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**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION**  
(of Unesco)

**Expert Consultation on OCEAN-PC, a Standard Software Package  
for Oceanographic Data Processing and Exchange  
Unesco, Paris, 7-9 November 1990**

## **SUMMARY REPORT**

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## 1. OPENING, AND ARRANGEMENTS FOR THE SESSION

1 The Expert Consultation on OCEAN-PC, a Standard Software Package for Oceanographic Data Processing and Exchange, started at 10 a.m. on Wednesday 7 November 1990 in Unesco House, Paris.

2 Dr. Klaus Voigt, Deputy Secretary IOC, opened the session by welcoming the participants on behalf of Dr. Gunnar Kullenberg, the Secretary of IOC. He apologized that Dr. Kullenberg could not be present as he was representing IOC at the Ministerial part of the Second World Climate Conference. The hope was that the Ministerial Declaration from this conference would stress the role of science and scientific observing systems, including their ocean aspects, in facing global climate problems. This role depended on modern data communication and management to serve the needs of scientists, scientific teams and environmental managers.

3 It was therefore important in the period leading up to the United Nations Conference for Environment and Development (Brazil, 1992) to reinforce the use of tools such as the PC for processing ocean data, both newly collected observations and historical data. Scientists need to be trained how to handle data and to make it compatible. The Consultation was well-timed, and there would be considerable interest in its report.

4 Finally, Dr. Voigt wished the participants every success in their work, and a pleasant stay in Paris.

5 The Consultation elected Mr. Christoph Brockmann as its Chairman, and Mr. J. Withrow as Rapporteur.

6 The Consultation adopted the Agenda as given in Annex I.

7 The Technical Secretary, Mr. Trevor Sankey, outlined the timetable and local arrangements. He then introduced the list of documents for the Consultation as given in Annex III. The List of Participants is given in Annex IV.

8 The Consultation noted that several participants would be demonstrating PC based software packages and tools during the meeting which would provide relevant background to its work. A complete list of Demonstrations is attached as Annex V.

## 2. REVIEW OF OCEAN-PC GOALS

9 The Chairman opened this item pointing out the great need, especially in the developing countries, for easy to use marine data handling software to be provided for the increasing number of personal computers available in the marine science community.

10 In response to a question the Assistant Secretary indicated that the recommendations of this consultation regarding the OCEAN-PC concept would be submitted to the IGOSS OTA meeting (Paris, 12-16 November 1990) and the IODE Officers meeting (Tianjin, China, 7-8 February 1991). These recommendations would then be forwarded to the IOC Assembly (Paris, 7-22 March 1991) for its consideration.

11 Dr. A. Laptev, WMO, presented the WMO CLICOM system, noting that it is a turn-key system with appropriate tools to meet the needs of both novice and expert users. The project software was designed with a core of data management surrounded by various applications. It is based on the DataEase database management system and was initially designed to meet the need for easy, accurate entry of meteorological station data. It has since been expanded to include other types of data including some marine data. Dr. Laptev summarized the goals of CLICOM as follows: (i) Help with data entry; (ii) Quality Control; (iii) Data Management; (iv) Climate Data Analysis; and (v) Climate Data Exchange. He demonstrated the system.

12 The Consultation believed that the successful development of the CLICOM system provides many valuable lessons that can be applied to the consideration of various aspects of the OCEAN-PC project. They agreed that the CLICOM experience would be examined again as appropriate when considering later agenda items. The Consultation noted, however, that because of the wide diversity of data requiring management in the marine community, and the need for tools and interfaces to meet the specific needs of

marine scientists which are different from those of meteorologists, the detailed requirements for OCEAN-PC are different from those for CLICOM.

- 13 It was pointed out that before defining goals, there was a need to characterize the potential users of the package. The Consultation agreed that the OCEAN-PC project should aim to meet the needs of the following main groups of users:

- (i) marine scientists in developing countries;
- (ii) marine scientists working with low volume and/or diverse data types such as marine biology, marine chemistry, pollution and coastal zone data;
- (iii) data managers at department, project and laboratory level;
- (iv) small NODCs, particularly in developing countries, using PCs as their main computer system;
- (v) all NODCs and WDCs as an ancillary system for tasks such as format conversions and handling of inventory information, when these functions have not been implemented on the Centre's main computer system.

- 14 While OCEAN-PC will not be specifically orientated towards shipboard work, the Consultation believed that many scientists would find it practical and valuable to use the package at sea.

- 15 With these user communities in mind, the Consultation proposed that the goal of the OCEAN-PC project be to promote the effective use of ocean data by:

- (i) facilitating the entry of and access to data through such means as the tools to assist data keying and the development of interfaces to existing and future data sets;
- (ii) implementation of appropriate quality control standards;
- (iii) management of the data in appropriate formats to permit application of standard tools and exchange of data;
- (iv) development of tools to permit various forms of ocean data analysis.

### 3. PACKAGE REQUIREMENTS

#### 3.1 PROCESSING CAPABILITIES

- 16 The Consultation discussed this item on the basis of document IOC/OCEAN-PC *Ad hoc*-1/7, Functional Requirements, and also took into account information available on existing relevant software packages (Documents IOC/OCEAN-PC *Ad hoc*-1/6, "Inventory of software and products for the display and analysis of marine data outside the ICES area", IOC/OCEAN-PC *Ad hoc*-1/Inf.1, "Resource Information", and ICES C.M. 1990/C:10, Annex II, "Inventory of software and products for the display and analysis of marine data").

- 17 The Consultation took note of the views expressed by Member States concerning OCEAN-PC in documents IOC/OCEAN-PC *Ad hoc*-1/Inf.2, "Summary of Comments and Views on OCEAN-PC", and IOC/OCEAN-PC *Ad hoc*-1/Inf.3, "Some approaches to OCEAN-PC".

- 18 Dr. J.R. Harger, ROSTSEA, informed the meeting of UNESCO activities taking place in regard to the development of PC software to meet marine requirements in his region. He demonstrated a system, called FILEBASE, compiled with CLIPPER and based on dBASE III files, which provided management and analytical support for a wide range of marine data.

- 19 The Consultation discussed three possible roles for WMO CLICOM in respect to OCEAN-PC. Firstly, CLICOM provides facilities to add additional parameters and thus could be used as it currently exists to process oceanographic data. The present interface provides data formats and processing facilities highly adapted to the specific needs of meteorological climate specialists. The Consultation believed that this strong reflection of the needs and viewpoint of a particular community of scientists is one of the keys to its success, and that OCEAN-PC should equally reflect the viewpoint of oceanographers. However this same specificity makes CLICOM less suitable for direct use by oceanographers.

- 20 Secondly, the Consultation felt that CLICOM interface could be adapted fairly easily to have more of an oceanographic flavour for the processing of synoptic oceanographic data from fixed stations. They noted however that only part of ocean data is of this type.
- 21 Finally the Consultation recognized the possibility of using the same tools and conventions adopted for CLICOM as a basis for a package to handle all types of oceanographic data including observations made from ships and other moving platforms, and observations at irregular intervals. The advantages and disadvantages of this approach require further evaluation.
- 22 The Consultation proceeded to an extensive discussion of the required data and information capabilities to be developed within OCEAN-PC. The Consultation summarized the required functions for OCEAN-PC as follows:
- (i) IODE related tasks such as generating and retrieving CSR(ROSCOP) information, MEDI inputs, data inventories, etc.;
  - (ii) Assistance for easy keying of manuscript data and data documentation;
  - (iii) General graphic utilities such as isolines, maps, plotting, gridding, and specific utilities for types of presentation commonly used for marine data;
  - (iv) Marine science related utilities such as quality control of specific data types, calculation of derived oceanographic parameters, etc.;
  - (v) Interfacing utilities for import and export from and to environmental data formats (GF3, BUFR, JGOFS), database systems, spreadsheets, other application packages, etc.;
  - (vi) Data sets with additional reference information such as coastlines, bathymetric information, characteristics of commonly used instruments, etc.;
  - (vii) Reference data sets of historical marine information such as the Pacific T/S data on CD-ROM, etc.;
  - (viii) Input and retrieval facilities for other information such as the ASFA Bibliographic database, INFOTERRA, directories of marine scientists, meetings lists.
- 23 There was then a discussion on the general concept to be adopted for OCEAN-PC. The Consultation concluded that an approach based on the concept of coherent building blocks would result in the most flexibility, the greatest adaptability and the most effective realization. Each of the main functions listed would be realized within a single block (from now on called a module).

### 3.2 USER INTERFACE NEEDS

- 24 This agenda item was opened by the Chairman with a brief review of the appropriate section of document IOC/OCEAN-PC Ad hoc-1/7. The Consultation accepted the user interface needs set forth in the document and emphasized the need for a friendly and easy to understand interface. The system should employ as far as possible the state of the art in visual presentation including, but not restricted to, pull down menus and mouse driven interactive graphics. However, while it was desirable to take advantage of the state of the art in graphics, it was necessary to maintain compatibility with the widest possible range of equipment configurations. The Consultation suggested that the idea of a staged system should be explored. In this, basic functions would be available to a minimum system and more sophisticated or expert functions available on a more advanced system. Stommel's Atlas for the North Atlantic was given as an example of the level of interface that should be provided as a minimum.

## 4. TECHNICAL APPROACH

### 4.1 TARGET SYSTEMS

- 25 Several participants provided information on the characteristics of IBM compatible microcomputers available in developing countries. The Consultation recommended that OCEAN-PC be designed to run on systems meeting the following basic specification as a minimum:

MS-DOS 3.0 upwards  
System RAM 640 K  
Hercules compatible Monochrome Graphics Adapter and monitor  
Hard disk 20 Mbyte  
Diskette unit (possibly via mother PC)

- 26           **The Consultation further recommended that:**
- (i)           where possible OCEAN-PC software should detect and make effective use of features available on more powerful machines, and in particular EGA and VGA graphics adapters with both monochrome and colour monitors;
  - (ii)          3.5" 720K diskettes should be used as the standard for distribution of the OCEAN-PC software and exchange of information between OCEAN-PC systems. 5.25" diskettes should be used only if specially requested.
- 27           **The Consultation recognized** that certain OCEAN-PC functions may require specific additional peripherals, for example a CD-ROM reader to import large datasets available in this form.

#### 4.2           PACKAGE ARCHITECTURE

- 28           **The Consultation recognized** the variety and quality of existing PC software demonstrated throughout the meeting.
- 29           Taking into account Recommendation IODE-XIII.6 that the package architecture should lead to improved exchange and application of oceanographic data by scientists, particularly in the developing countries, and the need to save time and money in package development, **the Consultation recommended** a dual approach for deriving a package architecture by
- (i)           developing the design specification for the OCEAN-PC software package comprising:
    - (a)          an internal data management kernel based on the relational data model;
    - (b)          a data transfer module to communicate between the kernel and various scientific and data management functions, some of them dependent on the parameter type;
    - (c)          import/export functions into data exchange formats;
  - (ii)          parallel to this approach, defining a project for:
    - (a)          making available existing heterogeneous software elements in form of an IOC software library;
    - (b)          undertaking an application evaluation scheme for this software;
    - (c)          using the response to modules and functions supplied within these library to contribute to the selection of the functions to be included into OCEAN-PC.

- 30           **The Consultation agreed** that the core of the OCEAN-PC system would be a central database facility to hold both data and meta-data. This would serve to link the modules performing oceanographic/scientific functions and data management functions. **The Consultation recommended** that a database based on the relational model be used. One possibility is to provide OCEAN-PC with a general interface so that the user can incorporate the database software package of his choice rather than being restricted to a particular commercial system. **The Consultation suggested** that this idea be investigated when the package is being designed.

- 31           **The Consultation envisaged** that functionality could then be added to fulfill the package requirements as defined above. The basic layout derived will be an open system where stepwise realization is possible and where additional modules could be added as needed by marine science, e.g. making high volume data storage accessible such as CD-ROMs.

- 32           **The Consultation agreed** that a detailed definition can not be achieved during the meeting, but must be part of the OCEAN-PC implementation plan.

- 33           **The Consultation noted with appreciation** the details on technical issues for OCEAN-PC prepared in document IOC/OCEAN-PC Ad hoc-I/8, and **recommended** that these be used as an input to the work of OCEAN-PC design.

#### 4.3 USER INTERFACE APPROACH

The demonstration given by several participants showed that the knowledge and tools are on hand to construct user interfaces which meet the needs of the marine scientist. A demonstration by Dr. Y. Sychoy illustrated the capability of software developed under the Microsoft WINDOWS 3.0 system to provide high quality user interfaces.

A final decision on an user interface will be influenced by constraints set by the resources available to develop and distribute OCEAN-PC.

#### 5. EQUIPMENT AND TRAINING NEEDS

The Consultation agreed that in general the aim of OCEAN-PC was to supply software for use on existing PCs and that supply of equipment should not be included in the project. Nonetheless there might be a need to meet particular equipment needs, for example by supplying CD-ROM readers to selected centres to provide access to large scale data sets and other information distributed on this medium.

The Consultation confirmed the need for adequate technical support and training for the OCEAN-PC System. The software should, however, be such that scientists can easily start to use it without necessarily having to attend a formal training course. The Consultation strongly endorsed the provision of on-line help and self-teaching tutorials in addition to a self-explanatory user interface.

The Consultation recommended that training on the use of OCEAN-PC should be included in IODE training courses on marine data and information management. Such courses could also be used to obtain feedback from the user community on performance, and on ideas for new developments.

The Consultation further recommended that national coordinators for IODE should be invited to appoint one focal point for their country, such a person being a first contact for the national marine science users of OCEAN-PC. This person should be fully aware of the capabilities and limitations of OCEAN-PC and, in case of more extensive problems or queries, be able to contact the responsible person at IOC immediately.

The Consultation also suggested that, along the lines of CLICOM, OCEAN-PC might consider using a Newsletter to establish contacts with its users, publish information on detected problems and their remedies, and to obtain feedback from the user community. In this context, a bulletin board on an electronic mail system was mentioned as a possible additional mechanism.

Further definition of documentation, training material and other supporting activities will be part of the implementation plan.

#### 6. IMPLEMENTATION PLAN

The Chairman opened this item by presenting document IOC/OCEAN-PC *Ad hoc*-1/9. The Chairman also reviewed the discussion that had taken place under agenda item 4 on technical issues indicating that the meeting was in favour of pursuing two different and complementary paths in the development of OCEAN-PC.

The first was the systematic development of an initial core of the OCEAN-PC system including the data management module and key functional modules.

The Consultation noted the need for consistent and expert management of this development effort including the definition of the elements of the initial modules and recommended that a Consultant be found, preferably with experience in ocean data collection and management, and in software definition, to produce detailed specifications of the Data Management Module and other key modules of OCEAN-PC in 1991.

The Consultation further recommended that a small group of potential users of the system be formed, in order to advise the Consultant during this study and ensure that appropriate elements and priorities are established.

- 46           **The Consultation recommended** that the Consultant be contracted to accomplish the following tasks, in consultation with the advisory group where appropriate:
- (i)           identify the functions required to meet OCEAN-PC goals, and set priorities among them;
  - (ii)          conduct a market survey of appropriate software to get an idea of what is available and what it costs. Software providers should be consulted regarding the application planned to obtain as much information about the design of data management software systems that may impact this effort;
  - (iii)         hold detailed consultations with the representatives of the World Meteorological Organization regarding their development of CLICOM. These consultations should address not only the possible application of CLICOM to ocean data management needs but also the WMO experience with the management aspects of the CLICOM development project;
  - (iv)         investigate methods of ensuring that the package user interface can be easily adapted for different languages;
  - (v)         submit to the IOC by early 1992 for review by appropriate IOC bodies an OCEAN-PC software specification and implementation plan documenting as completely as possible the package definition and proposed next steps for development.
- 47           **The Consultation estimated** that this task would require six person-months and suggested that a possible mechanism might be for a Member State to volunteer the services of an expert or experts to the project. There would be some advantages in having a team of two people with appropriate skills working together. A travel budget estimated at US \$15K would be required to allow for consultations with users, software companies and the Secretariat.
- 48           As to the second path, the Consultation was aware of the advantages of sharing software currently in use among marine scientists and in this way covering immediate needs, especially in the developing countries. Therefore a project should be initiated in the short term to serve marine science until OCEAN-PC is available.
- 49           To achieve these aims, **the Consultation recommended** that the project should be set up as follows:
- (i)           Identify marine science software applications to be shared starting with packages well-known in the IODE community, and extending the list by advertising in the IMS Newsletter, PC magazines, bulletin boards etc. using an approach involving a challenge to meet the threat of global change or perhaps a contest to obtain submissions. The software is to be non-commercial although templates and macros for existing commercial packages may be submitted.
  - (ii)          Evaluate the applications identified with respect to
    - (a)         the needs of the marine scientist
    - (b)         the improvements of global data exchange
    - (c)         the functionality required for later inclusion into the OCEAN-PC softwareby consideration of user friendliness, quality of documentation, fulfillment of description, state of development, adaptability, support, security etc. Individual scientists will perform the evaluation along with check-lists and evaluation forms and might suggest changes. Evaluated software is to be included in an inventory listing, circulated using all available means.
  - (iii)         This software will be included into a library, distributed by IOC. The library will include tools, time and productivity packages, format conversion and exchange routines etc., with particular focus on analytical capabilities, quality control and data visualization for marine science.
  - (iv)         Enhancements by suggestion and implementation of common layouts for user interfaces, and import/export functions between packages should be made when appropriate.
  - (v)         Functions supplied by this marine science software library should be considered for inclusion into OCEAN-PC in accordance with the specification to be derived in the OCEAN-PC planning phase.
  - (vi)         Coordination of the evaluation and distribution of the library at national level would be a first task for the OCEAN-PC national focal points proposed under Agenda item 5.
- 50           **The Consultation estimated** that this project would require about three person-months of consultant effort in the first year.



51       **The Consultation wished to stress the complementary nature of the two development paths outlined above. The second path would produce results quickly that would aid certain data management and scientific processing tasks and would provide valuable input for the design of OCEAN-PC. However, a professional and integrated design for OCEAN-PC is the only satisfactory path to provide the range of functions needed by scientists and data managers in a package that they can readily learn to use, and to give the flexibility to accommodate evolving requirements in the future.**

52       **The Consultation adopted Recommendation OCEAN-PC AC.10c.1.1**

## 7.       **ADOPTION OF THE SUMMARY REPORT**

53       **The Consultation adopted the Summary Report together with one Recommendation, and requested the IOC Secretariat to consult with the Chairman to produce the final version with editorial changes considered necessary.**

## 8.       **CLOSURE**

54       **The Chairman, in his closing remarks, thanked the participants for their active involvement in the discussions. He also thanked the Rapporteur, the Technical Secretaries, and the IOC supporting staff who had all helped the Consultation to work effectively. The Consultation thanked those participants who had prepared and given demonstrations, and thanked the Chairman for his excellent leadership.**

55       **The Chairman closed the Session at 4.30 p.m. on Friday 9 November 1990.**

**ANNEX I**

**AGENDA**

- 1. OPENING, AND ARRANGEMENTS FOR THE SESSION**
- 2. REVIEW OF OCEAN-PC GOALS**
- 3. PACKAGE REQUIREMENTS**
  - 3.1 PROCESSING CAPABILITIES**
  - 3.2 USER INTERFACE NEEDS**
- 4. TECHNICAL APPROACH**
  - 4.1 TARGET SYSTEMS**
  - 4.2 PACKAGE ARCHITECTURE**
  - 4.3 USER INTERFACE APPROACH**
- 5. EQUIPMENT AND TRAINING NEEDS**
- 6. IMPLEMENTATION PLAN**
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ANNEX II

ADOPTED RECOMMENDATION

Recommendation OCEAN-PC Ad hoc-1.1

**The Expert Consultation on OCEAN-PC, a Standard Software Package for Oceanographic Data Processing and Exchange,**

**Recognizing** that marine data collected by classical and modern methods contains important information needed to understand climate change and the entire ocean system at national, regional and global levels,

**Noting** many requests from developing countries for tools and training to handle these marine data,

**Considering** that to facilitate the assembly of this data into compatible data sets that can be applied for scientific analyses and practical purposes, there is a need to provide easy to use and standardized data management tools at the level of the individual scientist,

**Noting** the success of the WMO CLICOM project in establishing a distributed global data management system based on PCs for climatological weather observations,

**Recognizing** further that personal computers are now widely used in laboratories worldwide to process marine data,

**Sharing the view** of the IOC Executive Council at its Twenty Third Session on the importance, especially for developing countries, of the preparation of a PC software package to support and develop marine data processing and international data exchange through the IGOSS and IODE systems,

**Recommends** that the Secretary IOC allocate appropriate resources and where necessary seek additional resources from Member States and international organizations to

A

implement in 1991 a project using a consultant to:

- (i) identify available software for marine data handling, evaluate these software items in close co-operation with a selected number of marine scientists in the field and then make these available to a wide array of users;
- (ii) by this means define functions and identify possible components that could be used for OCEAN-PC;

B

plan OCEAN-PC through use of an IOC consultant with appropriate experience in software system design and environmental data management who, in consultation with an advisory group of users, should by early 1992:

- (i) derive a functional description of the system architecture and the software design;
- (ii) set up a detailed implementation plan for OCEAN-PC;
- (iii) submit the prepared implementation documents to IODE and IGOSS;

C

provide training:

- (i) for the software packages identified in the project under A within continuing IODE training activities;
- (ii) by preparing, in due course, specific training in the use of OCEAN-PC.

ANNEX III

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## ANNEX IV

### LIST OF DOCUMENTS

Document code	Title
<b>WORKING DOCUMENTS</b>	
IOC/OCEAN-PC <i>Ad hoc</i> I/1	Agenda
IOC/OCEAN-PC <i>Ad hoc</i> I/2	Annotated Provisional Agenda
IOC/OCEAN-PC <i>Ad hoc</i> I/3 prov.	Draft Summary Report (N.B. The final Report is this document, IOC/INF-828)
IOC/OCEAN-PC <i>Ad hoc</i> I/4	List of Documents
IOC/OCEAN-PC <i>Ad hoc</i> I/5	List of Participants
IOC/OCEAN-PC <i>Ad hoc</i> I/6	Inventory of software and products for the display and analysis of marine data, outside ICES area
IOC/OCEAN-PC <i>Ad hoc</i> I/7	Package requirements
IOC/OCEAN-PC <i>Ad hoc</i> I/8	Technical issues for OCEAN-PC
IOC/OCEAN-PC <i>Ad hoc</i> I/9	Draft implementation plan
<b>INFORMATION AND OTHER REFERENCE DOCUMENTS</b>	
IOC/OCEAN-PC <i>Ad hoc</i> -I/Inf.1	Resource Information
IOC/OCEAN-PC <i>Ad hoc</i> -I/Inf.2	Summary of Comments and Views on OCEAN-PC
IOC/OCEAN-PC <i>Ad hoc</i> -I/Inf.3	Some Approaches to OCEAN-PC (submitted by Dr. Y. Sychev)
IOC/GETADE-IV/3	Summary Report, Fourth Session, IODE Group of Experts on Technical Aspects of Data Exchange, Ottawa, Canada, 11-15 July 1988
IOC/IODE-XIII/3	Summary Report, Thirteenth Session, IOC Committee on International Oceanographic Data and Information Exchange, UN, New York, 17-24 January 1990
IOC/IODE-XIII/16	Draft outline for training programmes on marine data and information management
IOC/IODE-XIII/Inf.9	OCEAN CLICOM: A microcomputer system for entry and exchange of marine data
IOC/EC-XXIII/3	Summary Report, Twenty-third Session, IOC Executive Council, Unesco, Paris, 7-14 March 1990
ICES C.M. 1990/C:10 (Annex II only)	"Inventory of software and products for the display and analysis of marine data, May 1990" contained in "Report of the ICES Working Group on Marine Data Management, Sopot, 1-4 May 1990".

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N.B. This list is for reference only. No stocks of these documents are maintained, except for the Summary Report.

## ANNEX V

### LIST OF DEMONSTRATIONS

1. ATLANT package of USSR Academy of Sciences for display and analysis of Atlantic oceanography; MAPMAKER package of USSR State Committee for Hydrometeorology for geographical display of meteorological data under WINDOWS 3.0. (Dr. Y. Sychev)
2. CLICOM: WMO software package for input, processing and exchange of climatological data (Dr. A. Laptev)
3. FILEBASE utilities for editing and interactive analysis of marine environmental data stored in dBASE-III format; Quick BASIC "chaos" program giving interactive educational illustration of non linear effects of exponential positive feedback population growth equations (Dr. J.R. Harger)
4. ICAD software tools to create user interfaces, format conversion routines and graphical presentations (Mr. G.R. Itigi)
5. MARIS - Marine Geographic Information Manager (Mr. D. Schaap)
6. ROSIN, ROSEARCH: packages to input and access ROSCOP information (Dr. H.D. Dooley)
7. WORLDPLOT map drawing package written in GW BASIC, using the GULFPLOT format, and enabling the transmission of map data by electronic mail (Dr. D. McLain)