well as rivers and lakes. This structure also will allow to process data provided by other national and international entities with an aim of realizing an exchange of data both on the national and international level.

Actually, the necessary final tests of the system are underway after which the process will be started of digitizing the non-digital data.

5. CONCLUSIONS AND RECOMMENDATIONS

1. **The Workshop recommended** IOC to intensify its efforts of bringing to the attention of Member States in South America and the Caribbean, and in particular to the English speaking countries of the Caribbean, the benefits of active participation in IODE and especially in the GODAR project. **Conscious of the need** to make better known the benefits of data collection and exchange for both scientists and decision makers, **the Workshop further recommended** IOC to develop a brief but comprehensive document that indicates clearly such benefits, which include:

    - data centres not only compile data but also carry out quality control and provide data in a digitized uniform format, that facilitates international exchange of data;

    - data centres provide safe repositories that avoid the risk of loss of data from individual scientists and institutions;

    - data centres prepare specific products such as atlases that provide easy access to both general and specialized oceanographic parameters for the global ocean or for specific regions;

    - data centres assist in capacity building by providing advice concerning data management procedures and by implementing training;

    - data centres can assist in the development of software;

    - data centres make efficient use of limited resources and can assist in the solution of data problems common to a region;

    - data centres form a source of quality controlled information that can be useful to decision makers.

2. **Recognizing the need** to promote further the principal objectives of GODAR and **cognizant of the existence** of large amounts of historical data in the Caribbean, **the Workshop strongly recommended** that the Member States - with the assistance from IOC - urgently undertake the preparation of an inventory of historical data in each Caribbean country as an essential first step in the data rescue programme.

3. **Noting the recommendations** of the IOCARIBE-VI and SOC-VI requesting Member States of the region to facilitate their efforts in oceanographic data and information management, **the Workshop recommended** to intensify the contacts between the regional NODC's with the objective of exchanging experience so as to optimize the available, limited local resources and achieve a certain standardization where possible of the procedures used. In this respect one option could be a yearly meeting of the representatives of the NODC's in the region similar to the yearly meeting of the Northern European data centres in the context of ICES. **The Workshop**

invited the IOC Regional Bodies for IOCARIBE and SOC to cooperate with IOC in the implementation of this Recommendation.

4. **The Workshop noted** that in many countries the decision and policy makers are insufficiently aware of the relevance and importance of comprehensive datasets to the studies of climate change, biodiversity, coastal zone management and to the development of the national economies. **The Workshop invited** the Executive Secretary IOC to organize regional meetings addressing the cost/benefit issues related to the relation between changes in climate and environment on the one hand and the economy on the other, including the particular importance of oceanographic data in this context.

5. **Noting** the success of the OceanPC project in facilitating the processing, quality control and presentation of oceanographic data, **further noting** the large amount of data already identified in the region during the Workshop that require digitizing, **taking into account** that much of the digitizing effort could be made at the national level by the institutes or data centres themselves, **the Workshop invited** IOC to consider expanding the present OceanPC package with a module for digitizing data in the context of GODAR. In this respect the digitizing software protocol developed by NODC/WDC-A should be considered.

6. **The Workshop, recalling** the recommendation of GODAR III concerning the publication on CD-ROM of the BIOMASS dataset and documentation, **recommended** that additional efforts be made by SCAR and the British Antarctic Survey (BAS) to promote the publication of these valuable data so as to facilitate their access by the oceanographic community and by other interested users and **invited** IOC to co-operate with SCAR and BAS in this effort.

7. **The Workshop, aware** of the necessity to provide to the oceanographic community maximum benefits from the rescue and/or collection of data, **recognizing the need** to bring together data from specific projects, such as BIOMASS for archiving, **noting** the Recommendations of the Workshop on Ocean Climate Data, held in February 1992. Greenbelt, USA, **urged** the organizers of future large-scale scientific programmes to make every effort to build an effective data management scheme from the planning stage and make arrangements for the collection and publication of the data without delays. This will make the data available to a large group of users and will facilitate their preservation. **The Workshop suggested** that the previous experience in the creation of similar databases be used to maximum advantage.

8. **The Workshop recommended** that the oceanographic institutions with archives of physical, chemical and biological data from the Southern Ocean that are not yet stored at the RNODC-SOC data master files, submit data to this RNODC. **The Workshop requested** the Director of the RNODC-SOC to bring the current contents of the Centre master files to the attention of the relevant oceanographic institutions. More information can be found at the Internet address: http://www.conae.gov.ar/~ceado/rnodcsoc.html.

9. **Noting** the large amounts of oceanographic data present in various Cuban scientific institutions and agencies which would be of great relevance to the GODAR project of IODE, **noting as well** the need to improve the capabilities of Cuba to effectively participate in IOC programmes, especially IODE and GOOS, **the Workshop invited** IOC to support Cuba, specifically by:

   - providing expert advice and assistance for the establishment of a national oceanographic data management infrastructure,

   - assisting upon request in the implementation of a national training course on marine data and information management preferably in 1997 by making available 2-3 instructors from outside the country,

- providing technology for the acquisition and management of marine data and information specifically for effective access to the Internet.

10. **Noting** the responsibility of the Institute of Marine Affairs (IMA), Trinidad and Tobago as the Co-ordinating Centre for the Caribbean Community Ocean Sciences Network (CCOSNET) and the establishment of a regional archiving centre at IMA, **the Workshop strongly recommended** to use IMA facilities in the preparation of the inventory of the data holdings in the possession of small states of the Caribbean and **requested** IOC to provide expert advice and assistance to IMA in developing and maintaining meta databases of existing marine environmental numerical data sets in the region and in developing its capability to digitize data so as to make these available to the regional users.

11. **The Workshop noted** the summary report of the Workshop held in April 1996 in Concepcion, Chile, on Management of Ocean and Coastal Systems in the Eastern Pacific organized through a collaboration between the University of Concepcion, IOC and the European FAIR programme and the recommendations (see Annex V) adopted by that workshop. **The Workshop acknowledged** that some of the recommendations adopted by the Concepcion Workshop closely relate to IODE and its GODAR project and **requested** the IOC Secretariat to seek ways of establishing close co-operation and dialogue with the FAIR programme in order to share the burden of the implementation of the IODE/GODAR project in the region and avoid duplication of efforts.

12. **The Workshop noted** the wide range of programmes to rescue data and to recover climatological data from archives being implemented by different international organizations such as ARCHIS, GODAR (IOC), UNESCO/IHP, DARE (WMO), IGBP-PAGES (ICSU), etc. **and recommended** that efforts be made by the GODAR Project Leader to establish and/or improve links with the organizers of such programmes in an endeavour to improve co-operation and to avoid unnecessary duplication. **The Workshop further recommended** IOC to investigate the possibilities of organizing a meeting of representatives of these and other similar programmes in 1997.

13. **The Workshop, cognizant** of the importance of oceanographic data in the study of marine living resources, **urged** the establishment of strong links between FAO and the IODE system so as to improve the exchange of data and information for a better understanding of the world's marine fisheries.

14. **The Workshop noted** that the now common practice of making data available via the Internet represents a major improvement in the ability of the scientific and data management communities to efficiently exchange data. However, it was the sense of the meeting that Internet access is not a substitute for the archiving of data and associated meta data at national and international data centres. Electronic access alone does not provide for the maintenance and preservation of datasets. **The Workshop recommended** that IOC Member States support the continued operation and expansion of national oceanographic data centres and not rely solely on the Internet for archival functions.

15. **Noting** that there are substantial amounts of historical ocean observations in the area of Central and South America that are at risk of being lost, **recognizing** that limited funds, resources and personnel restrict active participation in the GODAR project, **the Workshop recommended** that the GODAR Project Leader makes all necessary efforts to get contributions from funding agencies (such as IAI, World Bank, etc.) in order to build up capacity of Member States of the region and to fulfil the following requirements:

- continue organizing training courses in IODE matters for Member States of the region in addition to scheduling short expert visits to WDC-A for Data Managers from the region.

- provide advice and assistance through expert missions to the relevant Member States of the region in order to assist in the process of setting up data systems and infrastructures in support of national and international exchange of ocean data and information including the GODAR project (specific requests from Cuba, Ecuador and Venezuela),

- implement technology transfer of both hardware and software from the most developed to the less developed Member States, to improve data reduction and quality control procedures. Also to provide Internet capabilities to Member States that don't have full access to it.

- to fund the cost of digitizing data obtained at a National level, in the framework of a GODAR project in each country.

16. **Recognizing** the lack of personnel with adequate training and experience in the science and art of interpretation of ocean data, **the Workshop recommended** IOC through its regional office in Cartagena and other relevant UNESCO regional offices organize training courses and seminars. Member States concerned and UNESCO/IOC will co-operate in providing the necessary funds for the participation of adequate numbers of trainees.

17. **The Workshop agreed** that the meeting was an important step in increasing awareness in the Member States on the IOC activities, particularly on its IODE programme. Member States of Central and South America have been requested to facilitate their participation in the IODE projects which do not need allocation of special resources for their implementation and will, at the same time, help to meet the objectives of effective data collection and management e.g., submission of properly filled in MEDI forms to the IOC Secretariat, participation in the NOP's announcement, submission of Cruise Summary reports to NODC's and WDC's. **The Workshop invited** Member States of IOCARIBE where there is a big gap in the IODE system, particularly Costa Rica, Cuba, Jamaica and Nicaragua, to take necessary actions for nominating IODE national co-ordinators and establishing a DNA or NODC.

ANNEX I

WORKSHOP PROGRAMME

8 October 1996

08:30-10:00	**Registration**
10:00-10:30	**Official Opening**
10:30-11:00	Coffee
11:00-12:30	IOC Regional Activities - IOCARIBE, El Niño, SOC (S. Velandia, E. Cabrera, I. Oliounine)
12:30-14:30	Lunch
14:30-15:10	IOC-IODE Programme - Benefits for Being a Partner (I. Oliounine)
15:10-15:20	Discussions
15:20-16:00	IOC-IODE Global Oceanographic Data Archaeology & Rescue Project (GODAR) -Four Years of Experience (S. Levitus).
16:00-16:10	Discussions
16:10-16:30	Coffee
16:30-17:10	Status of the Archival Climate History Project (M. Baker)
17:10-17:20	Discussions

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09:00-09:40	Scientific Results Made Possible by GODAR (S. Levitus)
09:40-09:50	Discussions
09:50-10:30	Historical Oceanographic Data: The Basis for Integrated Coastal Zone Management (P. Geerders)
10:30-10:40	Discussions
10:40-11:00	Coffee
11:00-11:40	National & International Scientific Initiatives of the WDC-A for Paleoclimatology Programme & the IGBP Past Global Changes (PAGES) Project (D. Anderson)
11:40-11:50	Discussions
11:50-12:10	National Report of Chile
12:10-12:15	Discussions
12:15-12:35	National Report of Cuba
12:35-12:40	Discussions
12:40-14:00	Lunch
14:00-14:40	Improving Historical Data for Assessing Cost/Benefit of El Niño Prediction (P. Lagos)
14:40-14:50	Discussions
14:50-15:10	National Report of Colombia
15:10-15:15	Discussions
15:15-15:45	Coffee
15:45-16:25	Scientific Results of the BIOMASS Programme & Some Data Management Lessons (S. El Sayed).
16:25-16:35	Discussions
16:35-16:55	National Report of Ecuador
16:55-17:00	Discussions
17:00-17:20	National Report of Mexico
17:20-17:25	Discussions
17:25-18:00	Establishment of an NODC: A Case Study (I. Oliounine) Working Groups

10 October 1996

09:00-09:40	Analysis of Nutrient & Chlorophyll Data for the Southern Hemisphere (M. Conkright-Gregg)
09:40-09:50	Discussions
09:50-10:30	Atlas of Surface Marine Data & Ocean Surface Observations 1994 (S. Levitus)
10:30-10:40	Discussions
10:40-11:00	Coffee
11:00-11:20	National Report of Trinidad & Tobago
11:20-11:25	Discussions
11:25-11:45	National Report of Venezuela
11:45-11:50	Discussions
11:50-12:10	National Report of Costa Rica
12:10-12:15	Discussions
12:15-14:00	Lunch
14:00-14:40	Variability of $C0_2$ & 0_2 in the Surface Waters of the Gulf of Mexico (S. Makkaveev)
14:40-14:50	Discussions
14:50-15:10	National Report of Jamaica
15:10-15:15	Discussions
15:15-15:35	National Report of Peru
15:35-16:00	Discussions
16:05-16:30	Coffee
16:30-17:10	Paleoclimate Record of Southern Chile (D. Anderson).
17:10-17:20	Discussions
17:20-18:30	Working Groups

11 October 1996

09:00-09:40	National Report of Argentina
09:40-09:50	Discussions
09:50-12:30	Round Table Discussions: Composition of the Summary Report, Recommendations & Conclusions
12:30-14:00	Lunch
14:00-17:30	Adoption of the Summary Report, Recommendations & Conclusions
17:30	Official Closure of the Workshop

ANNEX II

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ANNEX III

GODAR PROJECT PROPOSAL

Recommendation IODE-XIV.3

DATA ARCHAEOLOGY AND RESCUE PROJECT

The IOC Committee on International Oceanographic Data and Information Exchange,

Noting that historical observations of oceanographic parameters are not repeatable if lost,

Acknowledging that substantial amounts of historical ocean observations are at risk of being lost due to media degradation or neglect,

Recognizing that the international scientific and engineering communities need the most comprehensive oceanographic multi-decadal databases possible for research purposes, particularly for use in studies describing the role of the world ocean as part of the earth's climate system as well as for Global Change research,

Emphasising that in order to make sound policy decisions national governments and intergovernmental advisory groups need scientific observations of the state of the world ocean and for understanding of the role of world ocean as part of the earth's climate system,

Recommends that:

(i) IOC establish a Global Oceanographic Data Archaeology and Rescue Project under the IOC Committee on IODE as presented in the Annex to this Recommendation subject to the condition that additional funds be made available;

(ii) A project leader be designated by the Executive Secretary IOC in consultation with the Chairman of the IOC Committee on IODE to supervise its implementation;

(iii) IOC invite Member States and international organizations to participate in and support this project, including the possibility of direct funding ear-marked for this purpose within the IOC Trust Fund.

Annex to Recommendation IODE-XIV.3

Introduction

All countries of the world have a concern about climate change because of the global impact of climate variability, whether natural or anthropogenic.

If international agreements are to be implemented due to concern about climate change, the science on which these agreements is based must be international in scope. All data on which these studies are based must therefore be available to the international scientific community without restriction.

Historical oceanographic data is of fundamental importance for scientists studying the role of the ocean as part of the earth's climate system. Regardless of any particular view an individual scientist or nation has on these issues, it is necessary that scientific assessments and national and international actions be based on the most complete environmental databases possible.

Recognizing that oceanography is an observational science and that the world ocean is a major component of the earth's climate system it is suggested that the IOC sponsored activities will result in more complete global oceanographic databases. These activities should be viewed as an enhancement of existing IODE activities. The new and enhanced oceanographic databases will be available without restriction to the international science community. We call this effort the "Global Oceanographic Data Archaeology and Rescue Project" (GODAR). To do the most thorough job possible this project must have a lifetime of 5 to 10 years. Funds to support the activities of this project will be obtained through as many sources independent of IOC as possible, including foundations.

"Data Archaeology" is the term used to describe the process of seeking out, restoring, evaluating, correcting and interpreting historical datasets.

"Rescue" refers to the effort to save data at risk from being lost to the science community.

Physical, chemical and biological oceanographic data as well as surface marine meteorological observations are the specific types of data this project will focus on. These are the data types of greatest concern to IODE and climate research activities. Advances in computer technology both hardware and software (e.g., Relational Database Technology) now allow for the construction of integrated global oceanographic databases that include widely disparate types of oceanographic data from different oceanographic disciplines.

The data gathered as a result of this project will be of particular benefit to developing countries. The international availability of comprehensive global oceanographic datasets represents a policy of both, information sharing, as well as knowledge and technology transfer since the data can be used to study regional environmental oceanographic problems.

Rationale

Many oceanographic data are at risk of being lost to future use because of media degradation, hence the need for a "data rescue" effort in conjunction with the data archaeology effort. Sole copies of manuscript data are easily lost due to environmental damage or catastrophes such as fire. In addition, manuscript data are of minimal use to researchers who require data in digital form with all pertinent meta-data in order to perform the most comprehensive studies possible. It is the international scientific community which must advise national and international bodies on such issues as climate change. Thus, the most complete well-documented database possible must be available to the international community. Data archaeology and rescue activities at WDC-A, Washington; WDC-B, Obninsk; WDC-D, Tianjin; ICES, Denmark; The Japanese Oceanographic Data Centre, and other institutions all have identified major oceanographic databases that exist only in manuscript form. Efforts sponsored by the institutions have resulted in digitization of some of these data and further digitization ("data rescue") is planned. For example, the US NODC has located 150,000 MBT profiles in manuscript form and is contracting to have these data digitized. All the above institutions are already closely co-operating on archaeology and rescue activities to avoid duplication of effort and to maximise their resources.

Purpose

To facilitate the creation of global oceanographic databases for use by the international research community for the study of the role of the world ocean as part of the earth's climate system.

Main Emphasis

Specifically the project will emphasise:

(i) Digitization of data now known to exist only in manuscript and/or analogue form. This effort will have highest priority of all activities.

(ii) Ensuring that all oceanographic data available for international exchange is archived at two or more international data centres in digital form.

(iii) Preparing catalogues (inventories) of:

(a) Data now available only in manuscript form;
(b) Data now available only in analogue form; and
(c) Digital data not presently available to the international scientific community.

(iv) Making all data accessible on various media including CD-ROMs, as well as standard magnetic tape.

These efforts represent implicit acknowledgement of the value of the ICSU-IOC International Oceanographic Data and Exchange (IODE) system but also recognize the need to enhance and expand the existing scope and efforts of this system, as well other international exchange mechanisms such as bilateral agreements. In fact, this International Data Archaeology and Rescue Programme will build on existing data archaeology programmes at WDC-A, WDC-B, and ICES.

The enhanced databases will be made available as ASCII files on CD-ROM disks as this is the technology that represents the least expensive and most efficient means of distribution of large datasets.

The World Data Centre-A for Oceanography (WDC-A) volunteers its services for these activities. WDC-A will work with data centres and research institutions around the world to compile the most complete oceanographic databases possible and will arrange for the production and distribution of the resulting databases on CD-ROMs and magnetic tapes.

Proposed Activities

(i) The IOC Secretary in consultation with the Chairman of the Committee on IODE appoint a Project Leader to direct the project (March 1993) - no funds required.

(ii) A Project Leader with the assistance, if necessary, of selected experts, will prepare an implementation plan and identify priorities (April 1993) - no funds required.

(iii) A Workshop on GODAR will be arranged in Russia for Eastern European countries (May-June 1993) - 20K from IOC RF and 40K from extra budgetary sources.

(iv) IOC will mobilize and provide resources to sponsor series of regional and international meetings on the formation of global oceanographic databases for international distribution as part of GODAR (1994.) funds from IOC RF and extra-budgetary sources.

(v) IOC provide support via its VCP and by using extra-budgetary sources for the delivery of hardware/software required, and by arranging contracts with the staff of data centres to implement specific projects (1993...) funds from extra budgetary sources.

(vi) IOC requests its Member States to declassify as much militarily-restricted oceanographic data as possible for international distribution.

Data Types of Interest

(i) Hydrographic casts including all chemical and biological observations;
(ii) Salinity-Conductivity Temperature-Depth casts;
(iii) Expendable Bathythermograph casts; and
(iv) Mechanical Bathythermograph casts.

ANNEX IV

LIST OF GODAR PRODUCTS

Atlases

M.E. Conkright, S. Levitus, T. Boyer, 1994: World Ocean Atlas 1994, Vol. 1: Nutrients. NOAA Atlas NESDIS 1, US Govt. Printing Office, Washington, D.C., 150 pp.

Levitus, S., T. Boyer, 1994: World Ocean Atlas 1994, Vol. 2: Oxygen. NOAA Atlas NESDIS 2, US Govt. Printing Office, Washington, D.C., 186 pp.

Levitus, S., R. Burgett, T. Boyer, 1994: World Ocean Atlas 1994, Vol. 3: Salinity. NOAA Atlas NESDIS 3, US Govt. Printing Office, Washington, D.C., 99 pp.

Levitus, S., T. Boyer, 1994: World Ocean Atlas 1994, Vol. 4: Temperature. NOAA Atlas NESDIS 4, US Govt. Printing Office, Washington, D.C., 117 pp.

Levitus, S., T. Boyer, 1994: World Ocean Atlas 1994, Vol. 5: Interannual variability of upper ocean thermal structure. NOAA Atlas NESDIS 5. US Govt. Printing Office, Washington, D.C., 176 pp.

Technical Reports

Conkright, M.E., T. Boyer, & S. Levitus 1994: Quality control and processing of historical oceanographic nutrient data. NOAA Technical Report NESDIS 79, National Oceanographic Data Center, Washington, DC, 75 pp.

Conkright, M. & S. Levitus, 1994: Quality control and analysis of historical nutrient data in the Indian Ocean. Proceedings from workshop held at Sebastopol, Ukraine.

Boyer, T. & S. Levitus, 1994: Quality control of oxygen, temperature and salinity data. NOAA Technical Report N$^{o.}$ 81, National Oceanographic Data Center, Washington, DC, 65 pp.

GODAR Project Report

Levitus, S., R. Gelfeld, T. Boyer, & D. Johnson, 1994: Results of the NODC and IOC Data Archaeology and Rescue projects. Key to Oceanographic Records Documentation N$^{o.}$ 19, National Oceanographic Data Center, Washington, DC, 67 pp.

IOC/GODAR Workshop Reports

IOC, 1993: IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (Global Oceanographic Data Archaeology and Rescue [GODAR] project. IOC Workshop Report N$^{o.}$ 88. WDC-B, Oceanography Obninsk, Russia, 17-20 May 1993.

IOC, 1994a: IOC-SOA-NOA Regional Workshop for Member States of the Western Pacific - GODAR II (Global Oceanographic Data Archaeology and Rescue project). IOC Workshop Report N$^{o.}$ 100. World Data Centre 'D', Oceanography, Tianjin, China, 8-11 March, 1994.

IOC, 1994b: IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III (Global Oceanographic Data Archaeology and Rescue project. IOC Workshop Report N$^{o.}$ 107. Indian National Oceanographic Data Centre, Dona Paula, Goa, India, 6-9 December, 1994.

IOC, 1995: IOC-ICSU-NOAA Regional Workshop for Member States of the Mediterranean Sea - GODAR-IV (Global Oceanographic Data Archaeology and Rescue project). IOC Workshop Report N$^{o.}$ 110. University of Malta, Foundation for International Studies, Valletta, Malta, 25-28 April, 1995.

CD-ROMs

For example, the most basic data sets produced by this project are the observed level profiles with quality control flags. The quality control procedures used are well documented, so individual investigators can choose for themselves whether to accept the results of the quality control criteria we have developed. Scientists who want to use different criteria for quality control can do so.

Profiles of the data interpolated to standard depth levels are provided in digital form as well as profiles of the observed level data. Products such as seasonal 5-degree square statistics of the data values at standard levels, and the objective analyses of various parameters at standard levels for different compositing periods are also provided (Table 2).

CD-ROMs, in which all digital products are available as ASCII files are listed below. Profiles are organized by 10-degree squares (WMO system) so that investigators can select data by relatively small geographic regions if desired. Availability of inexpensive CD-ROM readers with recording formats governed by international standards makes this technology the medium of choice for distribution.

Disc 1: Objectively analysed temperature fields.
Disc 2: Objectively analysed salinity fields.
5-degree square statistics of data at standard levels.
Disc 3: Objectively analyzed fields of oxygen, Apparent Oxygen Utilization, oxygen saturation, phosphate, silicate, and nitrate.
Disc 4: Observed level profile data for the North Atlantic (0-40 N), North Indian and South Indian Oceans.
Disc 5: Observed level profile data for the North Atlantic (40 N-90 N) and South Atlantic Oceans.
Disc 6: Observed level profile data for the North Pacific (0 -30 N) and South Pacific Oceans.
Disc 7: Observed level profile data for the North Pacific (30 -90 N) Ocean.
Disc 8: Standard level profile data for the Atlantic and Indian Oceans.
Disc 9: Standard level profile data for the Pacific Ocean.
Disc 10: Yearly (1960-90) upper ocean temperature anomaly fields.
Disc 11: Replacement CTD data.

For more information contact:

Sydney Levitus, NODC/NOAA, E/OC5; 1315 East West Highway., Room 4362, Silver Spring, Maryland, USA. 20910-3282. It is crucial to put the code E/OC5 in the address! Tel: (301) 713 32 94, Fax: (301) 713 33 03.

Also try the NODC Home Page (http://www.nodc.noaa.gov/). It contains Errata Information for the World Ocean Atlas 1994 atlases and CD-ROMs as well as a section entitled "Frequently Asked Questions". For product availability etc., contact NODC User Services Branch via Internet: services@nodc.noaa.gov

ANNEX V

RELEVANT PROPOSALS FROM THE WORKSHOP ON MANAGEMENT OF OCEANIC SYSTEMS IN THE EASTERN PACIFIC, CONCEPCION, 9-16 APRIL 1996

1. Main proposal

To develop co-operation and co-ordination networks in marine sciences and technology between Latin America and Europe for the following topics: a) Integrated Coastal Zone Management, b) Sustainable Management of Living Resources, c) Global Change, Air-Sea Interaction and "El Niño" Phenomena, d) Post graduate Education and Research, and e) Marine Environmental Risks and Emergencies.

2. Specific actions (project proposals to be developed through networking co-operation between the sub region and Europe))

Thematic Group I (Integrated Coastal Zone Management).

(i) Characterisation of coastal zones for the Eastern Pacific;

(ii) Identification, quantification and validation of parameters and corresponding models for the coastal environments aimed at description and valorisation of corresponding ecosystems and their resources;

(iii) Human resources development for research and management of the coastal zone.

Thematic Group 11 (Sustainable Management of Living Resources).

(i) Pelagic resources and their relation with the marine environment for the South Eastern Pacific;

(ii) Strengthening activities dealing with management and protection of fisheries resources and the environment in general for Central American coasts;

(iii) Research and training in technologies for environmental management and diseases control related to mariculture activities in the Eastern Pacific.

Thematic Group III (Global Change, Air-Sea Interaction and "El Niño" Phenomena).

(i) Strengthen and/or develop the observation oceanographic/meteorological networking for operational purposes, as well as to develop a regional climatology base;

(ii) Establish climate regional models for the Central and South Eastern Pacific sub-regions including socio-economic evaluations and nested global change impacts at the coastal and inland areas;

(iii) Determine those oceanographic and meteorological components most relevant to impacts concerning fisheries resources.

Thematic Group IV (Post-graduate Education and Research).

(i) Complete a directory of post-graduate programmes in marine science and technology for the Eastern Pacific region;

(ii) Design and lecture advanced level courses in marine sciences and technology to fill gaps in ongoing post graduate programmes offered in Latin American academic centres;

(iii) Provide consultancies to design and evaluate curricula related to on-going pre- and post-graduate programmes in marine science and technology.

Thematic Group V (Marine Environmental Risks and Emergencies).

(i) Prepare an awareness and preventing information programme, related to marine environmental risks and emergencies;

(ii) Design a "cartography" of potential risks for the Eastern Pacific;

(iii) Establish a sub-regional network for Tsunamis surveillance and alert.

ANNEX VI

LIST OF ACRONYMS AND ABBREVIATIONS

ACMRR	Advisory Committee of Experts on Marine Resources Research
AOML	Atlantic Oceanographic & Meteorological Laboratory
ARCHIS	Archival Survey for Climate History
ATCM	Antarctic Treaty Consultative Meeting
AWI	Alfred Wegener Institut (Germany)
BAS	British Antarctic Survey
BATHY	Bathythermograph Report
BIOMASS	Biological Investigations of Marine Antarctic Systems & Stocks
BODC	British Oceanographic Data Centre
CARIPOL	Marine Pollution Monitoring Programme in the Caribbean
CARSTIN	Regional Network for the Exchange of Information & Experience in Science & Technology in the Caribbean
CCO	Colombian Commission on Oceanography
CCOSNET	Co-ordinating Centre for the Caribbean Community Ocean Sciences Network
CEADO	Argentinean Oceanographic Data Centre
CEC	Commission of the European Communities
CENDOC	Centro Nacional de Datos Oceanograficos de Chile
CENPAT	Patagonia National Centre
CICAR	Co-operative Investigations of the Caribbean
CICESE	Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (Mexico)
CINVESTAV	Centro de Investigaciones y Estudios Avanzandos (Mexico)
CIOH	Centro de Investigaciones Oceanograficas e Hidrograficas (Colombia)
CLIVAR	Climate Variability & Predictability
CONA	Comite Oceanografico Nacional (Chile)
CONCYTEC	National Council for Science & Technology (Peru)
CONICYT	Comision Nacional de Investigacion Cientifica y Tecnologica (Peru)
CPPS	Comision Permanente del Pacifico Sur
CRIP	Regional Centre for Fisheries Investigations (Mexico)
CTD	Conductivity-Temperature-Depth
CZCS	Costal Zone Colour Scanner
DBCP	Data Buoy Co-operation Panel
DBT	Digital Bathy Thermograph

DHN	Directoria de Hidrografia e Navegacao (Brazil)
DIMAR	General Directorate of Maritime & Port Affairs (Colombia)
DMA	Designated Maritime Agency
EEZ	Exclusive Economic Zone
ENAP	Empresa Nacional de Petrolea (Chile)
ERFEN	Regional Study of the Phenomenon known as 'El Niño'
FAO	Food & Agriculture Organization of the United Nations
GEBCO	General Bathymetric Chart of the Oceans
GEODAS	Geophysical Data System
GEOSAT	Geodetic Satellite (USA)
GF3	General Format 3
GHCN	Global Historical limate Network
GIPME	Global Investigation of Pollution in the Marine Environment
GIS	Geographic Information System
GLOBEC	Global Ocean Ecosystems Dynamics
GLOSS	Global Sea-level Observing System
GODB97	Global Ocean Data Base 1997
GOOS	Global Ocean Observing System
GTSPP	Global Temperature-Salinity Pilot Project
IAA	Instituto Antartico Argentino
IAI	Inter-American Institute for Global Change Research
ICA	International Council of Archives
ICES	International Council for the Exploration of the Sea
ICMYL	Institute for Marine Sciences & Limnology (Mexico)
ICSU	International Council of Scientific Unions
IDOE	International Decade of Ocean Exploration
IFOP	Instituto de Fomento Pesquero (Chile)
IGBP	International Geosphere-Biosphere Programme
IGOSS	Integrated Global Ocean Services System
IHO	International Hydrographic Organization
IHP	International Hydrological Programme
IIE	Institute for Electrical Engineering (Mexico)
IIO	Institute of Oceanological Investigations (Mexico)
IMA	International Maritime Agency
IMARPE	Instituto del Mar del Peru

IMTA	Mexican Institute for Water Technology
INACH	Instituto Antartico Chileno
INEGI	Instituto Nacional de Estadistica, Geografia e Informatica (Mexico)
INFOMAR	Marine Information Project (Colombia)
INIDEP	Instituto Nacional de Investigacion y Desarrollo Pesquero (Argentina)
INOCAR	Instituto Oceanografico de la Armada (Ecuador)
INP	National Institute of Fisheries (Mexico)
INVEMAR	Instituto de Investigaciones Marinas (Colombia)
IO	Institut Oceanographique (France)
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-Commission for the Caribbean & Adjacent Regions
IODE	International Oceanographic Data & Information Exchange
IOM	Instituto Oceanografico de Manzanillo (Mexico)
IPCC	Intergovernmental Panel on Climate Change
ISOS	International Southern Ocean Studies
ITSU	International Co-ordination group for the Tsunami Warning System in the Pacific
JGOFS	Joint Global Ocean Flux Study
JODC	Japan Oceanographic Data Centre
LDGO	Lamont-Doherty Geological Observatory
MBT	Mechanical Bathy Thermograph
MEDI	Marine Environmental Data Information Referral System
MIM	Marine Information Management
MOPAS	Oceanographic & Fisheries Monitoring in Selected Areas (Peru)
MOPFEN	Oceanographic Monitoring for El Niño Forecasting (Peru)
NESDIS	National Environmental Satellite, Data & Information Service
NGDC	National Geophysical Data Centre
NIO	National Institute of Oceanography (India)
NOA	National Oceanographic Agency (China)
NOAA	National Oceanic & Atmospheric Administration (USA)
NOC	National Oceanographic Centre
NODC	National Oceanographic Data Centre
NOP	National Oceanographic Programme
OCEANPC	Ocean Personal Computer Project
OCL	Ocean Climate Laboratory
OSLR	Ocean Science & Living Resources
OSNLR	Ocean Science & Non-Living Resources
PSMSL	Permanent Service for Mean Sea-Level

RAS	Russian Academy of Sciences
RNODC	Responsible National Oceanographic Data Centre
SCOR	Scientific Committee on Oceanic Research
SERNAGEOMIN	Servicio National de Geologia y Mineria (Chile)
SERNAP	Servicio National de Pesca (Chile)
SETMAR	Marine Technology Centres (Mexico)
SHN	Servicio Hidrografia Naval (Argentina)
SHOA	Servicio Hidrografico y Oceanografico de la Armada (Chile)
SMA	Servicio Meteorologico de la Armada (Chile)
SMMR	Scanning Multi-channel Microwave Radiometer
SOA	State Oceanic Administration (China)
SOC	Specialized Oceanographic Centre
SWCC	Second World Climate Conference
TEMA	Training, Education & Mutual Assistance in Marine Sciences
TESAC	Temperature, Salinity, Currents
UNAM	Universidad Nacional Autonoma de Mexico
UNCED	United Nations Conference on Environment & Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific & Cultural Organization
USGS	United States Geological Survey
UWI	University of the West Indies
VCP	Voluntary Co-operation Programme
VECEP	Venezuela/Colombia/Ecuador/Peru Project
WCRP	World Climate Research Programme
WDC	World Data Centre
WESTPAC	IOC Sub-Commission for the Western Pacific
WHOI	Woods Hole Oceanographic Institution (USA)
WMO	World Meteorological Organization
WOA	World Ocean Atlas
WOCE	World Ocean Circulation Experiment
WWW	World Wide Web/World Weather Watch
XBT	Expendable Bathy Thermograph

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