NODC Informal Report No. 11

NATIONAL OCEANOGRAPHIC DATA CENTER

Programs and Operations

Washington, D.C.
August 1989

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

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U.S. DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
John A. Knauss, Administrator

National Environmental Satellite, Data, and Information Service
Thomas N. Pyke, Jr., 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 interagency 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 Service (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).

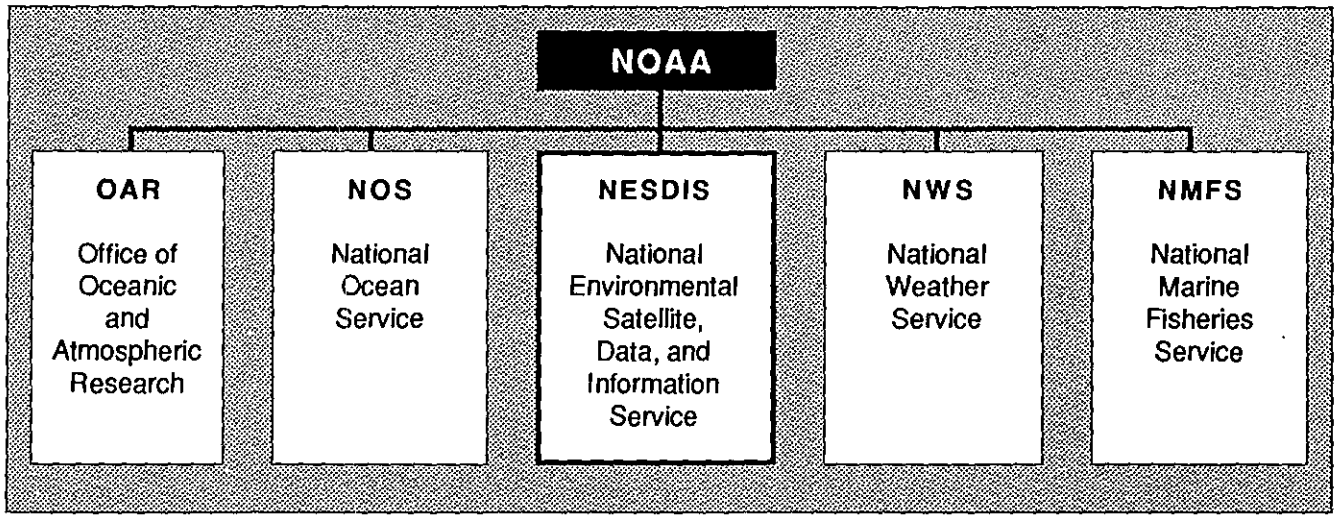
NODC's headquarters offices are located in Washington, D.C. The NODC also has personnel stationed at its six Liaison Offices (Woods Hole, Mass.; Washington, D.C.; Miami, Fla.; La Jolla, Calif.; Seattle, Wash.; Anchorage, Ak.) and at several other field sites.

NODC History and Mission

- **MISSION:** To acquire, process, store, disseminate, and exchange global oceanographic data and provide data management services
- **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, N.C. and the National Geophysical Data Center (NGDC), Boulder, Colo. 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 Organization

August 1990

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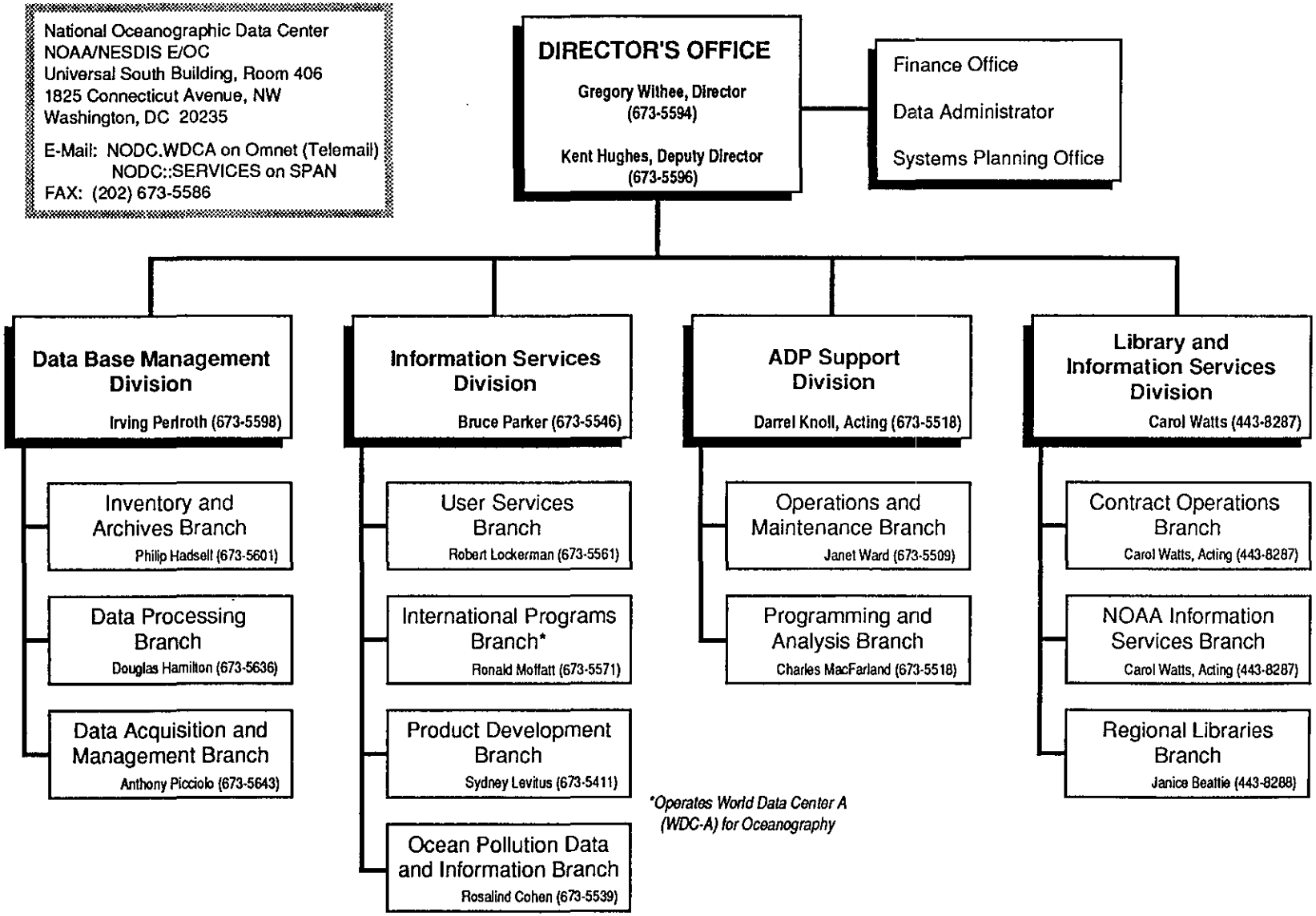
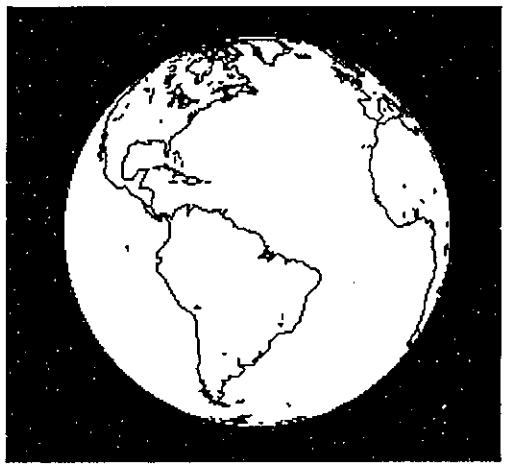


DATA SOURCES

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 faciilities 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 Data Sources

Delayed-mode data

- NOAA ocean programs
- U.S. Navy
- Other Federal agencies
- Universities and research institutions
- Industry
- Foreign organizations

NODC

Near-real-time data

- National Meteorological Center (NMC)
- Fleet Numerical Oceanography Center (FNOC)
- NOAA Ocean Products Center (OPC)
- U.S. Navy GEOSAT

International Cooperation and Data Exchange

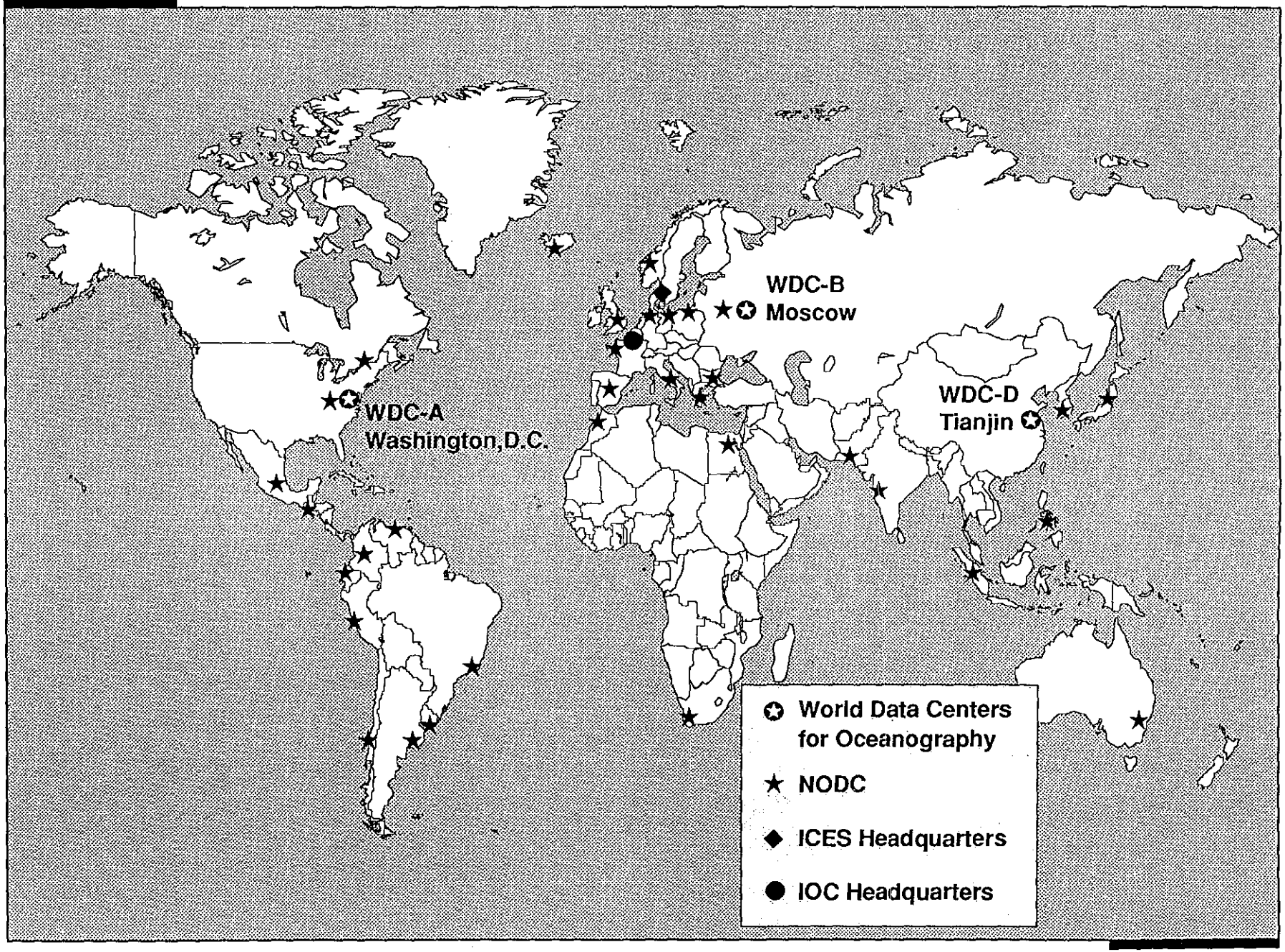
The NODC supports a number of international data exchange activities that help it fulfill its mission. Participation in these activities promotes data exchange and enables the NODC to augment its data holdings with valuable foreign data taken worldwide. NODC's interactions with international organizations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

International Cooperation and Data Exchange



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, mutidisciplinary 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 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*.

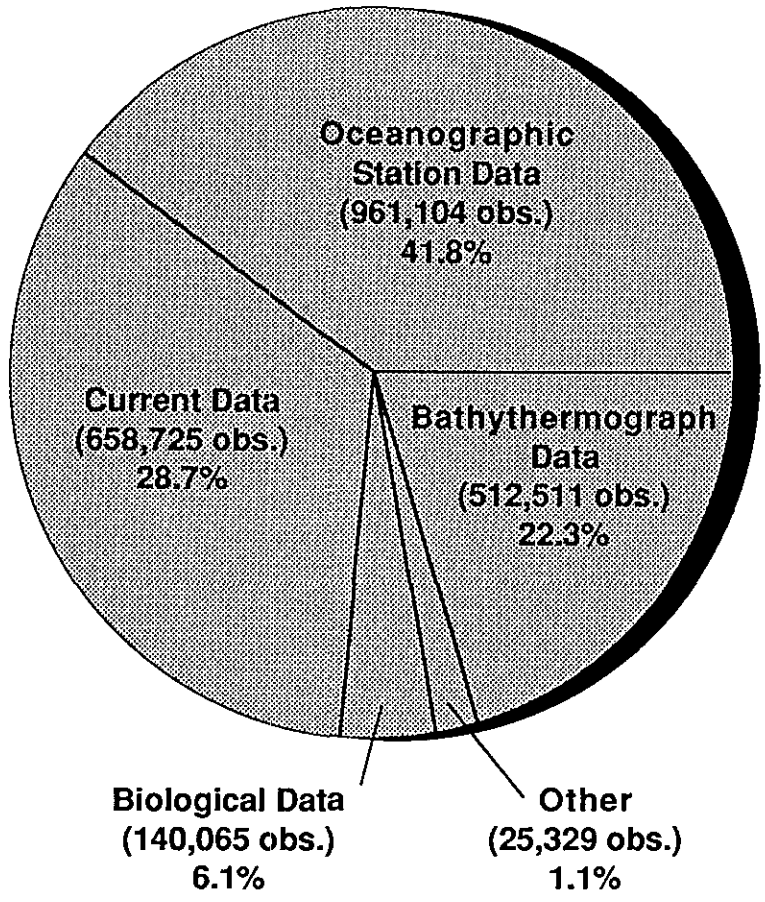
Approximately 1,500 marine scientific publications, reports, and articles are also received by WDC-A, Oceanography each year. These documents are listed and indexed by keyword and author in annual *Supplements* to the *Catalogue of Accessioned Publications*.

World Data Center A for Oceanography

Oceanographic Stations Received, 1980-1989

YEAR	STATIONS RECEIVED	TOTAL ON HAND
1980	34,265	654,107
1981	37,087	691,194
1982	38,173	729,367
1983	39,453	768,820
1984	30,420	799,240
1985	30,412	829,652
1986	34,659	864,311
1987	30,093	894,404
1988	34,428	928,832
1989	32,272	961,104

International Marine Data Base
CY 1989
(Total: 2.30 million obs.)



NODC-IOC Cooperation

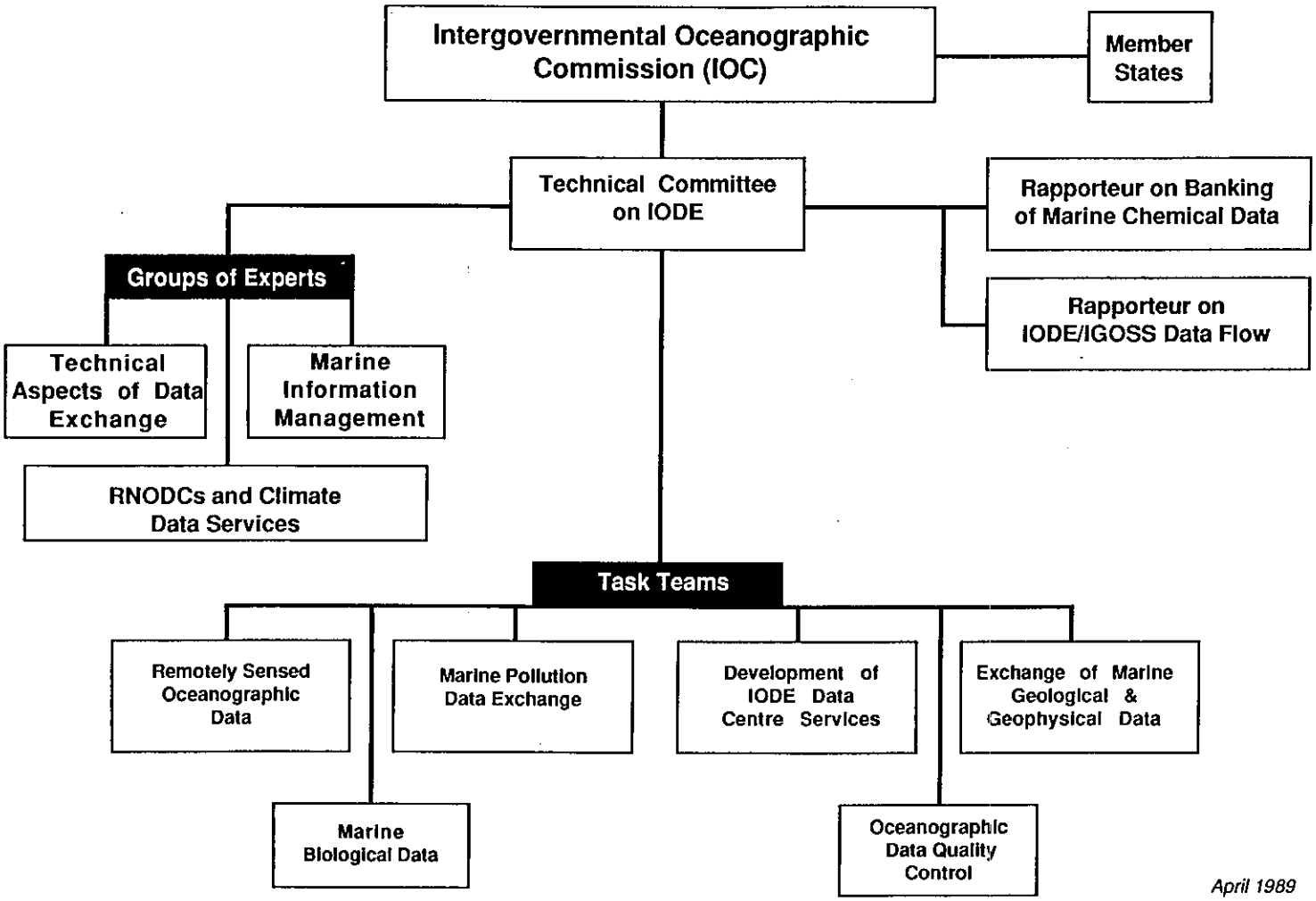
The Intergovernmental Oceanographic Commission, through its Technical Committee on International Oceanographic Data Exchange (IODE), encourages the adoption of those practices intended to facilitate the exchange of marine data internationally. The IODE approach utilizes task teams, groups of experts, 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

NODC-IOC Cooperation

International Oceanographic Data & Information Exchange (IODE)



Integrated Global Ocean Services System

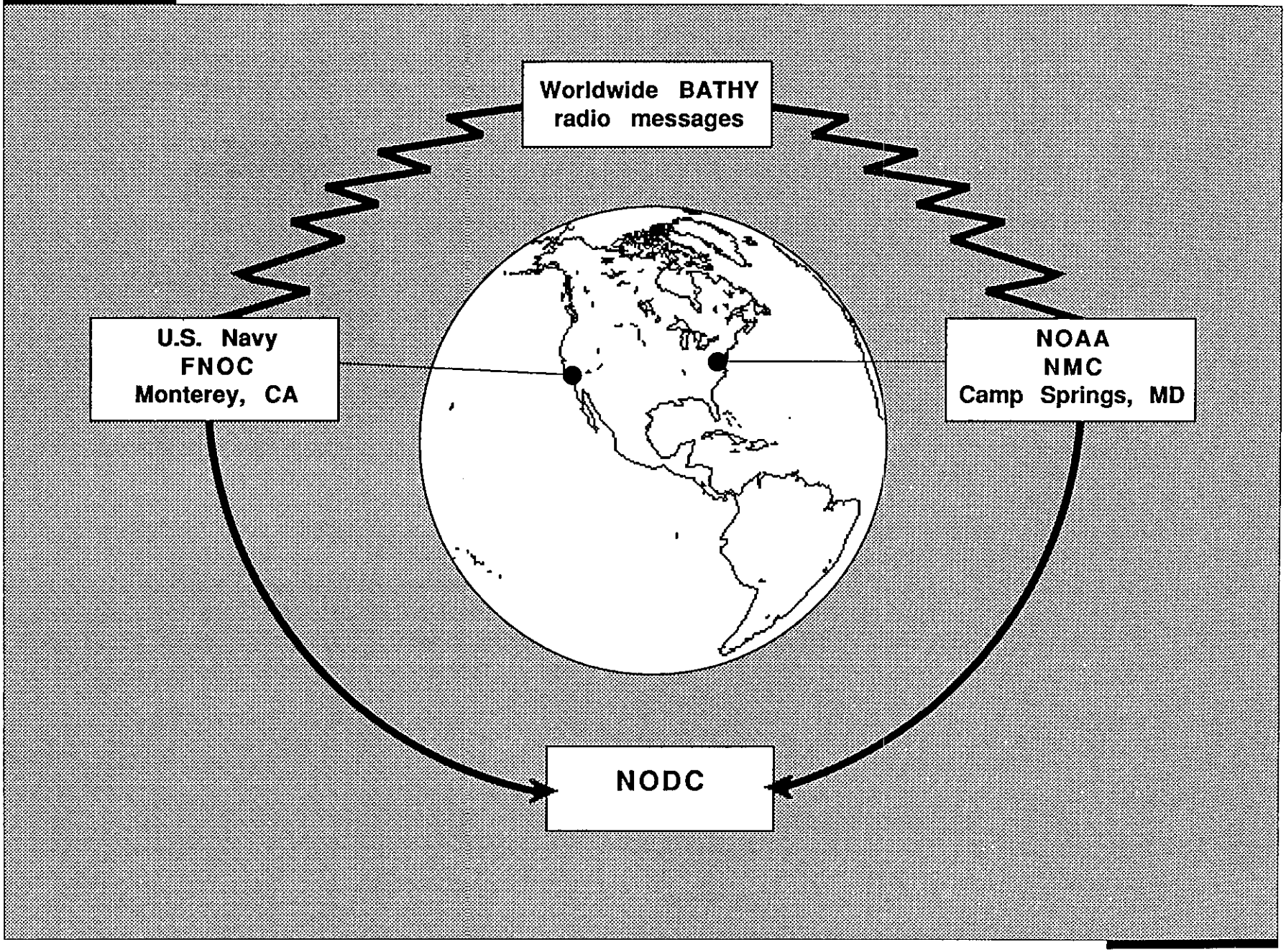
The Integrated Global Ocean Services System (IGOSS) is a worldwide cooperative program for rapid collection, exchange, and analysis of oceanographic data, as well as the timely preparation and dissemination of ocean products and services. Over 40 countries are actively involved in one or more aspects 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.

Once a month the accumulated observations received at these two centers are forwarded to the NODC where they are further quality controlled, checked for duplicates, and entered into NODC's Radio Message BT Data File. Observations from the tropical Pacific region also become part of NODC's TOGA data base.

As a Responsible National Oceanographic Data Center (RNODC) for IGOSS, the NODC assists World Data Center A for Oceanography in providing data services (e.g., data inventories, summaries) from the IGOSS data file. An average of about 30,000 IGOSS BT observations are received by the NODC each year.

Integrated Global Ocean Services System



U.S. Navy GEOSAT

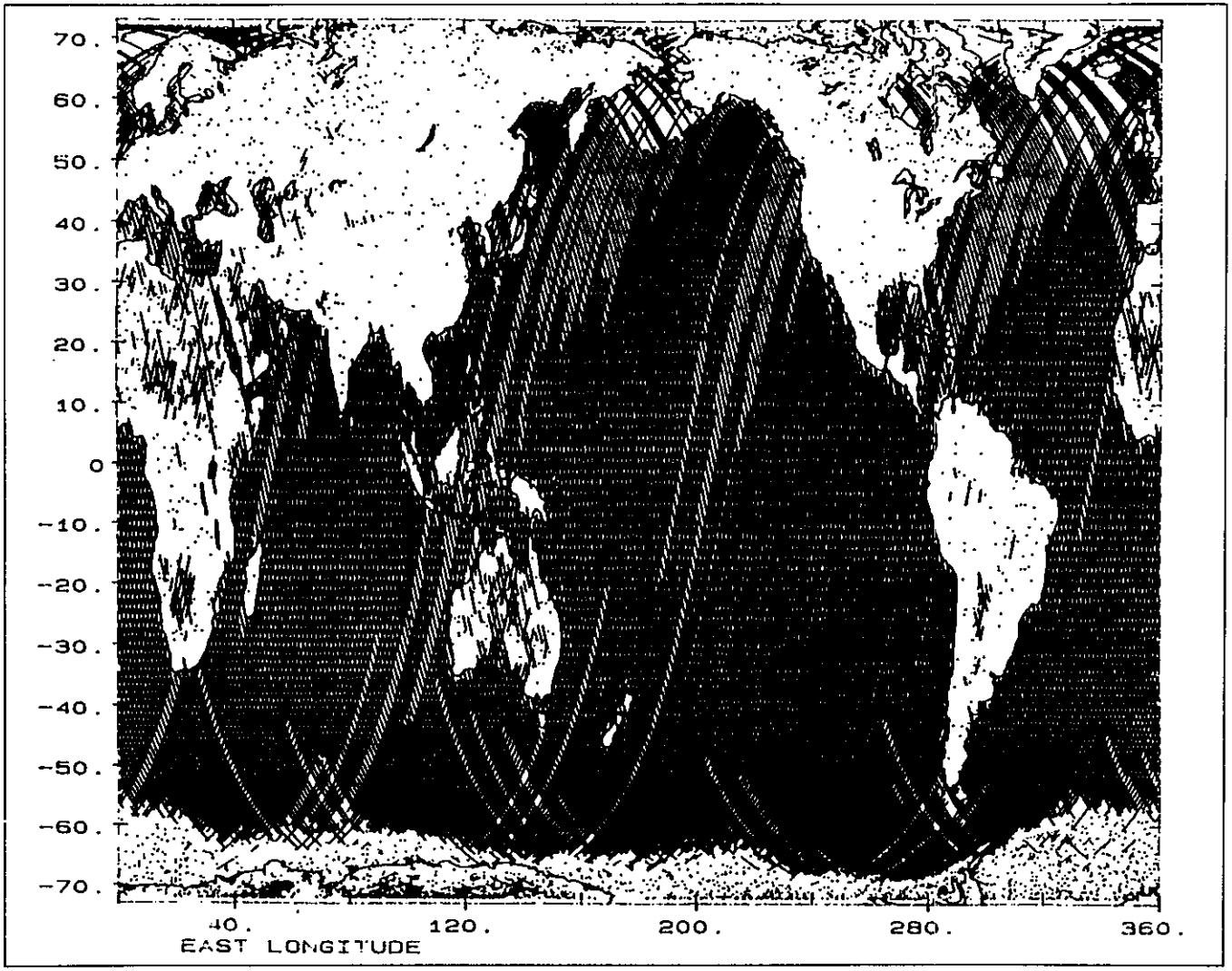
The U.S. Navy Geodetic Satellite (GEOSAT) is the first ocean sensing satellite collecting data that are being archived and disseminated by the NODC. Designed and built by the Applied Physics Laboratory of Johns Hopkins University, GEOSAT was launched into orbit in March 1985. Following the successful conclusion of the GEOSAT Geodetic Mission, the satellite's orbit was changed in October 1986 to permit acquisition of additional radar altimetry data for the research community. This phase of GEOSAT operations is called the Exact Repeat Mission (ERM). GEOSAT is providing the first long-term global observations of sea level, wind speed, wave height, and ice topography.

GEOSAT data are being collected and organized based on the 17-day ERM orbital cycle. A group within the NOAA National Ocean Service processes GEOSAT data by merging the raw altimeter sensor data and orbital data and making corrections for atmospheric and tidal effects. The processed data are in a standard format known as Geophysical Data Records (GDRs). Each GDR archive tape contains data from two 17-day orbital repeat cycles; the lag time from satellite observation to data availability is about two months. The NODC provides users with GEOSAT ocean data* on an annual subscription basis.

In addition the NODC received and is disseminating a special data set of wind/wave records from the 18-month GEOSAT Geodetic Mission. During this time GEOSAT was in an orbit with a non-repeating ground track, providing the densest coverage of any altimeter flown to date. Because of its military nature, the complete data set from the Geodetic Mission is classified and not available to the general public. A condensed data set giving only the radar cross section, wind speed, and significant wave height was submitted to the NODC, however, and copies of this data set can be provided to requesters.

*GEOSAT land and ice data are managed jointly by the National Geophysical Data Center and the National Snow and Ice Data Center

U.S. Navy GEOSAT



GEOSAT Ground Track
(All data, ERM cycle no. 22,
Day 304-320, 1987)

DATA HOLDINGS AND DATA PROCESSING

NODC Master Data Files

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 printouts 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.

PHYSICAL/CHEMICAL DATA FILES

Oceanographic Station Data
Low-resolution CTD/STD Data
High-resolution CTD/STD Data
Bathythermograph (BT) Data
- Mechanical BT Data
- Expendable BT Data
- Selected Level BT Data
- Radio Message BT Data

Ship Drift Surface Currents
Drifting Buoy Data
Current Meter Data (Resultants)
Curent Meter Data (Components)
Meteorology and Wave Spectra from Buoys
Wind Measurements from Buoys
Pressure Gauge Data
Water Physics and Chemistry
Marine Chemistry
Marine Toxic Substances and Pollutants

BIOLOGICAL DATA FILES

Phytoplankton
Zooplankton
Primary Productivity
Intertidal/Subtidal Organisms and Habitats
Benthic Organisms
Fish/Shellfish Surveys
Marine Animal Sighting and Census

NODC Master Data Files

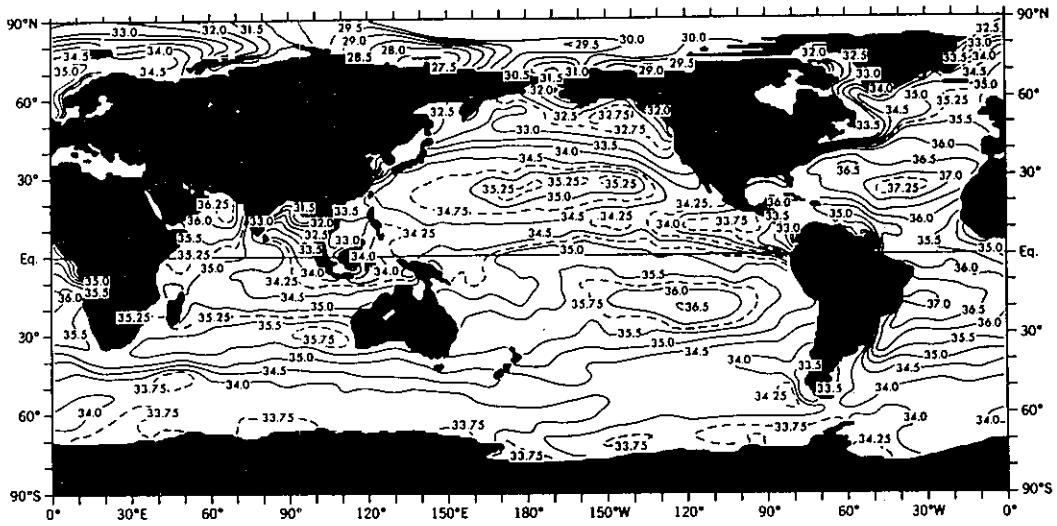
DISCIPLINE	VOLUME *(GBytes as of July 1990)*
PHYSICAL	
Buoy (Wind/Waves)	5.27
Current	3.53
Ocean Station	1.49
Salinity/Temperature/Depth	1.09
Subsurface Temperature	0.76
Other	0.07
TOTAL PHYSICAL	12.21
BIOLOGICAL	
Fish/Shellfish	0.11
Benthic/Intertidal Organisms	0.09
Plankton	0.03
Other	0.02
TOTAL BIOLOGICAL	0.25
CHEMICAL	
Marine Chemistry	0.07
Pollutants/Toxic Substances	0.02
TOTAL CHEMICAL	0.09
TOTAL DATA BASE	**12.55**

NODC Originator 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. Originator Data Sets are provided to users only as direct one-to-one copies of whole data tapes. Selected subsets cannot be retrieved from these data sets.

Examples of Originator Data Sets held by the NODC include data from the *Southern Ocean Atlas,* data from the Nearshore Sediment Transport Study (NSTS) Torrey Pines and Santa Barbara Experiments, the FGGE Operational Year Global Ocean Climate Data Base, data from the *Climatological Atlas of the World Ocean,* and data from the scientific programs SEQUAL and FOCAL.

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



Annual mean salinity at the sea surface (from the Climatological Atlas of the World Ocean).

NODC Originator Data Sets

For example,

- Southern Ocean Atlas Data Tapes
- Data from the NSTS Torrey Pines Experiment
- Data from the NSTS Santa Barbara Experiment
- Climatological Atlas of the World Ocean Data
- Worldwide Ocean Water Color/Water Transparency Data
- SEQUAL/FOCAL Data Sets
- FGGE Operational Year Global Ocean Climate Data Base
- GEOSAT Altimetry Data from the Exact Repeat Mission
- GEOSAT Wind/Wave Data from the Geodetic Mission

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.

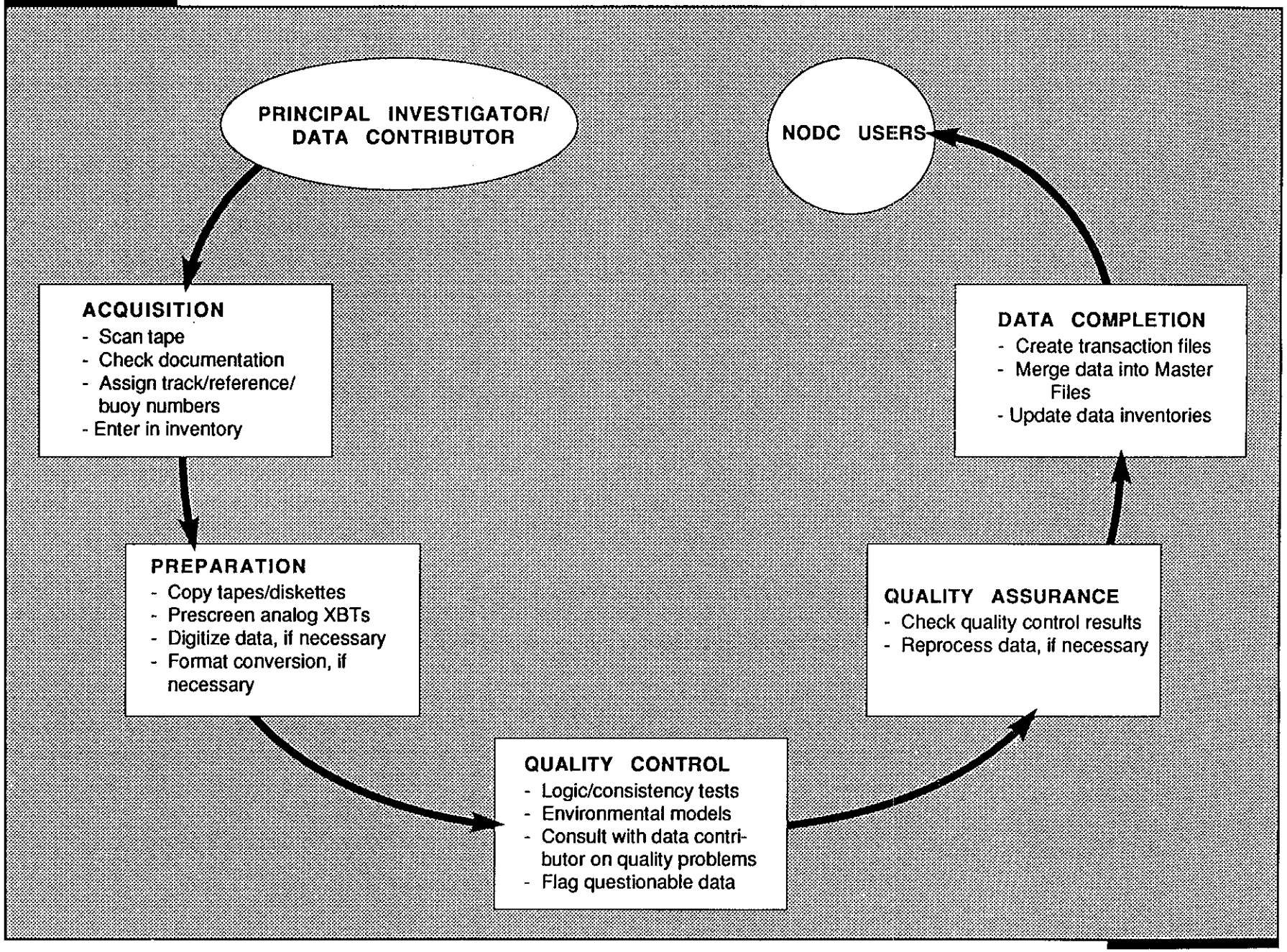
- **Preparation.** Copies are made of data submitted in digital form. Data in report/publication form are digitized. If necessary, data are converted to an NODC format. Expendable bathythermograph (XBT) analog strip charts are prescreened for errors and digitized. At the end of this step, the data are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



Ocean Data Quality Control

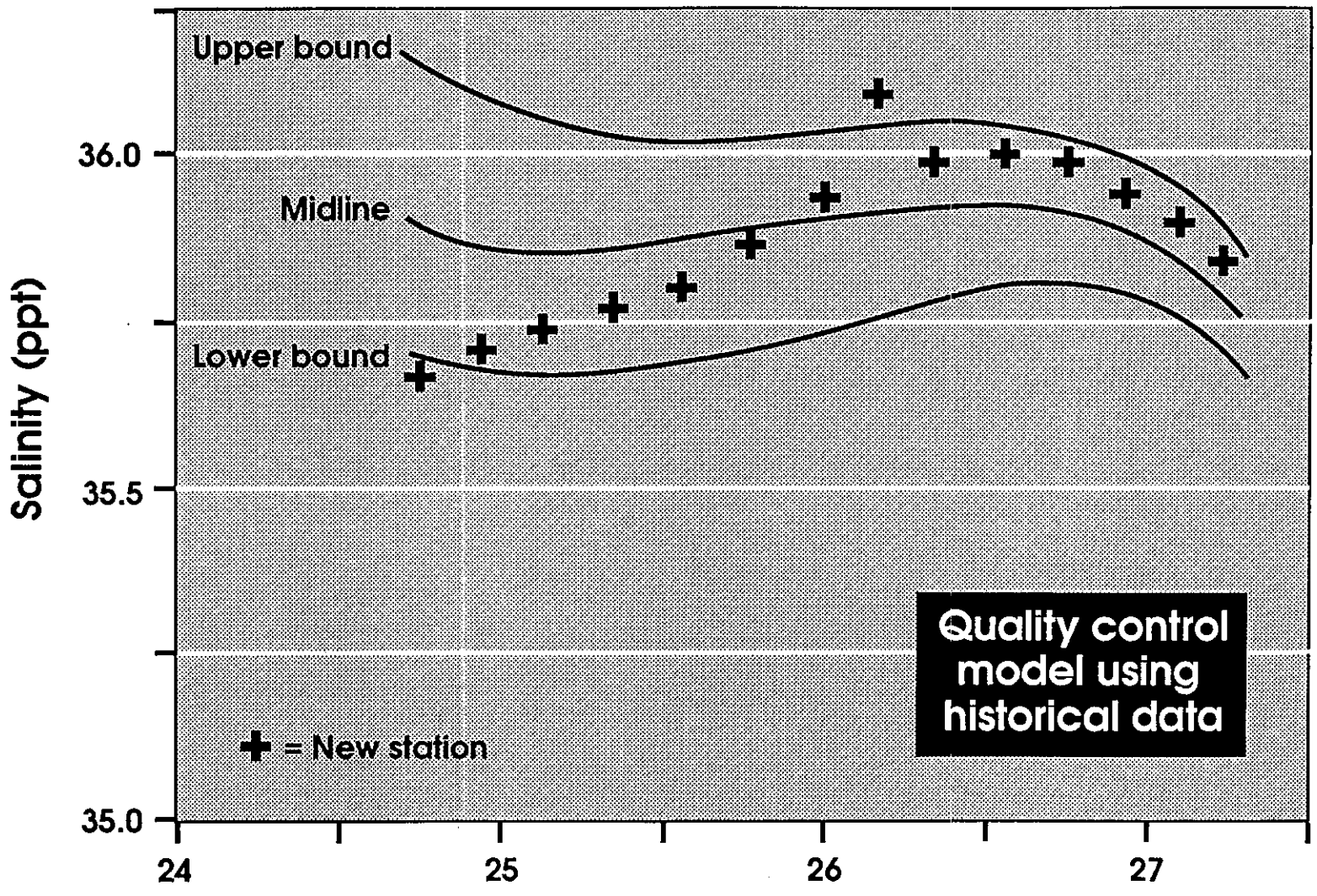
Although primary responsibility for the quality of ocean data submitted to the NODC rests with the data contributor, NODC does apply various quality checks that can detect both gross errors--for example, observations with reported positions that fall on land--and more subtle problems such as oceanographic 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.

Ocean Data Quality Control



PRODUCTS AND SERVICES

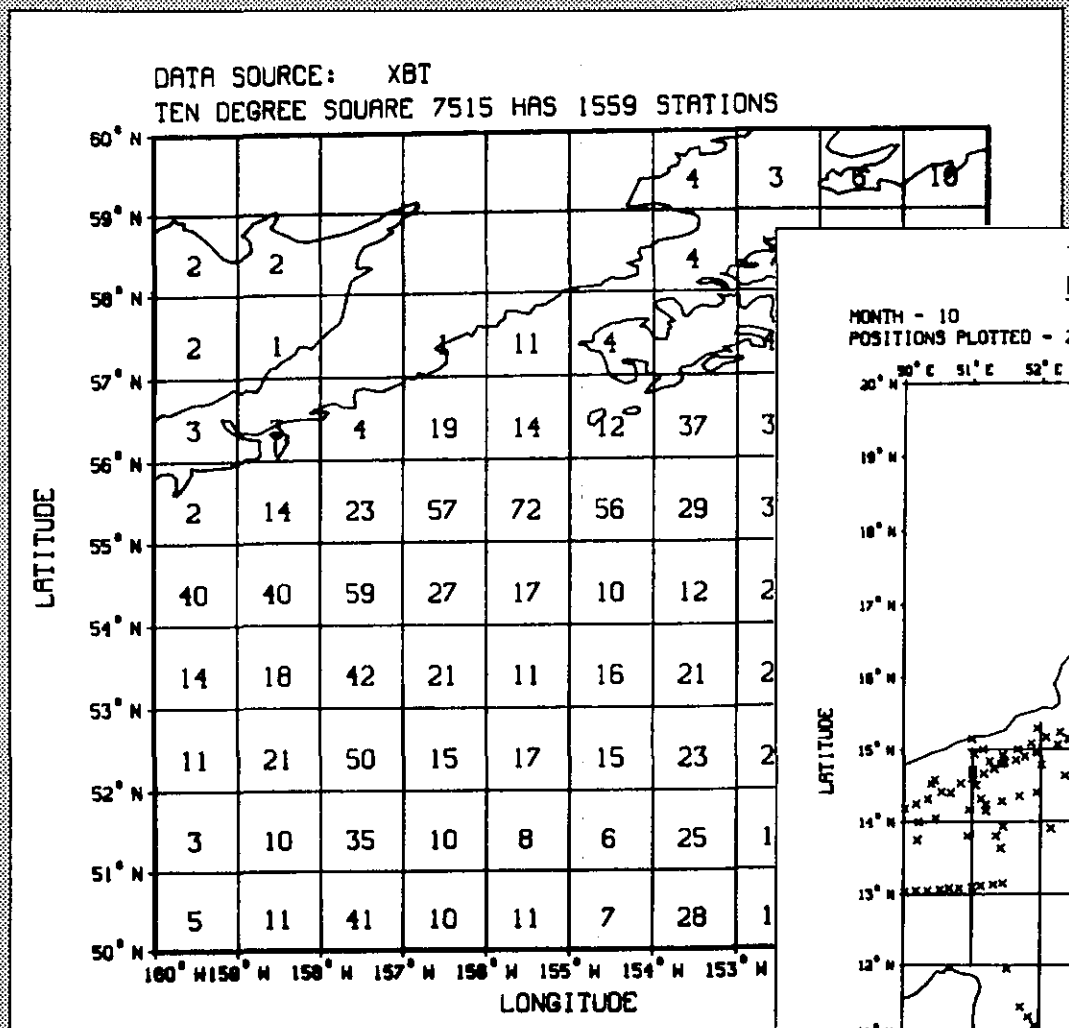
Data Inventories

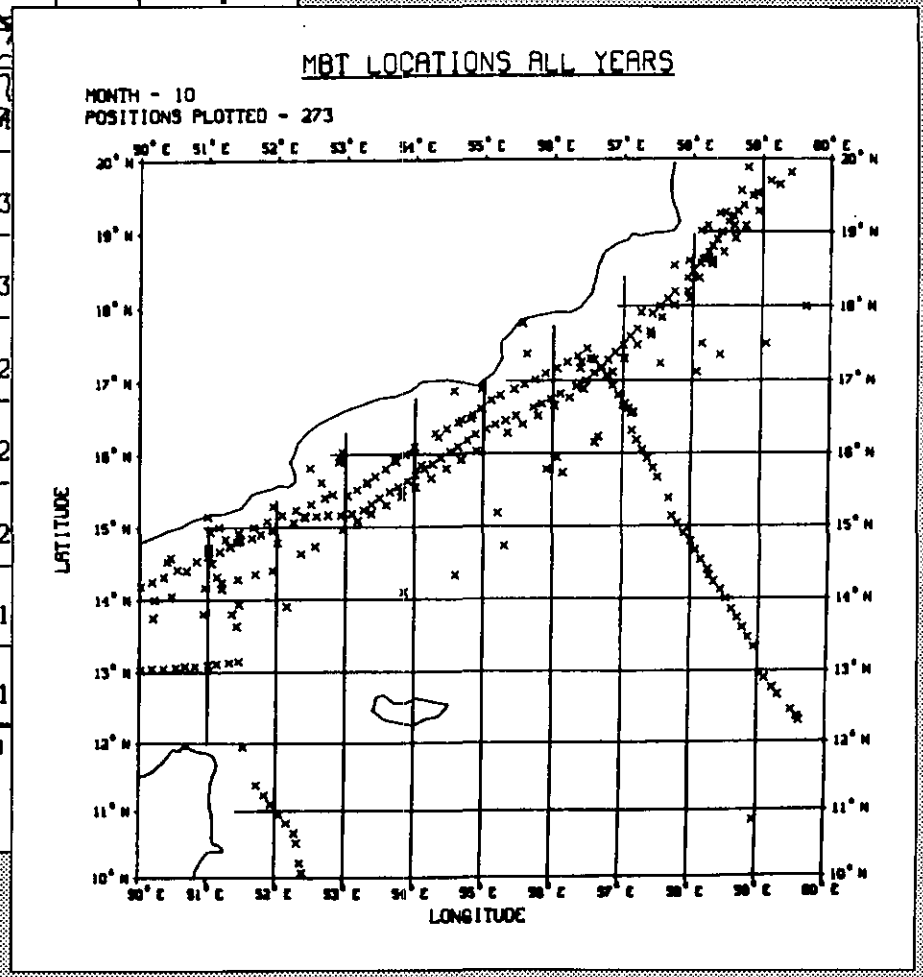
When users contact the NODC their first question is often "How much data do you have in my area of interest?" Or they may ask if NODC holds the data from a specific cruise or project. To answer these questions--which have endless specific variations--the NODC maintains several data inventory systems.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

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. Now--with the inauguration of the NODC Ocean Science Information Exchange (NOSIE)-- the NODC has its first data inventory modules available online. By providing this kind of browse capability, the NODC hopes to improve customer service and increase use of its data resources.

Data Inventories

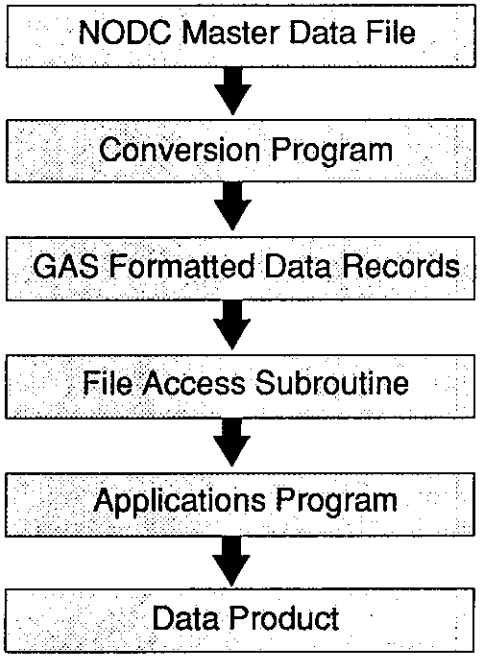




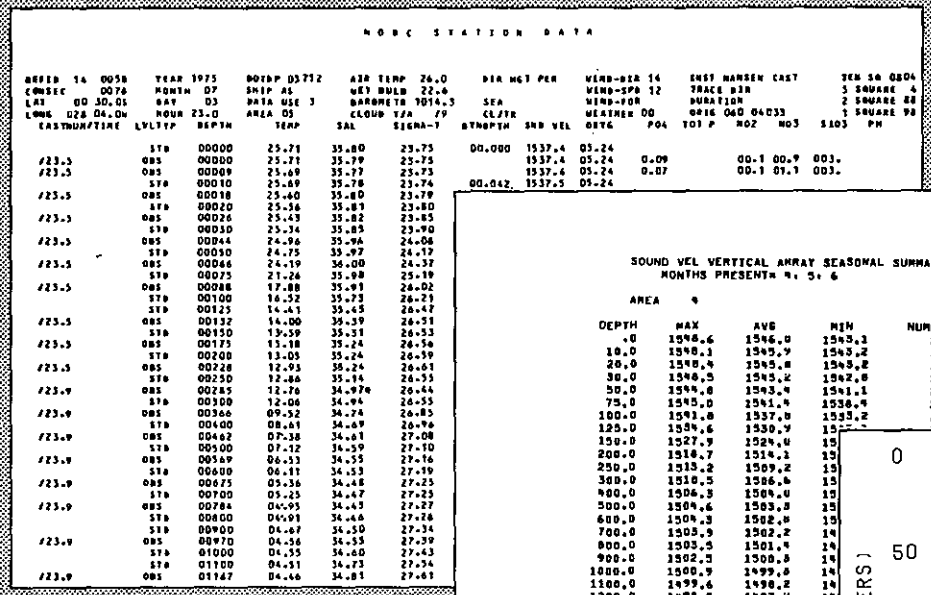
Data Products

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.



Data Products



NODC STATION DATA

CAST/HOUR/TIME	LVL/TYP	DEPTH	TEMP	SAL	SIGMA-T	ATMOPTH	SND VEL	DELTA	PO4	TOT P	NO2	NO3	SIO3	PH
	STD	00000	25.71	35.80	23.75	00.000	1537.4	05.24						
/23.5	OBS	00000	25.71	35.79	23.75		1537.4	05.24	0.09		00.1	00.9	003.	
/23.5	OBS	00009	25.69	35.77	23.75		1537.6	05.24	0.07		00.1	01.1	003.	
	STD	00010	25.69	35.78	23.74	00.042	1537.5	05.24						
/23.5	OBS	00018	25.60	35.80	23.79									
	STD	00020	25.56	35.81	23.80									
/23.5	OBS	00026	25.43	35.82	23.85									
	STD	00030	25.36	35.85	23.90									
/23.5	OBS	00044	24.96	35.96	24.06									
	STD	00050	24.75	35.97	24.17									
/23.5	OBS	00066	24.19	36.00	24.37									
	STD	00075	21.26	35.98	25.19									
/23.5	OBS	00088	17.88	35.91	26.02									
	STD	00100	16.52	35.73	26.21									
	STD	00125	14.41	35.45	26.47									
/23.5	OBS	00132	14.00	35.39	26.51									
	STD	00150	13.59	35.31	26.53									
/23.5	OBS	00173	13.18	35.24	26.56									
	STD	00200	13.05	35.24	26.59									
/23.5	OBS	00228	12.93	35.24	26.61									
	STD	00250	12.86	35.14	26.55									
/23.9	OBS	00285	12.76	34.97e	26.44									
	STD	00300	12.06	34.94	26.55									
/23.9	OBS	00366	09.52	34.74	26.85									
	STD	00400	08.61	34.69	26.96									
/23.9	OBS	00462	07.38	34.61	27.08									
	STD	00500	07.12	34.59	27.10									
/23.9	OBS	00569	06.53	34.55	27.16									
	STD	00600	06.11	34.53	27.19									
/23.9	OBS	00675	05.36	34.48	27.25									
	STD	00700	05.25	34.47	27.25									
/23.9	OBS	00784	04.95	34.45	27.27									
	STD	00800	04.91	34.46	27.28									
	STD	00900	04.67	34.50	27.34									
/23.9	OBS	00970	04.58	34.53	27.39									
	STD	01000	04.55	34.60	27.43									
	STD	01100	04.51	34.73	27.54									
/23.9	OBS	01147	04.46	34.81	27.61									

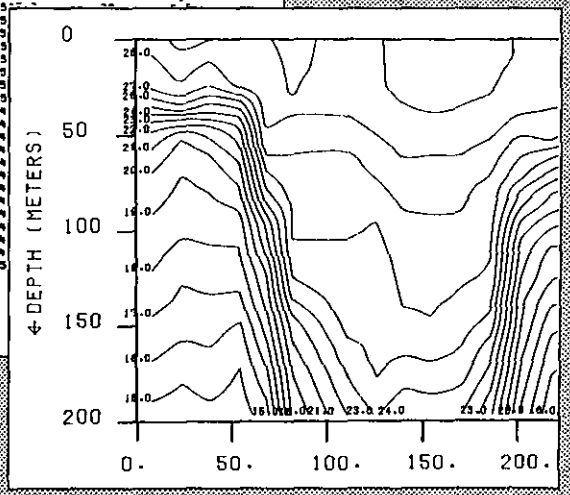
Formatted Data Listings

SOUND VEL VERTICAL ARRAY SEASONAL SUMMARY
MONTHS PRESENT= 4, 5, 6

AREA 4

DEPTH	MAX	AVG	MIN	NUMBER	STAN DEV
.0	1548.6	1546.0	1543.1	20	1.8
10.0	1548.1	1545.9	1543.2	20	1.8
20.0	1548.4	1545.8	1543.2	20	1.9
30.0	1548.5	1545.2	1542.8	20	1.8
50.0	1544.8	1543.4	1541.1	20	1.9
75.0	1545.0	1541.4	1538.4	20	1.6
100.0	1541.8	1537.8	1533.2	20	2.6
125.0	1534.6	1530.9	15		
150.0	1527.9	1524.0	15		
200.0	1518.7	1514.1	15		
250.0	1513.2	1509.2	15		
300.0	1510.5	1506.6	15		
400.0	1506.3	1504.0	15		
500.0	1504.6	1503.3	15		
600.0	1504.3	1502.8	15		
700.0	1503.9	1502.2	14		
800.0	1503.5	1501.4	14		
900.0	1502.3	1500.5	14		
1000.0	1500.9	1499.6	14		
1100.0	1499.6	1498.2	14		
1200.0	1498.5	1497.2	14		
1300.0	1497.7	1496.4	14		
1400.0	1497.1	1495.9	14		
1500.0	1496.7	1496.0	14		
1750.0	1496.6	1495.8	14		
2000.0	1495.0	1494.6	14		
2500.0	1500.4	1500.1	14		
3000.0	1507.5	1507.4	15		

Data summaries and analyses



Graphic data plots

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:

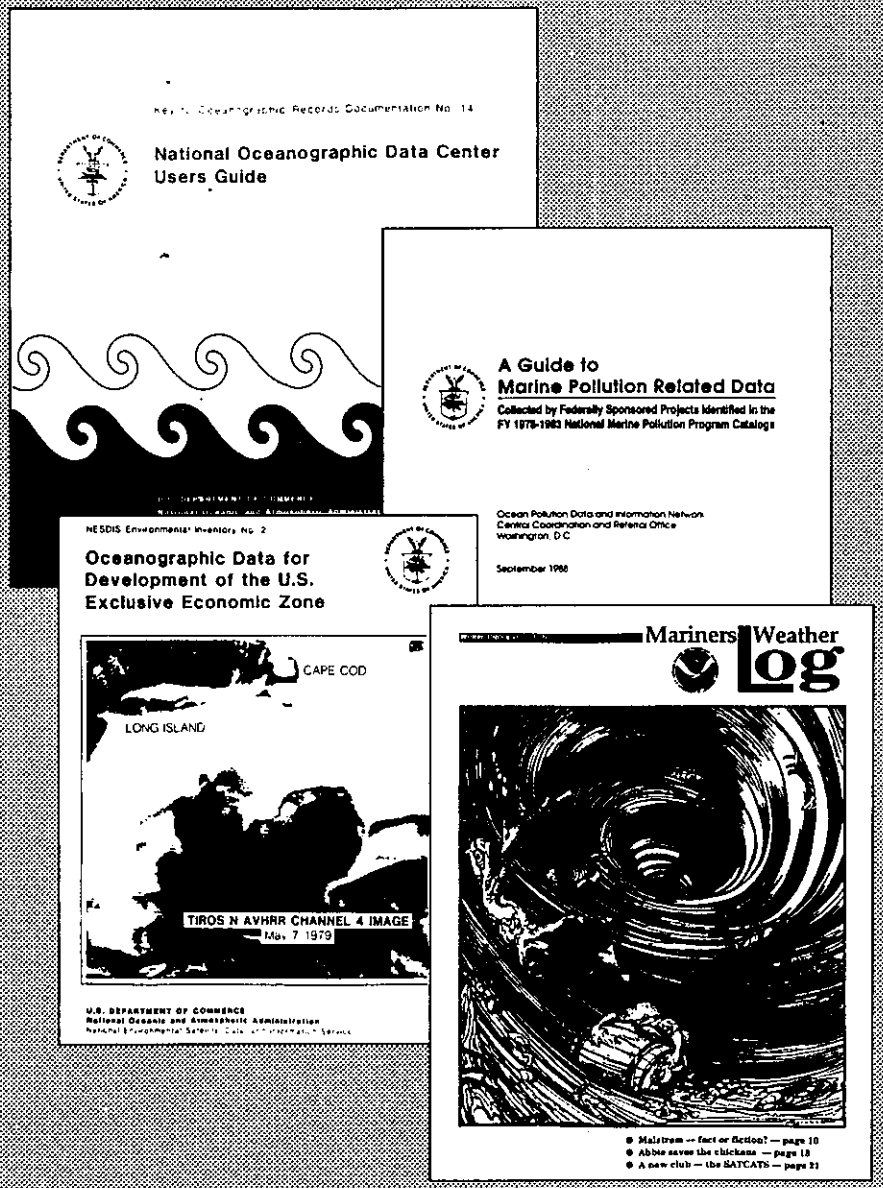
- **Key to Oceanographic Records Documentation.** The KORD series contains publications that summarize or describe NODC data or information holdings. These include special data inventories and project reports as well as the *NODC Users Guide.*

- **NODC Environmental Information Bulletin.** This series covers fliers and order forms announcing new NODC publications, data sets, and other data products and services.

- **NESDIS Environmental Inventory.** Publications in this series show in graphic form the major types of environmental data available from the NESDIS data centers. Each volume presents data inventory information for a different area or region of the globe.

- **Mariners Weather Log.** This quarterly publication is a unique source of information on marine weather and climate and their effects 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; information on the National Weather Service's Marine Observation Program; 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, yachtsmen, and other maritime interests.

NODC Publications



- NODC Users Guide
- Data announcements
- Mariners Weather Log
- Data inventories and atlases
- Special reference publications
- Technical reports

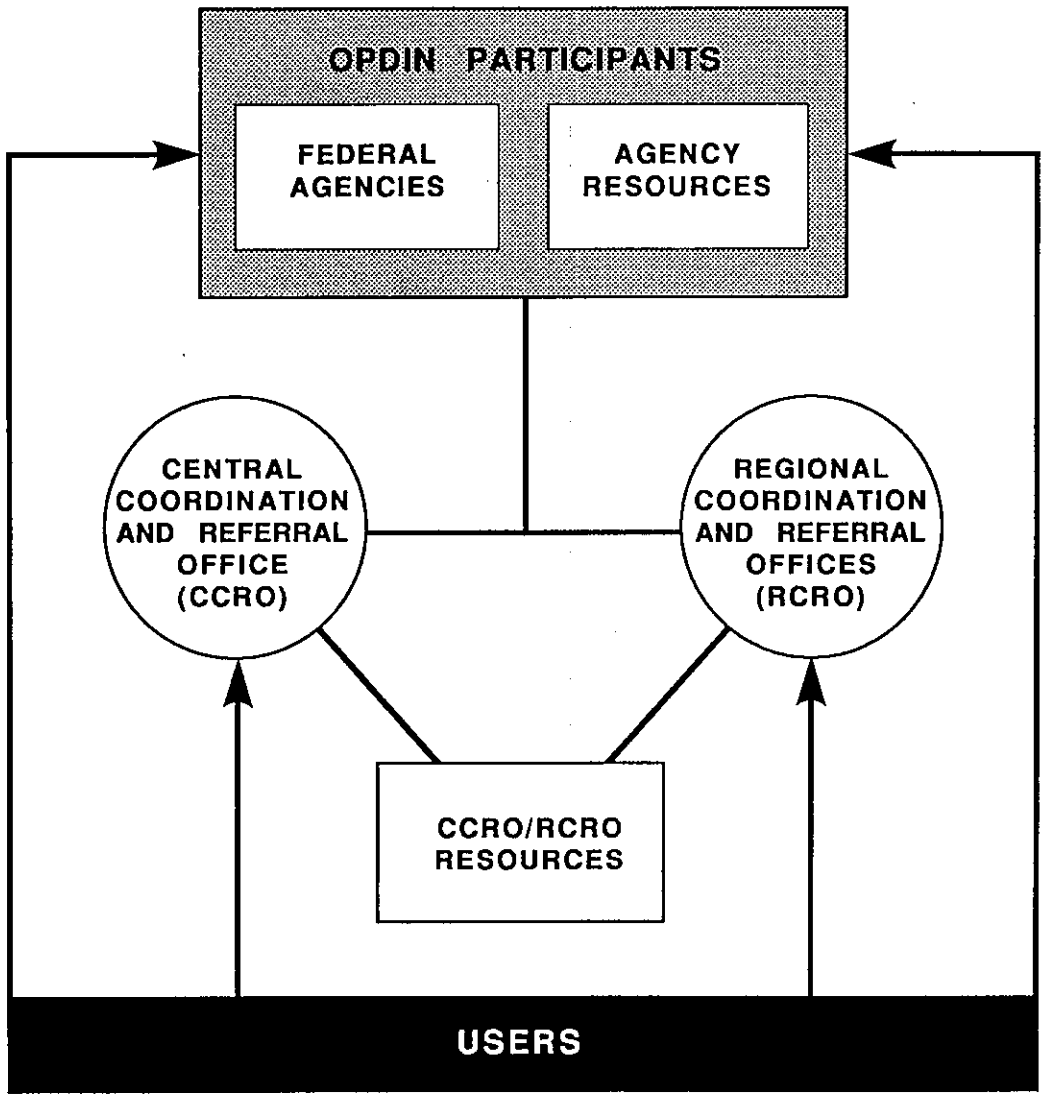
Ocean Pollution Data and Information Network

The Ocean Pollution Data and Information Network (OPDIN) facilitates user access to the ocean pollution data and information generated by 11 participating Federal departments and agencies. OPDIN is managed by the Central Coordination and Referral Office (CCRO) established within the NODC. The CCRO cooperates closely with the NOAA National Ocean Pollution Program Office and with the NODC Liaison Offices.

The OPDIN provides a wide range of products and services to researchers, managers, and others who need data and information on ocean pollution. It maintains a directory of Federal ocean pollution data and information systems and services, lists of ocean pollution scientists and managers and their fields of expertise, and annually-updated catalogs of Federal ocean pollution related projects. To answer user inquiries it provides copies of catalogs, directories, technical reports, data inventories, and data products.

The Network was created to fulfill the mandate of Section 8 of the National Ocean Pollution Planning Act of 1978 (P.L. 95-273) and subsequent amendments. Section 8 requires that NOAA take the lead in ensuring that the results and findings of Federally conducted or sponsored ocean pollution research, development, and monitoring projects are readily available to all users.

Ocean Pollution Data and Information Network



OPDIN PARTICIPANTS

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Energy
- Environmental Protection Agency
- Department of Health and Human Services
- Department of Interior
- National Aeronautics and Space Administration
- National Science Foundation
- Nuclear Regulatory Commission
- Department of Transportation

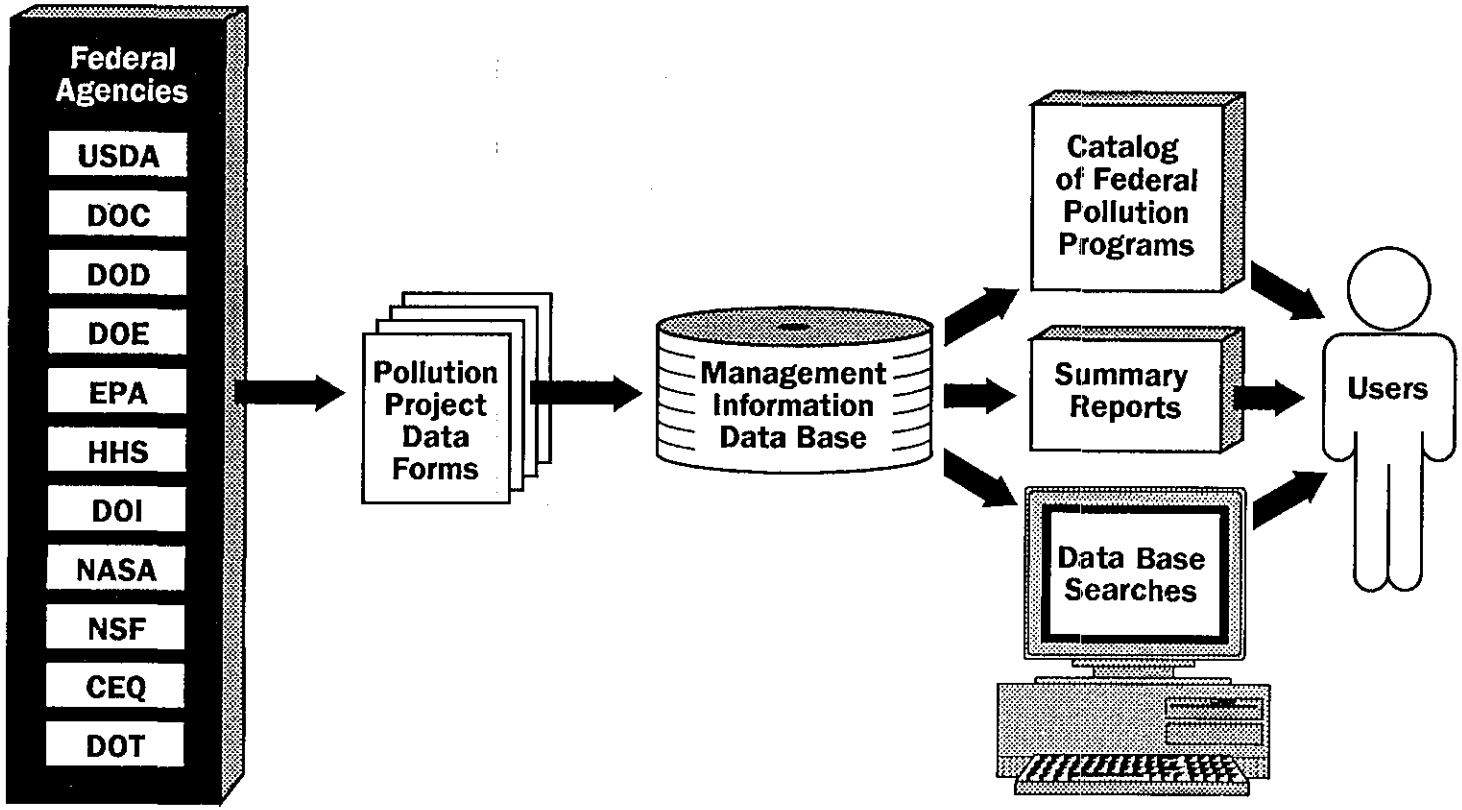
National Marine Pollution Information System

One of the major tools used by OPDIN in carrying out its responsibilities is the National Marine Pollution Information System (NMPIS). NMPIS is a data base containing descriptions of marine pollution programs and projects conducted or funded by agencies of the Federal government. Approximately 600 projects from over 60 programs funded by 11 Federal departments and agencies are reported to NMPIS each year. Each project profile includes:

- project title, duration, and description
- project purpose
- principal investigator name, address, and organization
- funding sources and levels
- percentage of funds spent by region, state, zone, pollutant, and polluting activity

The principal product generated from NMPIS is an annual publication titled the *Summary of Federal Ocean Pollution Programs and Projects*. NMPIS project descriptions for fiscal years 1982 to the present are available through interactive searches of the computerized data base. The NMPIS data base management system facilitates the printing of a variety of reports. NMPIS records can be selected and sorted using any combination of available information categories. Results can be presented in the form of directories, catalogs, tables, and funding analyses.

National Marine Pollution Information System



Ocean Data on CD-ROM

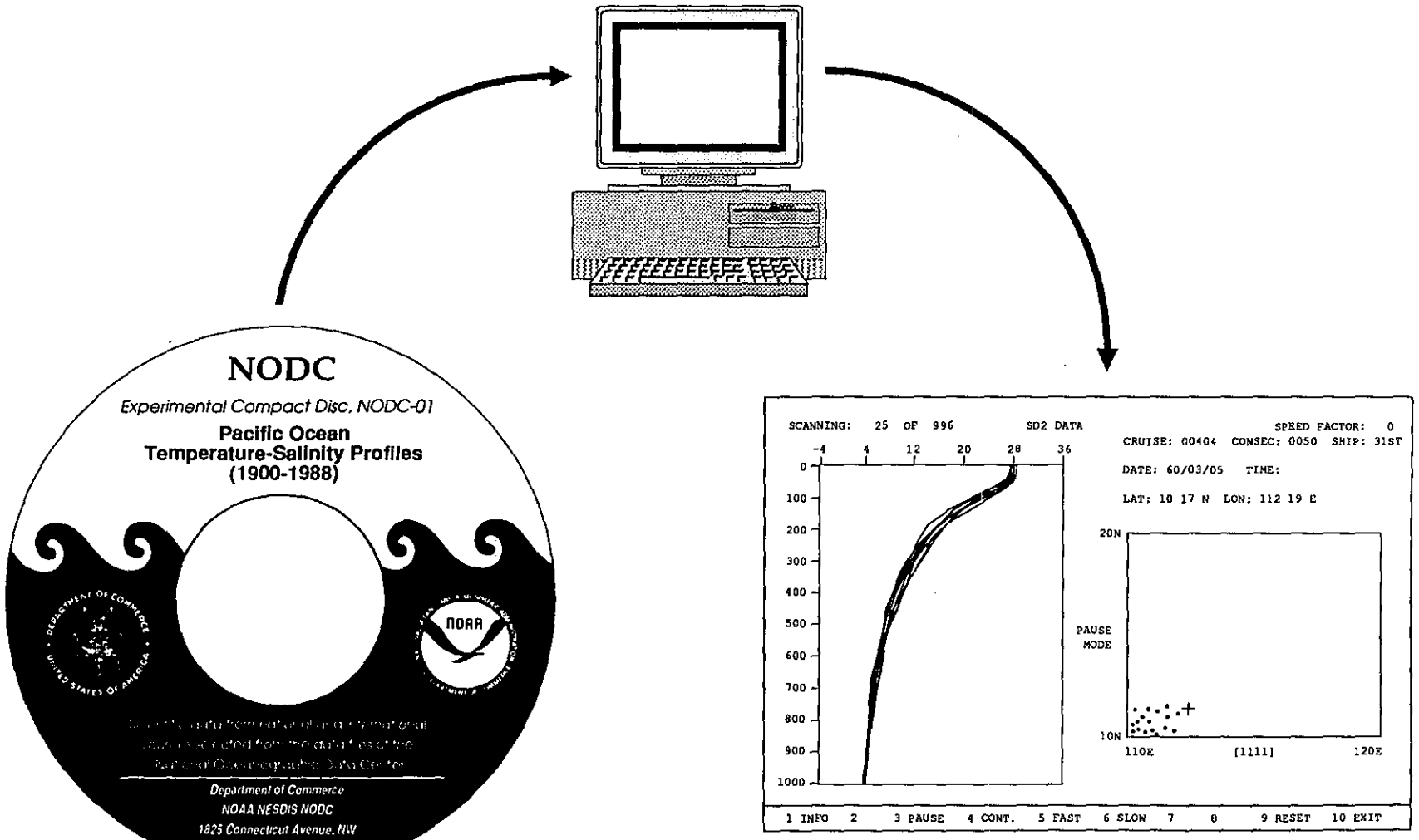
In June 1989 the NODC released a compact disk containing over 1.3 million temperature-depth and salinity-depth profiles taken in the Pacific Ocean between 1900 and 1988. Designated as CD-ROM NODC-01, this is the first in a planned series of ocean data compact disks holding major portions of NODC's global data archives.

To enable users to plot and compare profiles, CD-ROM NODC-01 is accompanied by data access and display software provided on a single high density (1.2 Mb) floppy disk. Because the CD-ROM and companion software were developed as experimental prototypes, researchers were asked to test and evaluate them and to provide their comments and suggestions to the NODC. User comments about data quality control, data organization, software enhancements, science applications, and related topics will help guide NODC in developing future CD-ROMs.

Using CD-ROM NODC-01 and its data access/display software requires an IBM compatible personal computer system with:

- a CD-ROM reader capable of accessing compact disks formatted with the ISO 9660 standard
- Microsoft MS-DOS Extensions for CD-ROM (version 2.0 or higher)
- 640K of memory, with at least 500K available
- an EGA graphics adapter
- an EGA or multi-synchronous color graphics monitor
- a 1.2 Mb, 5.25-inch floppy disk drive.

Ocean Data on CD-ROM



1.3 million temperature-depth and salinity-depth profiles taken in the Pacific Ocean between 1900 and 1988

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 anteceded 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.

NOAA Library Mission and History

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

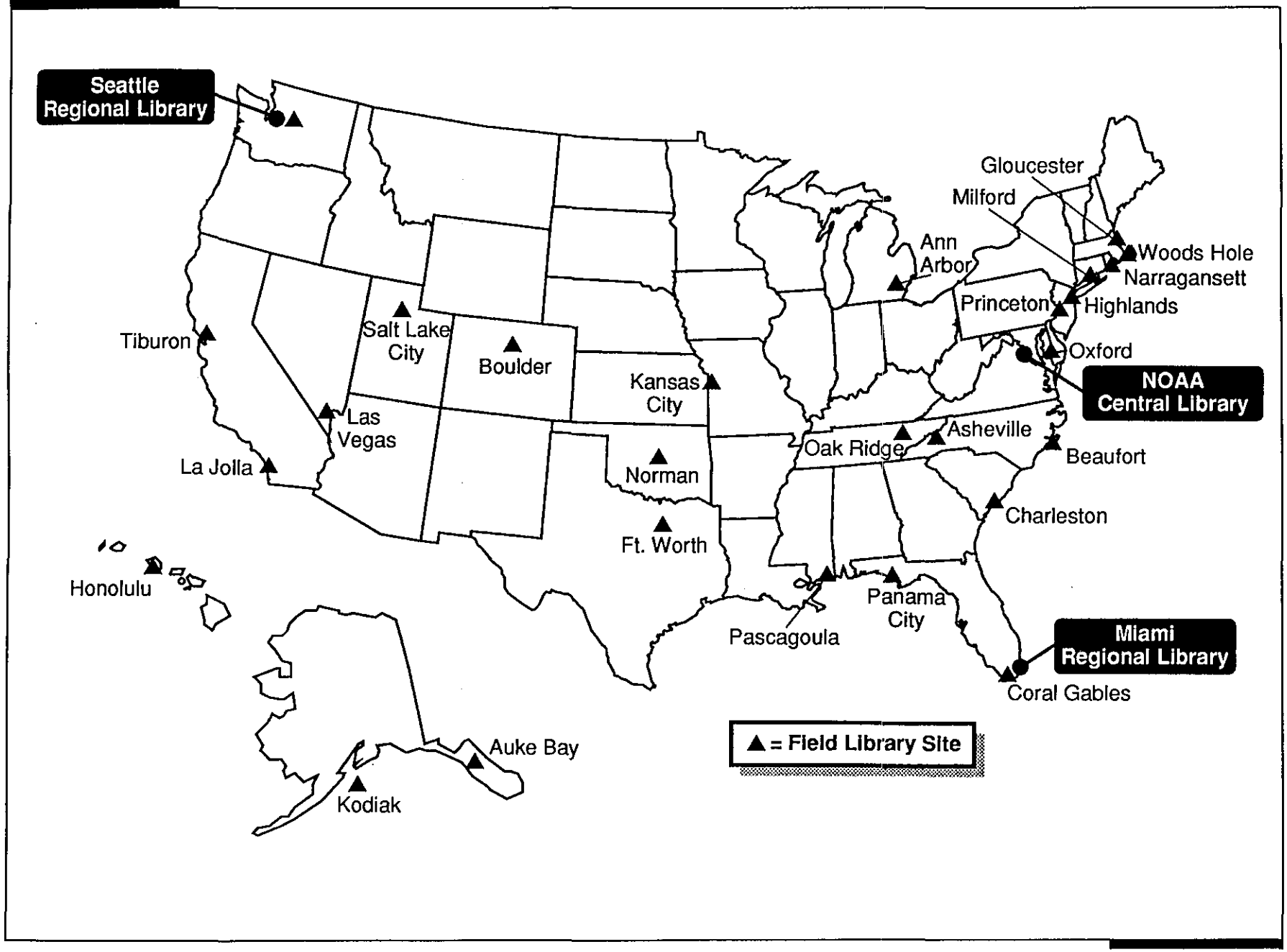
The NOAA Library and Information Network (NLIN) administered by the Library and Information Services Division (LISD) consists of three components:

- the Central Library in 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 Rockville, Miami, and Seattle sites
- National Climatic Data Center
- RAS/Mountain Administrative Support Center, Boulder, Colo.
- R/E/Geophysical Fluid Dynamics Laboratory, 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 Library and Information Network



NOAA Library and Information Network Operations

In 1988 NOAA awarded a contract to a private company to provide technical and public services at the Central Library. Inherently governmental library functions, however, remain Federally staffed. These are:

- **Administration**
  including budgeting, long-range planning, and staff recruitment and supervision

- **Collection development**
  including selecting library materials, fostering foreign exchange, and obtaining input from subject specialists

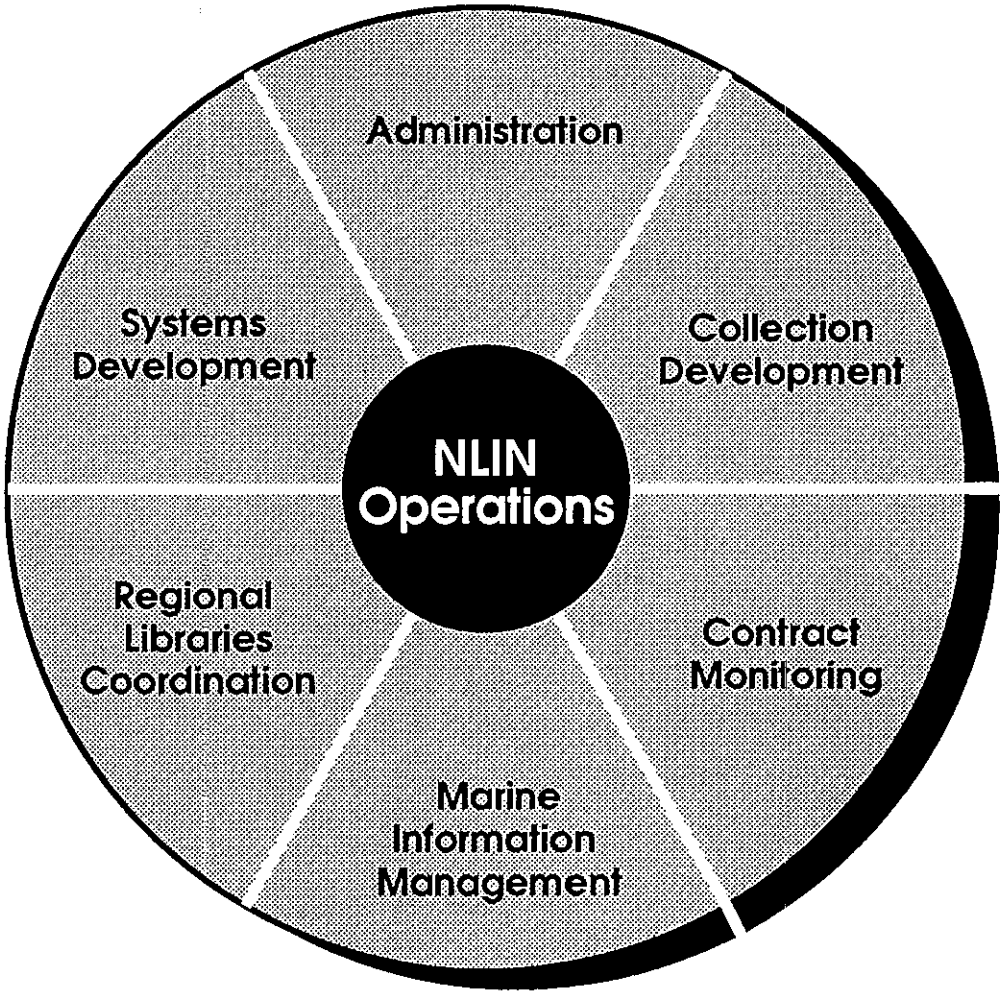
- **Contract monitoring**
  including oversight of acquisitions, cataloging, interlibrary loan, user services, and other contract operations

- **Marine information management**
  including coordinating NOAA participation in international information programs and representing NODC at national and international meetings

- **Regional Libraries coordination**
  including technical consultation and resource sharing

- **Systems development**
  including specifying ADP requirements, testing equipment and software, conducting training, and developing long-range ADP plans

NOAA Library and Information Network Operations

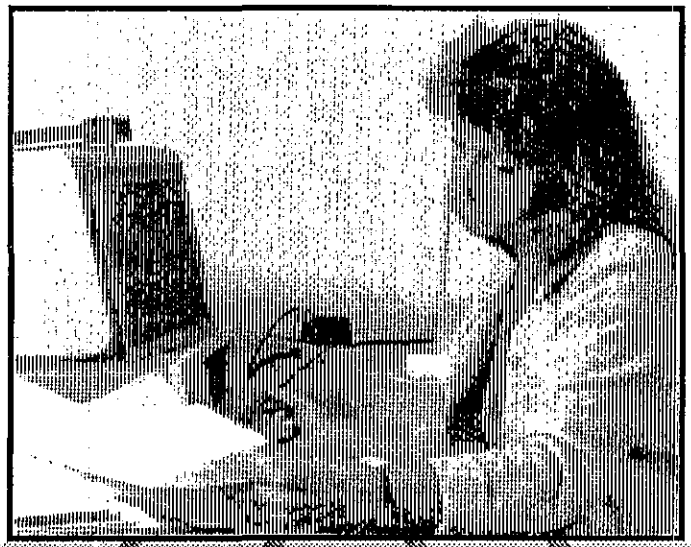


NOAA Central Library Services

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 Services



Provision of books, reports, journals, & data

Reference services

Computer-based information retrieval

Literature searches

Current awareness (Selective Dissemination of Information)

Reference Questions

Each year NOAA libraries around the country respond to the information needs of research scientists, engineers, environmental planners, lawmakers, business and commerce, and the general public. Although many requests relate to specific individual needs, a significant number of requests concern major current topics of research and environmental concern. Recent research and speculation about climate change, for example, has prompted numerous requests for infomation on topics such as the "greenhouse effect" and global warming. Among topics of recent user inquiries are:

- Environmental impact of mining mineral deposits in the U.S. Exclusive Economic Zone
- Meteorological and climatological data for Portugal (request from the World Bank)
- How to order a copy of the *NOAA Diving Manual*
- Correlation between altitude and climate for selected inland cities in the United States
- Background information on El Niño (request from *USA Today*)
- Data on hurricanes in the 1880s
- Detailed information on the worst winter storm on record in Washington, D.C.
- Marine protected areas around the world
- Species assemblages in eastern U.S. estuaries
- Quality control of environmental data bases

Reference Questions

Fishery resources?

Greenhouse effect?

Acid rain?

Marine sanctuaries?

Hurricane statistics?

El Niño?

Diving safety?

Paleoclimate data?

Ozone hole?

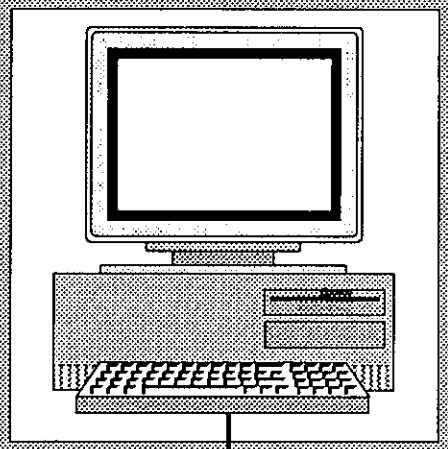
Computer-based Information Retrieval

The NOAA Central Library provides computer-based information retrieval from more than 500 data bases. The majority of these are accessed through such remote dial-up systems as DIALOG, BRS, NEWSNET, WESTLAW, and OCLC. OCLC, the Online Computer Library Center, is an international network used in thousands of libraries, including members of the NOAA Library and Information Network, for bibliographic control of materials.

A growing number of data bases are also available in the Central Library on CD-ROM (Compact Disk-Read Only Memory), which the individual user can search at special workstations. Indexes available in this format include: *Applied Science and Technology Index,* the *National Technical Information Service, Grolier's Encyclopedia,* and the *Aquatic Sciences and Fisheries Abstracts.* Selected data available in this format include hourly precipitation and summary of the days compiled by the National Climatic Data Center.

Online data bases most often used to satisfy NOAA literature search requests are: *Meteorological and Geoastrophysical Abstracts, Oceanic Abstracts, Georef, Compendex, CA Search* (chemistry), and *Science Citation Index.* Other data bases vital to current programs are: *Biosis, Inspec* (physics), *Zoological Record, ERIC* (education), *Medline,* and *Dissertation Abstracts.*

Computer-based Information Retrieval



OCLC

e.g.,

- Bibliographic verification
- Subject access
- Acquisitions
- Journal check-in
- Cataloging
- Interlibrary loan

Online Data Bases

e.g.,

- Meteorological & Geoastrophysical Abstracts
- Oceanic Abstracts
- Georef
- Compendex
- CA Search
- Science Citation Index

CD-ROM

e.g.,

- Applied Science & Technology Index
- NTIS
- Grolier's Encyclopedia
- Aquatic Sciences & Fisheries Abstracts

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 meterological 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.

NOAA Central Library Collection

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

NOAA Library ADP Operations

The cornerstone of ADP for library operations is the OCLC (Online Computer Library Center) System, which supports acquisitions, journal check-in, cataloging, and interlibrary loan. In addition to the Central Library, many of the NLIN libraries use OCLC for these same functions (as do thousands of libraries nationwide.) It is noteworthy that the acquisitions and journal check-in modules have migrated from online remote dial-up utilities to local area network microcomputer-based workstations.

The cataloging records created on OCLC have become the basis for the NOAA Library Public Access Catalog, featuring the data base of the NOAA libraries' holdings on CD-ROM. Public Access Catalog workstations are now located in more than 18 NOAA sites throughout the United States.

NOAA Library ADP Operations

Library Workstation

OCLC
(Online Computer Library Center)

- Acquisitions
- Cataloging
- Journal check-in
- Interlibrary loan

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 Bougher, 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

THE

General History

OF THE

AIR,

Designed and Begun

BY THE

Hon^ble *ROBERT BOYLE* Esq.

IMPRIMATUR.

June 29. 1692. *Robert Southwell*, P. R. S.

LONDON,

Printed for *Awnsham* and *John Churchill*, at the Black Swan in *Pater-noster-Row*, near *Amen-Corner*.

MDCXCII.

DANIELIS BERNOULLI Joh. Fil.

Med. Prof. Basil.

ACAD. SCIENT. IMPER. PETROPOLITANÆ, PRIUS MATHESEOS SUBLIMIORIS PROF. ORD. NUNC MEMBRI ET PROF. HONOR.

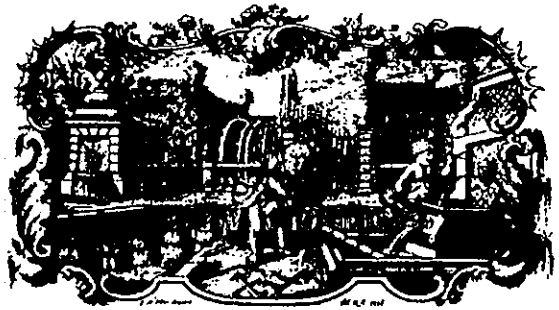
HYDRODYNAMICA,

SIVE

DE VIRIBUS ET MOTIBUS FLUIDORUM COMMENTARII.

OPUS ACADEMICUM

AB AUCTORE, DUM PETROPOLI AGERET, CONGESTUM.



ARGENTORATI,

Sumptibus JOHANNIS REINHOLDI DULSECKERI;

Anno M D CC XXXVIII.

Typis Joh. Henr. Deckeri, Typographi Basilicensis.

THE

PHYSICAL GEOGRAPHY

OF

THE SEA.

BY M. F. MAURY, LL.D., U.S.N.,

SUPERINTENDENT OF THE NATIONAL OBSERVATORY.

AN ENTIRELY NEW EDITION.

NEW YORK

HARPER & BROTHERS, PUBLISHERS,

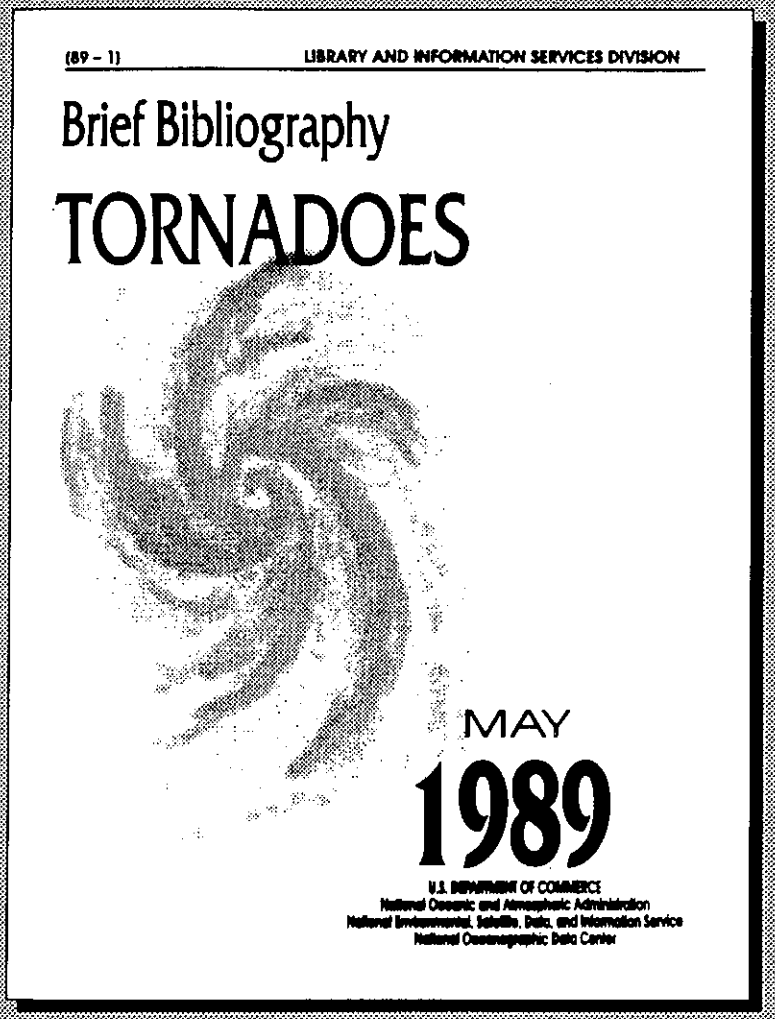
FRANKLIN SQUARE.

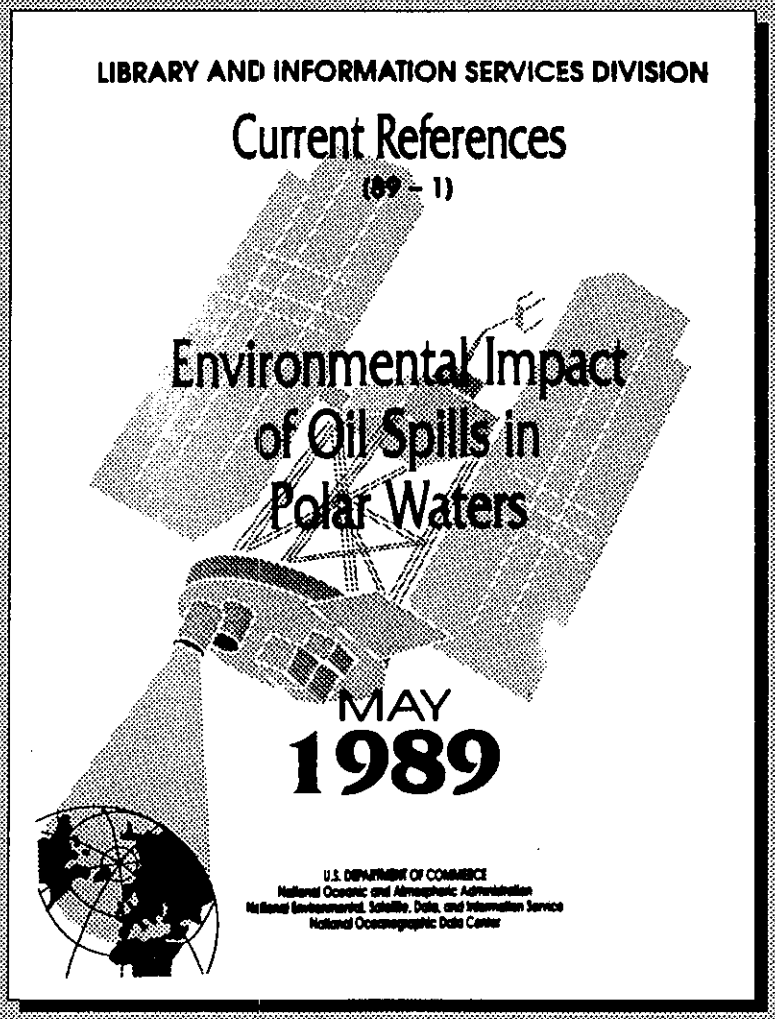
1856.

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.*

NOAA Library Publications

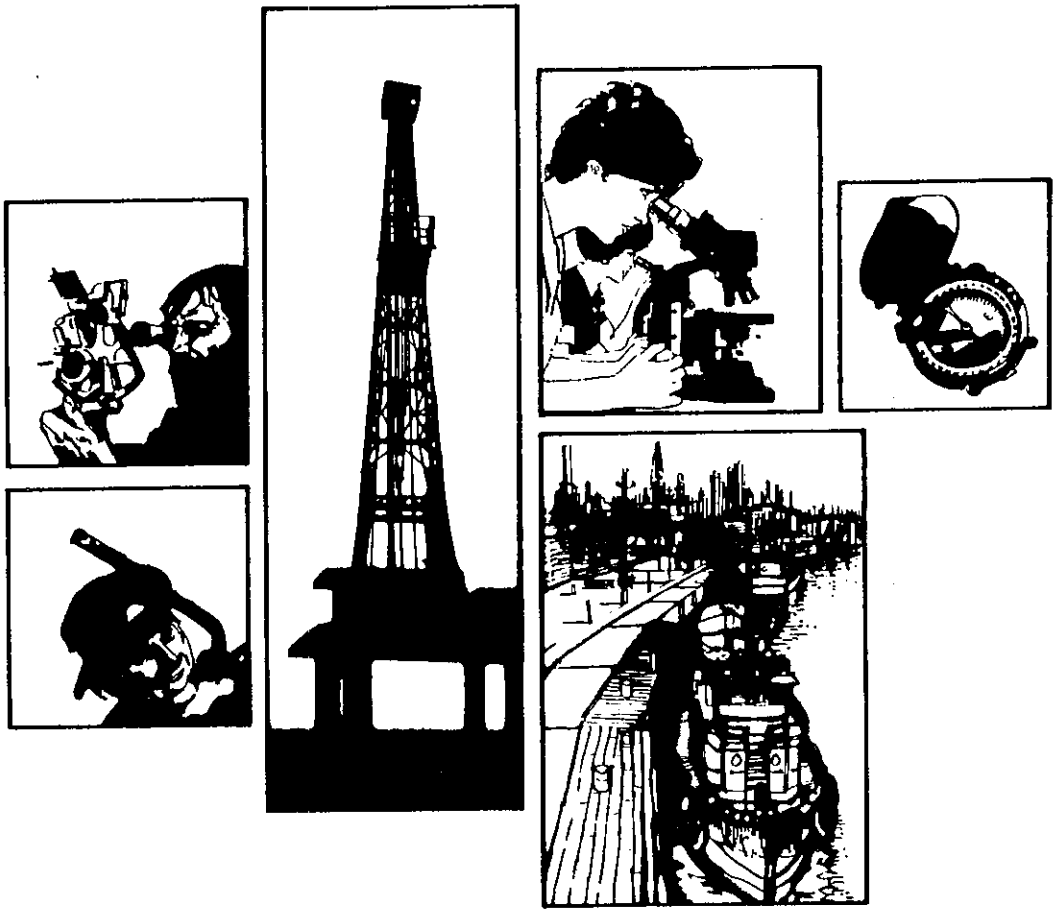




USERS AND USER ACCESS

NODC Data Applications/Data Users

Each year the NODC provides ocean data and information to thousands of customers. 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.



NODC Data Applications/Data Users

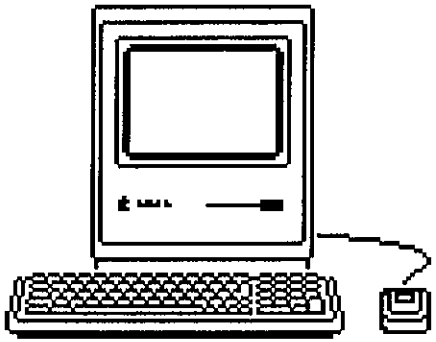
■ **Basic Research**	- SIO, WHOI, NOAA/AOML, NOAA/PMEL, URI, Univ. of Miami, Univ. of Washington, JPL
■ **Climate Studies**	- TOGA, WOCE, JGOFS
■ **Defense**	- Naval Research Laboratory, Naval Ocean System Center, Naval Oceanographic Office, NATO ASW Research Center, EDO Corp., Tracor, Vitro Corp.
■ **Environmental Assessment**	- EPA, Batelle, SAIC, NOAA/NOS, Continental Shelf 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

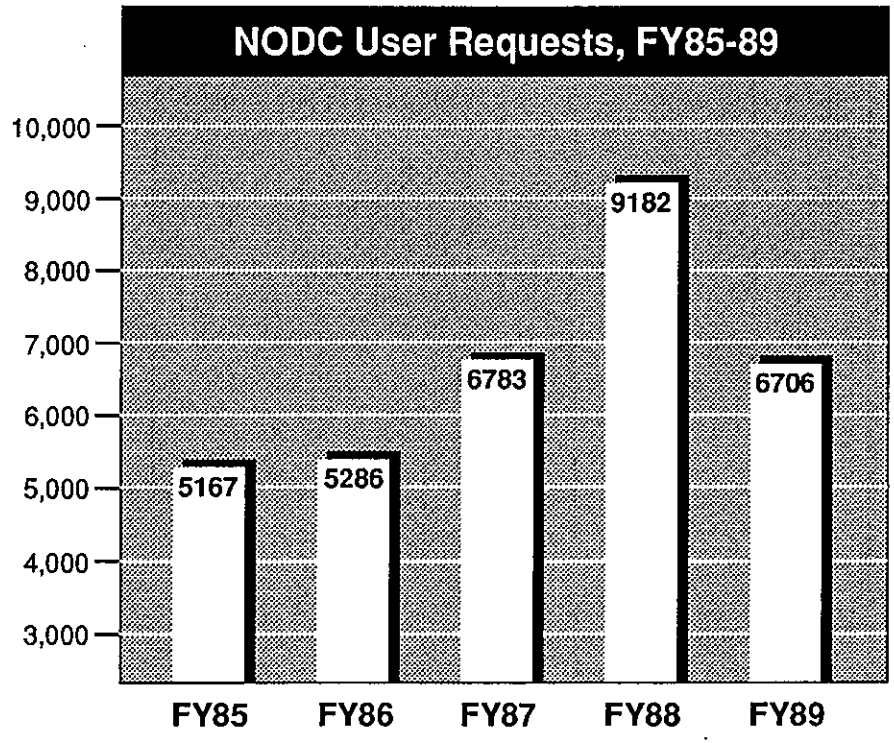
NODC User Summary

Over the past five years, NODC user requests have increased substantially. Although part of this growth represents increased usage of NODC's more traditional *in situ* data resources, a good part of it reflects demand for new data types--particularly ocean satellite data and certain types of near-real time-data--added to NODC's suite of products and services in recent years.

In FY 1989 the largest percentage of NODC users were from NOAA (28%), followed by users from academia (18%), foreign countries (16%), other government agencies (15%), business (12%), and the general public (11%).

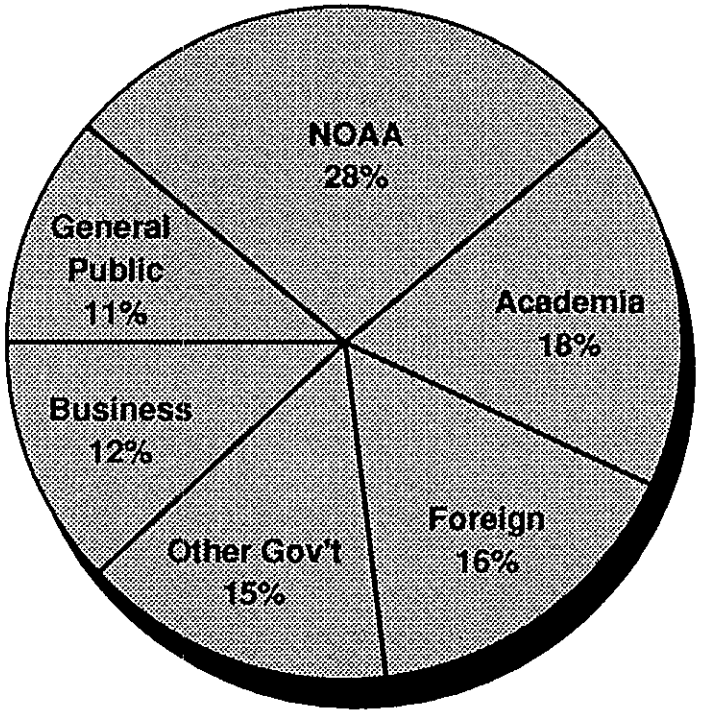
NODC User Summary





NODC Requests by User Class, FY89

(Total Requests = 6,706)



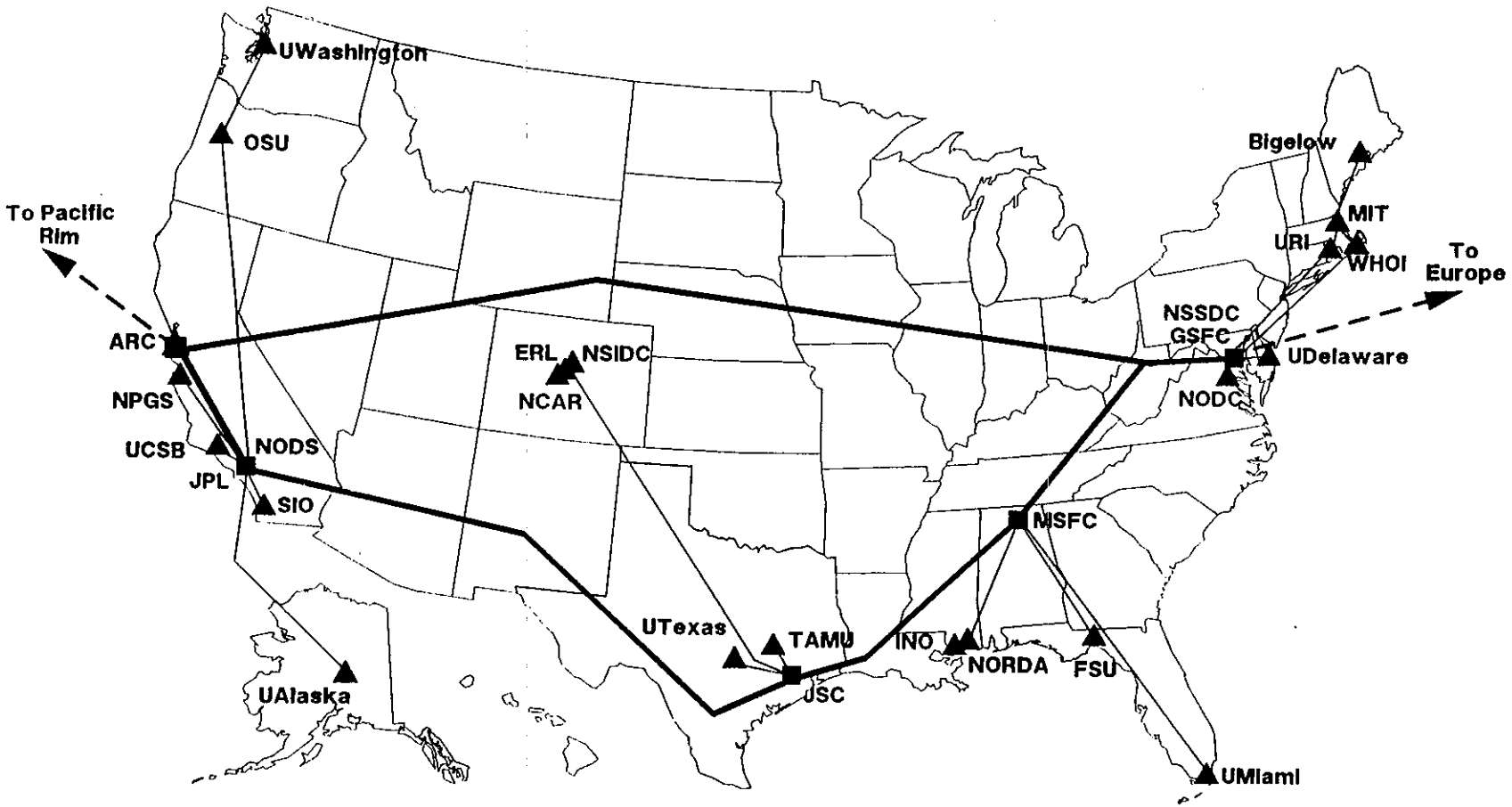
SPAN Ocean Network

Operating on the National Aeronautics and Space Administration's SPAN computer communications network, the SPAN Ocean Network links major ocean research facilities in academia and government. SPAN (for Space Physics Analysis Network) began operations in 1981 to serve the needs of researchers in space plasma physics. Today, however, the solar-terrestrial, astrophysics, planetary science, atmospheric science, land science, climate science--as well as the ocean science--disciplines are all served by SPAN, both domestically and through international links.

In the SPAN topology five routing centers are linked over a backbone circuit. These routing centers are the Jet Propulsion 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 became a node on the SPAN Ocean Network in March 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.

SPAN Ocean Network



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 six sites of major concentrations of marine research and development activity: Woods Hole, Mass.; Washington, D.C.; Miami, Fla.; La Jolla, Calif.; Seattle, Wash.; and Anchorage, Ak. 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.

Alaska Liaison Office
NOAA/NESDIS
707 A Street
Anchorage, AK 99501
Telephone: 907/271-4063 or 257-2741
FTS 868-4063

Northwest Liaison Office
NOAA/NESDIS/Bin 15700/Bldg. 1
7600 Sand Point Way, NE
Seattle, WA 98115
Telephone: 206/526-6263
FTS 392-6263

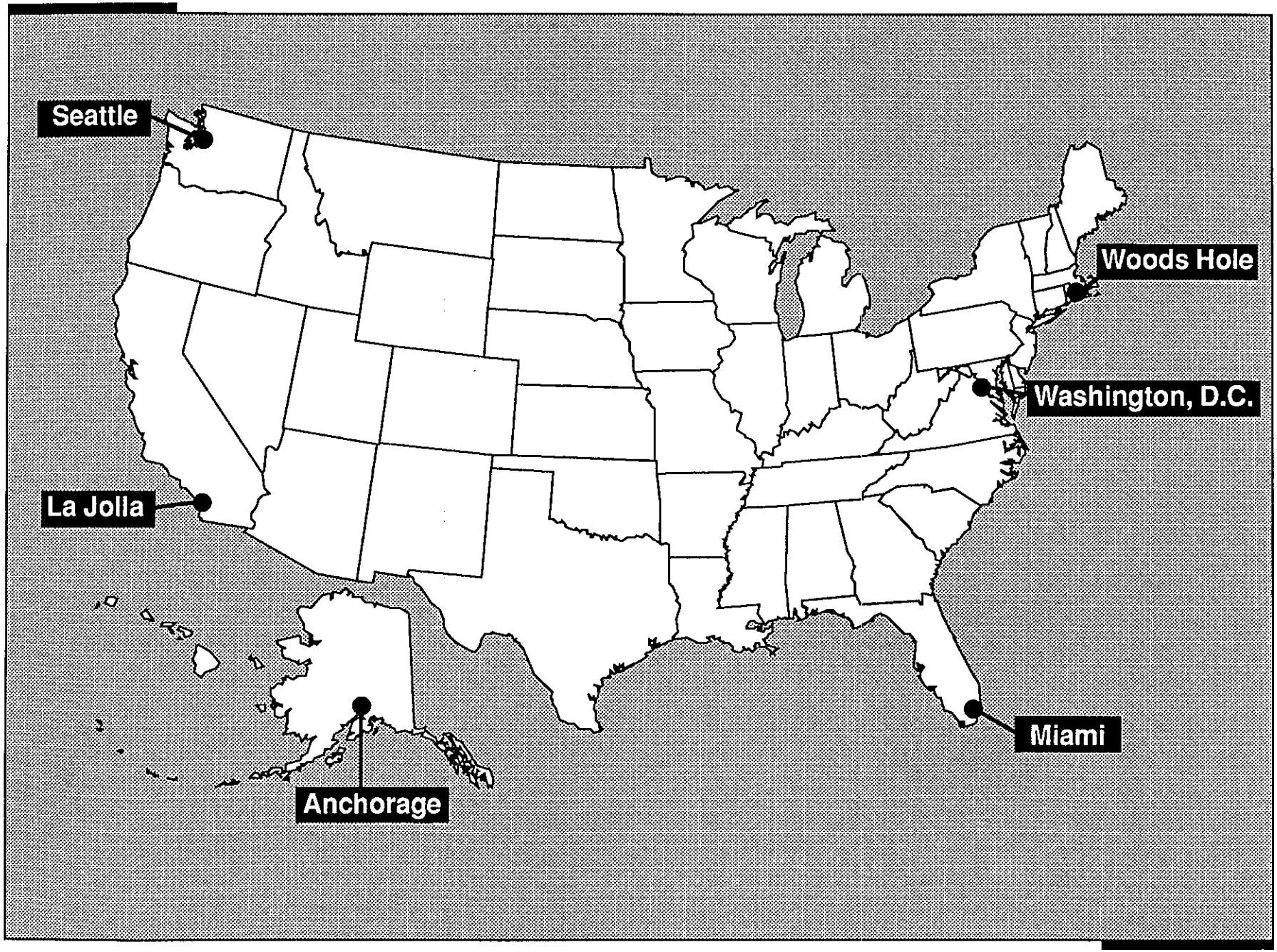
Southwest Liaison Office
NOAA/NESDIS
8604 La Jolla Shores Drive
P.O. Box 271
La Jolla, CA 92037
Telephone: 619/546-7110
FTS 893-7110

Southeast Liaison Office
NOAA/NESDIS/AOML Bldg.
4301 Rickenbacker Causeway
Miami, Fl 33149
Telephone: 305/361-4305
FTS 350-1305

Mid-Atlantic Liaison Office
NOAA/NESDIS/NODC
1825 Connecticut Avenue, NW
Washington, DC 20235
Telephone: 202/763-5643
FTS 763-5643

Northeast Liaison Office
NOAA/NESDIS/McLean Laboratory
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
Telephone: 617/548-1400 X2497
FTS 828-9279

NODC Liaison Offices



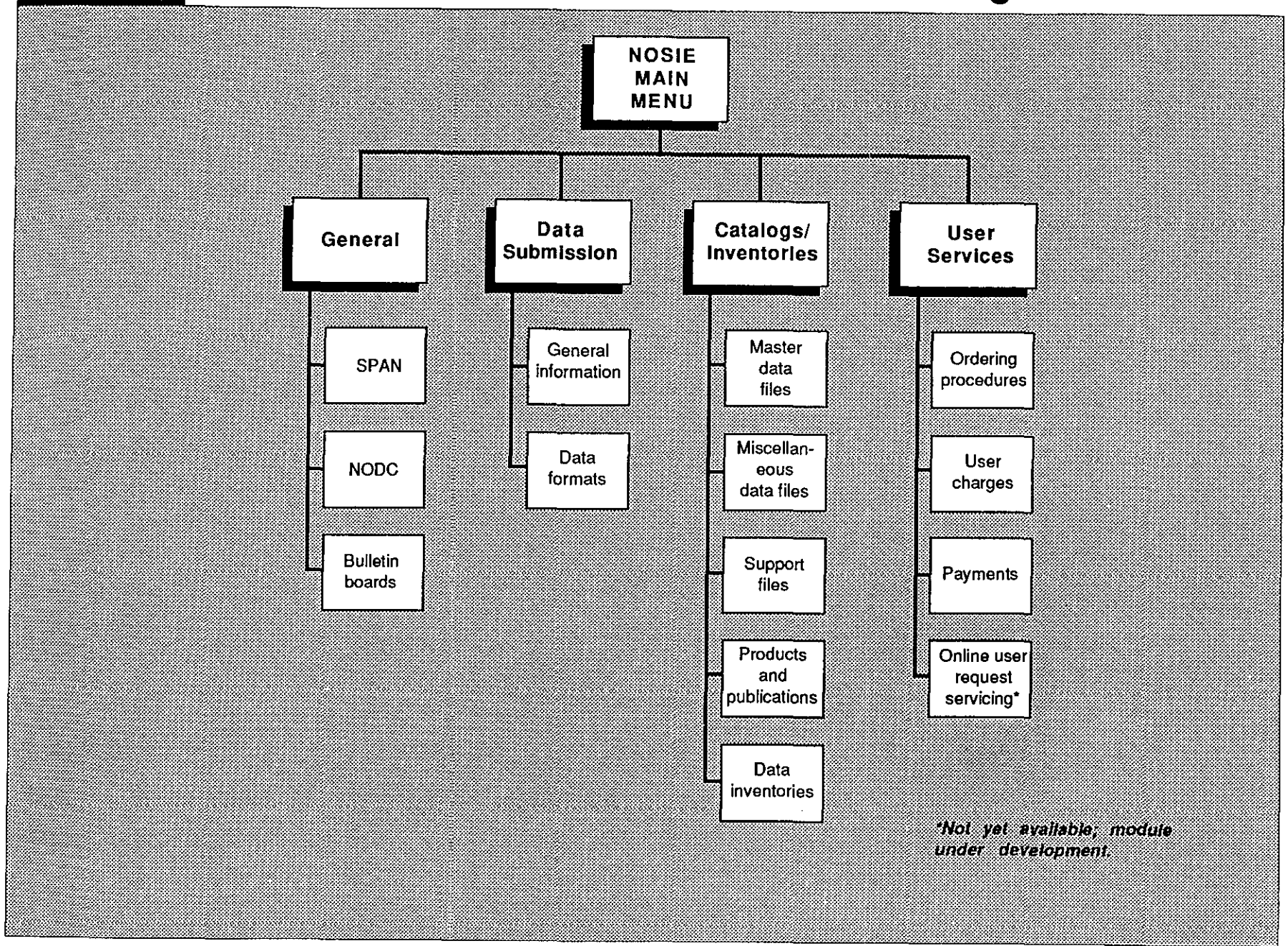
NODC Ocean Science Information Exchange

The NODC Ocean Science Information Exchage (NOSIE) is a prototype system created to provide users with easy access to information about NODC data holdings, products, and services. NOSIE operates on the NASA SPAN computer network. This menu-driven, online information resource provides:

- general information about SPAN and the NODC
- descriptions of NODC data files and other data holdings
- down-loadable record layouts (data formats) for principal NODC data files
- a catalog of NODC data products and publications
- NODC data submission guidelines
- searchable inventories of principal NODC data files
- an NODC bulletin board and a facility for submitting user requests and data orders.

NOSIE can be accessed via SPAN, Omnet/Sciencenet on the Telemail system, or direct dial-up modem.

NODC Ocean Science Information Exchange



OCEAN PROJECT DATA MANAGEMENT

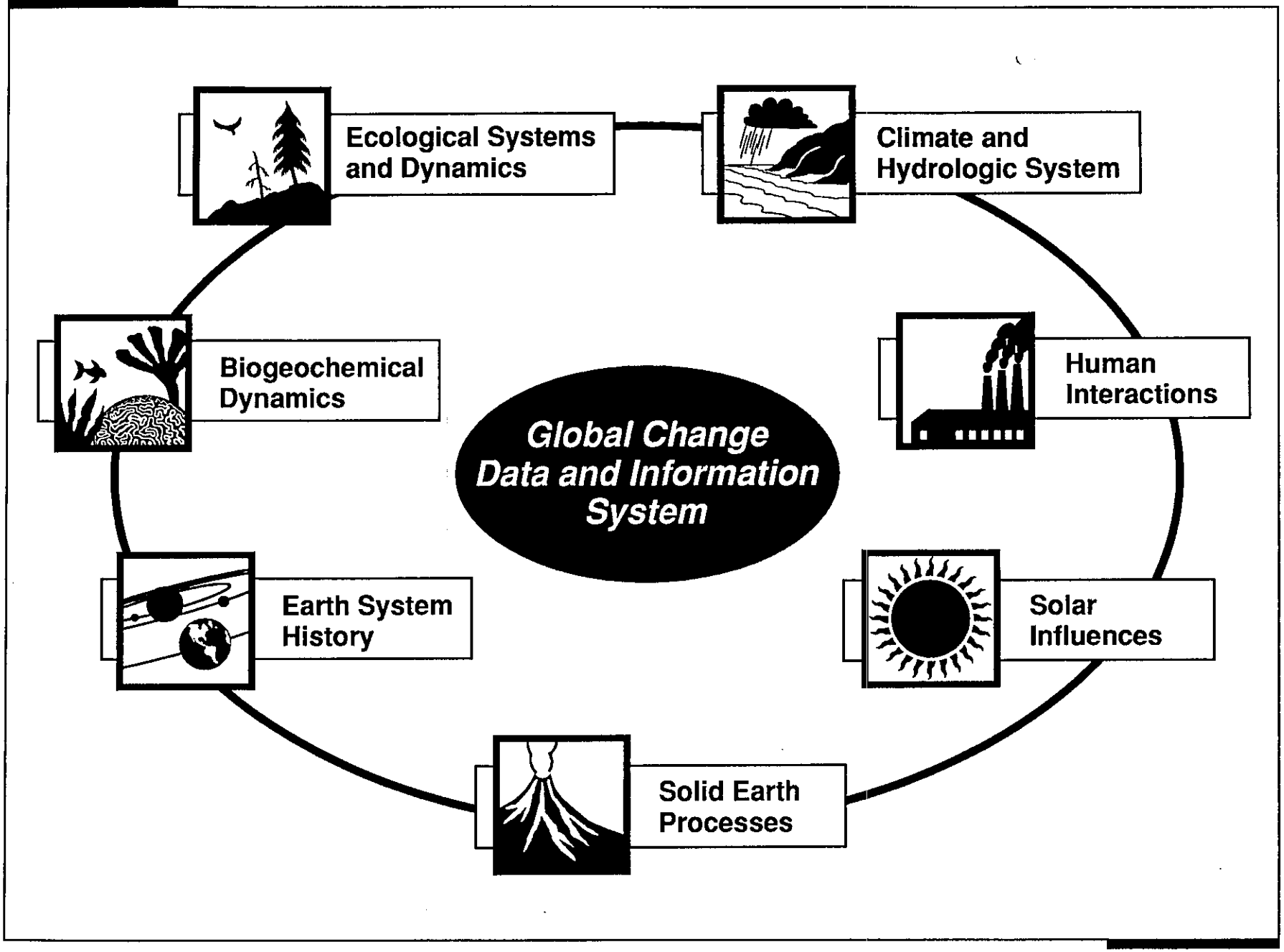
Data Management for Global Change

Acid rain, ozone depletion, the greenhouse effect, rising sea level, and related phenomena are all aspects of global climate 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. And advances in each of these science elements will 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 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. Such a system will will provide for:

- management of global-scale, long-term data from observing systems
- organization of data sets to improve the understanding of global change processes
- analyses and preparation of data sets for development and validation of predictive global change models.

Data Management for Global Change



Ocean Science and 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.

Ocean Science and Global Change

Tropical Ocean-Global Atmosphere (TOGA) project
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 intital 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.

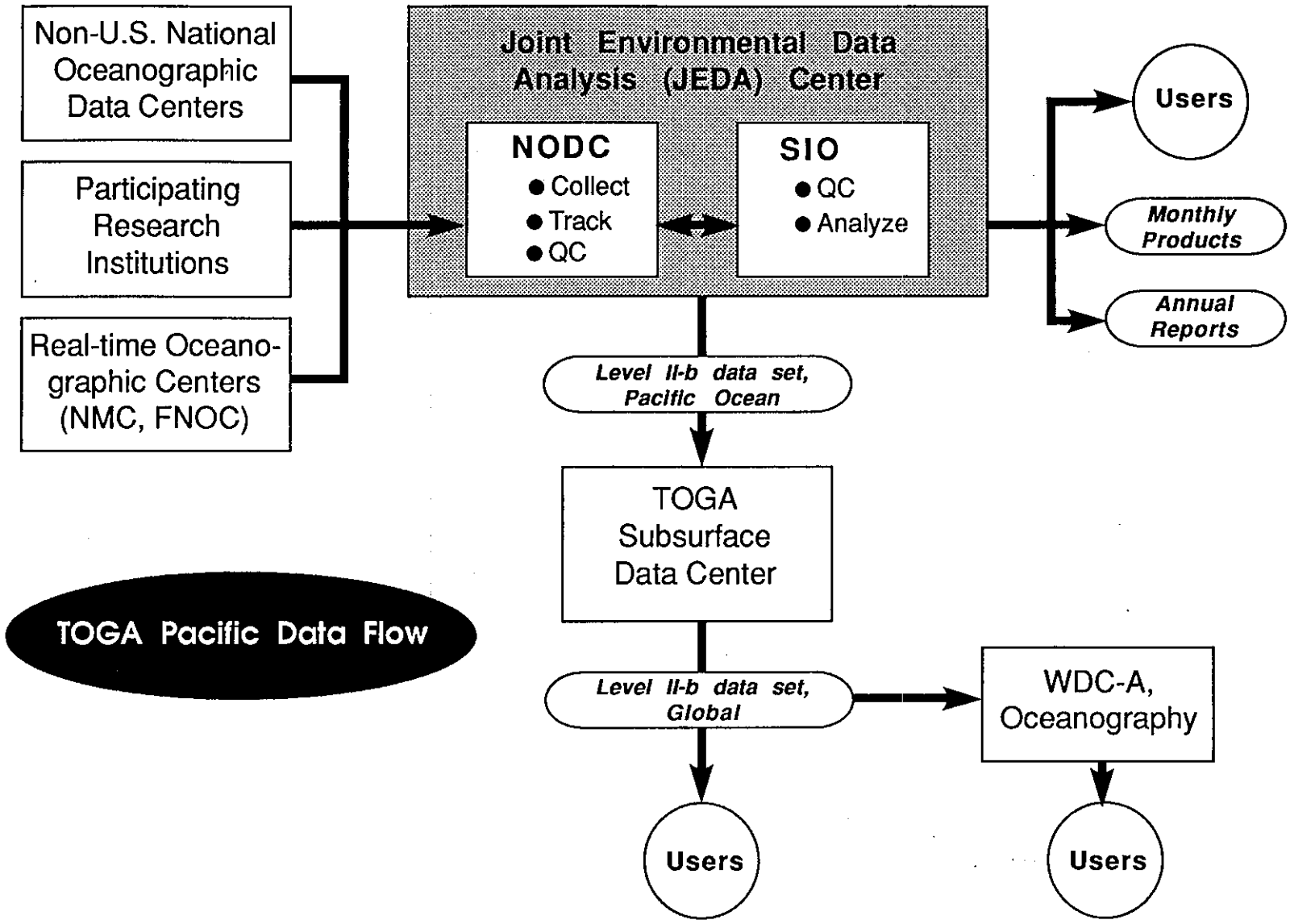
Joint Environmental Data Analysis (JEDA) Center

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 SPAN 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 Environmental Data Analysis (JEDA) Center



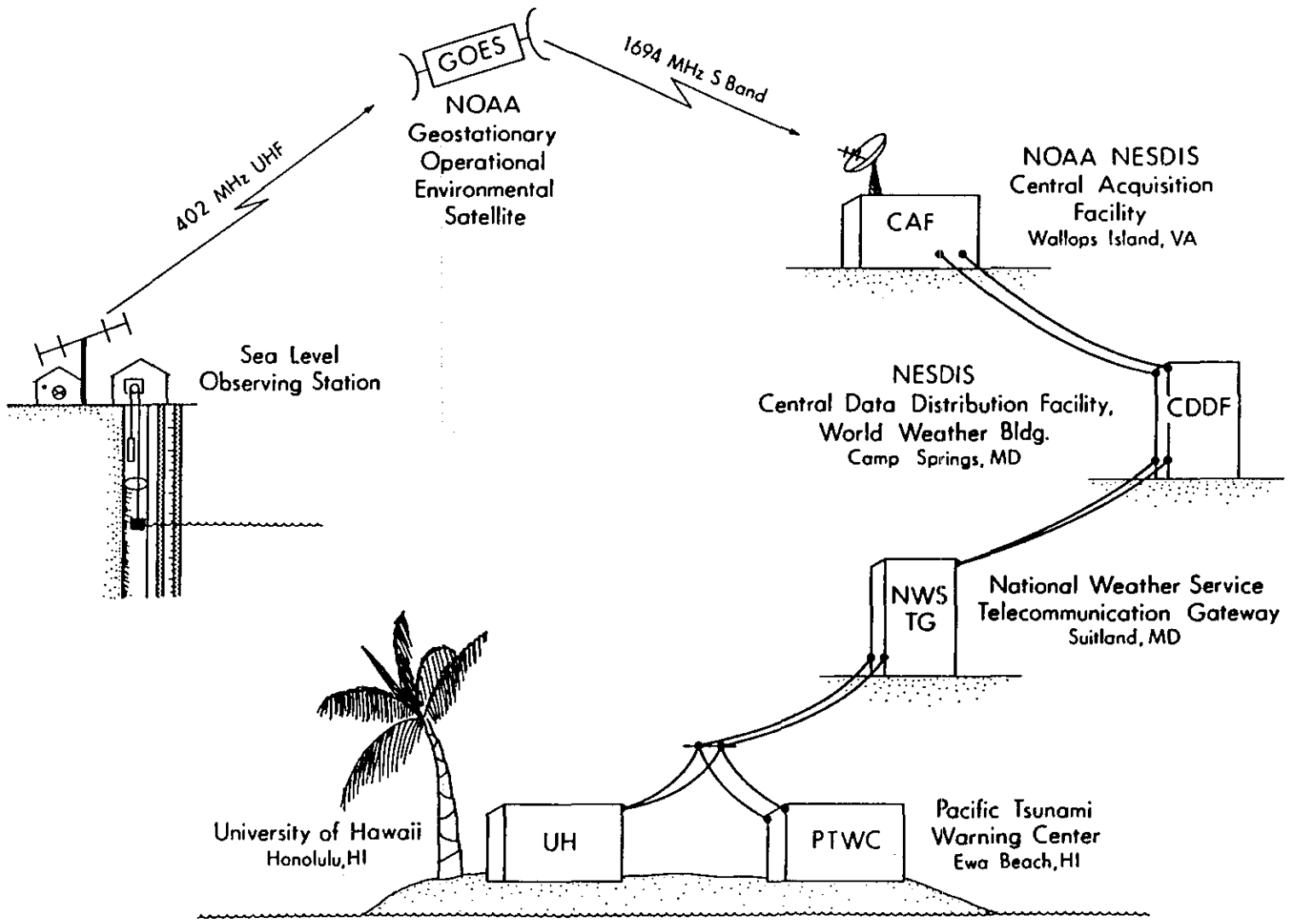
Joint Archive for Sea Level

The topography of the sea surface is a quantity 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 Nino 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. It is planned that the permanent archive at the NODC will contain complete 12-month data sets that have been quality controlled and include data at 15-minute, hourly, daily, and monthly intervals.

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 serve as the basis for a global sea level network.

Joint Archive for Sea Level



Satellite data transmission pathway for stations within the Pacific Sea Level Network.

Joint Center for Research in Management of Ocean Data

The Joint Center for Research in the Management of Ocean Data (JCRMOD) 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. JCRMOD 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 JCRMOD are: evaluating and improving the quality of historical data sets; developing improved 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.

Joint Center for Research in Management of Ocean Data

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

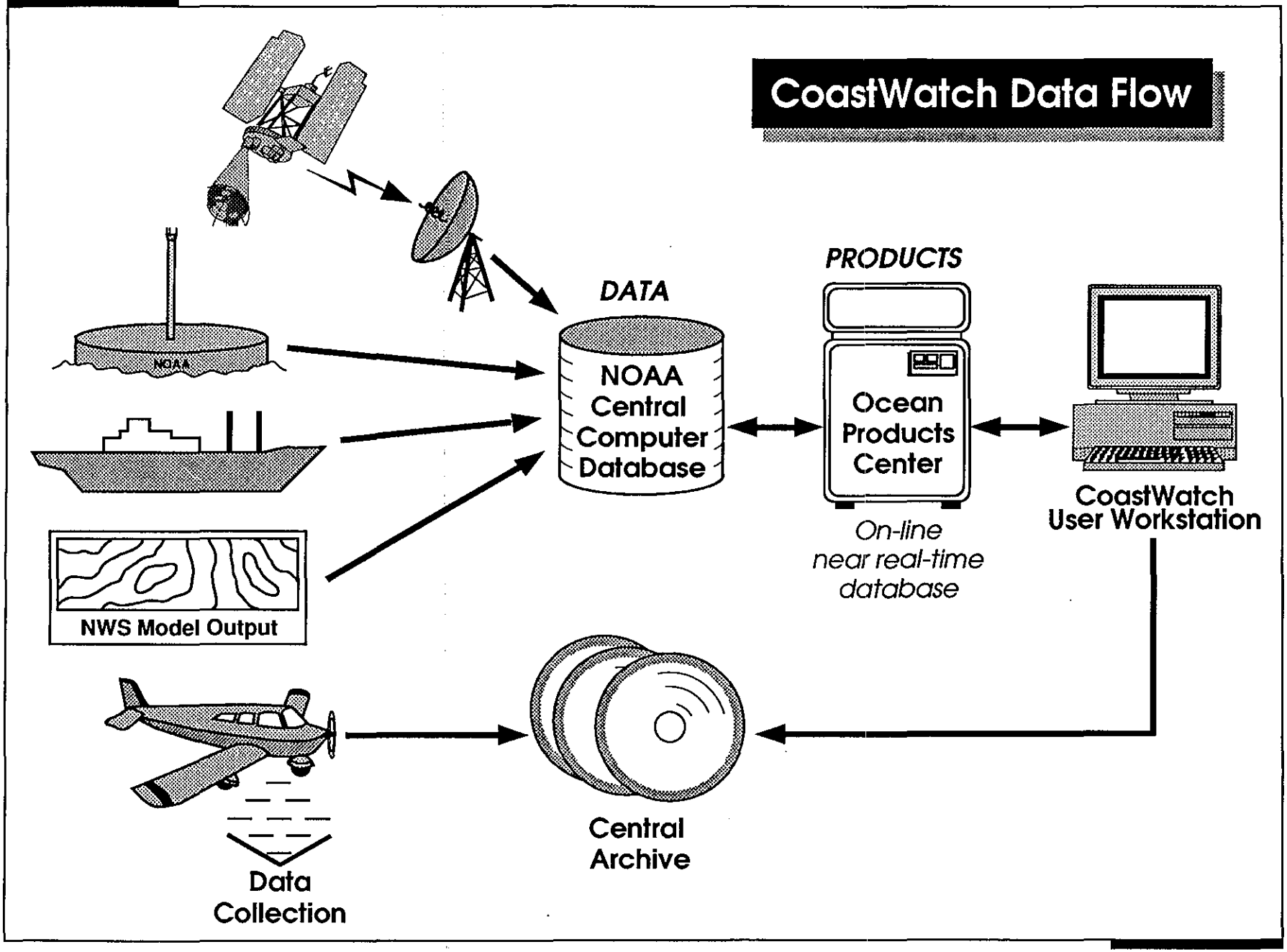
Data Management for Coastal Oceanography

To monitor threats to the Nation's natural resources in coastal areas, NOAA initiated a project called CoastWatch. CoastWatch is a predictive tool that relies on data collection, analysis, and communications capabilities within the National Marine Fisheries Service, the National Weather Service, the National Ocean Service, and the National Environmental Satellite, Data, and Information Service. A principal goal of NOAA CoastWatch is to provide scientists, state and Federal agencies, commerce and industry, and the public with near-real-time data products such as sea surface temperature and ocean circulation patterns that affect algal blooms, oxygen depletion, and outbreaks of "red tides", and related phenomena in coastal waters. A longer-term goal will be monitoring of gains or losses in coastal wetlands.

CoastWatch is undergoing a phased implementation that will ultimately provide coverage for all U.S. coastal areas including the Great Lakes. Southeast CoastWatch was initiated in August 1988 in response to a red tide event that devastated commercial and recreational shell fisheries in the Carolinas the previous fall. An experimental weekly *CoastWatch Bulletin* has been produced and distributed for this area since that time. Chesapeake Bay CoastWatch began in early 1989 as a pilot cooperative effort between NOAA and the multi-state/Federal agency Chespeake Bay Program. In the coming years other areas will be added to NOAA's CoastWatch.

The NODC is coordinating the development of CoastWatch within the NOAA Coastal Ocean Program in cooperation with other NOAA Line Offices.

Data Management for Coastal Oceanography



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.

Marine Information Management