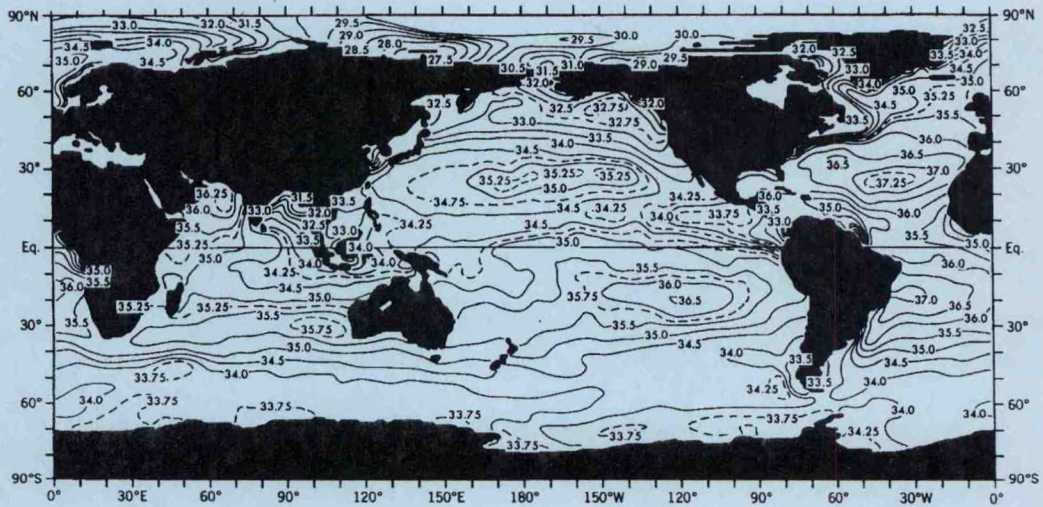


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NODC Informal Report No. 11



National Oceanographic Data Center PROGRAMS AND OPERATIONS



Washington, D.C.
February 1993

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service



National Oceanographic Data Center USER SERVICES

Detailed information about NODC data holdings, products, and services is available on request from the:

National Oceanographic Data Center
User Services Branch
NOAA/NESDIS E/OC21
1825 Connecticut Avenue, NW
Washington, DC 20235

Telephone: (202) 606-4549
Fax: (202) 606-4586
Omnet: NODC.WDCA
Internet: services@nodc2.nodc.noaa.gov

COVER: Annual mean salinity at the sea surface based on an objective analysis of data in the NODC's major global data files.
(From S. Levitus, *Climatic Atlas of the World Ocean*)

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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary
National Oceanic and Atmospheric Administration
John A. Knauss, Interim Under Secretary

National Environmental Satellite, Data, and Information Service
Gregory W. Withee, Acting Assistant Administrator



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INTRODUCTION



NODC History and Mission

The National Oceanographic Data Center (NODC) was established in late 1960 and formally dedicated in early 1961 as an inter-agency facility "to acquire, process, preserve, and disseminate oceanographic data." The NODC was administered by the U.S. Naval Hydrographic (later Oceanographic) Office until it became part of NOAA when that agency was created in 1970.

The Interagency Charter establishing the National Oceanographic Data Center under the administration of the U.S. Naval Hydrographic Office was signed on December 23, 1960. The original sponsoring agencies were the Department of the Navy; the U.S. Coast and Geodetic Survey, Department of Commerce; the Bureau of Commercial Fisheries, Department of Interior; the U.S. Weather Bureau; the National Science Foundation; and the Atomic Energy Commission. These were later joined by the U.S. Coast Guard; the Coastal Engineering Research Center, Corps of Engineers of the Department of the Army; the U.S. Geological Survey; and the Department of Health, Education, and Welfare.

When NOAA was created by Executive Order in October 1970, the NODC was transferred to the NOAA Environmental Data Ser-

vice (EDS), which combined NODC with the pre-existing ESSA Environmental Data Service. The NODC has remained an element of this major NOAA component as it was renamed the Environmental Data and Information Service (EDIS) in 1978 and merged with NOAA's satellite offices in 1982 to form the National Environmental Satellite, Data, and Information Service (NESDIS).

NODC's headquarters offices are located in Washington, D.C. The NODC also has personnel stationed at its five Liaison Offices, located in Woods Hole, Massachusetts; Washington, D.C.; Miami, Florida; La Jolla, California; Seattle, Washington; and Honolulu, Hawaii.

The NODC maintains the world's largest archive of historical ocean data. It provides data and information management support for major global ocean research programs. Through international ocean data exchange programs it enhances the ocean data record available to climate change and other researchers worldwide. Each year it provides ocean data and information to thousands of users in government, academia, business, and the general public, both in the United States and around the world.

NODC Milestones

- **1960** Established as an interagency facility under the administration of the U.S. Navy
- **1970** Transferred to NOAA's Environmental Data Service
- **1982** Incorporated into NOAA's National Environmental Satellite, Data, and Information Service
- **1989** Delegated management responsibility for the NOAA Library System

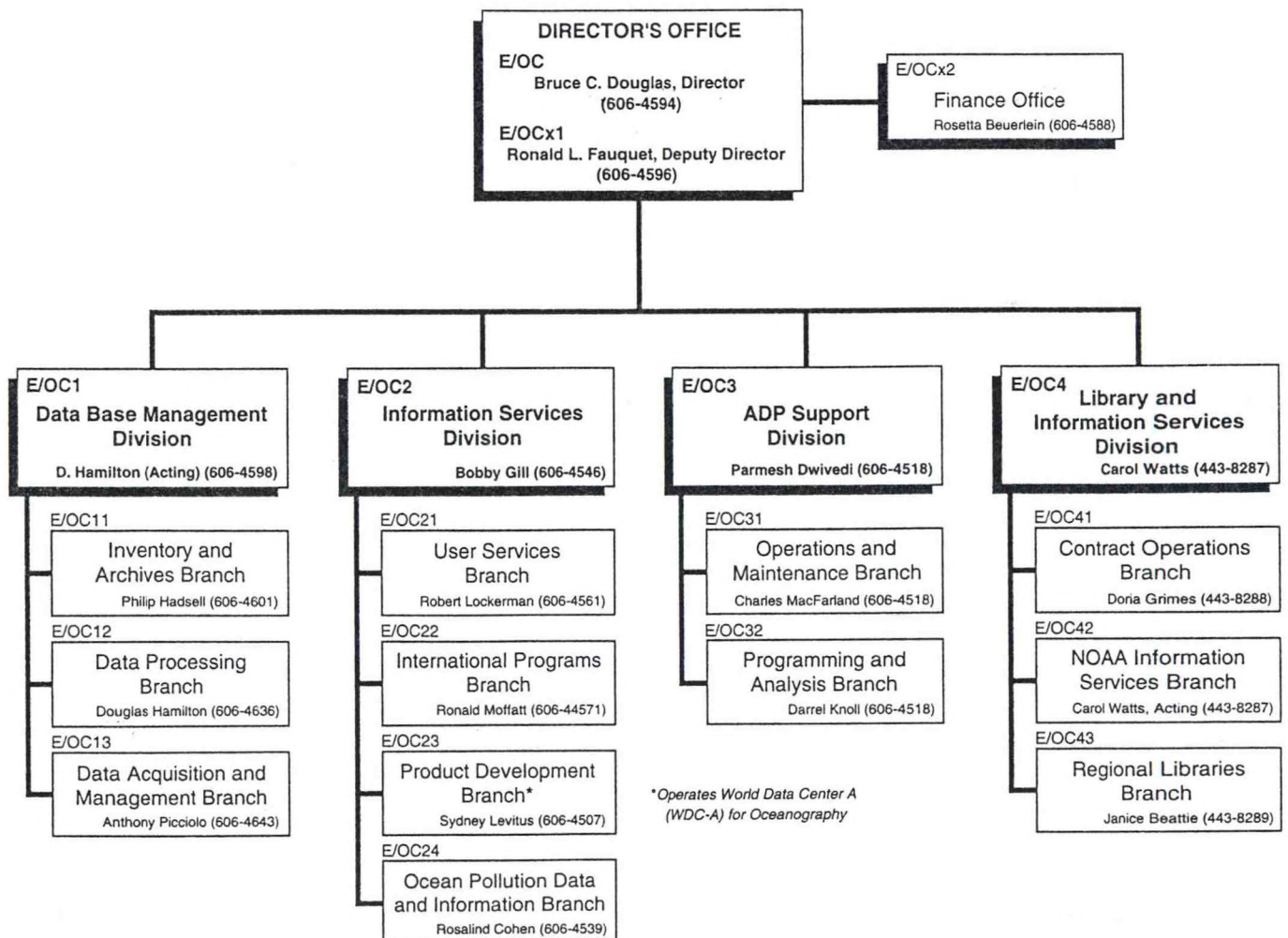
NODC Organization

The NODC operates as one of the three national data centers within the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. NESDIS is one of the five NOAA major line components.

NODC's sister data centers within NESDIS are the National Climatic Data Center (NCDC), Asheville, North Carolina and the National Geophysical Data Center (NGDC), Boulder, Colorado. In addition, the National Snow and Ice Data Center (NSIDC) is operated for the NGDC by the

University of Colorado, which is also in Boulder. Working together the NESDIS data centers provide users with a full range of environmental data services covering the oceans, atmosphere, solid earth, and solar-terrestrial phenomena.

NODC's ocean data management functions are carried out through three divisions: Data Base Management, Information Services, and ADP Support. In addition, through the Library and Information Services Division, the NODC manages the NOAA library system, which includes the Central Library in Silver Spring, Maryland, and field libraries throughout the United States.





DATA AQUISITIONS AND DATA HOLDINGS



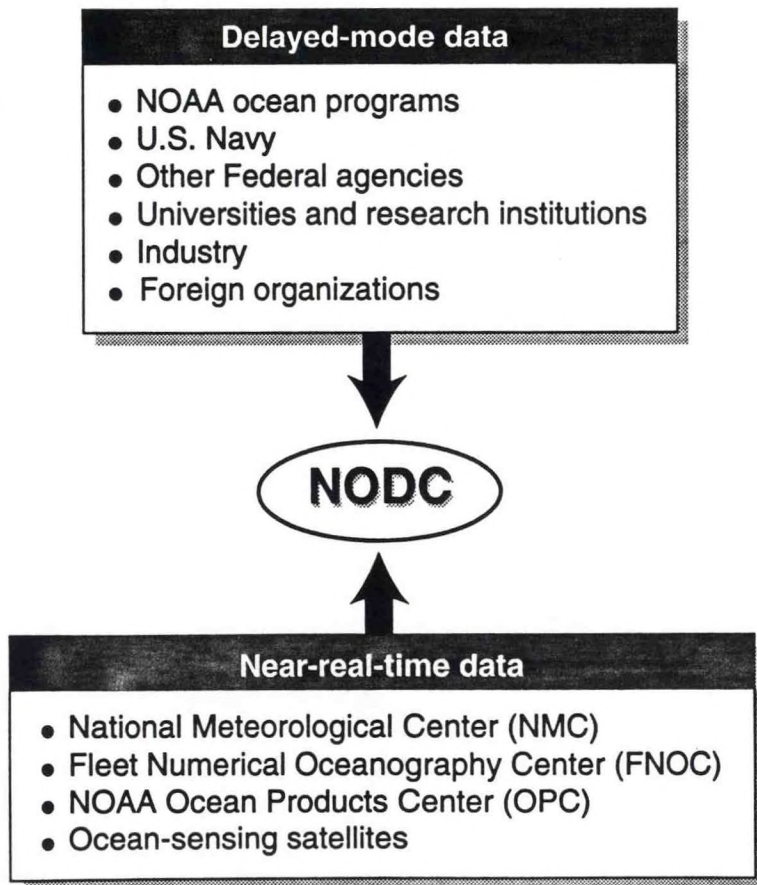
NODC Data Sources

The National Oceanographic Data Center receives data collected by NOAA and other U.S. Federal agencies, including the Department of Defense (primarily the U.S. Navy); state and local government agencies; universities and research institutions; and private industry. Because oceanography is an international science, a large portion of NODC's worldwide deep-ocean data holdings are of foreign origin. NODC acquires foreign data directly through bilateral exchanges with other countries and through the facilities of World Data Center A for Oceanography, which is operated by the NODC under the auspices of the U.S. National Academy of Sciences.

The NODC receives both delayed-mode and near-real-time data. Delayed-mode ocean data are collected to support ocean research or

operational programs and are submitted to NODC after they have served their primary purpose. Typically such data are received at the NODC months to years after collection.

Near-real-time ocean data support more immediate marine operations such as ocean prediction and monitoring and are received at the NODC within a period of a few days to a month or so after collection. Collected by ocean-sensing satellites and in situ instruments, these data are telecommunicated to central processing facilities that then provide them to the NODC. The three primary contributors of such data to the NODC are the NOAA National Meteorological Center (NMC), the U.S. Navy Fleet Numerical Oceanography Center (FNOC), and the NOAA Ocean Products Center (OPC).



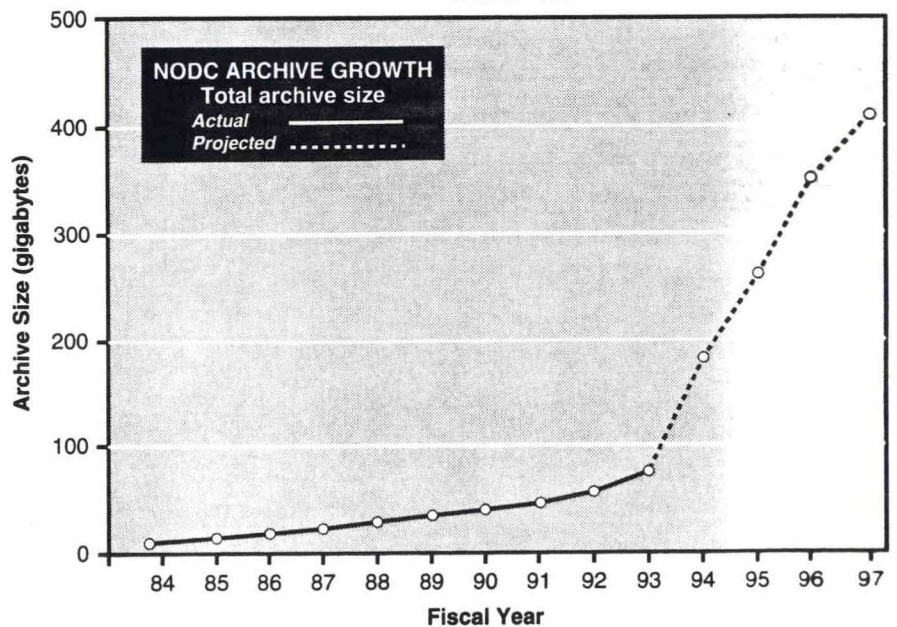
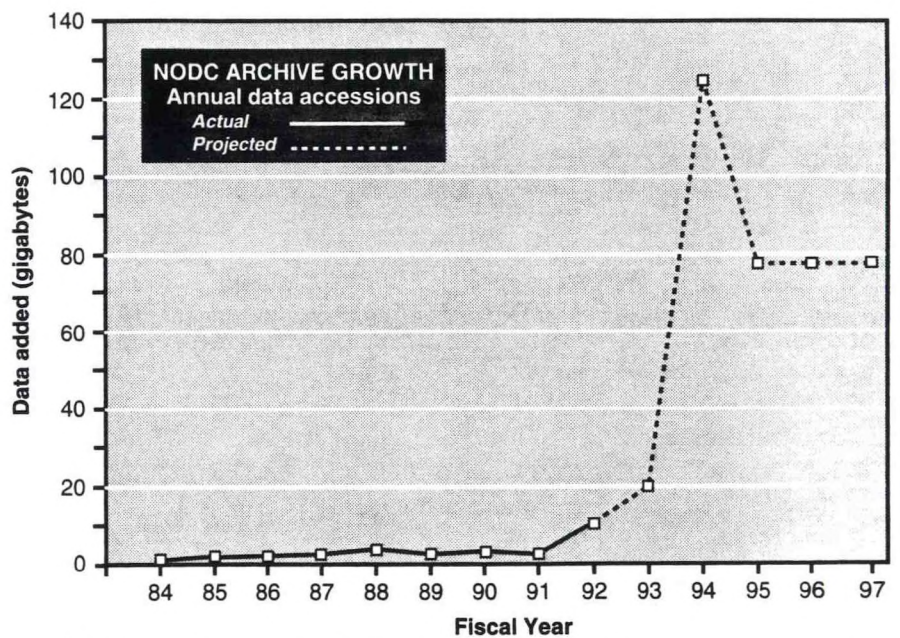
NODC Database Growth

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NODC Ocean Data Holdings

The NODC receives worldwide physical/chemical oceanographic data from government agencies, academic institutions, and other organizations in the United States and in dozens of other countries. NODC's data holdings provide global coverage of basic ocean physical/chemical properties such as temperature, salinity, waves, and currents. In U.S. coastal and outer continental shelf areas, these physical/chemical data holdings are supplemented by substantial quantities of marine biological data. These data derive primarily from environmental assessment programs conducted to ensure the wise use and protection of offshore resources.

NODC's Master Data Files hold numerous individual data submissions that undergo NODC quality control procedures and are

stored in standard NODC archive formats. Data in these files are available as copies of specified data subsets. For the major global files data are also available as formatted print-outs or as data summaries. To speed data retrieval the major global files are maintained in two separate versions, one sorted by cruise number (cruise file) and one sorted by a geographic grid numbering system (geofile). Data in these files can generally be selected by users either by geographic area and time period or by specific cruise or cruises.

Data not amenable to being merged into one of the NODC Master Data Files are held as individual data sets in originator formats and provided to users as direct one-to-one copies of entire data sets.

NODC Ocean Data Holdings

DISCIPLINE	VOLUME * (MBytes)	DISCIPLINE	VOLUME * (MBytes)
PHYSICAL/CHEMICAL DATA		MARINE BIOLOGICAL DATA	
Master Data Files		Master Data Files	
Buoy data (Wind/Waves)	7,585	Fish/Shellfish	118
Currents	3,973	Benthic organisms	69
Ocean stations	1,623	Intertidal/Subtidal organisms	30
Salinity/Temperature/Depth	1,430	Plankton	29
BT temperature profiles	824	Marine mammal sighting/census	21
Marine chemistry/marine pollutants	89	Primary productivity	7
Other	68	Subtotal	274
Subtotal	15,592		
Individual Data Sets, for example		Individual Data Sets, for example	
Geosat data sets	12,841	Marine bird data sets	52
CoastWatch data	15,000	Marine mammal data sets	11
Levitus Ocean Atlas data sets	61	Marine pathology data sets	4
Other (estimated)	11,000	Other (estimated)	200
Subtotal	28,902	Subtotal	267
TOTAL PHYSICAL/CHEMICAL	54,494	TOTAL BIOLOGICAL	541
		TOTAL DATA HOLDINGS	55,309

NODC Data Sets

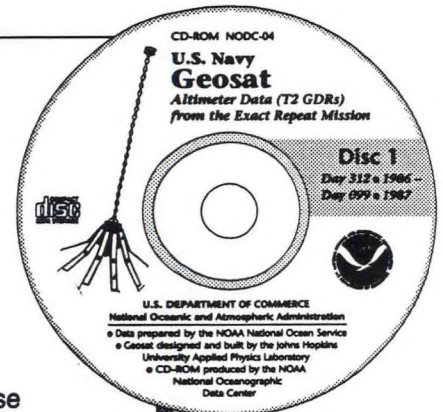
In addition to its Master Data Files, the NODC also holds a number of individual data sets in originator formats. These data sets typically represent data from completed projects or data compilations subject to special editing, quality control, or analytic procedures. In some cases data held by the NODC separately in its original form may also be incorporated in whole or in part in the appropriate Master Data Files. NODC data sets are provided to users on magnetic tapes, floppy disks, or CD-ROM.

Examples of data sets held by the NODC include data from the *Southern Ocean Atlas*, the FGGE Operational Year Global Ocean Climate Data Base, data from the *Climatological Atlas of the World Ocean*, data from the scientific programs SEQUAL and FOCAL, and data sets from the U.S. Navy Geodetic Satellite (Geosat).

NODC data sets expected to be of wide interest to the ocean community are announced by issuance of fliers in the NODC Environmental Information Bulletin series.

Selected NODC Data Sets

- *Southern Ocean Atlas* Data
- *Climatological Atlas of the World Ocean* Data
- Global Ocean Water Color/Water Transparency Data
- SEQUAL/FOCAL Data Sets
- FGGE Operational Year Global Ocean Climate Data Base
- GEOSAT Wind/Wave Data from the Geodetic Mission
- GEOSAT Altimeter Data (T2 GDRs) from the Exact Repeat Mission
- GEOSAT Altimeter Data from the Geodetic Mission, 30°S-72°S





INTERNATIONAL PROGRAMS



International Cooperation and Data Exchange

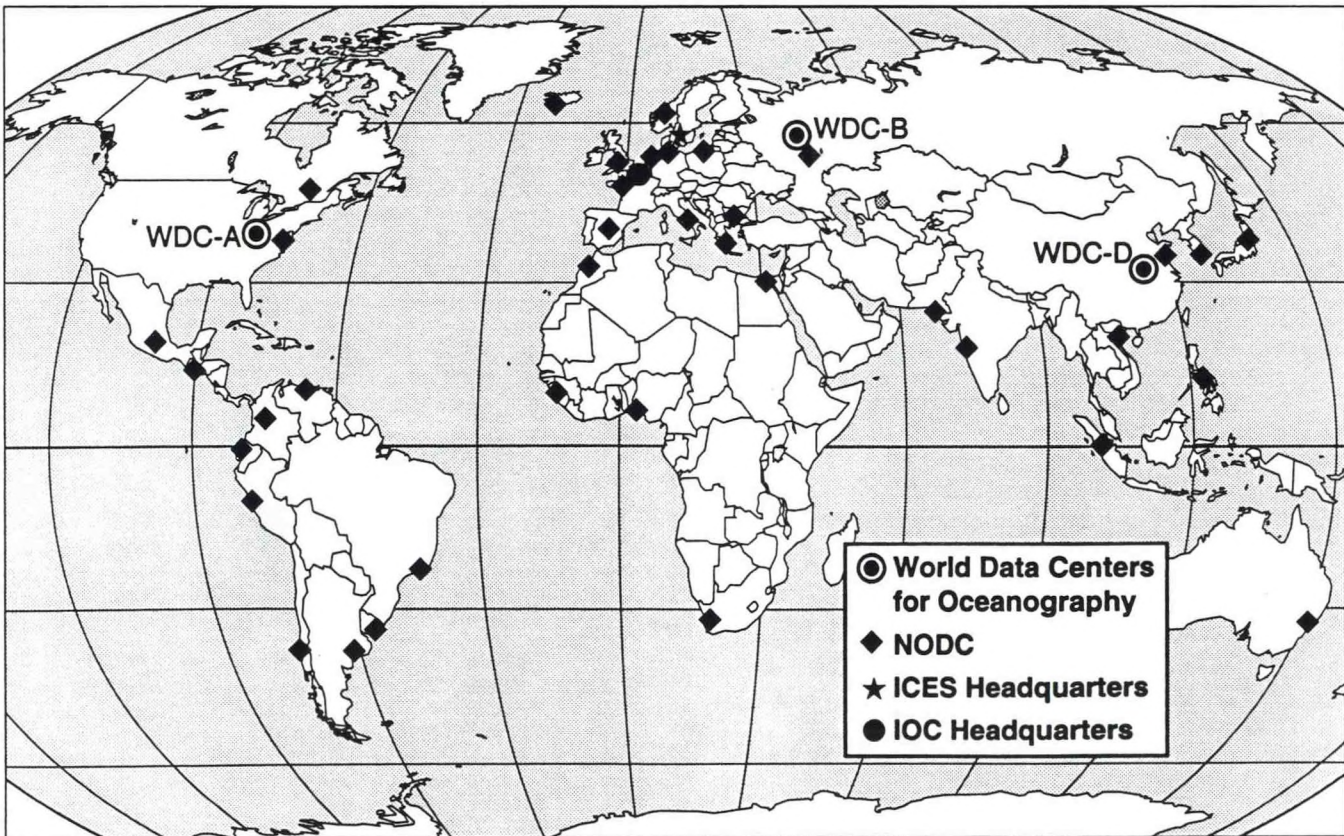
The NODC supports a number of international data exchange activities that help it fulfill its mission. Participation in these activities promotes data exchange and enables the NODC to augment its data holdings with valuable foreign data taken worldwide. NODC's interactions with international organizations and foreign data centers also enhance its scientific and technical capabilities.

NODC provides facilities and support for the collocated World Data Center A (WDC-A) for Oceanography, one component of the World Data Center System, a network of discipline subcenters operating under the guidance of the International Council of Scientific Unions (ICSU). WDC-A, Oceanography exchanges marine scientific data, publications, and data inventory information internationally in accordance with principles set forth by ICSU.

The NODC serves as the U.S. focal point for data exchange activities conducted under the purview of the Working Committee on

International Oceanographic Data Exchange (WC/IODE) of the Intergovernmental Oceanographic Commission (IOC). The IOC operates within the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Through its representation on the Working Group on Marine Data Management of the International Council for the Exploration of the Sea (ICES), the NODC is also involved in a number of activities intended to facilitate the exchange of data.

When it was established, the U.S. NODC was the first such organization in the world. Today there are national oceanographic data centers and similar organizations in about 40 other countries. The NODC conducts ongoing oceanographic data exchange with nearly two dozen other countries including Argentina, Australia, Canada, France, the Federal Republic of Germany, Mexico, the People's Republic of China, Peru, and the United Kingdom.



World Data Center A for Oceanography

The World Data Center A for Oceanography is physically collocated with and operated by the NODC, which maintains a large, multidisciplinary marine scientific data base and which has facilities for computer processing of oceanographic data. The NODC performs data processing functions on behalf of WDC-A, Oceanography. Data received by WDC-A that are amenable to computer processing are transferred to the NODC and incorporated into the NODC's data files. Through data exchanges between WDC-A for Oceanography and WDC-B for Oceanography (Moscow, USSR) the data holdings of the NODC have been enriched by ocean data from the Soviet Union and other Eastern Bloc nations.

The WDC-A for Oceanography primarily exchanges the following types of numerical data:

- serial oceanographic station data
- bathythermograph observations
- surface and subsurface current observations
- biological observations
- sea surface observations.

The international data base of the Center now contains data for more than 2.3 million scientific observations. On the average, data for about 100,000 observations, including 35,000 oceanographic stations, are received yearly. All data held by the Center are described in the *Catalogue of Data* and the annual *Change Notices to the Catalogue*.

Approximately 1,500 marine scientific publications, reports, and articles are also received by WDC-A, Oceanography each year. These documents are listed and indexed by keyword and author in annual *Supplements to the Catalogue of Accessioned Publications*.

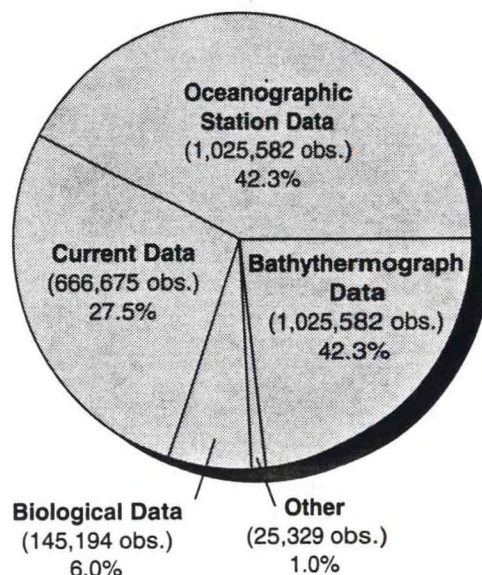


Oceanographic Stations Received 1981-1991

YEAR	STATIONS RECEIVED	TOTAL ON HAND
1982	38,173	729,256
1983	39,453	768,709
1984	30,346	799,055
1985	30,412	829,414
1986	34,659	863,985
1987	30,093	894,078
1988	34,432	928,510
1989	42,075	970,585
1990	24,209	994,875
1991	31,151	1,025,582

International Marine Database (as of Dec. 1991)

(Total: 2.42 million obs.)



NODC-IOC Cooperation

The Intergovernmental Oceanographic Commission, through its Technical Committee on International Oceanographic Data Exchange (IODE), encourages the adoption of those practices intended to facilitate the exchange of marine data internationally. The IODE approach utilizes task teams, groups of experts, and discipline-oriented rapporteurs to deal with specialized problems confronting international oceanographic data and information exchange.

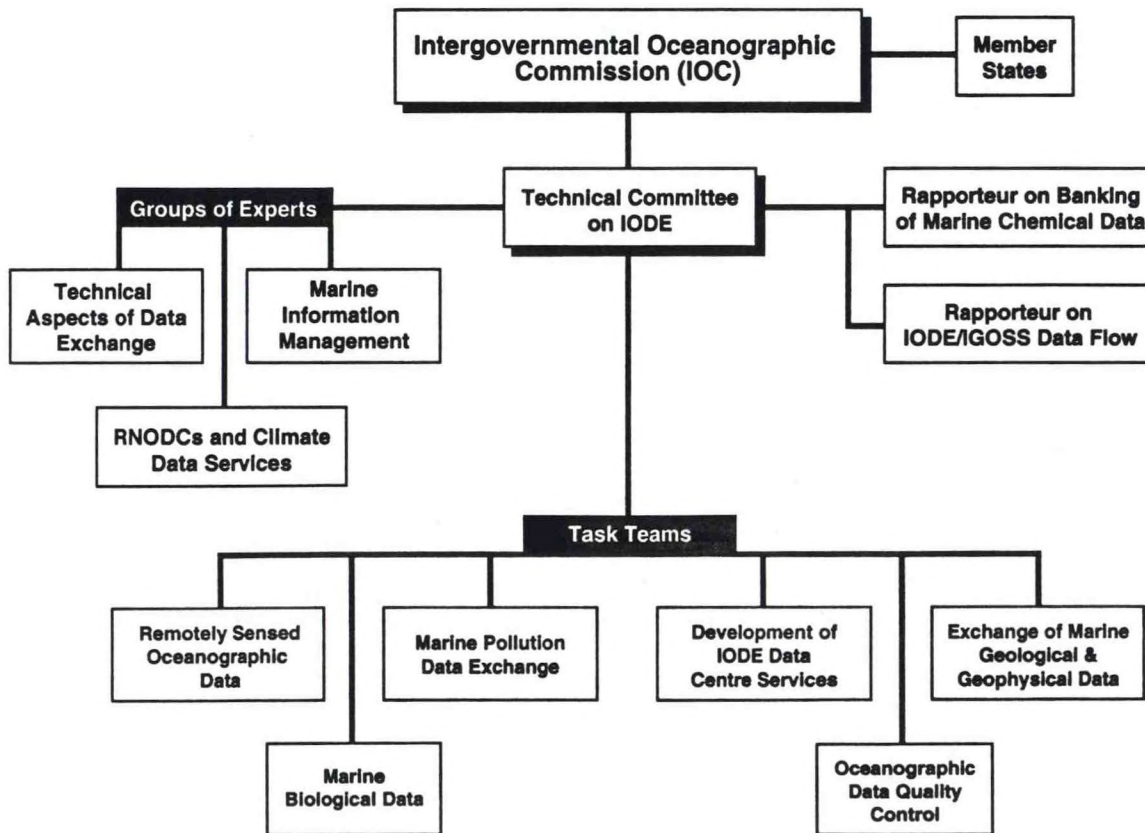
Some of the more important accomplishments of the IODE have been: (1) standardizing forms for reporting and coding data, (2) promulgating the concept of Declared National Programs (DNPs) as national activities being carried out with the intention to exchange the resulting data, (3)



assisting the development of national oceanographic data centers, (4) supporting and facilitating exchange of, and access and referral to, information resulting from international programs such as MEDI and ASFIS*

(5) adopting the automated General Format 3 (GF-3) for international exchange of marine scientific data, (6) providing the mechanism for creation of Responsible National Oceanographic Data Centers (RNODCs) that provide special data processing and compilation support for specific programs, and (7) issuing and updating the *Manual on International Oceanographic Data Exchange*.

*MEDI = Marine Environmental Data Information Referral System;
ASFIS = Aquatic Sciences and Fisheries Information System



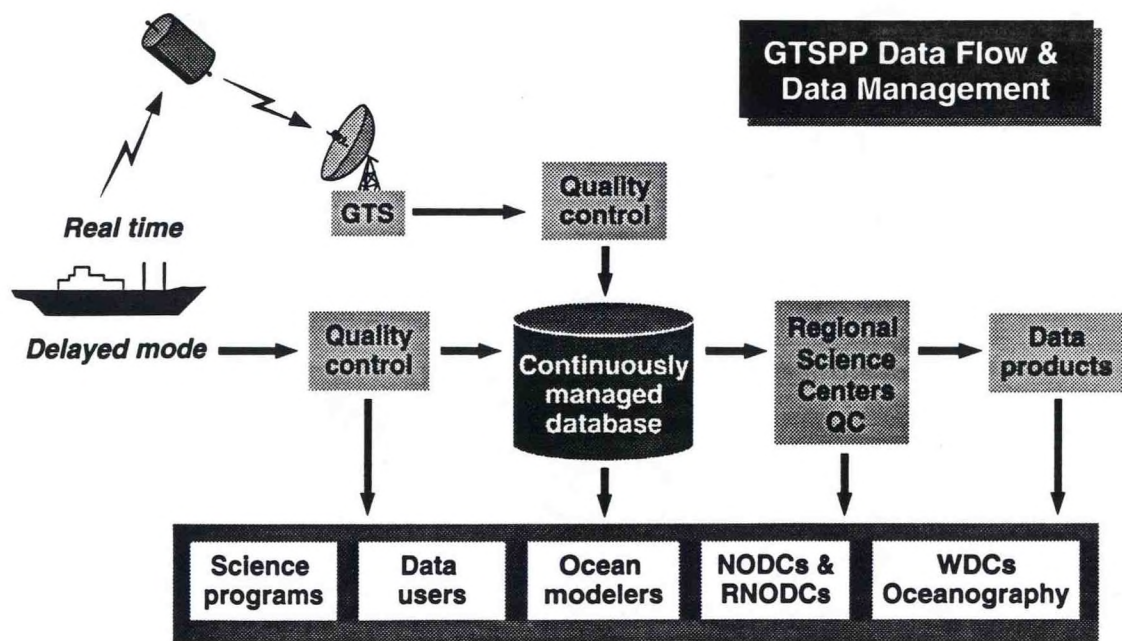
Global Temperature-Salinity Pilot Project

The Global Temperature-Salinity Pilot Project (GTSP) is an international effort to increase the number of ocean temperature-salinity observations available to climate researchers worldwide. The U.S. NODC, the Canadian Marine Environmental Data Service (MEDS), and other institutions around the world are jointly contributing to the operation of a continuously managed temperature-salinity data base.

The GTSP is working to improve access to near-real-time temperature-salinity observations collected by the the Integrated Global Ocean Services System (IGOSS). IGOSS is a worldwide cooperative program for rapid collection, exchange, and analysis of oceanographic data, as well as the timely preparation and dissemination of ocean products and ser-

VICES. Over 40 countries are actively involved in one or more aspects of the System, which is sponsored jointly by the World Meteorological Organization and the Intergovernmental Oceanographic Commission.

One of the principal types of IGOSS observations is bathythermograph (BT) ocean temperature profiles. These data are taken by shipboard observers, coded into the IGOSS BATHY format for radio transmission, and broadcast over the Global Telecommunications System. In the United States these radio message data are received by the NOAA National Meteorological Center (NMC) and the U.S. Navy Fleet Numerical Oceanography Center (FNOC) where they are processed, quality controlled, and used in civilian and military weather forecasting models.



Ocean Data Archaeology and Rescue Project

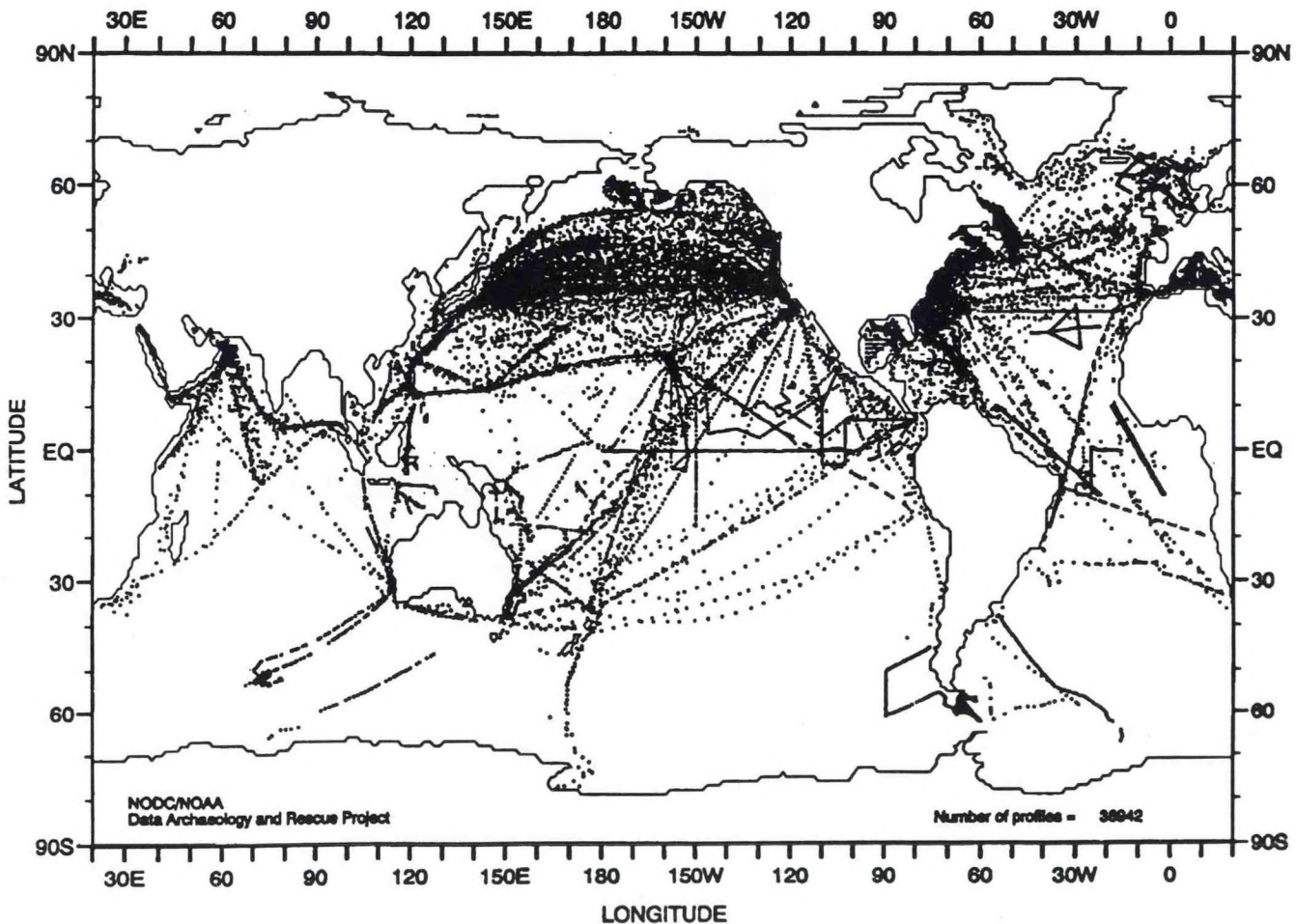
A critical requirement for climate and global change research is the availability of digital oceanographic data covering long time spans. It has been estimated, however, that perhaps two-thirds of all historical oceanographic data exist only in manuscript form or have not been submitted to a national data center, and thus remain effectively unavailable to researchers.

To address this problem, the U.S. NODC and its collocated World Data Center A for Oceanography have initiated an Oceanographic Data Archaeology and Rescue Project. "Data archaeology" is the term used to describe the process of seeking out, restoring, evaluating, correcting, and interpreting historical data sets. The project was formally launched at an international workshop hosted by the NODC and WDC-A in 1990.

A proposal for an International Data Archaeology and Rescue Project was presented by the NODC/WDC-A at the Fourteenth Session of the Committee on International Oceanographic Data and Information Exchange (IODE) in December 1992. The IODE endorsed this proposal and will submit it for approval by its parent body, the Intergovernmental Oceanographic Commission, in February 1993.

The Oceanographic Data Archaeology and Rescue Project has already resulted in the submission to NODC of additional data sets from many countries. To help researchers identify and locate ocean data not yet in the NODC archives, the NODC has begun a series of special data inventory publications that show the NODC's digital data holdings.

NODC Expendable Bathythermograph Profiles
for all countries as of June 1992
This plot for year 1980



DATA PROCESSING AND DATA SYSTEMS



Ocean Data Processing

NODC's Master Data Files grow through the addition of newly acquired and processed data. Data processing procedures at NODC vary depending on data type, but generally involve five steps:

- **Acquisition.** Submitted data are reviewed to determine if they are processable, and if they are accurately described in accompanying documentation. Identifying numbers are assigned and recorded in the NODC Data Inventory Data Base. If processable, the data go on to the next step; otherwise they are stored "as is" in the originator format.

- **Preparation.** Copies are made of data submitted in digital form. Data in report/publication form are digitized. If necessary, data are converted to an NODC format. Expendable bathythermograph (XBT) analog strip charts are prescreened for errors and digitized. At the end of this step, the data are stored as a

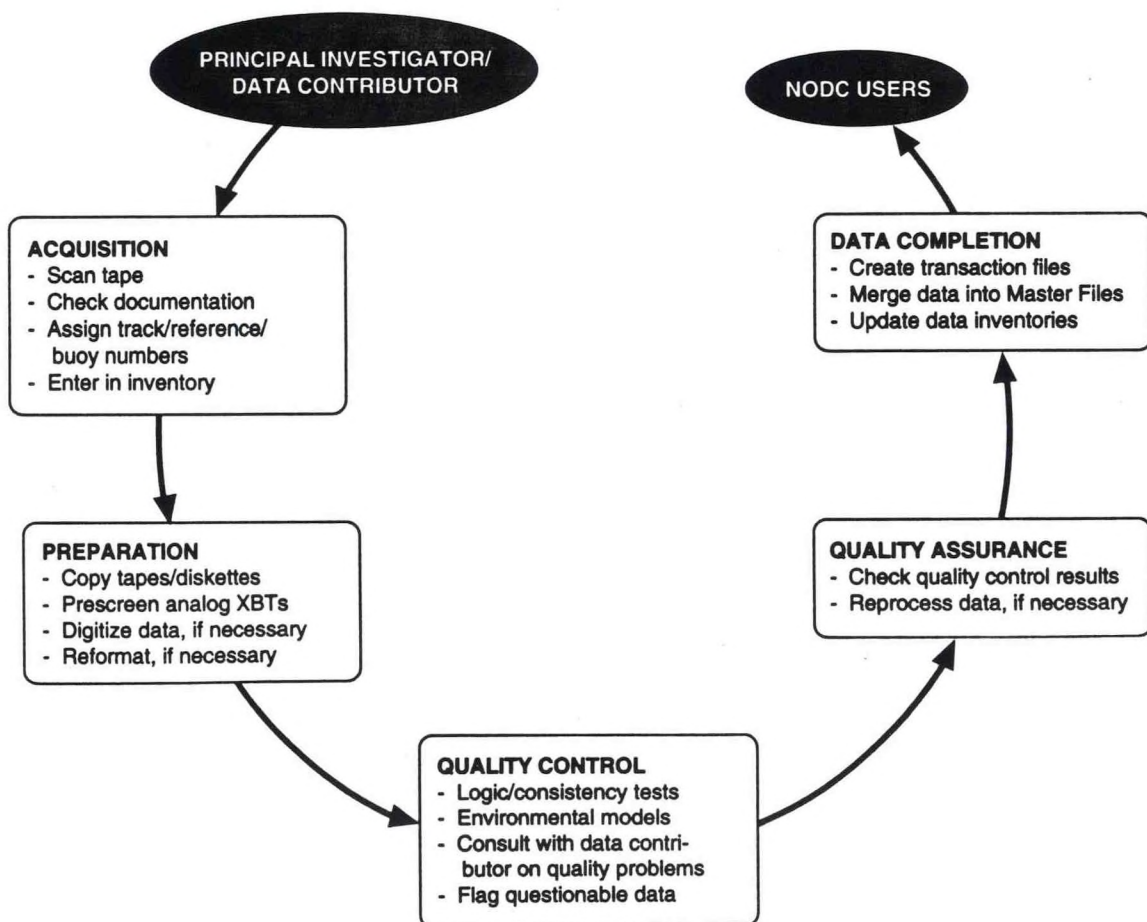
production file on hard disk.

- **Quality Control.** Quality control programs check for mandatory fields, proper agreement between related fields, expected ranges of parameters, and similar items.

Oceanographic station and XBT data are also compared to environmental models derived from historical data in those files.

- **Quality Assurance.** Quality control results for all oceanographic stations and a representative sample of XBT data are reviewed to ensure the data are meeting quality specifications.

- **Data Completion.** Each week data sets that are completely processed are collected on disk files segregated by data type. Each month the weekly finals are written to magnetic tape. The data are then merged into NODC's data files where they are available for dissemination to customers.



Ocean Data Quality Control

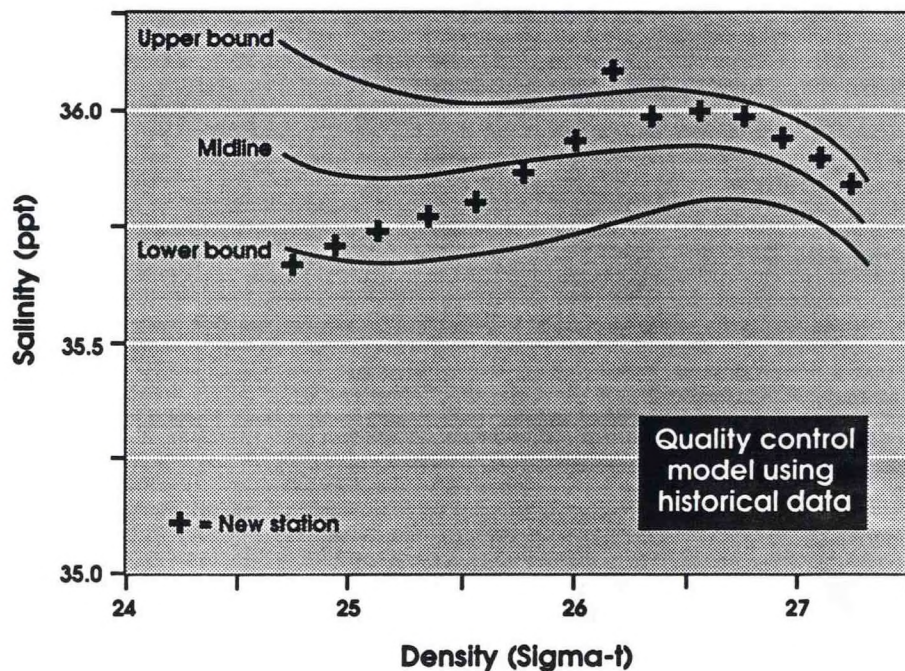
Although primary responsibility for the quality of ocean data submitted to the NODC rests with the data contributor, NODC does apply various quality checks that can detect both gross errors—for example, observations with reported positions that fall on land—and more subtle problems such as oceanographic stations with physically unrealistic properties. NODC quality control procedures are of two types: (1) logic and consistency tests that are applied to most data that undergo processing and (2) comparison with environmental quality control models that is applied only to oceanographic station data and expendable bathythermograph (XBT) data.

The logic and consistency tests include checks for:

- valid ship speed between consecutive observations
- valid ranges or upper limits for data parameters

- consistency between related data fields
- valid use of taxonomic, chemical, and other codes
- acceptable vertical stability properties (for ocean station data)
- valid calibration temperature and depth (for XBT data).

As a further refinement for quality control of oceanographic station and XBT data, NODC generated environmental models from the historical data already in those files. New observations are compared to these models to see if they fall within expected values. For oceanographic station data models were generated for each five-degree square of ocean with a sufficient number of observations. The models define expected values and ranges of salinity versus density. The XBT models were computed for one-degree ocean squares and compare five traits of the temperature-depth profiles to historical averages of those traits.



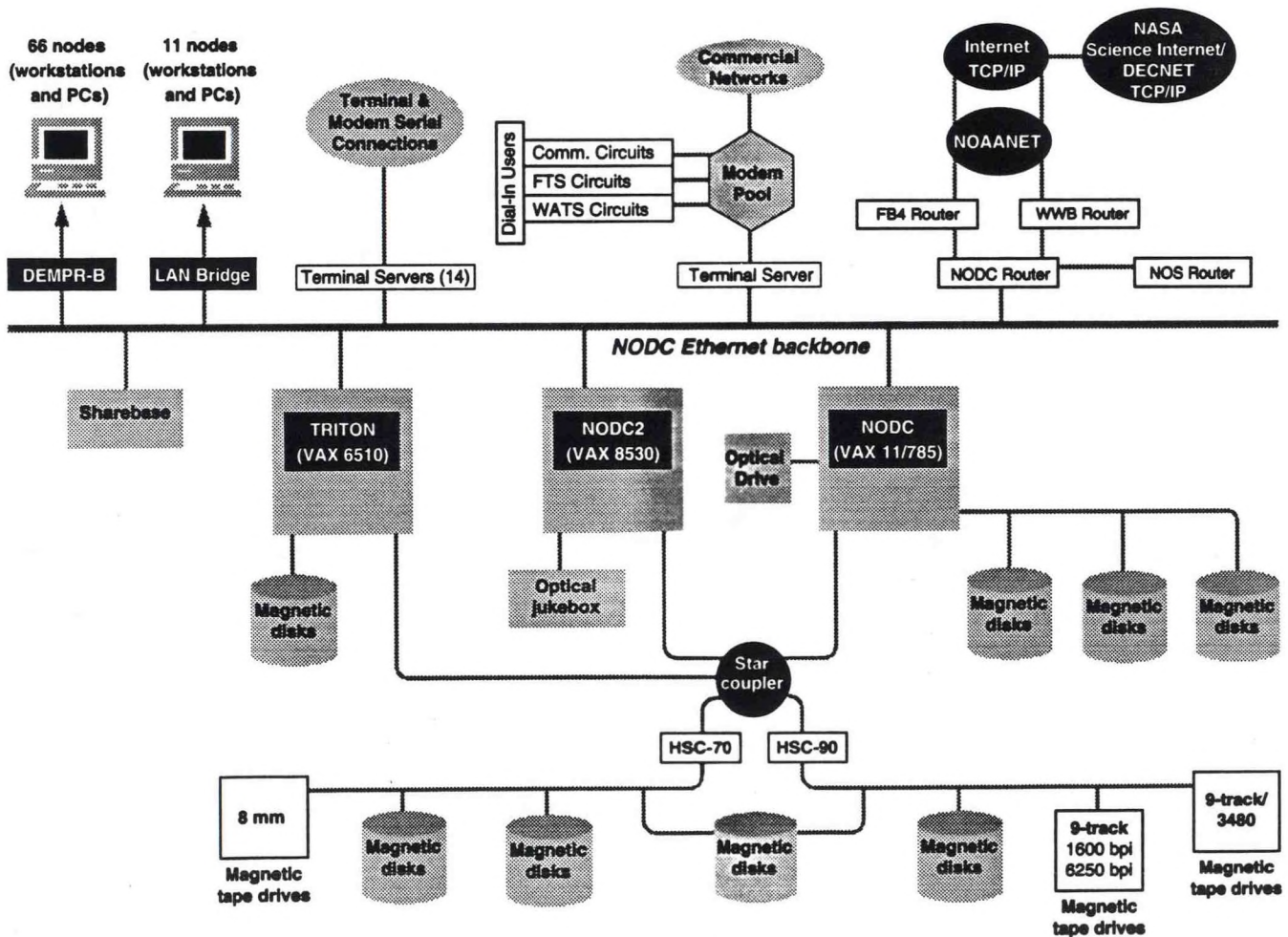
NODC Computer Resources

NODC's in-house computing resources support data processing and quality control, data analysis and data product development, user services functions, and communications. NODC'S data archives are maintained on a Unisys mainframe computer system located at the National Climatic Data Center in Asheville, N.C. Called the Data Archive Management and User Services System (DAMUS), this computer system serves as a central data archive for the three NESDIS national data centers.

Currently an Ethernet backbone serves to link the distributed computing resources at NODC's headquarters offices in Washington, D.C., in a Local Area Network (LAN). A cluster of three DEC VAX minicomputers (with over 40 gigabytes of magnetic disk storage) supports central computer processing and communications support and control, as well as functioning as a server for the LAN.

Peripheral devices include tape drives (9-track, 8mm, and IBM 3480 cartridge), an optical disk drive, and an optical disk "jukebox" that provides over 300 gigabytes of mass storage. A Sharebase database system provides SQL access through the cluster nodes to four gigabytes of online storage. The Ethernet LAN supports about 90 nodes, including both high speed workstations and PC-class computers. The LAN management system is DEC Pathworks. It operates over both the DECnet and TCP/IP protocols.

The LAN supports communications using TCP/IP over a T1 line (1.54 Mbs) to the NOAA subnet of Internet. Connection to the NASA Science Internet (NSIInet) using the DECnet protocol is provided over a 9.6 Kbs channel. In addition dial-in and dial-out access is available via modem at up to 34 Kbs. Anonymous FTP is supported over Internet to NODC2.NODC.NOAA.GOV.



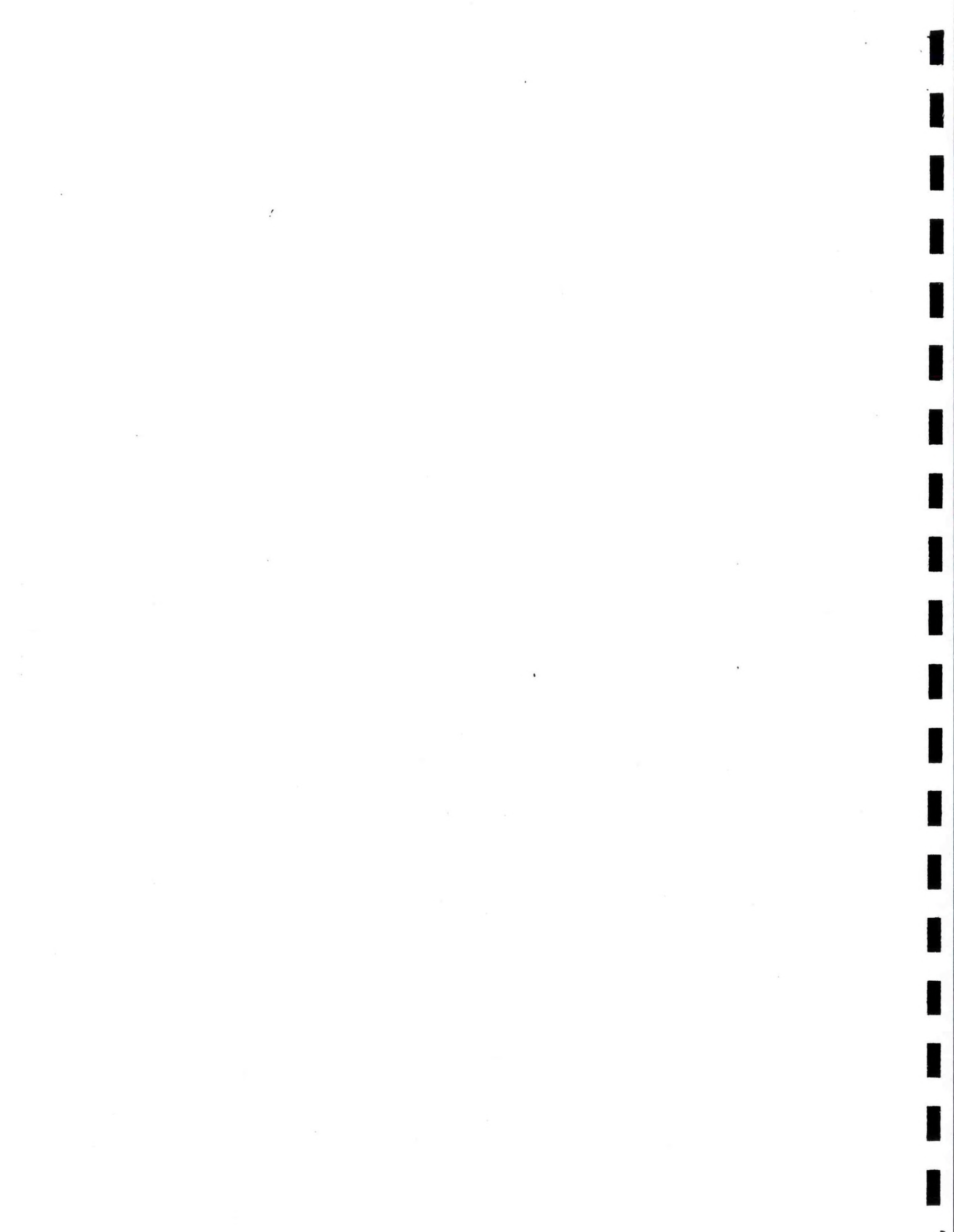
NODC Data System Modernization

The NODC is currently working to modernize its computing environment and to upgrade its computing resources. To save on maintenance costs for its older VAX minicomputers, the NODC plans to migrate to a client-server workstation environment in which database functions are supported by a relational database management system (RDBMS) operating on UNIX workstations.

Using the Global Temperature Salinity Pilot Project (GTSP) to prototype this sys-

tem, the NODC plans to implement a workstation database server using an X Windows front-end graphic user interface (GUI) in Motif. After the database server is established, client workstations will be developed to access the server. Several alternative configurations for the client workstations are under evaluation.

This system will be implemented in phases over the next several years.



PRODUCTS AND SERVICES



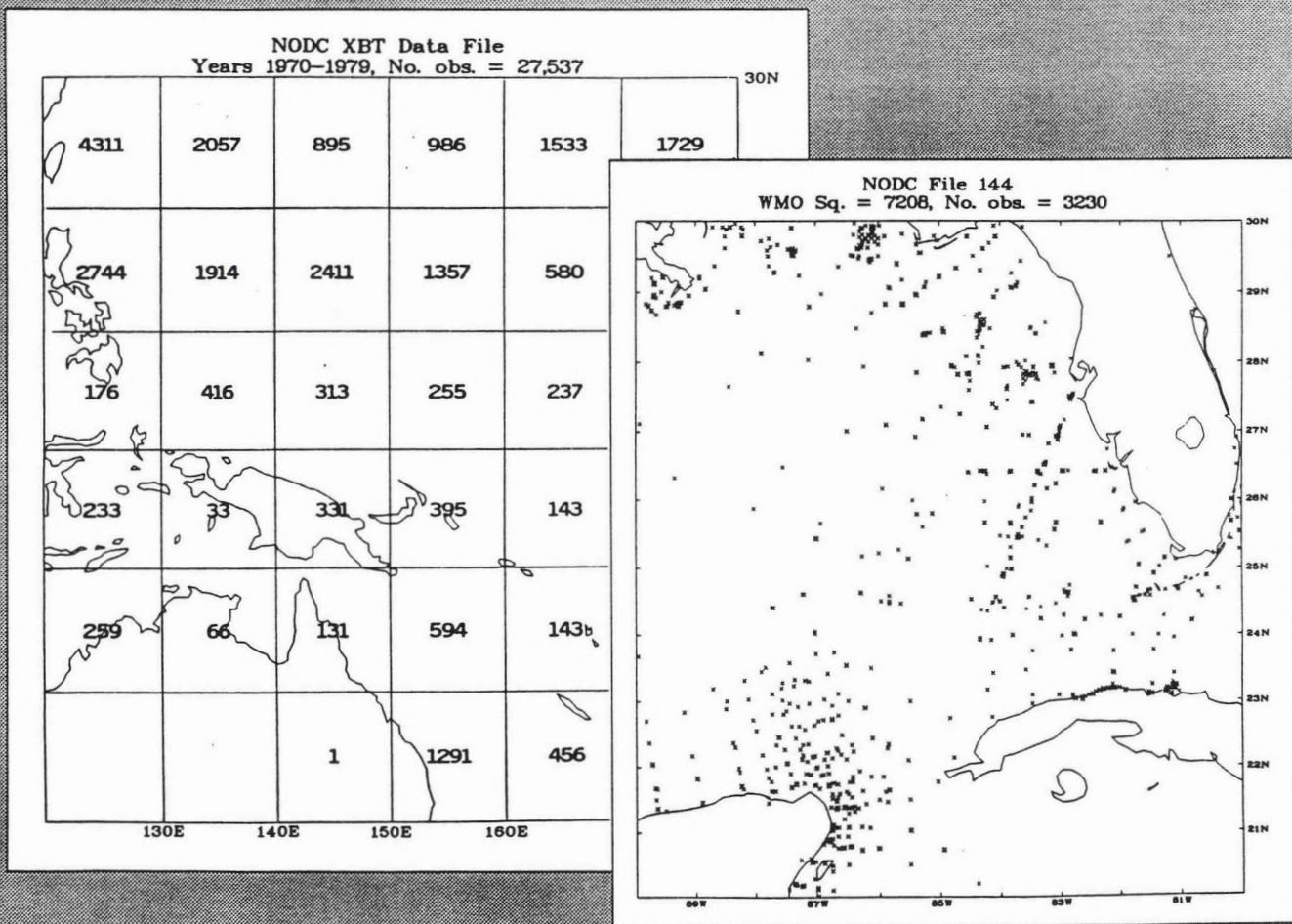
Data Inventories

When users contact the NODC their first question is often "How much data do you have in my area of interest?" Or they may ask if NODC holds the data from a specific cruise or project. To answer these questions—which have endless specific variations—the NODC maintains several data inventory systems. The goal of these systems is to answer in as much detail as possible user inquiries about data availability.

Depending on their needs, NODC users can be provided with various types of data inventory products. These range from total counts of observations meeting specified selection criteria to more complex products that

show the distribution of available data in time and space. These products include data summaries by year, season, or month; counts of observations by one-, two-, five-, or ten-degree subsquares; or graphic plots showing the actual locations of selected observations.

In years past NODC's inventory systems were available only in-house and results of inventory searches had to be provided to users by telephone or mail. The NODC is now working to make its data inventory information available online. By providing this kind of browse capability, the NODC hopes to improve customer service and increase use of its data resources.

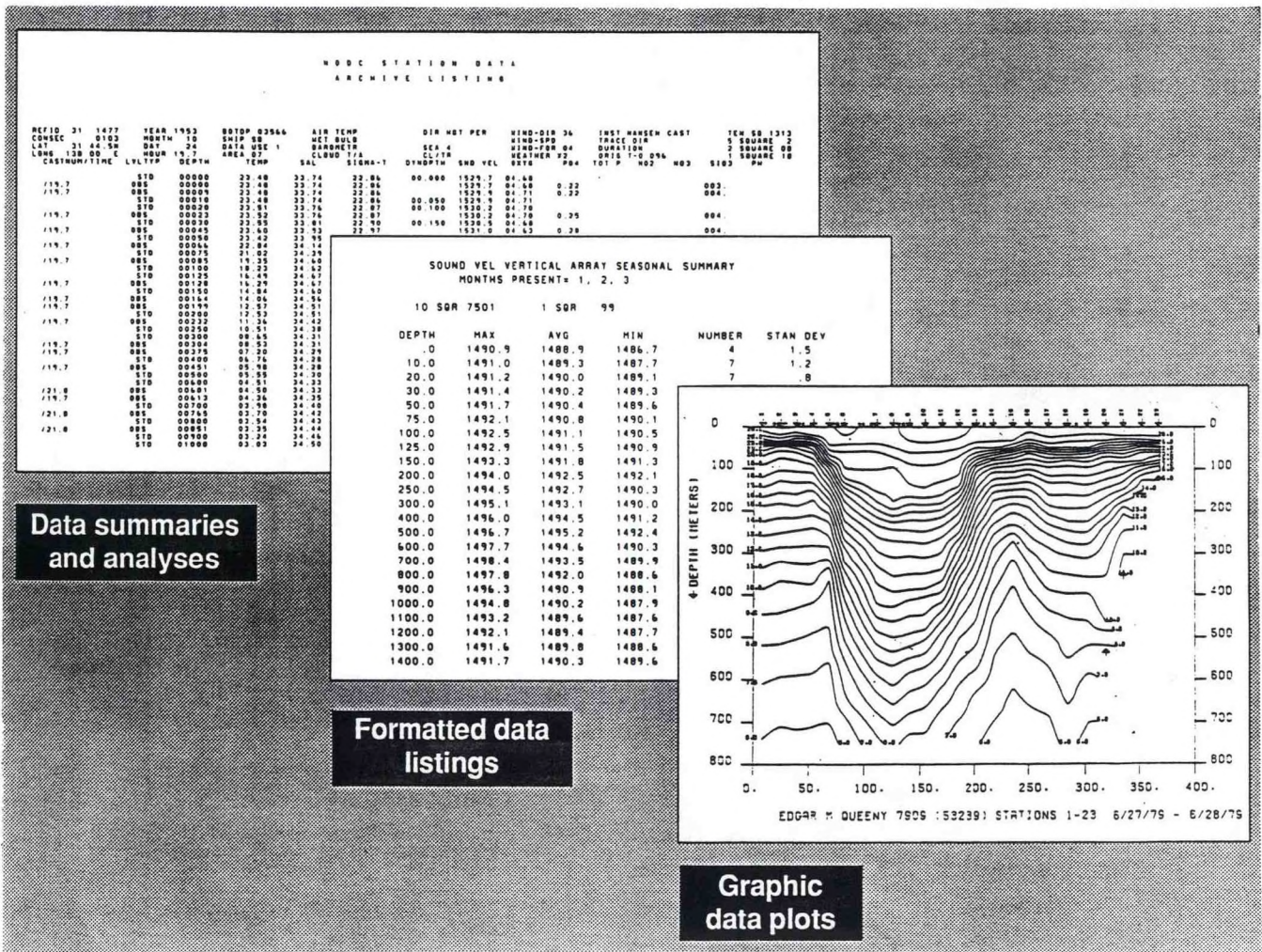


Data Products

Data in NODC Master Data Files can be provided to users in a variety of forms from simple magnetic tape copies of selected data to complex computer-generated data summaries, statistical analyses, and graphic plots. These data products include most of the standard oceanographic presentations such as parameter-depth plots, parameter-parameter (e.g., temperature-salinity) plots, vertical section plots, and mixed layer/thermocline analysis.

NODC's applications software is designed for maximum flexibility. Therefore, although some products are specific to a certain kind of

data, others are generic and may be produced for a variety of parameters from several different data files. For example, Vertical Array Summaries (which present maximum, minimum, mean, and standard deviation of a parameter at selected depths) may be generated for 10 different parameters from one or more of four data files. When data in separate files are stored in a common format (e.g., mechanical and expendable bathythermograph data), the user also has the option of requesting products from a merged data set that includes data from more than one file.



NODC Publications

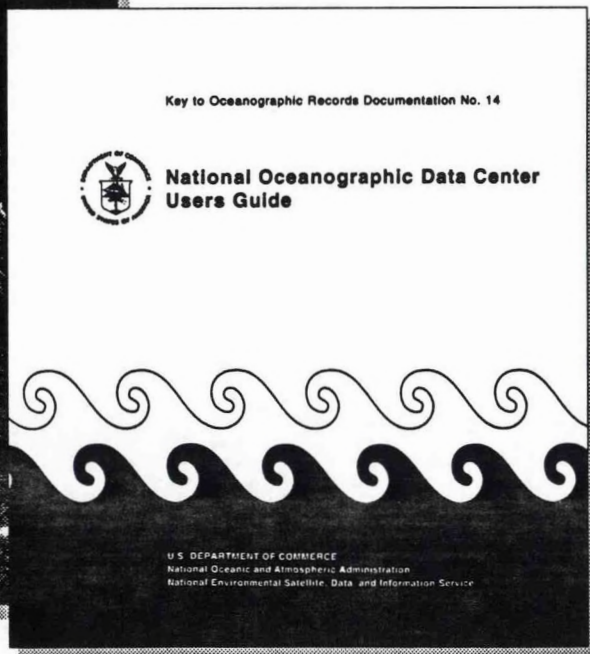
NODC publications describe its data holdings, products, and services; provide summaries or analyses of marine environmental data; document its data processing formats, procedures, and systems; or provide general marine science information of value to NODC users.

The NODC's principal publications and publication series include:

- **Key to Oceanographic Records Documentation.** The KORD series contains publications that summarize or describe NODC data or information holdings. These include special data inventories and project reports as well as the *NODC Users Guide*.
- **NODC Environmental Information Bulletin.** This series covers fliers and order forms announcing new NODC publications, data sets, and other data products and services.
- **Mariners Weather Log.** This quarterly publication is a unique source of information on marine weather and climate and their ef-

fects on operations at sea. The *Log* provides comprehensive coverage of major storms of the North Atlantic and North Pacific and related ship casualties, reports and annual summaries on tropical cyclones, and information on the National Weather Service's Marine Observation Program. It also provides selected gale and wave observations, climatological summaries of data from offshore buoys, and other data and information of value to merchant seamen, shipping companies, research meteorologists and oceanographers, yachtmen, and other maritime interests.

In support of NOAA's Earth System Data and Information Management (ESDIM) program, the NODC also produces the *Earth System Monitor*. The *Monitor* is a quarterly information bulletin that reports on NOAA data and information management programs, projects, and activities.



Automated Electronic System for Ocean Pollution

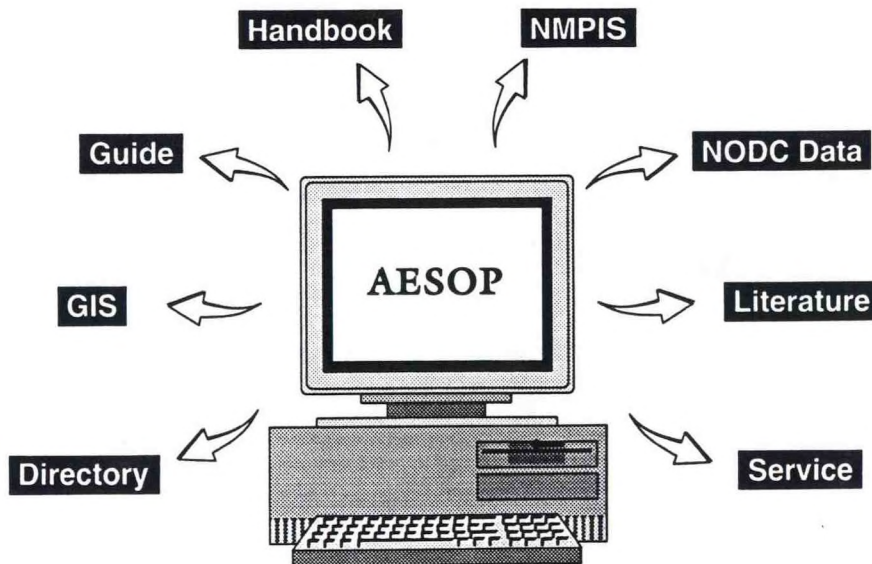
The Automated Electronic System for Ocean Pollution (AESOP) is a newly developed software application created to provide quick and easy access to ocean and Great Lakes pollution databases. The data are essentially the same as in our hardcopy publications but in an object oriented, windows format designed for fast, easy retrieval. Numerous search routines are built into the system allow quick response to user inquiries. AESOP provides access to the:

- *Summary of Federal Programs and Projects* which contains information for Federally funded projects during FY 1986-1988. Data are organized by department or agency with project title, project summary, principle investigator with address, and a breakdown of funding for the current and succeeding fiscal years.
- *Guide to Marine Pollution Related Data* which contains information from projects that

were listed in the *Summary* that collected marine pollution field data. Types of data, as well as the location and zone are used as search criteria for the automated searches. Projects from FY 1978-1987 are available.

- *Handbook of Federal Systems and Services* which contains information on Federal systems and services identified as having data or information relevant to marine pollution or other man-induced disturbances to the marine environment. Names and addresses of principle contacts are included.

- *Marine, Great Lakes, and Arctic Pollution Related Literature*, three databases containing several thousand pollution related literature citations dealing with almost every aspect of marine pollution and marine pollution research. Updates are made on a regular basis to keep the citations current.



Ocean Data on CD-ROM

The combination of low unit cost and high data volume (about 650 megabytes per disc) makes CD-ROM an efficient medium for providing large data sets to researchers and other customers. In 1989 the NODC produced its first ocean data CD-ROM, a prototype disc holding temperature-salinity profiles for the Pacific Ocean. Since that time the NODC has increased the pace of CD-ROM production and currently is producing about 12 ocean data CD-ROMs per year.

To support its CD-ROM production efforts, the NODC has installed a CD-ROM mastering workstation.

CD-ROMs already released by the NODC include:

- Global Ocean Temperature-Salinity Profiles
 - Disc 1: Atlantic and Indian Oceans

- Disc 2: Pacific Ocean
- Data access/display software on floppy disk
- Geosat Altimetry Data
 - Six disc set of Exact Repeat Mission geophysical data records
 - Eight disc set of Geodetic Mission crossover differences
 - Two disc set of Geodetic Mission data for the Southern Ocean (30°S-72°S)Among ocean data sets planned for future release on CD-ROM are:
 - NOAA buoy data
 - Time series repeated oceanographic sections
 - Area/regional discs holding multiple data types



LIBRARY AND INFORMATION SERVICES



NOAA Library Mission and History

The mission of the NOAA Library and Information Network is to provide scientific, technical, and legislative information services and document delivery to NOAA scientists, administrators, and others working in related disciplines in support of NOAA's scientific research and technological development programs. The principal resource for accomplishing this mission is a million-volume research collection with comprehensive coverage of:

- Hydrographic Surveying (from 1820)
- Oceanography, Meteorology, and Hydrology (from 1870)
- Living Marine Resources (from 1970 with selected coverage from 1870)
- Meteorological Satellite Applications (from 1960)

This collection traces its origin to the library started by F. R. Hassler, the first Superintendent of the Coast Survey, a few years after that agency was established in 1807 (making it the oldest scientific agency in the United States). The library collection incorporates the holdings of the agencies that antedated NOAA—notably the Coast and Geodetic Survey Library and the Weather Bureau Library—and reflects many organizational and program changes during the past 25 years. After NOAA was established in 1970, for example, the library extended information services to the National Marine Fisheries Service by adding materials related to living marine resources.



YEAR	AGENCY/LIBRARY MILESTONES
1807	Survey of the Coast
1811	Coast & Geodetic Library created
1870	U.S. Weather Bureau U.S. Fisheries Commission
1871	Weather Bureau Library started
1965	ESSA/Environmental Data Service (EDS)
1966	Scientific Information Documentation Division
1970	NOAA
1977	Atmospheric Sciences and Marine & Earth Sciences Libraries merged
1978	EDS renamed Environmental Data and Information Service (EDIS) Library and Information Services Division (LISD) established to manage NOAA Library System
1982	EDIS merged into National Environmental Satellite, Data, and Information Service (NESDIS)
1988	Library operations contract awarded
1989	LISD becomes a component of the NODC

NOAA Library and Information Network

The NOAA Library and Information Network (NLIN) administered by the Library and Information Services Division (LISD) consists of three components:

- the Central Library in ^{Silver Springs}Rockville, Md.,
- Regional Libraries in Miami, Fla. and Seattle, Wash., and
- more than 30 field libraries and information centers throughout the United States.

Contributors to the international computerized bibliographic data network that is the basis for the NLIN public access catalog are:

- NODC/LISD for the ^{Silver Springs}Rockville, Miami, and Seattle sites
- National Climatic Data Center
- RAS/Mountain Administrative Support Center, Boulder, Colo.
- R/E/Geophysical Fluid Dynamics Labora-

tory, Princeton, N.J.

- R/E/Great Lakes Environmental Research Laboratory, Ann Arbor, Mich.
- R/E/Meteorological Laboratory, Research Triangle Park, N.C.
- NMFS/Northeast Fisheries Center—Woods Hole (Mass.) Laboratory, Milford (Ct.) Laboratory, Sandy Hook (N.J.) Laboratory, Oxford (Md.) Laboratory
- NMFS/Southeast Fisheries Center—Beaufort (N.C.) Laboratory, Charleston (S.C.) Laboratory, Miami (Fla.) Laboratory, Pascagoula (Miss.) Laboratory
- NMFS/Southwest Fisheries Center—La Jolla (Calif.) Laboratory, Tiburon (Calif.) Laboratory
- NMFS/Northwest and Alaska Fisheries Center—Seattle (Wash.) Laboratory

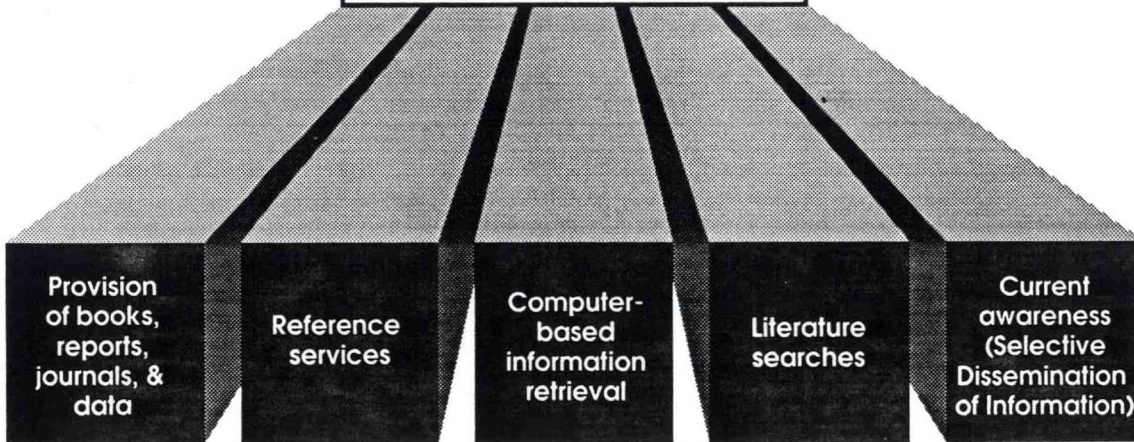


NOAA Central Library Services

The Central Library's facilities and collection are available during normal business hours to NOAA personnel and for on-site use by the general public. Services to NOAA and other Department of Commerce personnel are provided by telephone, inter-office mail, fax, U.S. mail, and special courier (for rush requests). Services include:

- Acquisition and provision of books, reports, journals, and data
- Loan of materials from the collection
- Borrowing of materials from other libraries
- Photocopying of library materials

- Client assistance in using the collection
- Quick information retrieval
- Instruction in library use and information skills
- Local climatological data retrieval
- Author/title verification
- Referrals
- Computer-based data and information retrieval online and on CD-ROM
- Journal subscription placement for NOAA line and staff offices
- Publication of bibliographies of topical interest and other reference materials



NOAA Central Library Collection

Because the NOAA Central Library collection incorporated library holdings of several independent predecessor agencies, different parts of the collection use different classification schemes. There are five older collections:

- climatology (C and Dewey Decimal)
- Coast and Geodetic Survey (Dewey Decimal)
- meteorology (M-decimal)
- foreign meteorological data (by country)
- Atlases (by country)

Modern and growing collections are organized in four sections:

- journals (alphabetical by title)

- books and technical reports (Library of Congress)
- local meteorological data (by location)
- technical reports on microfiche (by number assigned by source such as NTIS, NASA)

Holdings include: 1,000,000 volumes, 9,000 serial titles in all major languages, 1,500 currently received journal subscriptions, 35,000 reports, and meteorological data publications from approximately 100 countries. Current issues of several hundred of the most popular and important journals are on display at the Central Library at all times. The collection is growing by approximately one percent per year.

HISTORIC COLLECTIONS

- Climatology
- Coast & Geodetic Survey
- Meteorology
- Foreign Meteorological Data
- Atlases

MODERN COLLECTIONS

- Journals
- Books
- Technical Reports
- Local Meteorological Data
- Technical Reports on Microfiche

TOTAL HOLDINGS INCLUDE

1,000,000	Books
9,000	Serial Titles
1,500	Journal Subscriptions
35,000	Reports

*Plus access to 500
online databases*

Rare Book Collection

A special component of the Central Library's holdings is a 1,000-volume rare book collection. A few examples give some idea of the flavor and scope of works in this collection:

- 16th and 17th century scientific treatises including

De Ventis, Francis Bacon, 1648

The General History of the Air, Robert Boyle, 1682

- 18th century works including

Hydrodynamica, Daniel Bernoulli, 1738

The Storm, Daniel Defoe, 1740

Cook's *Voyages*, 1790

Nouveau Traité de Navigation, Pierre

Bouguer, 1792 (bought in Europe by F. R.

Hassler, first Superintendent of the Coast

Survey)

- 19th and 20th century works including *The American Coast Pilot*, Edmund M. Blunt, 1817

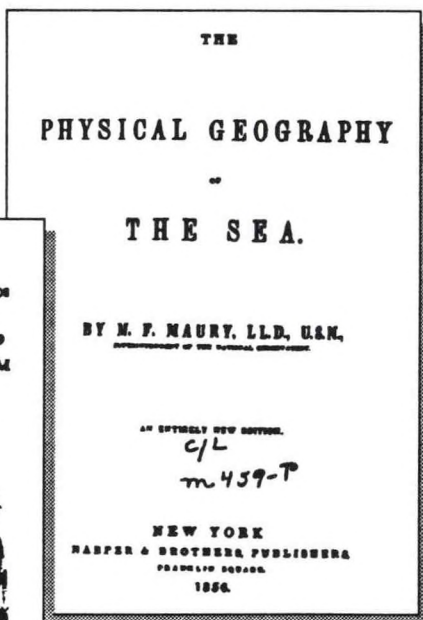
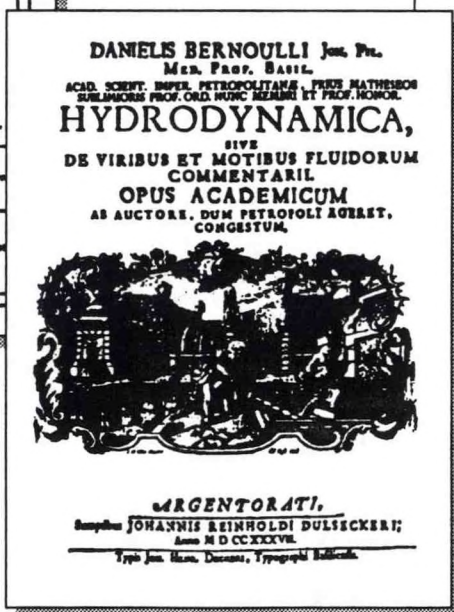
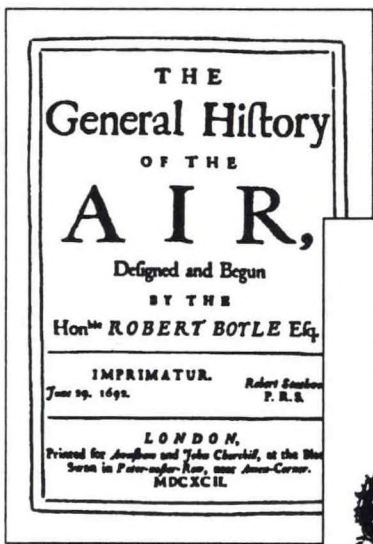
Complete works of Benjamin Franklin, 1825 edition

The Physical Geography of the Sea, M. F. Maury, 1856

Record set of coast surveys, including monumental 1899 Pacific Coast Pilot by George Davidson

Manuscript weather records of George Washington Carver, from 1899-1932

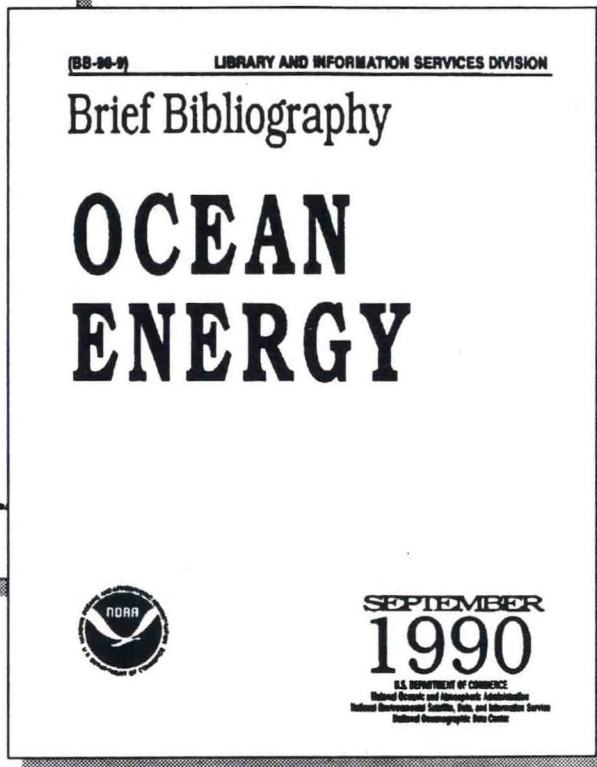
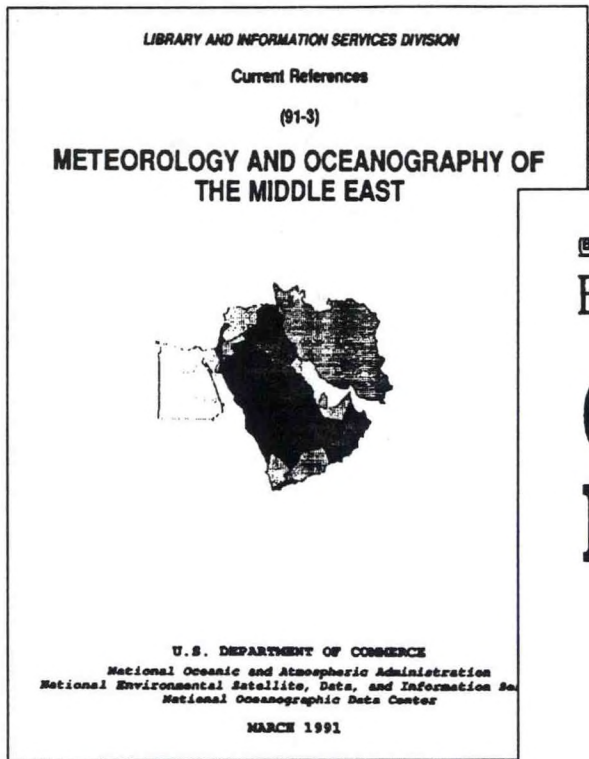
Collected papers of Dr. William Bowie, U.S. Coast and Geodetic Survey, 1909-1936



NOAA Library Publications

The NOAA Central Library issues two monthly publications—the Accessions List announcing books and reports recently added to the collection and the Brief Bibliography covering a topic of current research interest to NOAA. A lengthier, more comprehensive

quarterly bibliography title *Current References* focusses on topics of major significance. An example is *Environmental Impact of Oil Spills in Polar Waters*. NOAA Library and Information Network titles also include its *Directory* and its *Guidebook for Field Library Operations*.





USERS AND USER ACCESS



NODC Data Applications and Data Users

During fiscal year 1992, the NODC provided data and information to users in about 60 different countries around the globe. Applications of NODC data and information are as varied as its customers and include research and development activities related to ocean minerals and energy; ocean engineering of ships,

submersibles, undersea cables, offshore structures, and port facilities; environmental assessment of deep ocean mining, ocean dumping, and oil drilling; ocean dynamics, climate, heat transport, and effects on atmospheric circulation; and national defense.



Selected NODC Users

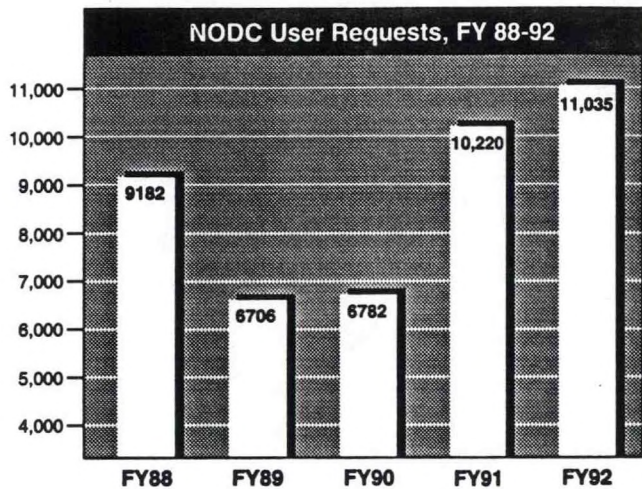
- **Basic Research**
 - SIO, WHOI, NOAA/AOML, NOAA/PMEL, URI, Univ. of Miami, Univ. of Washington, JPL
- **Defense**
 - Naval Research Laboratory, Naval Ocean System Center, Naval Oceanographic Office, NATO ASW Research Center, EDO Corp., Tracor, Vitro Corp.
- **Environmental Assessment**
 - EPA, Batelle, SAIC, NOAA/NOS, Continental Shel Associates
- **Mineral/Energy Resources**
 - DOI/MMS, Marathon Oil, Shell Development Co., Exxon Corp., Sea Energy Corp.
- **Ocean Engineering**
 - GE, Naval Ship R&D Center, Ferranti ORE, Seaconsult Marine Research

NODC User Summary

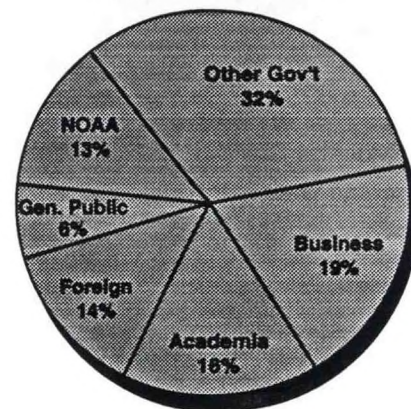
In FY 1992 the NODC fulfilled an all-time high number of 11,035 user requests. Although the NODC has experienced growth in requests for its *in situ* data resources, a large part of this increase in the number of user requests reflects demand for new data types such as ocean satellite data and ocean data on the new medium of CD-

ROM that have been added to NODC's suite of products and services in recent years.

The largest percentage of NODC users were from non-NOAA government agencies (32%), followed by users from business (19%), academia (16%), foreign countries (14%), NOAA (13%), and the general public (6%).



NODC Requests by User Class, FY 92
(Total Requests = 11,035)



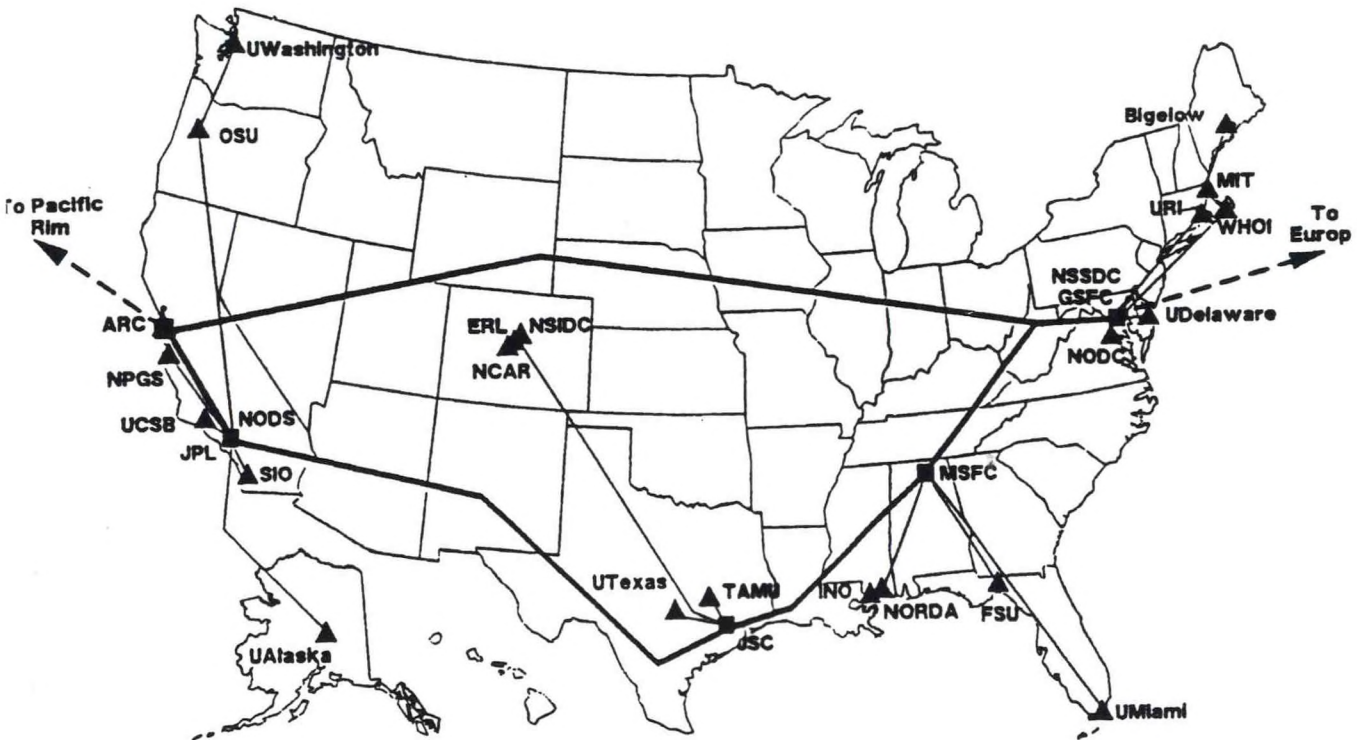
Computer Network Access

Operating over the NASA Science Internet-DECnet computer communications network, the Ocean Network links major ocean research facilities in academia and government. Sponsored by the National Aeronautics and Space Administration, the NSI-DECnet serves researchers in the disciplines of solar-terrestrial science, astrophysics, planetary science, atmospheric science, land science, climate science--as well as the ocean science.

In the NASA Science Internet topology five routing centers are linked over a backbone circuit. These routing centers are the Jet Propul-

sion Laboratory (JPL), the NASA Ames Research Center (ARC), and the NASA Goddard, Marshall, and Johnson Space Flight Centers (GSFC, MSFC, JSFC). Tail (non-routing) circuits extend from these five routing centers to end-nodes at universities and research centers.

The NODC has been a node on the Ocean Network since 1987. This network is used to transmit small data sets to and from requesters at remote locations and provides one mode of online access to the NODC Ocean Science Information Exchange.



NODC Liaison Offices

The NODC has field representatives—Liaison Officers—stationed at strategic locations around the U.S. coast. The NODC Liaison Offices are located at five sites of major concentrations of marine research and development activity: Woods Hole, Massachusetts; Miami, Florida; La Jolla, California; Seattle, Washington; and Honolulu, Hawaii. The Liaison Officers

who head these facilities assist users in both submitting data to and obtaining data from the NODC and the other NESDIS data centers. Through their extensive networks of personal contacts, they can be particularly helpful in providing information about marine science activities, experts, and data sources in their respective regions.



Northeast Liaison Office
NOAA/NESDIS
McLean Laboratory
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
Telephone: 508-559-5279

Southeast Liaison Office
NOAA/NESDIS
AOML Bldg.
4301 Rickenbacker Causeway
Miami, FL 33149
Telephone: 305-361-4305

Southwest Liaison Office
NOAA/NESDIS
8604 La Jolla Shores Drive
P.O. Box 271
La Jolla, CA 92037
Telephone: 619-546-7110
FTS 893-7110

Northwest & Alaska Liaison Office
NOAA/NESDIS
Bin 15700/Bldg. 1
7600 Sand Point Way, NE
Seattle, WA 98115
Telephone: 206-526-6263

Hawaii Liaison Office
NOAA/NESDIS
University of Hawaii - MSB 316
1000 Pope Road
Honolulu, HI 96734
Telephone: 808-956-4105



OCEAN PROJECT DATA MANAGEMENT



Ocean Science and Global Change

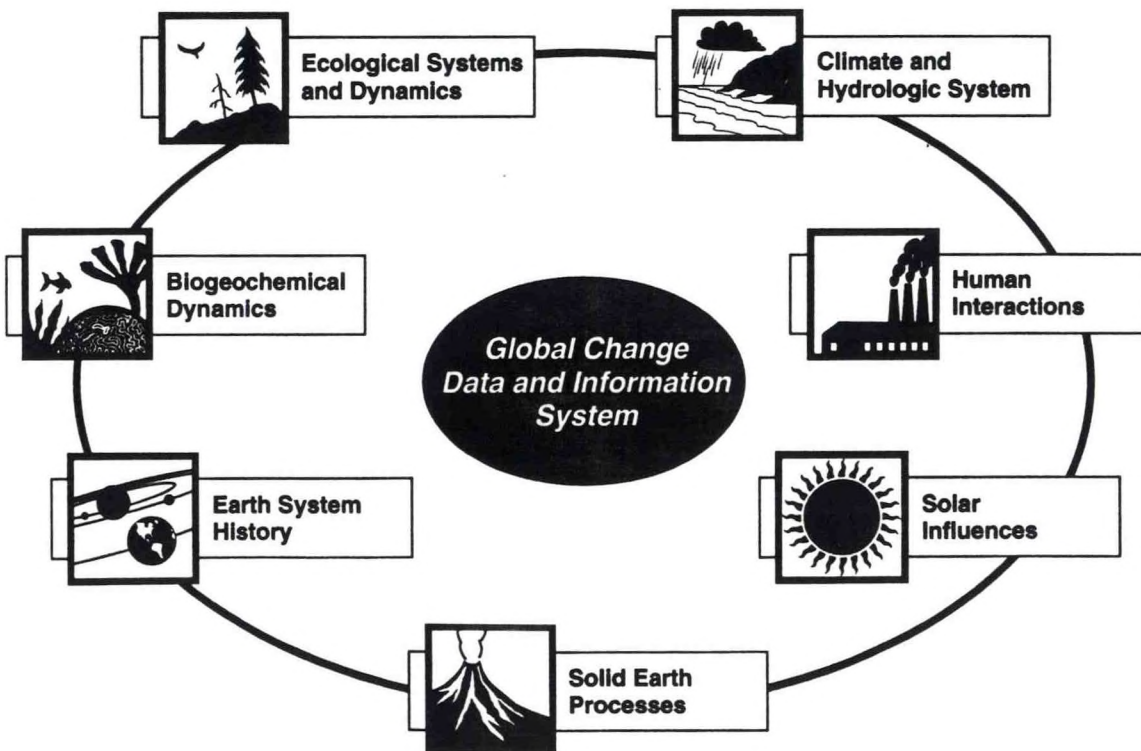
To be able to understand and predict long-term changes in the atmosphere and oceans, researchers must learn more about many elements of earth science. These include: biogeochemical cycles, ecological systems and their dynamics, climate and the hydrologic cycle, human interactions with the environment, earth system history, solid earth processes, and solar influences on the earth. Advances in each of these science elements will in turn depend on improvements in data management.

The NODC and other NOAA components are contributing to this effort through participation in the Interagency Working Group on Data Management for Global Change (IWGDMGC). In addition to NOAA this group includes representatives from the Department of Energy, NASA, Navy, the National Science Foundation, the Department of Agriculture, and the U.S. Geological Survey. The goal of the Working

Group is to create by 1995 a data and information system for global change that is consistent across agencies and that involves and supports the university and other user communities.

One critical element of data management for global change is the problem of accessing and retrieving very large data sets important for climate applications. Some of the most important of these have been designated as "pathfinder" data sets. The Pathfinder program currently includes AVHRR, TOVS, and GOES operational satellite data*, with current data volumes of 4 TB (terabytes), 0.4 TB, and 125 TB respectively. The NODC is working closely with NASA and others to preserve these data and make them more accessible by transcribing them from aging magnetic tapes to optical disk.

* AVHRR - Advanced Very High Resolution Radiometer
TOVS - TIROS Operational Vertical Sounder
GOES - Geostationary Operational Environmental Satellite



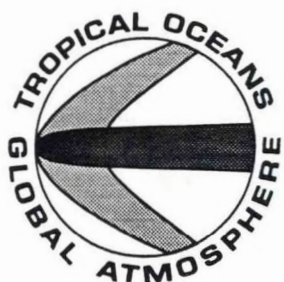
Data Management for Global Change

As their contribution to studies of global climate change, ocean scientists have organized several new long-term research projects of unprecedented scope and complexity. Chief among these are the:

- Tropical Ocean-Global Atmosphere (TOGA) project,
- World Ocean Circulation Experiment (WOCE),
- Joint Global Ocean Flux Study (JGOFS), and
- Global Sea Level Network.

Through participation in dozens of working groups and scientific panels, the NODC is

helping to plan for management of ocean data from these projects. And it is already providing data management support for them. The success of this research effort will depend on close cooperation between government and academic institutions. To help promote improved working relations with the academic ocean research community, the NODC has entered into formal agreements with research groups at major universities and established a series of joint centers to support ocean data management for global change.



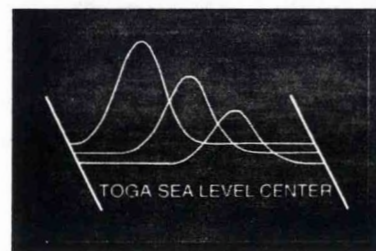
Tropical Ocean-Global Atmosphere (TOGA)
ten-year study of interannual climate variability with measurement, assessment, and modelling components.

World Ocean Circulation Experiment (WOCE)
long-term monitoring and research in ocean circulation using current drifters, hydrographic measurements, satellite observations, and sea level data.



Joint Global Ocean Flux Study (JGOFS)
study of biogeochemical cycles in the oceans; from its historical data holdings the NODC has compiled an initial chlorophyll data set that will serve as the basis for a global JGOFS chlorophyll data base.

Global Sea Level Network
monitoring of global sea level fluctuations via a worldwide network of sea level stations.



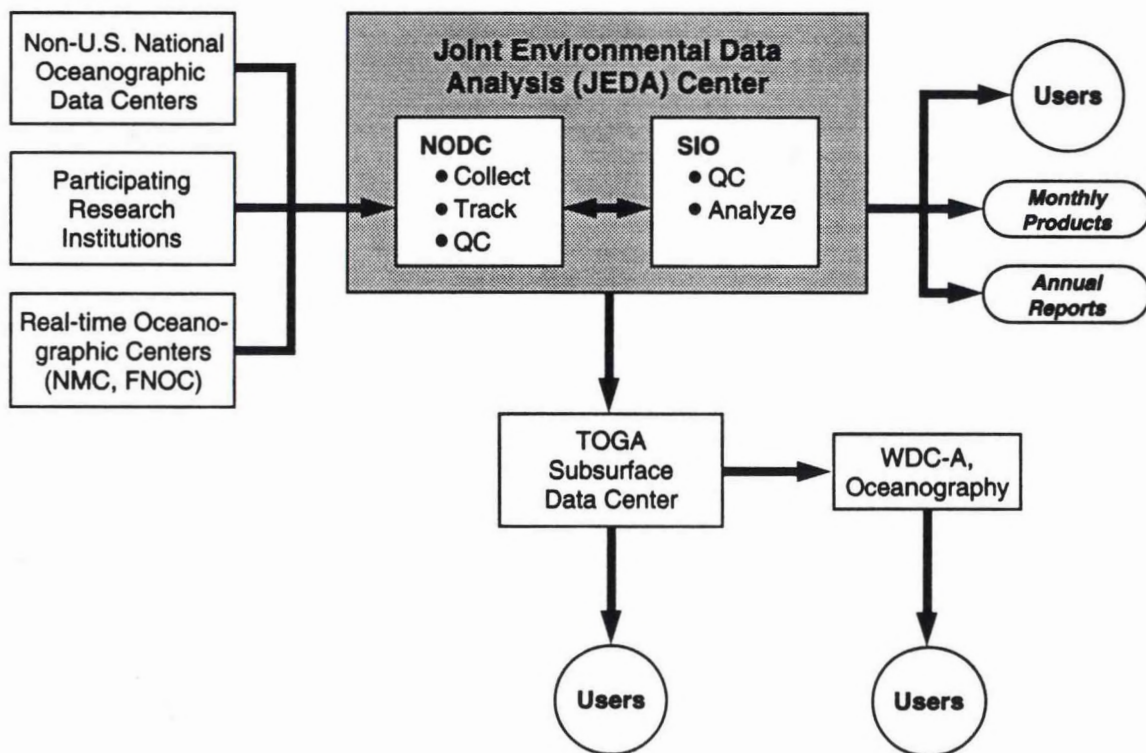
Joint Environmental Data Analysis (JEDA) Center

The Joint Environmental Data Analysis (JEDA) Center was established by the NODC and the Scripps Institution of Oceanography (SIO) of the University of California at San Diego under the sponsorship of the U.S. TOGA Project Office within NOAA and the National Science Foundation. The JEDA Center was created specifically to provide the kind of ocean data management support required by global climate research programs such as TOGA and WOCE. The initial objective of the JEDA Center is to maintain the tropical Pacific Ocean subsurface data base in support of TOGA. Over the next three years, however, the Center plans to extend its task of intake, quality control, and analysis of available upper ocean thermal data to include first the entire Pacific Ocean and then the Indian Ocean (in 1989) and the North Atlantic Ocean (in 1990).

The JEDA Center combines the strengths of the NODC in locating, acquiring, and reformatting data with SIO's proven ability in providing

quality control, objective analysis, and scientific results. Each month the Center compiles a scientifically quality-controlled data set and issues a suite of near real-time products that aid scientists in understanding and predicting oceanographic phenomena in the tropical Pacific.

The NODC acts as the focal point for radio message data collected through the Integrated Global Ocean Services System and forwarded by the NOAA National Meteorological Center and the U.S. Navy's Fleet Numerical Oceanography Center. After these data are reformatted, reviewed, and merged, they are transmitted during the first days of each month over NSI-DECnet to the JEDA Center at SIO, which produces quality-controlled thermal data sets and data products. To augment the historical thermal data base for the TOGA area, the NODC actively acquires delayed mode data from a wide variety of volunteer observing ship programs and from its numerous foreign data exchange sources.



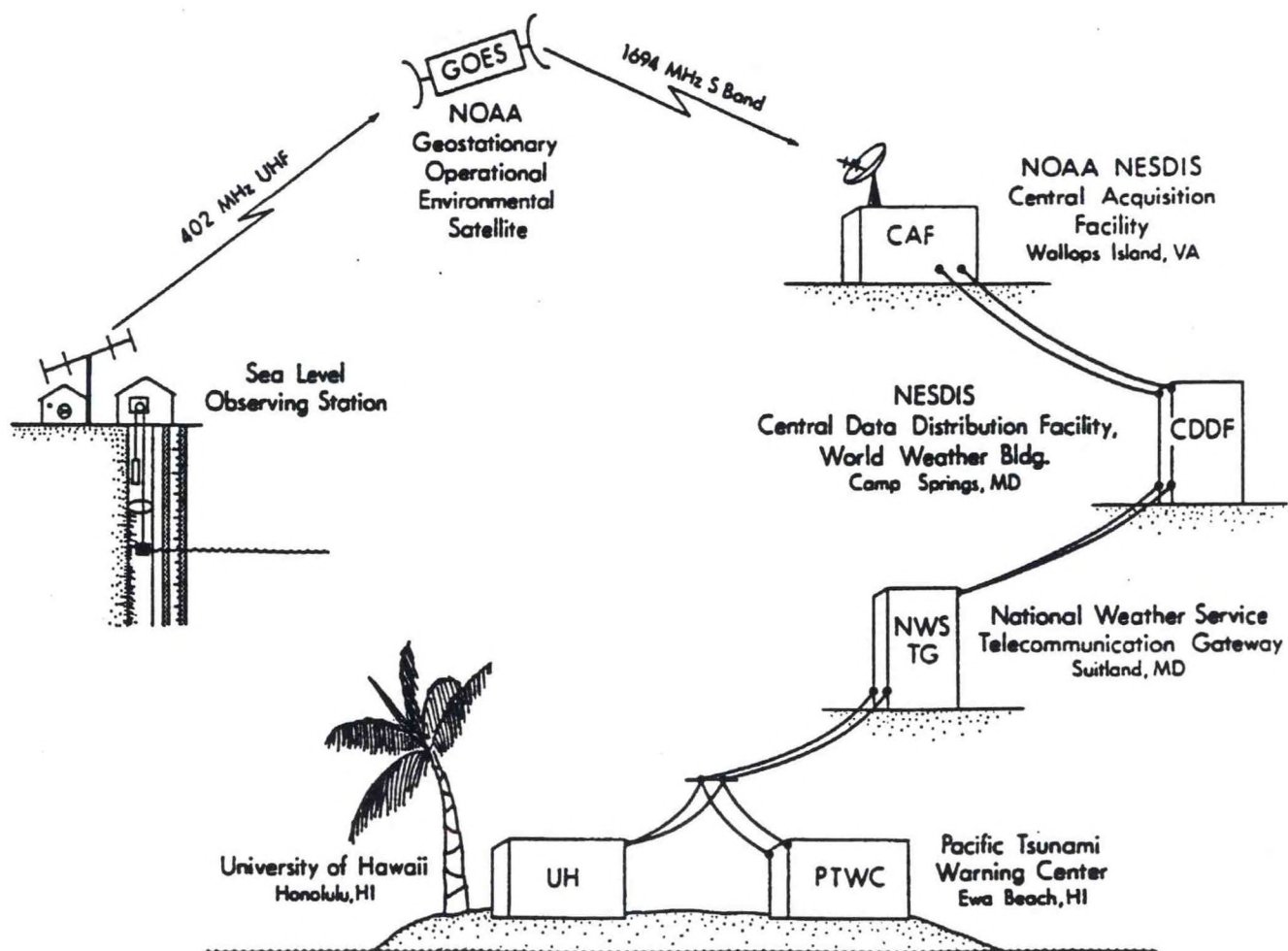
Joint Archive for Sea Level

The topography of the sea surface is of great interest to climate researchers. In the early 1970s, scientists began using sea level data to derive information about ocean circulation, heat storage, and water budgets. In 1974 researchers at the University of Hawaii under the leadership of Dr. Klaus Wyrtki initiated a network of sea level gauges in the equatorial Pacific that developed into the Pacific Sea Level Network. The purpose of the Network is to monitor the large-scale, low-frequency sea level fluctuations associated with the variations of the equatorial currents and with El Niño events. To ensure that this increasingly large and valuable data resource is preserved for use by future generations, the NODC and the University of Hawaii established the Joint Archive for Sea Level (JASL).

To avoid data loss most stations in the

Pacific Sea Level Network have two or more sea level sensors. Many stations also have satellite telemetry capability. The data are collected and processed at the University of Hawaii. The JASL permanent data archive at the NODC contains hourly, daily, and monthly sea level data from 94 stations in the Pacific Ocean and 40 stations in the Indian Ocean.

With the beginning of the World Ocean Circulation Experiment and the advent of satellite altimetry measurements of sea level, the work of the Pacific Sea Level Network has become even more important. Data from the network will provide ground truth for satellites and allow independent checks on their results. It is expected that the Network will be extended to other ocean basins and grow into a global sea level network.



Joint Center for Research in Management of Ocean Data

The Joint Center for Research in the Management of Ocean Data (JCRM_{OD}) was created to address one of the major challenges of global climate research: how to cope with and effectively use the enormous quantities of data that will flow from new observing systems and ocean-sensing satellites. JCRM_{OD} formalizes long-standing working ties between the NODC and the College of Marine Studies (CMS) of the University of Delaware and is based at the CMS facility at Lewes, Del.

The Center will not conduct studies in the underlying phenomena of climate and climate change. Rather it will foster research into the methods, systems, and technology used to handle the data that make such fundamental studies possible. Some research topics of interest to JCRM_{OD} are: evaluating and improving the quality of historical data sets; developing im-

proved user interfaces to historical data archives and exploring new procedures for locating, searching, browsing and obtaining data sets; and applying computer networks to create distributed data systems that will better meet the needs of the far-flung ocean research community.

An initial project of JCRM_{OD} was the establishment and operation of a data information unit (DIU) in support of the World Ocean Circulation Experiment (WOCE). Using the successful WOCE DIU as a model, a DIU was created for the Tropical Ocean Global Atmosphere (TOGA) Coupled Ocean-Atmosphere Response Experiment (COARE). In addition to an oceanographic component, TOGA/COARE also includes an atmospheric component and an ocean-atmosphere interface component and will thus extend the types of data to be tracked beyond those for WOCE.

JCRM_{OD} Areas of Interest

Research Applications of Large Data Bases

- Improve quality of historical data
- Merge satellite and conventional data

Management of Oceanographic Data

- Develop online catalogs, directories, and inventories
- Develop distributed systems
- Explore new graphical display techniques

Technology

- Experiment with effective use of computer networks
- Establish standards for formats and documentation
- Test feasibility of "standard" software for common algorithms

NOAA CoastWatch

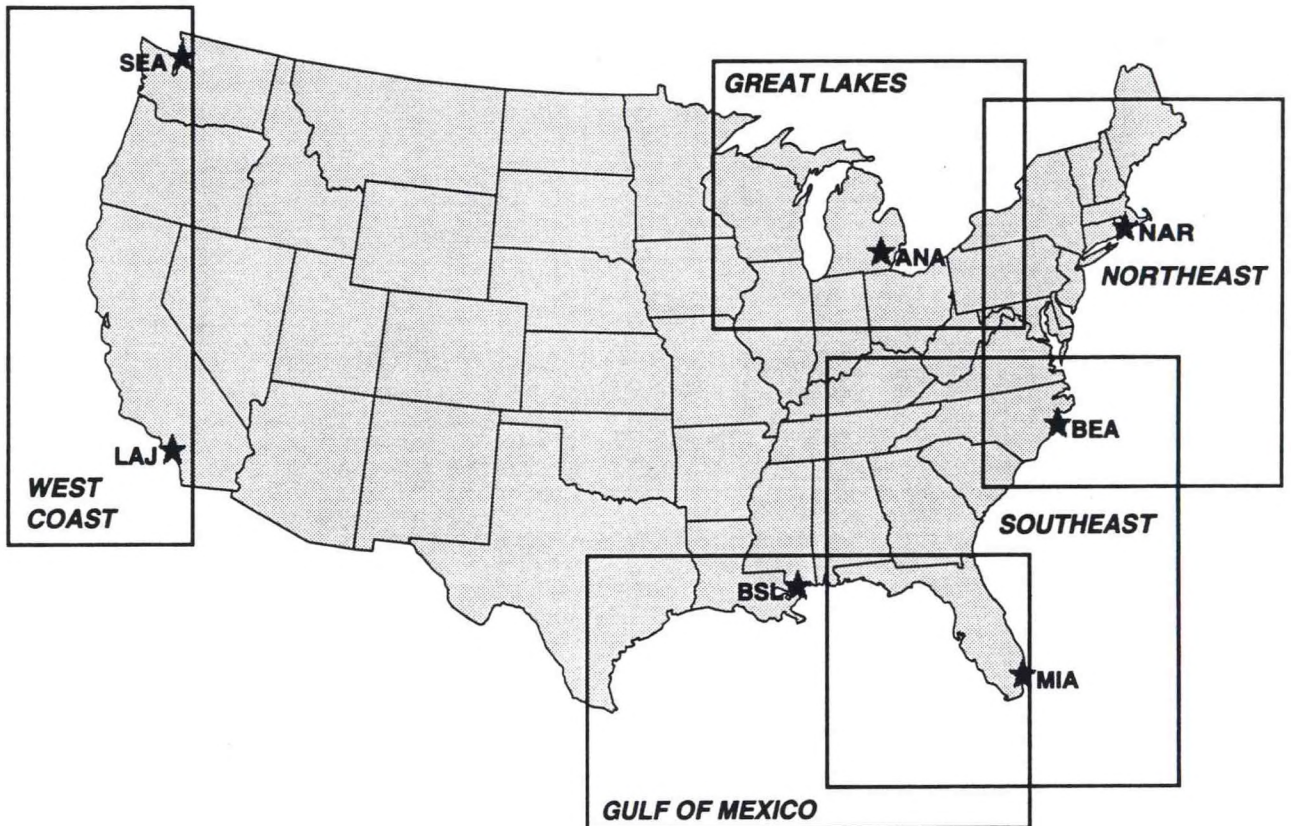
To address critical coastal environmental problems, the National Oceanic and Atmospheric Administration has established the Coastal Ocean Program. Within this program NOAA CoastWatch is designed to provide Federal and state decision makers and researchers with rapid access to satellite data and imagery of U.S. coastal and offshore regions. NOAA CoastWatch focuses on specific regional and national priorities such as unusual environmental events (e.g., red tides), accumulating algal biomass (that contributes to oxygen depletion), and mapping tidal wetland change.

The NODC is participating in this NOAA-wide effort through development and operation

of the NOAA CoastWatch Archive and Access System (NCAAS). NCAAS will handle the archival of all CoastWatch products and provide on-line access to data and products following their near-real-time release by the NOAA Ocean Products Center. The NODC will archive CoastWatch data on optical platters on a "juke-box" system installed on NODC's VAX computer system.

An upgraded telecommunications system called the NOAA Ocean Communications Network is being created to link the CoastWatch regional facilities and serve as part of the infrastructure to implement this program.

COASTWATCH REGIONAL SITES



Marine Information Management

In addition to fostering international exchange of ocean data, the NODC also plays a significant role in fostering national and international management and exchange of marine science information. The cornerstone of the international marine information system is ASFIS, the Aquatic Sciences and Fisheries Information System. ASFIS is co-sponsored by the Intergovernmental Oceanographic Commission and several components of the United Nations: the Food and Agriculture Organization (FAO), UNESCO, the United Nations Environment Program (UNEP), and the Office of Ocean Affairs and Law of the Sea. ASFIS Centers in numerous countries ensure that the marine science literature in all major languages is entered into the bibliographic database component of ASFIS, which is known as ASFA, the Aquatic Sciences and Fisheries Abstracts. ASFA is

available online and on CD-ROM. Other products and services available through ASFIS include the *Marine Science Contents Tables*, the *International Directory of Marine Scientists*, the ASFIS Register of Experts and Institutions, and specialized bibliographies.

In the United States, the NOAA Library System and the Aquaculture Information Center of the National Agriculture Library (USDA) cooperate to support ASFIS. The NODC fulfills NOAA's responsibility for providing the U.S. representative to the ASFIS/ASFA Advisory Board.

ASFIS is not a static system, but is undergoing continual development. One current area of activity is the application of expert systems, hypermedia, and other advanced technology to the design and development of prototype systems for enhanced ASFIS products.

