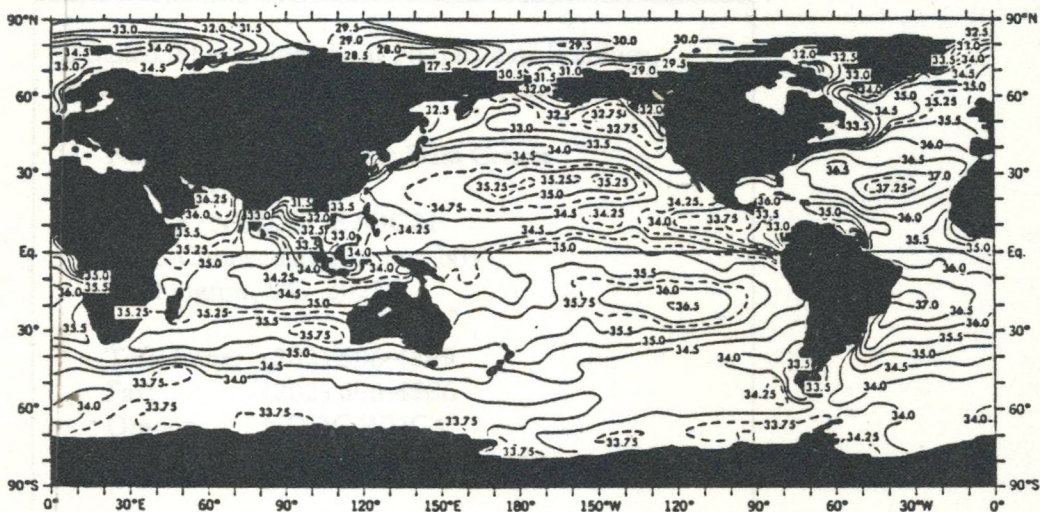


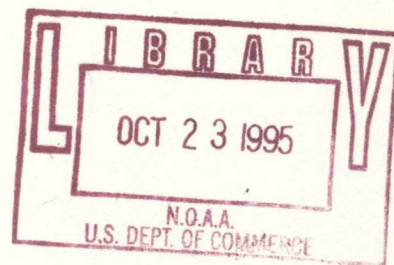
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.N38  
1993  
Oct.



# National Oceanographic Data Center PROGRAMS AND OPERATIONS



Washington, D.C.  
October 1993



**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@nodc.noaa.gov](mailto:services@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*)

NODC Informal Report No. 11

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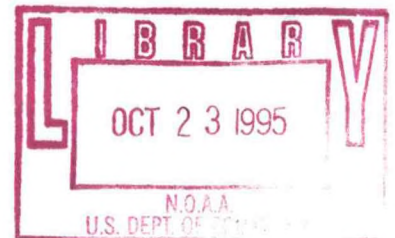


# National Oceanographic Data Center PROGRAMS AND OPERATIONS

Washington, D.C.  
October 1993

**U.S. DEPARTMENT OF COMMERCE**  
**Ronald H. Brown, Secretary**  
**National Oceanic and Atmospheric Administration**  
**D. James Baker, Under Secretary**

National Environmental Satellite, Data, and Information Service  
Robert S. Winokur, Assistant Administrator





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*Section 1*  
**INTRODUCTION**

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## NOAA's National Data Centers

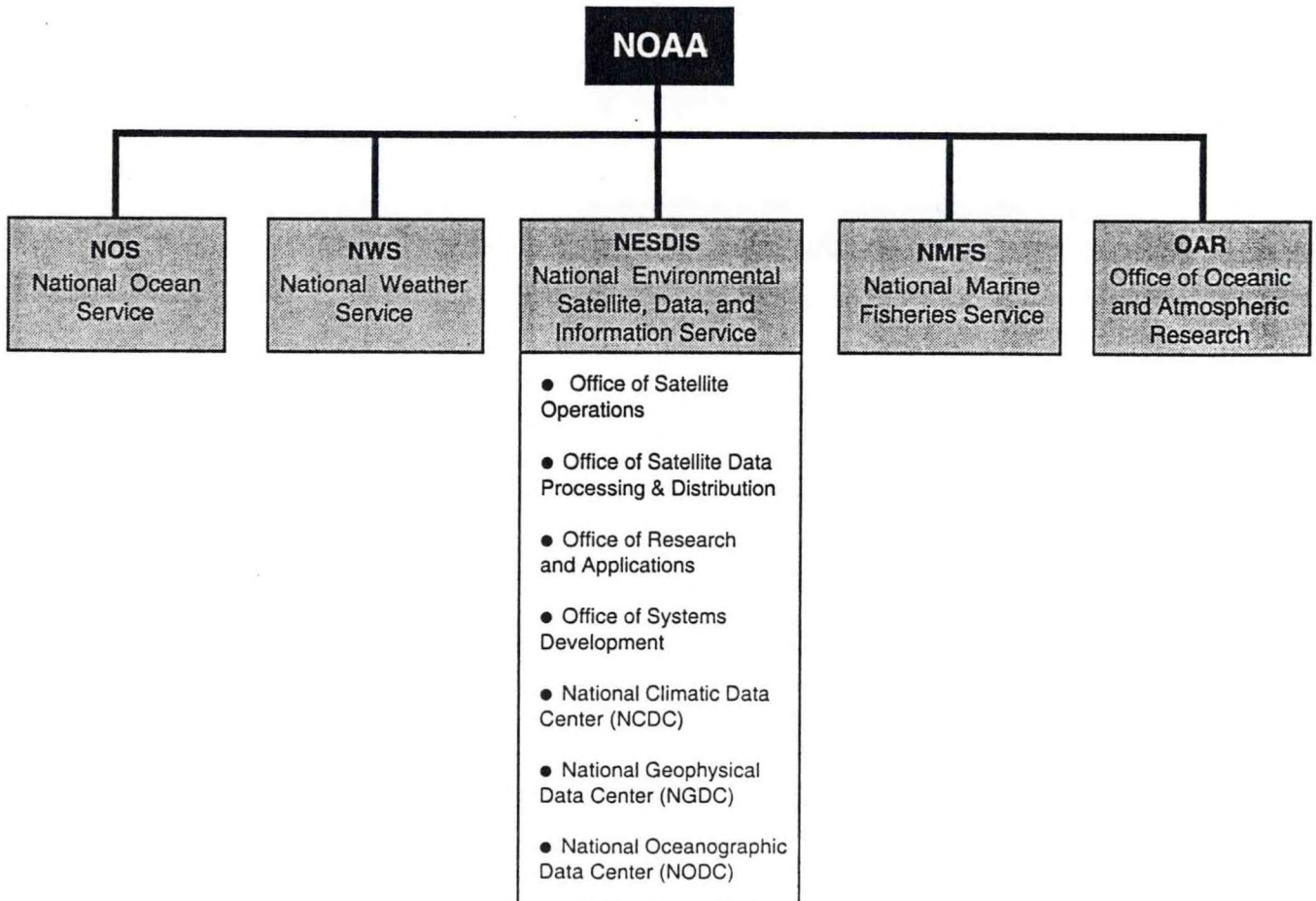
The National Oceanographic Data Center (NODC) is one of the national environmental data centers operated by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. NOAA is organized into five major line offices: the National Weather Service (NWS), the National Ocean Service (NOS), the National Marine Fisheries Service (NMFS), the National Environmental Satellite, Data, and Information Service (NESDIS), and the Office of Oceanic and Atmospheric Research (OAR). NESDIS is responsible for operating NOAA's weather satellites, including both polar orbiting and geostationary meteorological satellites. It also manages NOAA's three national environmental data centers:

- the National Climatic Data Center (NCDC), Asheville, N.C.,
- the National Geophysical Data Center (NGDC), Boulder, Colo., and

- the National Oceanographic Data Center (NODC), Washington, D.C.

In addition, the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, is operated for NOAA by the University of Colorado through the Cooperative Institute for Research on Environmental Sciences (CIRES).

These discipline-oriented centers serve as national repositories and distribution facilities for valuable environmental data. The earth science data archives amassed by the NODC and the other centers provide a record of earth's changing environment and support numerous research and operational applications. Working in close cooperation, the centers provide data products and services to scientists, engineers, resource managers, policy makers, and other users in the United States and around the world.



## NODC History and Mission

The National Oceanographic Data Center 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 NODC 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, the Department of Commerce, the Bureau of Commercial Fisheries, the 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; 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

Ocean data management functions of the NODC 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, Md., and field libraries throughout the United States.

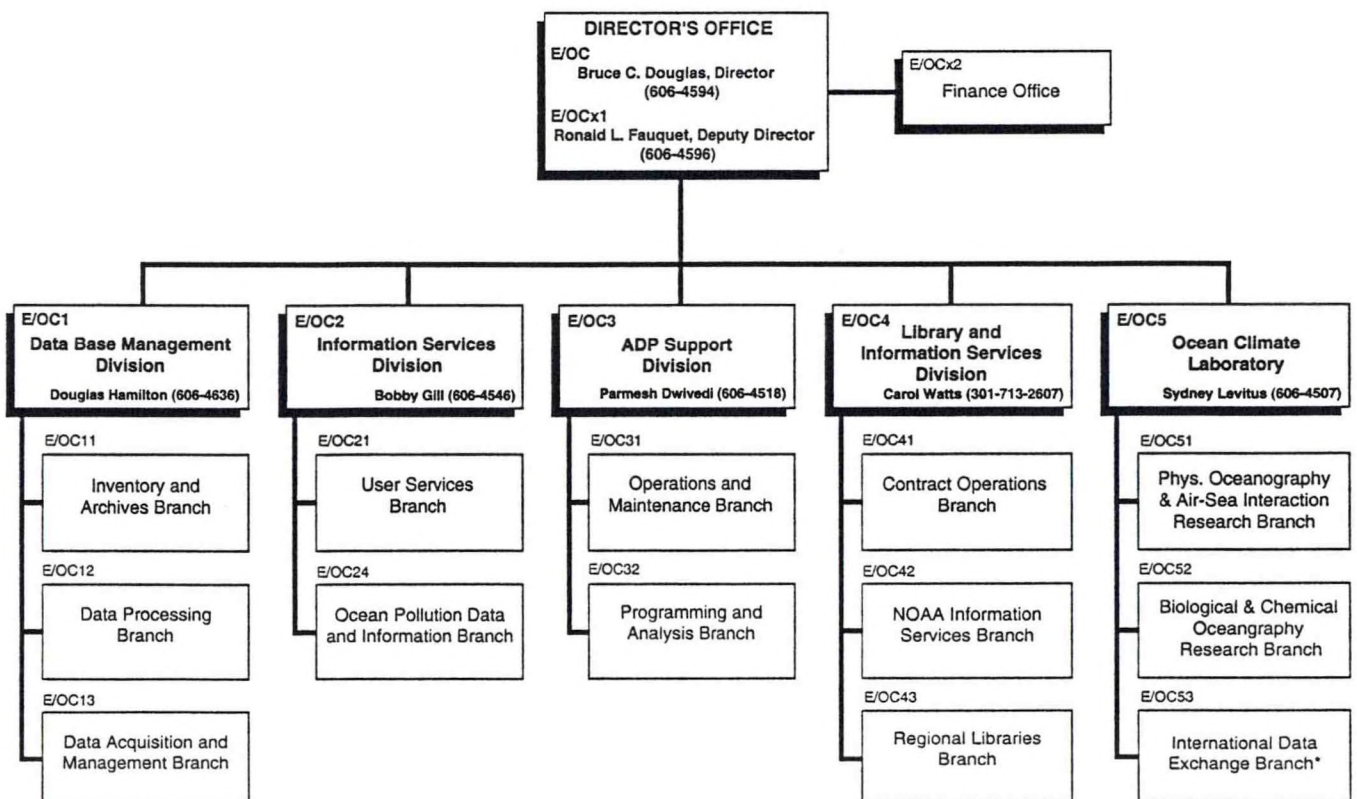
The Data Base Management Division coordinates the accessioning of ocean data sets by the NODC, manages all steps in the data processing and quality control process, updates data inventory systems, and maintains NODC's archive databases.

The Information Services Division provides ocean data services to NODC customers, produces NODC publications such as the *NODC Users Guide*, coordinates international data exchange with organizations and institu-

tions in other countries, and operates the World Data Center A for Oceanography. This Division also includes the NODC research group that develops scientific applications of NODC's data holdings such as the production of improved ocean climatologies from NODC data.

The ADP Support Division manages NODC's in-house computer resources, operates the NODC Local Area Network, and provides programming and systems development support for new NODC computer systems and applications.

The Library and Information Services Division, which is located at the NOAA Central Library in Silver Spring, Md., is responsible for providing NOAA personnel and outside users with information services through the facilities and resources of the Central Library and the NOAA field libraries.



\*Operates World Data Center A (WDC-A) for Oceanography

## 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 Li-

aison 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  
FAX: 508-457-2183

### Southeast Liaison Office

NOAA/NESDIS  
AOML Bldg.  
4301 Rickenbacker Causeway  
Miami, FL 33149  
Telephone: 305-361-4305  
FAX: 305-361-4402

### Southwest Liaison Office

NOAA/NESDIS  
8604 La Jolla Shores Drive  
P.O. Box 271  
La Jolla, CA 92037  
Telephone: 619-546-7110  
FAX: 619-456-7003

### Northwest & Alaska Liaison Office

NOAA/NESDIS  
Bin 15700/Bldg. 3  
7600 Sand Point Way, NE  
Seattle, WA 98115  
Telephone: 206-526-6263  
FAX: 206-526-6485

### Hawaii Liaison Office

NOAA/NESDIS  
University of Hawaii - MSB 316  
1000 Pope Road  
Honolulu, HI 96734  
Telephone: 808-956-4105  
FAX: 808-956-2352

*Section 2*

**DATA AQUISITIONS AND DATA HOLDINGS**

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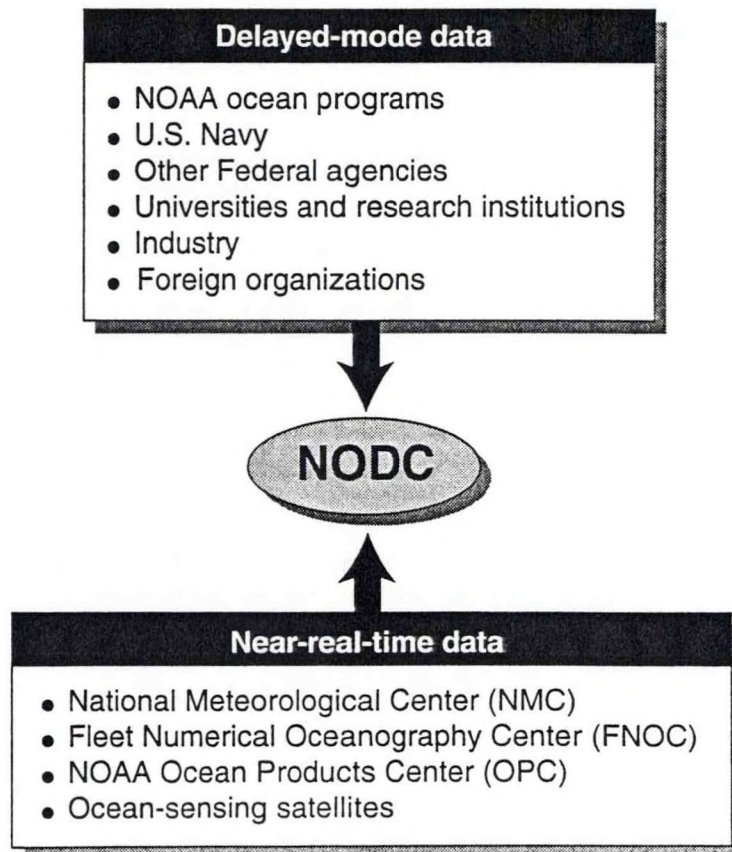
## NODC Data Sources

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 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. The 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.

The 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 (as of July 1993)

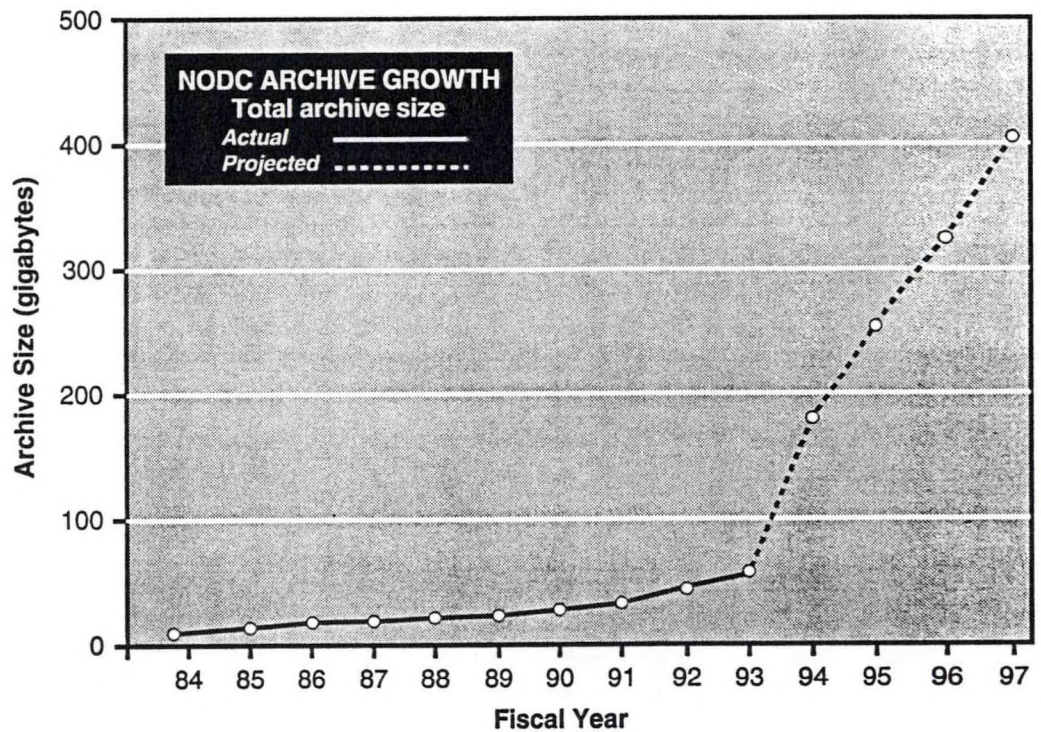
DISCIPLINE	VOLUME (MBytes)	DISCIPLINE	VOLUME (MBytes)
<b>PHYSICAL/CHEMICAL DATA</b>		<b>MARINE BIOLOGICAL DATA</b>	
<b>Master Data Files</b>		<b>Master Data Files</b>	
Buoy data (Wind/Waves) .....	8,232	Fish/Shellfish .....	115
Currents .....	4,046	Benthic organisms .....	69
Ocean stations .....	1,637	Intertidal/Subtidal organisms .....	30
Salinity/Temperature/Depth .....	1,482	Plankton .....	29
BT temperature profiles .....	844	Marine mammal sighting/census .....	21
Sea level .....	114	Primary productivity .....	7
Marine chemistry/marine pollutants .....	89	Subtotal .....	271
Other .....	68		
Subtotal .....	16,512		
<b>Individual Data Sets, for example</b>		<b>Individual Data Sets, for example</b>	
Geosat data sets .....	12,841	Marine bird data sets .....	52
CoastWatch data .....	18,000	Marine mammal data sets .....	4
Levitus Ocean Atlas data sets .....	61	Marine pathology data sets .....	4
Other (estimated) .....	11,000	Other (estimated) .....	200
Subtotal .....	41,902	Subtotal .....	260
TOTAL PHYSICAL/CHEMICAL ....	58,414	TOTAL BIOLOGICAL .....	531
		<b>TOTAL DATA HOLDINGS .....</b>	<b>58,945</b>



## NODC Database Growth

In the mid- to late-1990s and beyond, the National Oceanographic Data Center expects to receive major new data accessions from multinational oceanographic programs and from new ocean-sensing satellites. As a result of this flood of new data, the NODC projects rapid growth in the total volume of its data holdings through the end of the century. The NODC's data archive could easily quadruple in size by 1997.

To cope with this huge influx of data, the NODC is modernizing its data management system through adoption of new technology. A new client-server computing environment based on advanced workstations and mass storage devices, including optical disc, will help the NODC accommodate this rapid increase in data accessions. It will also make data in the NODC archive more easily accessible to researchers and other users.



## Ocean Temperature

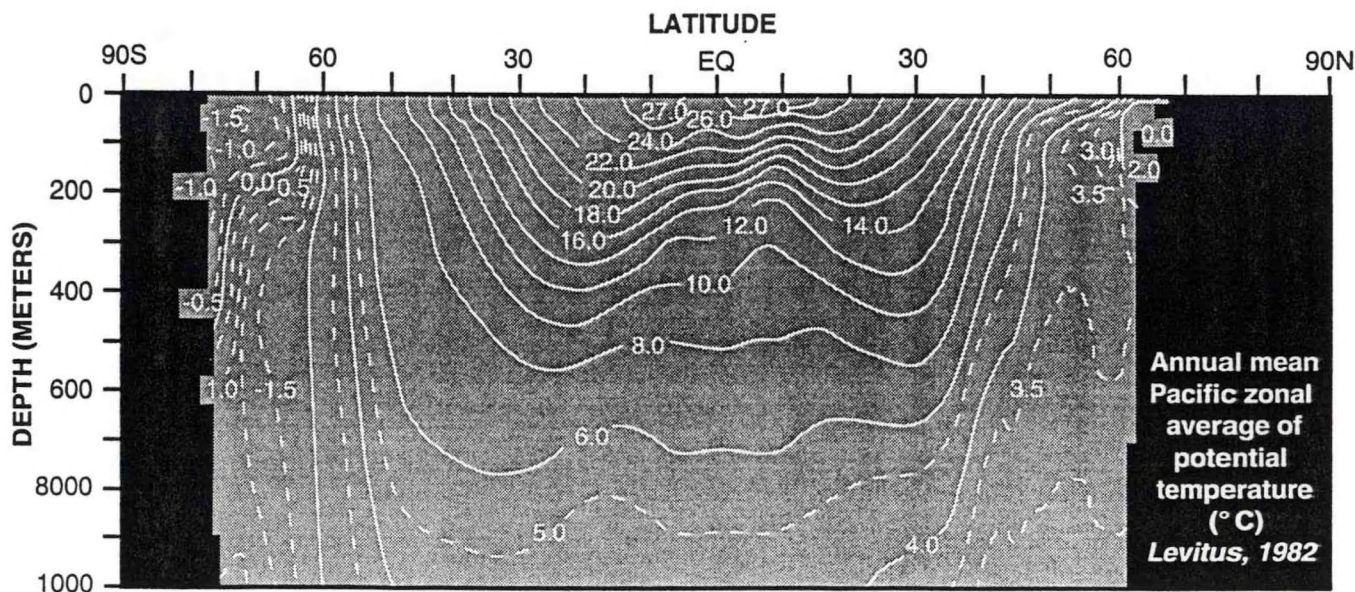
NODC's major data files contain well over 3 million ocean temperature profiles from oceanographic stations (bottle casts), bathythermograph (BT) observations, and CTD/STD (conductivity-temperature-depth/salinity-temperature depth) casts. Bathythermograph instruments have limited depth range (for example, up to 760 m for a standard expendable bathythermograph or XBT), so BT data provide information on the thermal structure of only the upper layers of the ocean. Deep observations from oceanographic stations and CTD/STD casts, however, provide temperature data to depths of thousands of meters in the ocean.

In addition to the ocean temperature profiles in its major archive data files, the NODC also holds special data sets that include ocean temperature and other major ocean parameters. A number of these data sets contain data subject to special editing or analysis procedures. For example, the NODC distributes both the atlas data set and grid point data set produced in conjunction with

the *Southern Ocean Atlas* published by Columbia University Press and gridded fields of major ocean parameters developed from the NODC data files and published in 1982 as the *Climatological Atlas of the World Ocean* (NOAA Professional Paper No. 13).

Sydney Levitus, author of the *Climatological Atlas of the World* and now head of the NODC's research group, has a project underway to update and refine these ocean data analyses. The volume of data added to the NODC files since the atlas was published makes it possible to develop significantly improved ocean climatologies for support of climate and global change research.

The NODC's holdings of *in situ* temperature-depth profile data are now also supplemented by sea surface temperature (SST) data collected by ocean satellites. One of the largest collections of such data at NODC is SST imagery for U.S. coastal areas archived and disseminated under the auspices of the NOAA CoastWatch program.

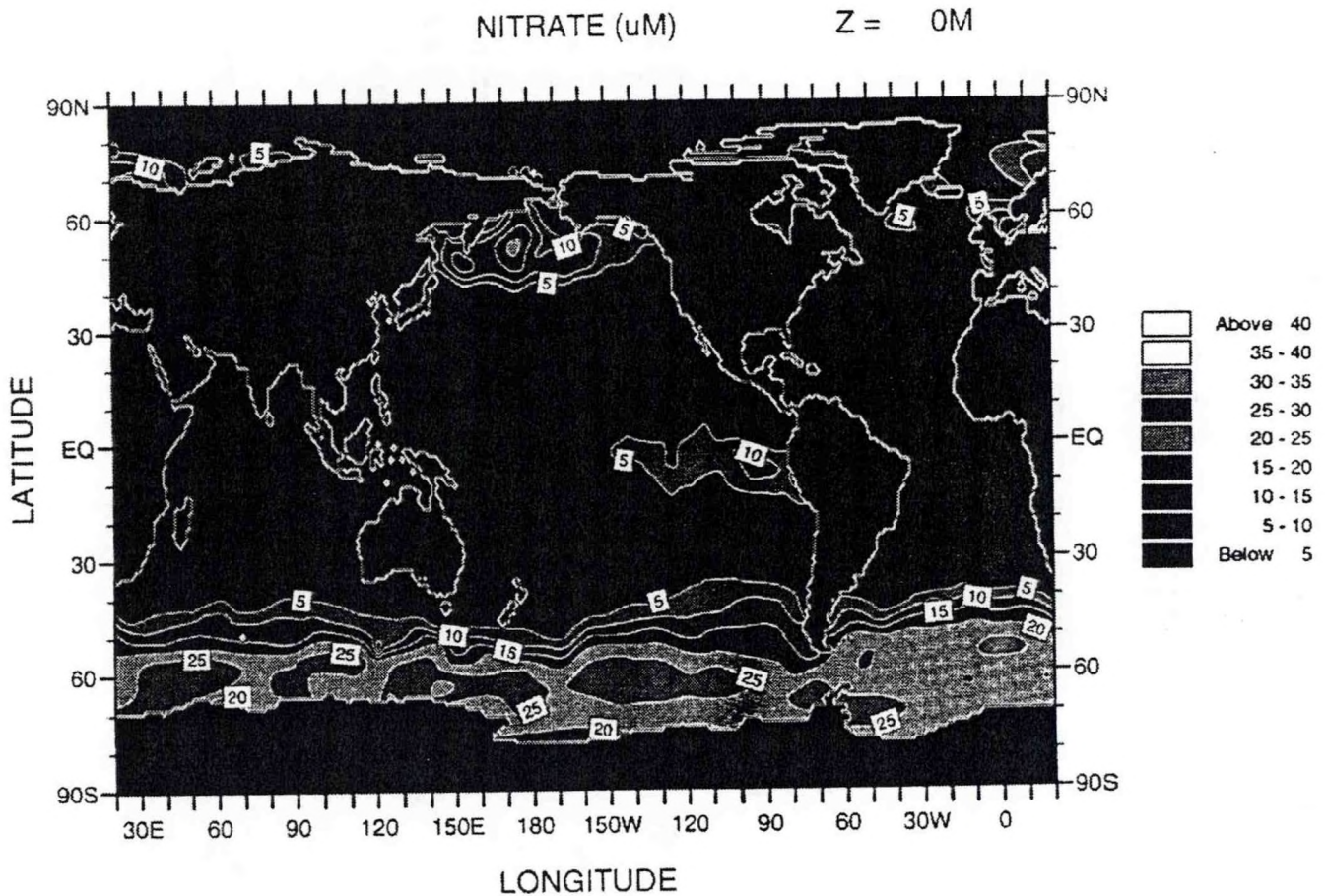


## Ocean Chemistry

Several NODC archive data files contain ocean chemistry data. The Oceanographic Station Data file, which holds observations made using multi-bottle Nansen casts or other types of water samplers, provides global measurements of salinity, dissolved oxygen, pH, and nutrients (e.g., phosphate, nitrate, nitrite, silicate) at serial depths. Salinity (along with some dissolved oxygen data) is also available from CTD/STD data files.

In addition to its global holdings of salin-

ity, dissolved oxygen, and nutrient data, the NODC holds smaller quantities of other chemical parameters primarily from U.S. coastal waters and a few other selected areas. These parameters include chlorophyll, ammonia, and dissolved and particulate organic carbon. In its Marine Toxic Substances and Pollutants Data File, the NODC also has measurements of the concentrations of heavy metals, hydrocarbons, pesticides, and other pollutants.



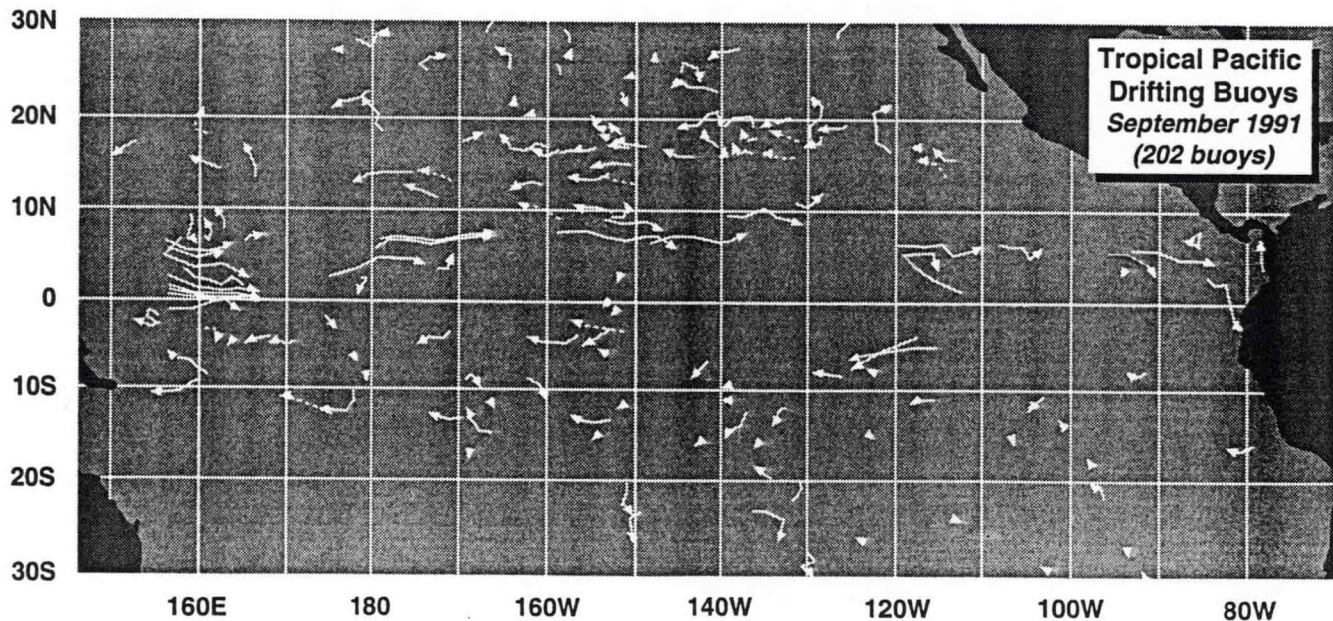
## Ocean Currents

The NODC's holdings of ocean current data include time series measurements of sub-surface ocean currents from moored current meters. The data record comprises values of the east-west and north-south vector current components (or resultant current direction and speed) at specified date and time.

Time series ocean circulation data is also provided by drifting buoys, drogues, or other instrumented devices. Movement is reported as point-to-point geographic positions determined by shore-based, surface ship, aircraft, or satellite observations. The NODC's ocean current data holdings have been enriched by new observations received from the TOGA drifters deployed in the tropical oceans. TOGA (for Tropical Ocean-Global Atmosphere Program) is a major international research program that is studying the El Niño and other complex dynamical interactions between the oceans and atmosphere.

Another type of ocean current data is ship drift data. In the years before direct ocean current measurements were widely available, indirect determinations of ocean surface currents were made using the ship drift method. The NODC Ship Drift Surface Current Data File holds such data collected over the period from about 1850 to 1974.

In the ship drift method, the difference between a ship's dead-reckoned position (determined from its previous position, speed, and heading) and actual position determined from a navigational fix is ascribed solely to the effect of ocean surface currents. Because other factors such as wind that affect the ship's course are ignored in this approximation, the individual observations are not highly accurate. However, this data file does provide useful statistical summaries of average current direction and speed.

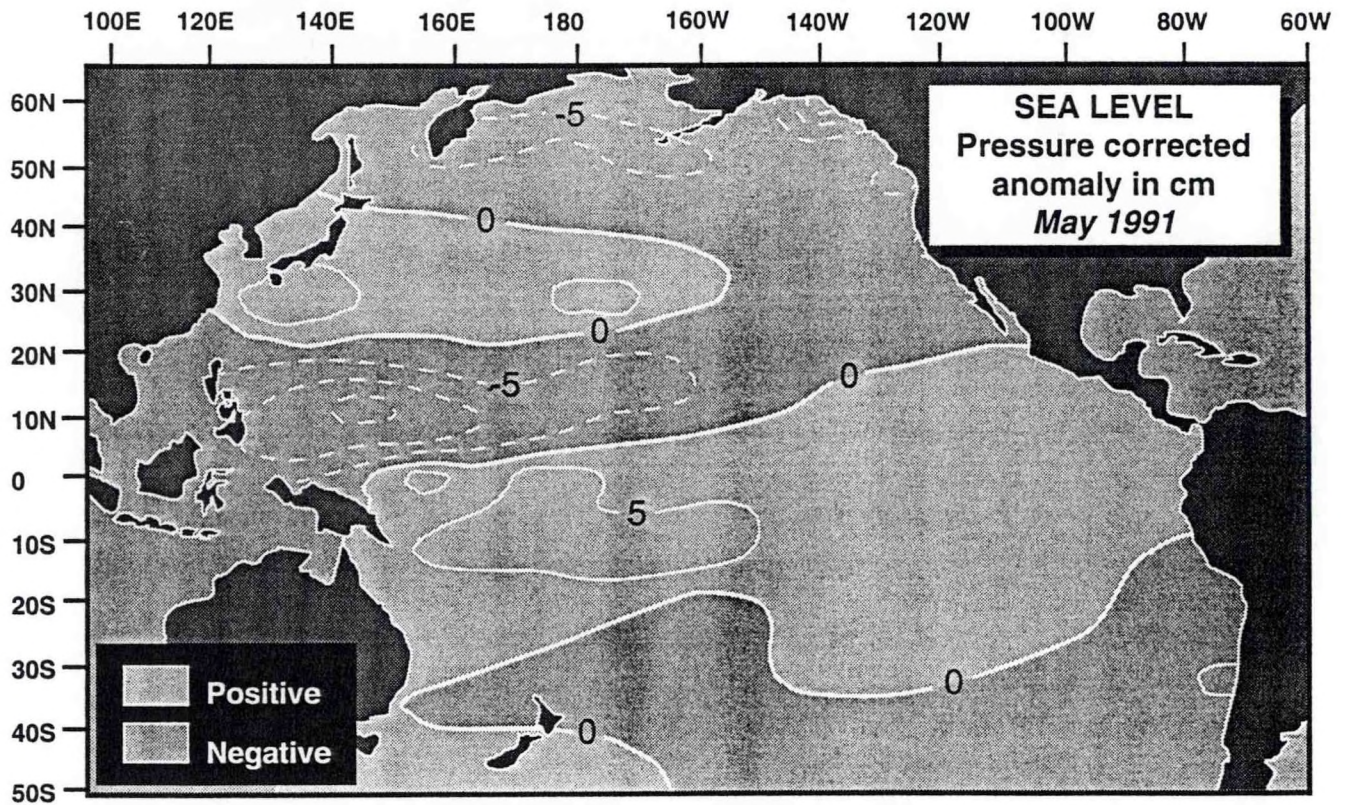


## Sea Level

The NODC holds both *in situ* sea level data from a global network of coastal and island stations and remotely-sensed sea level data derived from satellite altimeter instruments. To coordinate the acquisition, processing, quality assessment, archiving, and distribution of *in situ* data being collected worldwide, the NODC and the University of Hawaii established the Joint Archive for Sea Level (JASL). The data are assembled, processed, and quality controlled at the University of Hawaii. Once a year the new data are sent to the NODC for inclusion in the JASL permanent data archive. The JASL data archive at

the NODC now contains hourly, daily, and monthly sea level data from 191 stations, including 116 in the Pacific Ocean, 26 in the Atlantic Ocean, and 49 in the Indian Ocean.

Ocean satellite altimetry provides another source of sea level data. Altimeter instruments onboard ocean sensing satellites can measure the elevation of the sea surface with an accuracy of a few centimeters. Data from the U.S. Navy Geosat archived by the NODC have been used, for example, to study the El Niño-Southern Oscillation in the tropical Pacific Ocean as reflected by changes in sea level.



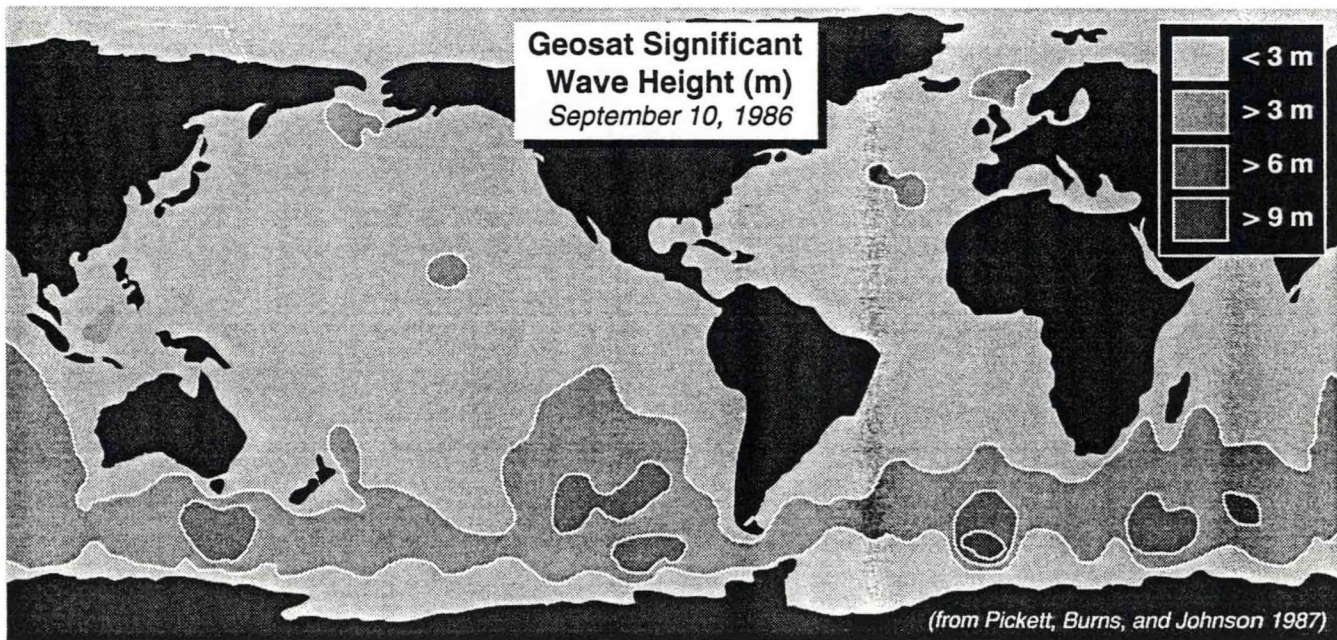
## Ocean Wind/Waves

One of the NODC's most frequently used data files contains time series meteorological and oceanographic data collected by moored buoys and C-MAN (Coastal-Marine Automated Network) stations operated by the NOAA National Data Buoy Center (NDBC). The ocean wave data available from the NOAA buoys is particularly valuable and finds wide application in ocean science, ocean engineering, and marine operations.

The buoy network began operation in the early 1970s. The earliest data in the NODC archive is from 1972. The first C-MAN stations became operational in March 1983, and the NODC data archive holds data beginning in January 1985. These data are telecommunicated to U.S. operational centers for use in real-time forecasting and then accumulated and transmitted to NODC for

permanent storage. Principal parameters reported by both buoy and C-MAN stations include air temperature and pressure, wind speed and direction, wind gust, and sea surface temperature. The buoys (and a few C-MAN stations located on offshore platforms) also report wave data which may include significant wave height, average and dominant wave period, and wave spectra. Data are currently being received each month from about 60 buoys and 60 C-MAN stations.

Today, *in situ* wind and wave data is supplemented by global wind and wave data derived from ocean satellite observations. NODC data holdings include a global wind/wave data set derived from measurements taken by the U.S. Navy Geodetic Satellite (Geosat).



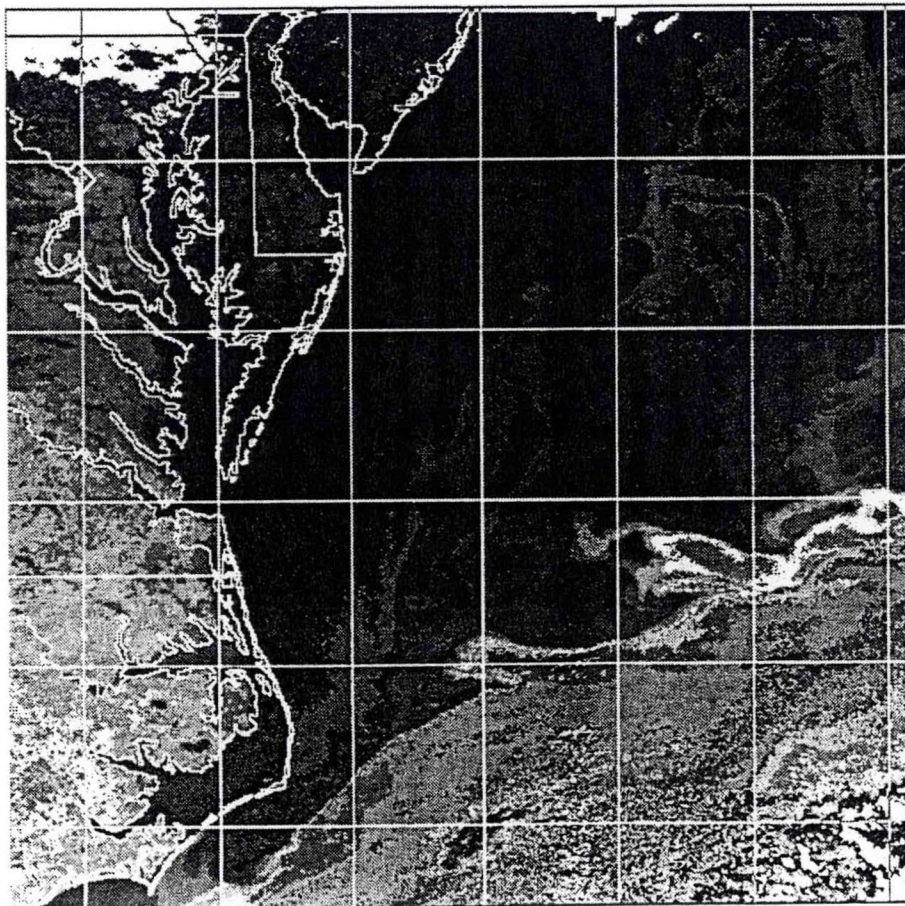
## Ocean Satellite Data

By providing a global view of the oceans, satellites are revolutionizing the science of oceanography. Instruments on ocean satellites measure only ocean surface properties, however, and do not replace *in situ* measurements of ocean parameters at depth. Satellite and *in situ* data complement each other and enable researchers to develop a more complete understanding of ocean processes and phenomenon.

The NODC holds several important ocean satellite data sets and anticipates receiving and disseminating others in the future. Working in cooperation with the Satellite and Ocean Dynamics Branch of the NOAA National Ocean Service, the NODC has archived and made available on CD-ROM several sets of altimeter data from the U.S. Navy Geodetic Satellite (Geosat) that operated from 1985 through the end of 1989. In addition to their

applications in oceanographic research (e.g., sea level, global winds and waves), these data are valuable for studies related to marine geodesy and the geophysics of the oceanic crust.

In support of the NOAA Coastal Ocean Program, the NODC archives and disseminates satellite data and imagery for U.S. coastal areas collected as part of NOAA CoastWatch. The primary product is sea surface temperature (SST) for various U.S. coastal areas. The raw data from which these products are derived are collected using the Advanced Very High Resolution Radiometer (AVHRR), a radiation-detection instrument onboard NOAA's TIROS-N Polar Orbiting Environmental Satellites. Since 1990 about 55,000 CoastWatch images have been archived at the NODC on optical disc.

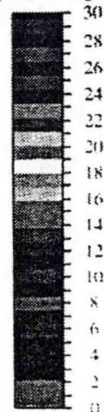


### CoastWatch

#### MCSST Temperature

Filename:  
nc9306619.c17  
IMGMAP Image  
NOAA 11 Orbit: 22956  
300793 JD 66 19:58 GMT  
Pixel Size: 1.39 km  
Lat Range: 34.50N to 39.80N  
Lon Range: 77.56W to 70.80W  
Inflset: -5867 -1  
Joffset: 14656 -3

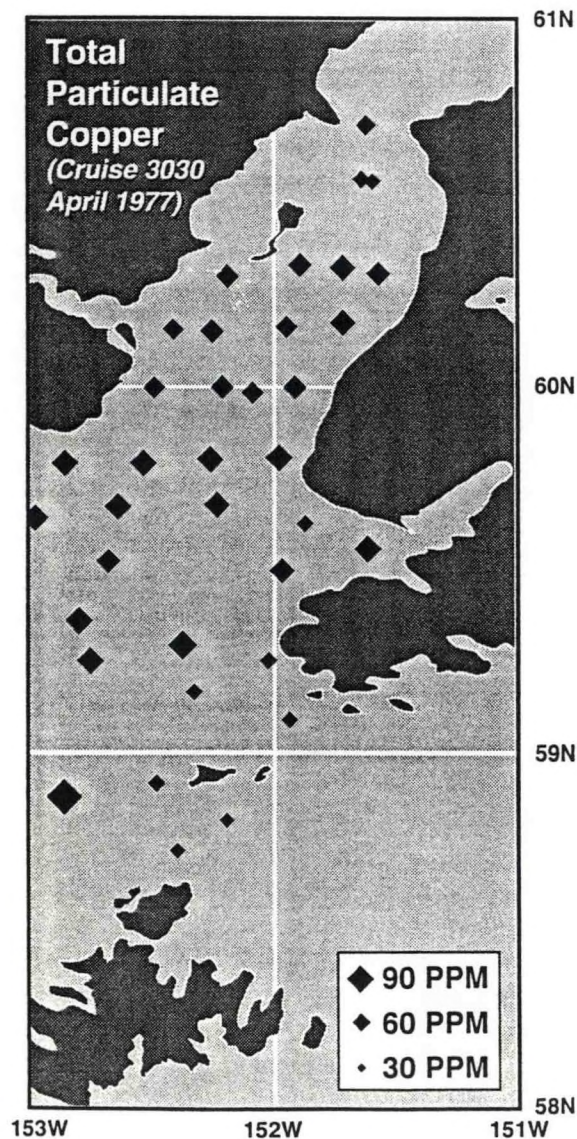
#### MCSST Temperature (Degrees Centigrade)



## Ocean Pollutants

The NODC's Marine Toxic Substances and Pollutants Data File contains data on concentrations of toxic substances and other pollutants in the marine environment, plus water chemistry data. Geographic coverage includes U.S. coastal waters, the Gulf of Mexico, the Caribbean Sea, and the Pacific coast of Mexico. Because the NODC received data from major environmental studies related to the development of Alaska's offshore oil deposits, the data coverage around Alaska is particularly heavy.

The data in this file are derived from laboratory analyses of samples of water, sediment, or marine organisms. Samples may have been collected near marine discharge sites or during monitoring of large ocean areas. The data record comprises concentration values (or a code to indicate trace amounts) for each chemical substance analyzed. Chemical substances are identified by codes based on the registry numbers assigned by the Chemical Abstracts Service of the American Chemical Society.



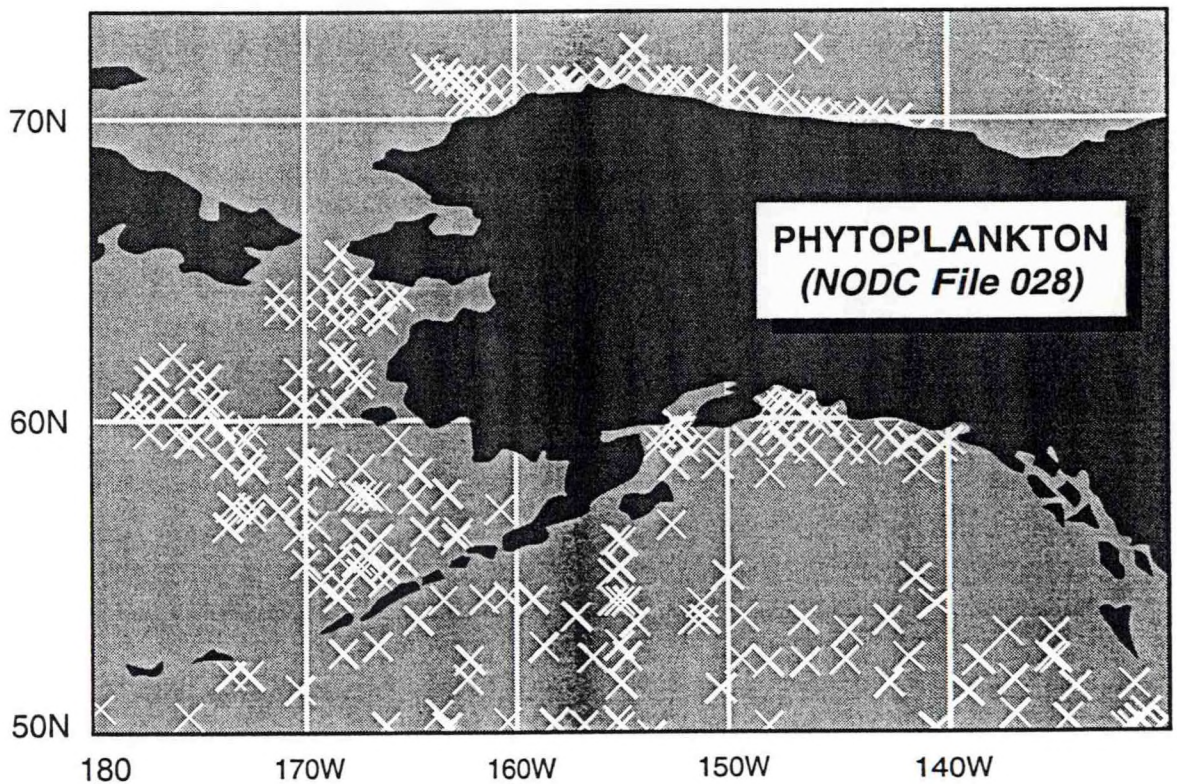


## Marine Biological Data

The NODC'S primary marine biological data holdings include data on phytoplankton, zooplankton, primary productivity, intertidal/subtidal organisms and habitats, benthic organisms, and fish and shellfish. In addition, the NODC also holds smaller marine biological data sets such as data on marine birds, marine mammals, and marine pathology (e.g., fin rot, fish pathology).

These data derive mainly from several major environmental assessment programs of the late 1970s and 1980s conducted to study the

effects of ocean dumping, offshore resource development, and other human activities in the coastal zone of the United States. Chief among these studies were the Outer Continental Shelf Environmental Assessment Program (OCSEAP) conducted in Alaskan waters and the Marine Ecosystems Analysis (MESA) program that focused on the New York Bight area and Puget Sound. Therefore, most of the NODC's marine biological data holdings are from these specific geographic areas.



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*Section 3*

**INTERNATIONAL PROGRAMS**

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## International Cooperation and Data Exchange

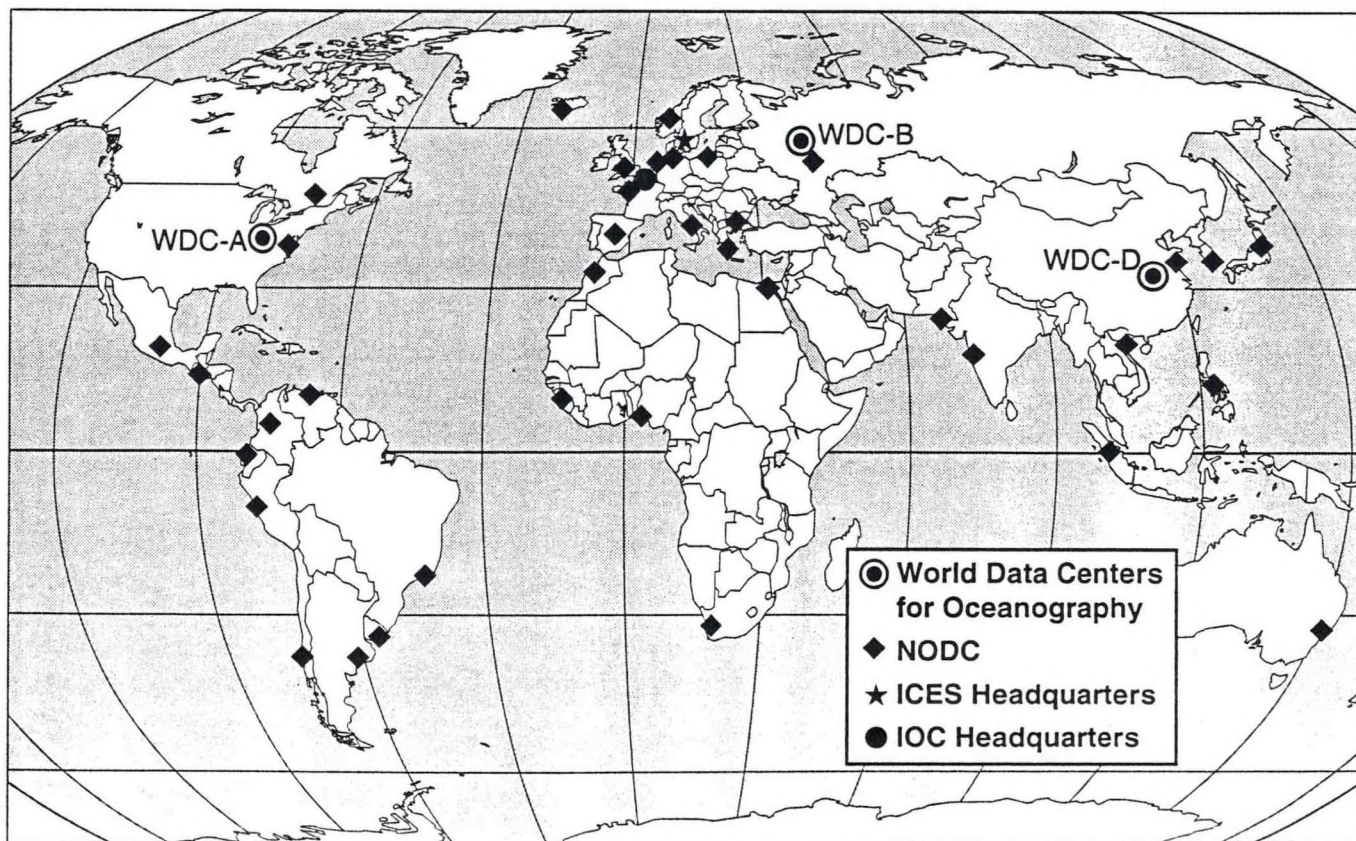
The NODC supports a number of international data exchange activities that help it fulfill its mission. Participation in these activities promotes data exchange and enables the NODC to augment its data holdings with valuable foreign data taken worldwide. NODC's interactions with international organizations 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, 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, Russia) the data holdings of the NODC have been enriched by ocean data from Russia and other nations of the former Soviet Union.

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 2.75 million scientific observations. On 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*.

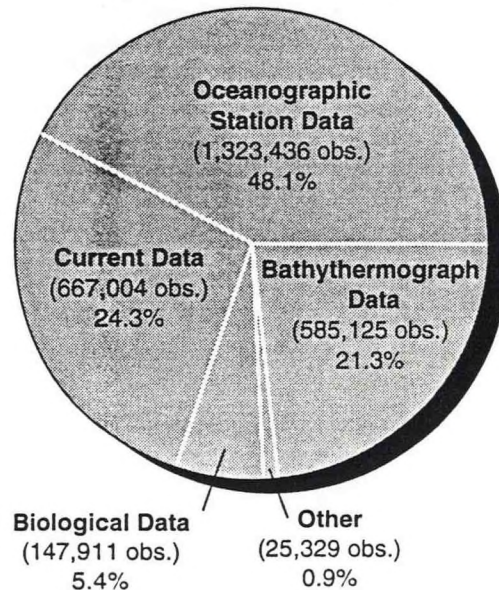


### Oceanographic Stations Received 1983-1992

YEAR	STATIONS RECEIVED	TOTAL ON HAND
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
1992	297,854	1,323,436

### International Marine Database (as of Dec. 1992)

(Total: 2.75 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.

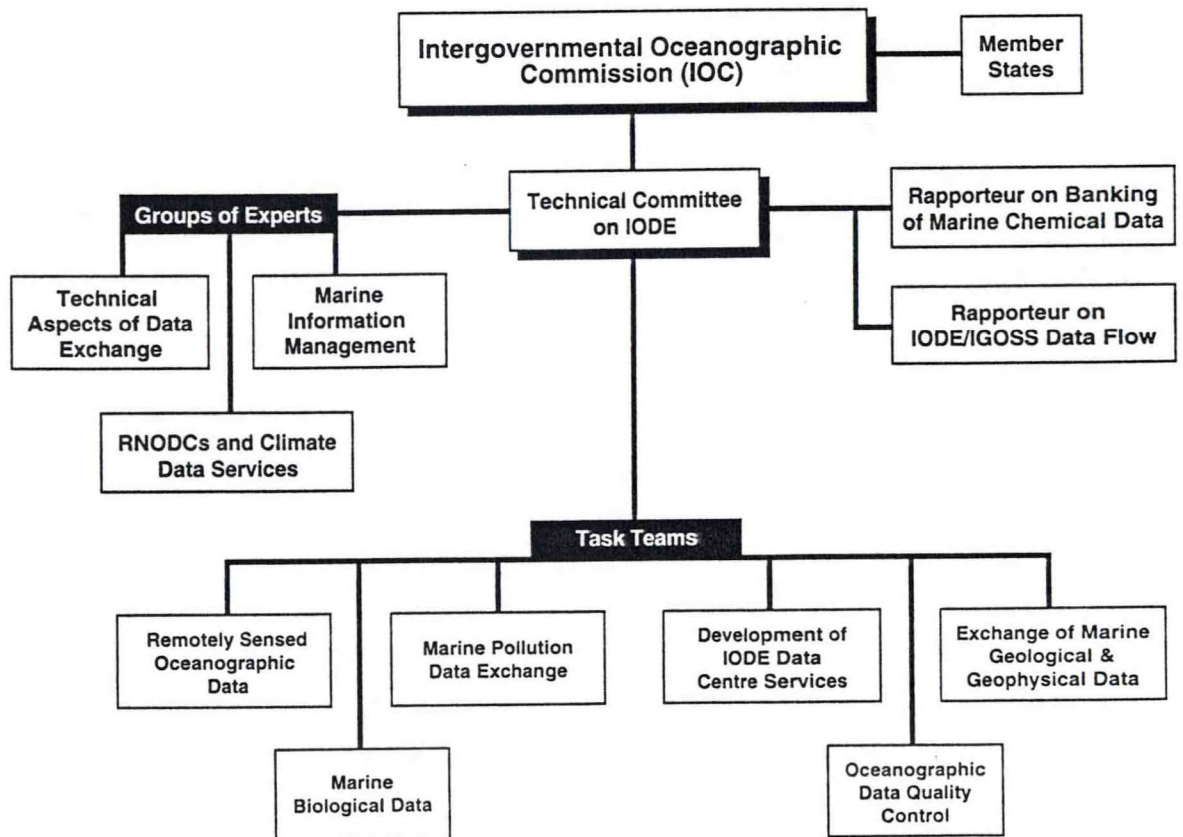
Some of the more important accomplishments of the IODE have been: (1) standardizing forms for reporting and coding data, (2) promulgating the concept of Declared National Programs (DNPs) as national activities being carried out with the intention to exchange the resulting data, (3)

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 and quality of ocean temperature-salinity observations available to climate researchers worldwide. Goals of the GTSP are to:

- improve the flow of real-time data over the Global Telecommunications System,
- develop and implement standard procedures for data quality control,
- build and maintain a continuously managed database of global ocean temperature-salinity data, and
- incorporate into the GTSP database data quality flags and changes resulting from scientific analysis of the data.

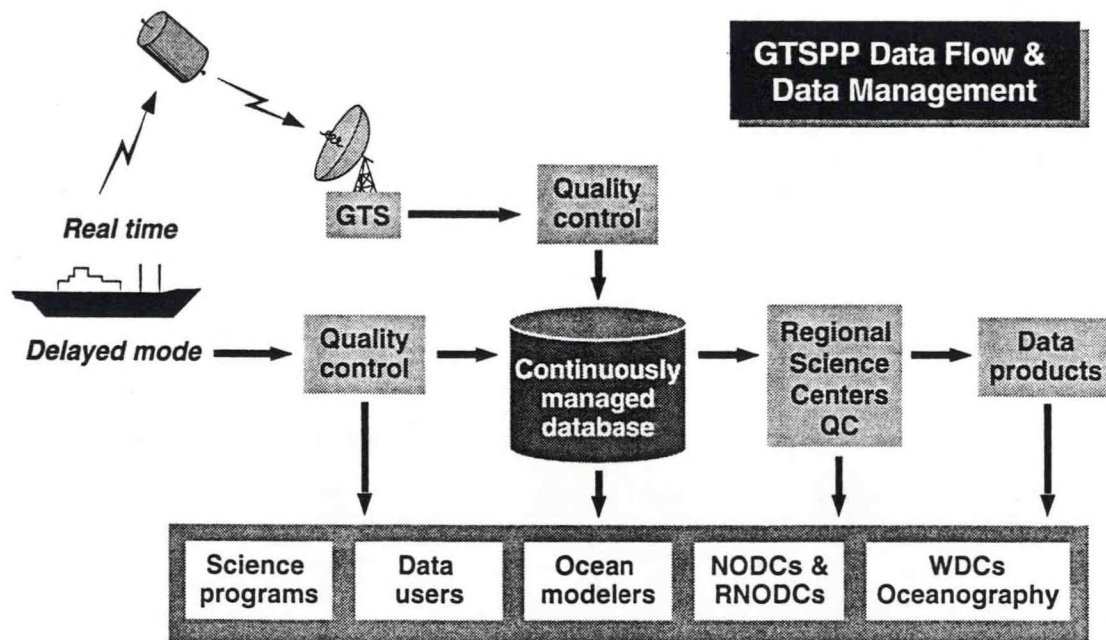
GTSP operations were initiated in January 1991 when real-time ocean temperature-salinity data began flowing to the U.S. NODC from Canada's Marine Environmental Data Service (MEDS). MEDS provides initial quality control for the real-time data. The U.S. NODC provides quality control for the delayed mode data and merges the incoming

data into the GTSP database.

The NODC divides the data stream into three files, one for each of the major ocean basins: Atlantic, Pacific, and Indian. Each month data for each of the ocean basins is transmitted via computer network to one of three science centers responsible for scientific analysis and quality control of the data. These centers are:

- *Atlantic Ocean*: NOAA Atlantic Oceanographic and Meteorological Laboratory, Miami, Florida,
- *Pacific Ocean*: Scripps Institution of Oceanography, La Jolla, California,
- *Indian Ocean*: CSIRO Division of Oceanography, Hobart, Tasmania, Australia.

In addition, the data are transmitted to the TOGA Subsurface Thermal Data Center, Brest, France, which also maintains a global temperature-salinity data file. The real-time data received each day are also immediately forwarded to the NOAA Climate Analysis Center where they are used in an upper ocean temperature model.





## Global Oceanographic Data Archaeology and Rescue Project

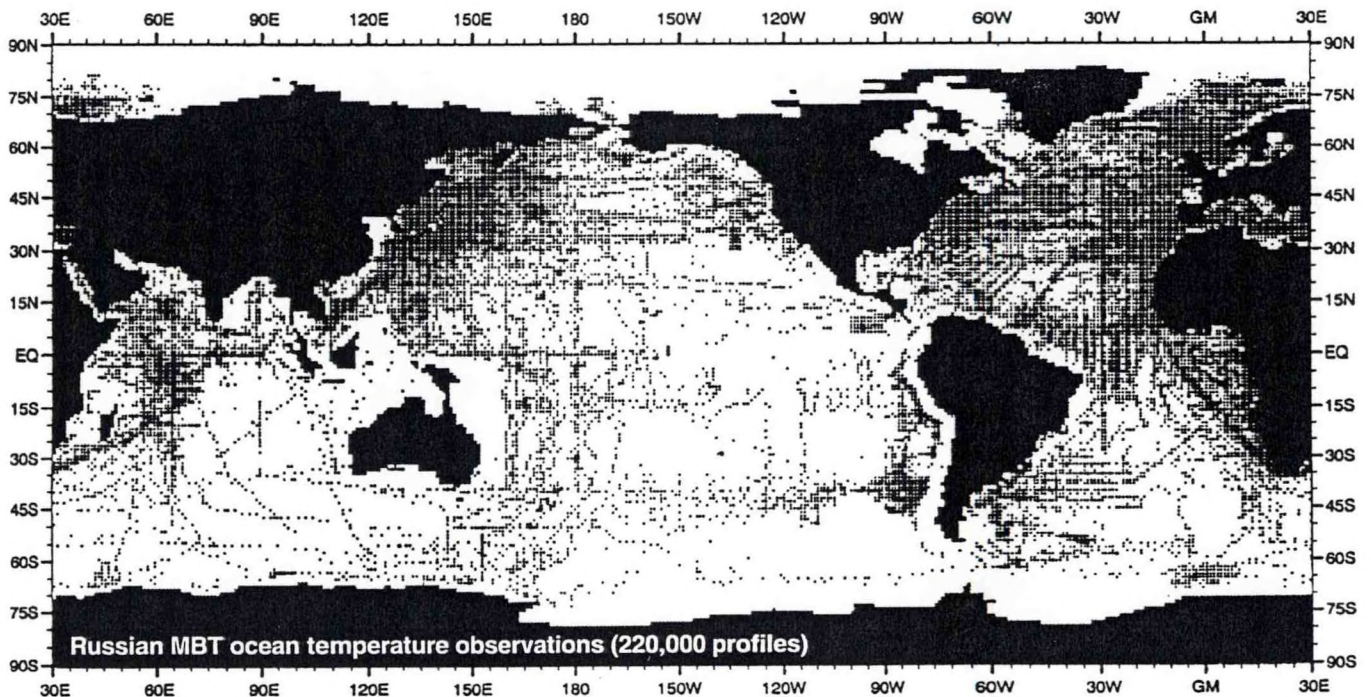
A critical requirement for climate and global change research is the availability of digital oceanographic data covering long time spans. It has been estimated, however, that perhaps two-thirds of all historical oceanographic data exist only in manuscript form or have not been submitted to a national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

and Rescue Project was presented by the NODC/WDC-A at the 14th Session of the Committee on International Oceanographic Data and Information Exchange (IODE) in December 1992. The IODE approved this proposal and forwarded it to its parent body, the Intergovernmental Oceanographic Commission, which endorsed it at the 17th IOC Assembly in March 1993. The U.S. NODC/WDC-A has been designated to lead this international project.

The Global 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.





*Section 4*

**DATA PROCESSING AND DATA SYSTEMS**

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## 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:

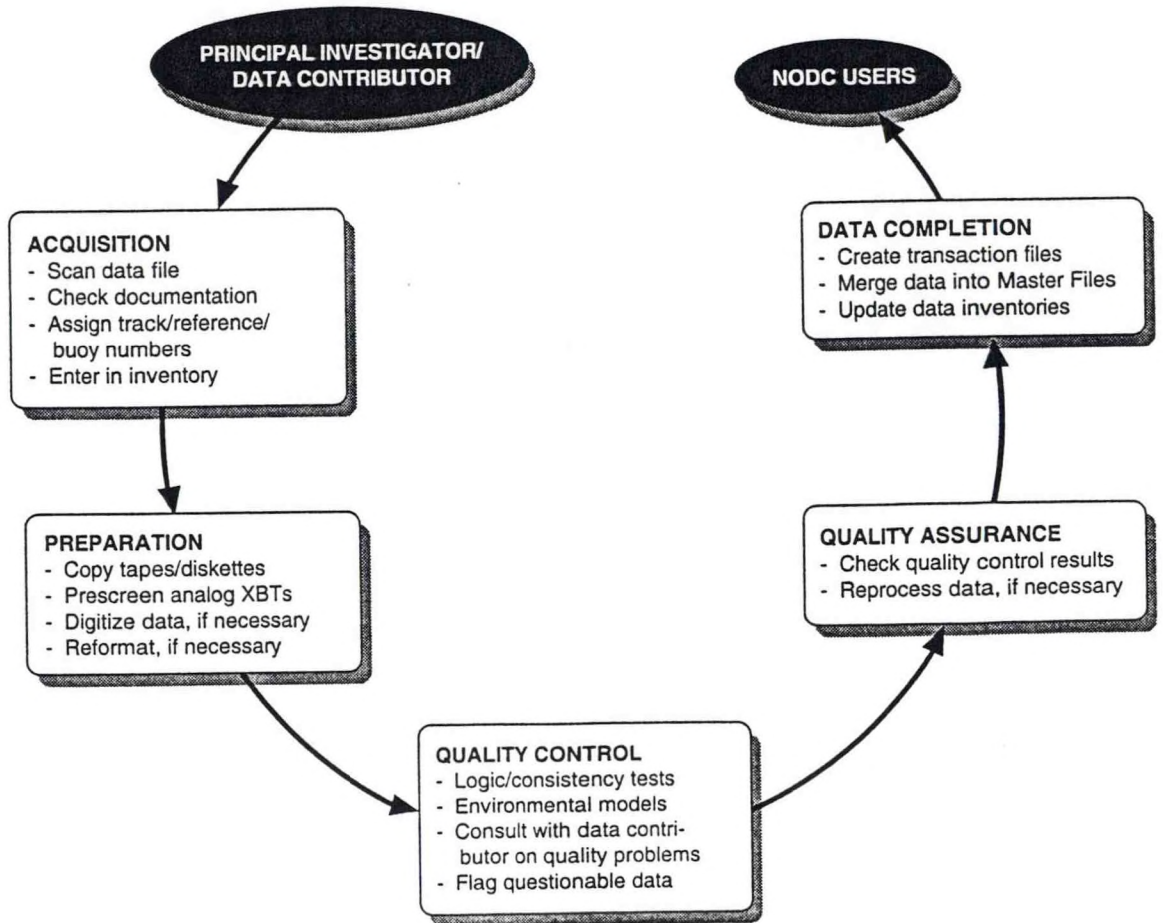
- **Acquisition.** Submitted data are reviewed to determine if they can be processed, and if they are accurately described in accompanying documentation. Identifying numbers are assigned and recorded in the NODC Data Inventory Data Base. If they can be processed, the data go on to the next step; otherwise they are stored "as is" in the originator format.
- **Preparation.** Copies are made of data submitted in digital form. Some data in report/publication form are digitized. When feasible, 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, CTD, 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 meet 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, CTD, and expendable bathythermograph (XBT) data.

The logic and consistency tests include checks for:

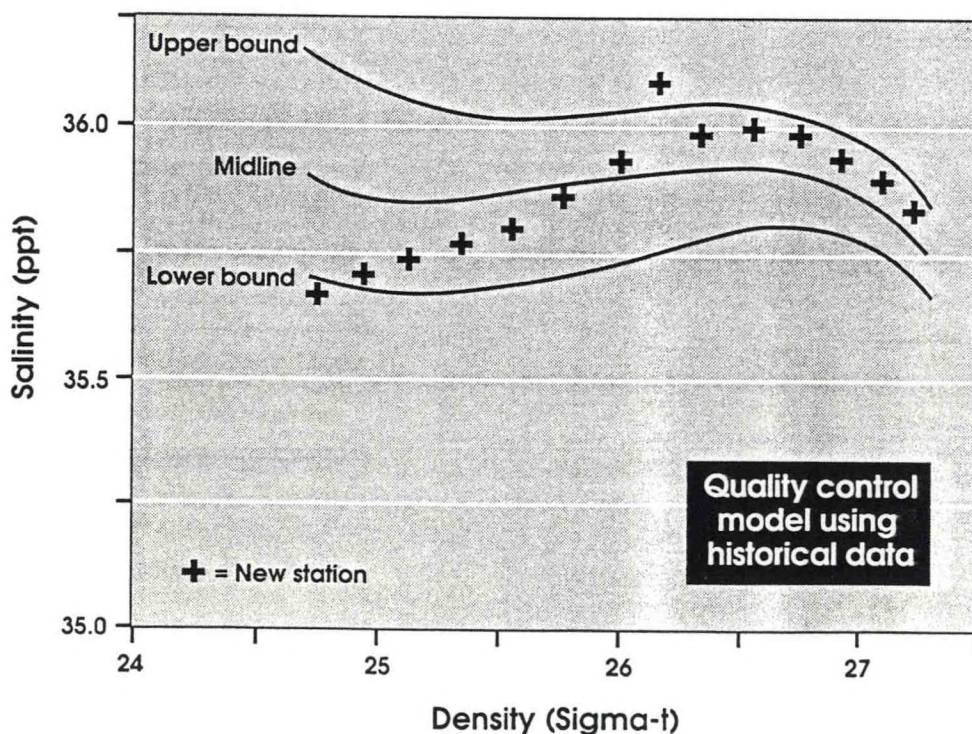
- valid ship speed between consecutive observations
- valid ranges or upper limits for data parameters
- consistency between related data fields
- valid use of taxonomic, chemical, and other codes
- acceptable vertical stability properties (for

ocean station and CTD data)

- valid calibration temperature and depth (for XBT data).

As a further refinement for quality control of oceanographic station, CTD, 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.

An enhanced quality control system, developed as part of the international Global Temperature-Salinity Pilot Project, is being implemented on UNIX-based workstations within NODC's new client-server computer system. The new procedures and systems will be more efficient and allow more peer review of data quality.



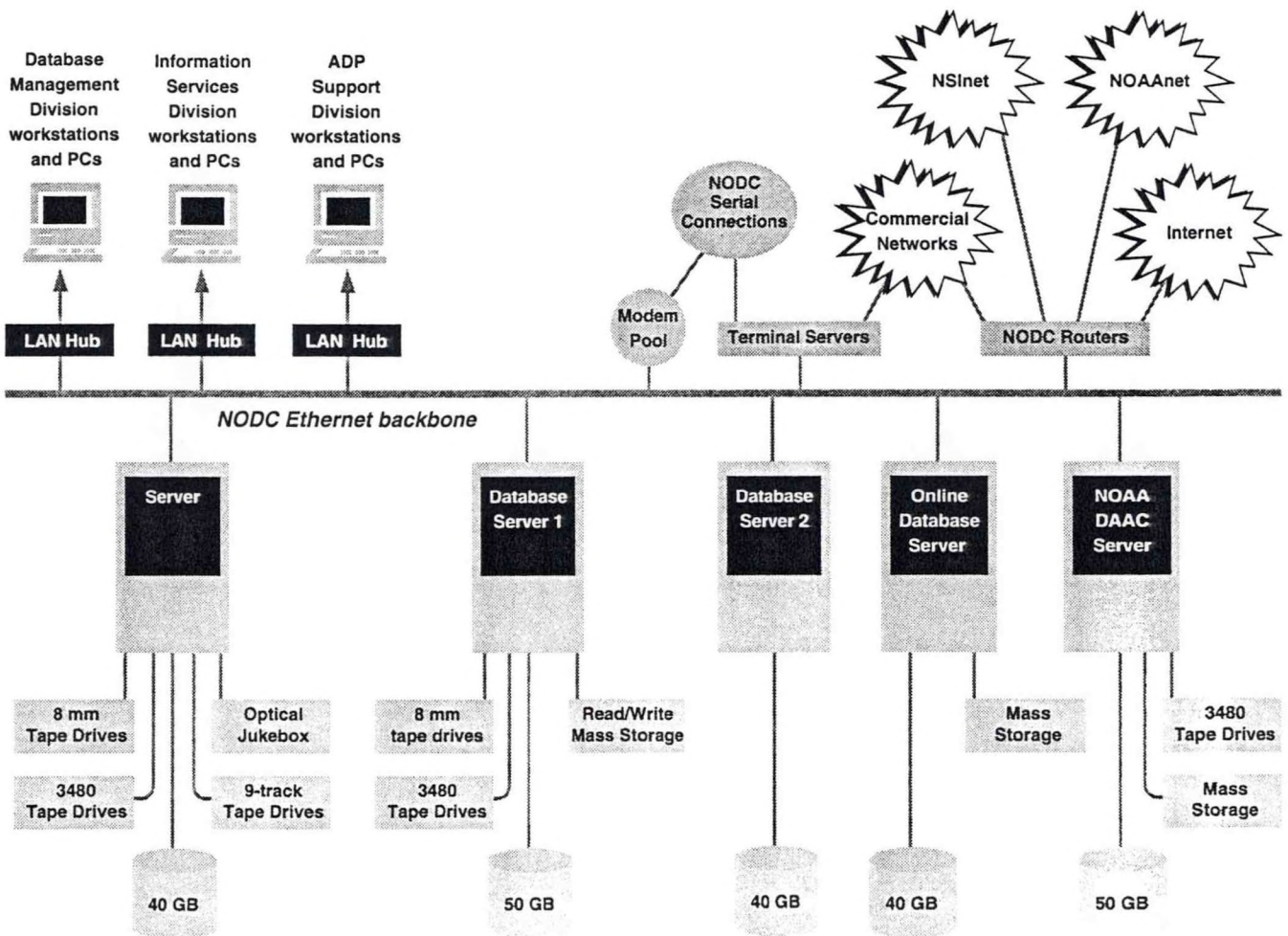
## NODC Computer Resources

During 1993 the NODC will complete the conversion of its computer system from an older configuration based on a cluster of DEC VAX computers to a modern client-server architecture based on advanced workstations.

An Ethernet Local Area Network (LAN) links the distributed computing resources at NODC's headquarters offices. Silicon Graphics workstations function as servers to support NODC operations including data processing, database updating, user services, and data communications. Peripheral devices include magnetic tape drives (9-track, 8mm, 4 mm, and IBM 3480 cartridge), an optical disk drive, and an optical disk "jukebox" that pro-

vides over 300 GB of mass storage. The Ethernet LAN operates with the TCP/IP protocol and supports about 90 nodes, including both high speed workstations and PC-class computers.

The LAN supports communications using TCP/IP over a T1 line (1.54 megabits/sec) to the NOAA subnet of Internet. Connection to the NASA Science Internet (NSInet) is provided over a 9.6-kilobit/sec channel. In addition dial-in and dial-out access is available via modem at up to 34 kilobits/sec. Anonymous file transfer protocol (FTP) is used to provide for transmission of data over the Internet.







*Section 5*

**DATA PRODUCTS AND SERVICES**

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## Selective Data Retrieval

Personnel in the NODC User Services Branch work with customers to fulfill requests for data selected from NODC's archive databases. NODC data products are provided on a cost recovery basis. Charges for customized data products are determined by actual costs incurred to retrieve the data and to provide them to the customer on a specified medium.

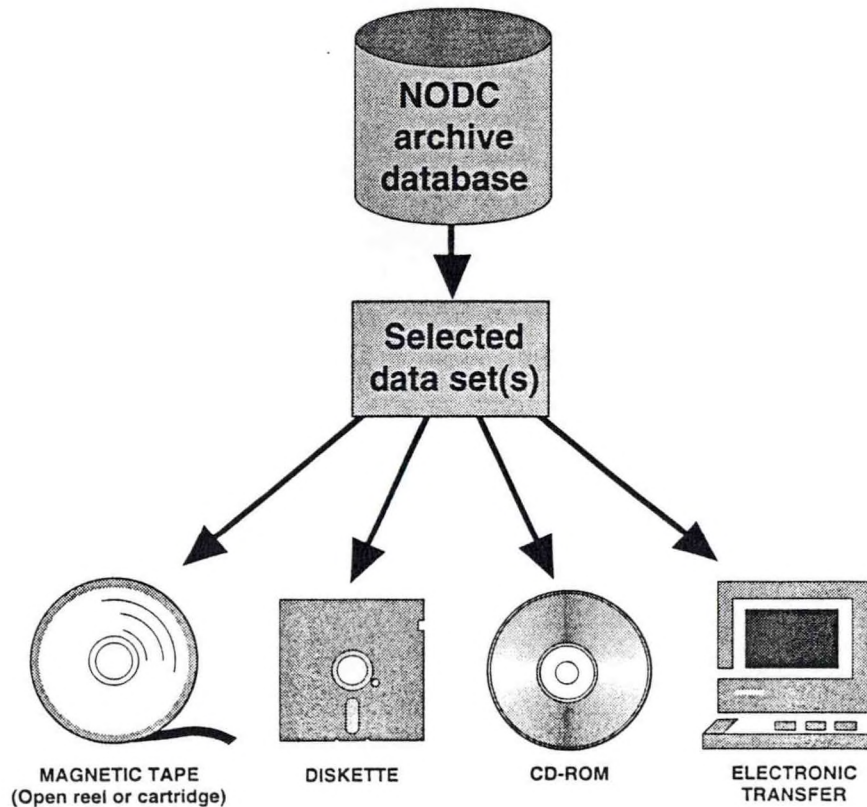
When customers contact the NODC their first question is often, "How many data do you have in my area of interest?" Or they may ask if NODC holds the data from a specific cruise or project. To answer these questions, services personnel rely on NODC data inventory and data directory systems. The purpose of these systems is to help answer user inquiries about data availability. Depending on their needs, NODC users can be provided with various types of data inventory information. This information may range from total counts of observations meeting specified selection criteria to the spatial and temporal distribution of available data.

Data in NODC's archive databases can be

provided to users on magnetic media (tape or diskette), on write-once CD-ROMs, or via anonymous file transfer protocol (FTP) over computer networks.

For some of the NODC's global data files, data summaries are also available. 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 has the option of requesting products from a merged data set holding data from more than one file.

Detailed information about NODC's data holdings, products, and services is provided in the *NODC Users Guide*, which is available free. This publication is issued in a three-ring binder format so it can be kept current through the periodic release of new and updated pages.



## Ocean Data on CD-ROM

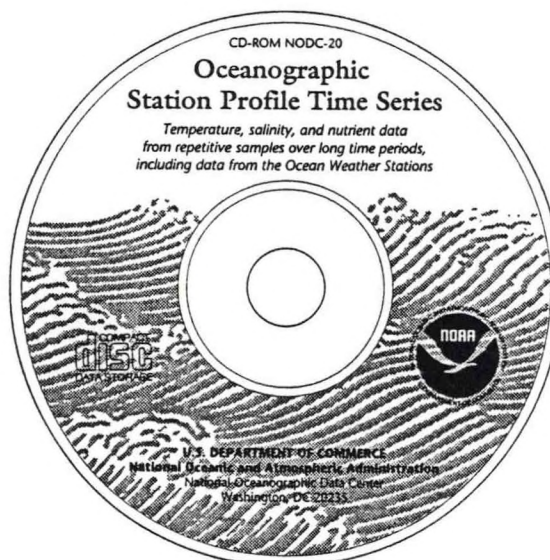
The combination of low unit cost and high data volume (about 650 megabytes per disc) makes CD-ROM an efficient medium for providing large data sets to NODC customers. In 1989 the NODC produced its first ocean data CD-ROM, a prototype disc holding temperature-salinity profiles for the Pacific Ocean. Since that time the NODC enhanced its CD-ROM production capabilities and now produces new ocean data CD-ROMs at a rate of over one disc per month.

To support its CD-ROM production efforts, the NODC installed a CD-ROM mastering workstation that includes a CD-ROM recorder. The NODC uses the discs (*one-offs*) produced with this device to test and evaluate prototype CD-ROMs before they are sent to commercial plants for mass replication. Writable CD-ROMs containing data selected from

NODC's archive databases are also provided to individual customers as an alternative to receiving data on magnetic tape or diskette.

CD-ROM data sets available from the NODC include:

- Global Ocean Temperature-Salinity Profiles (2 discs; Disc 1 - Pacific Ocean and Disc 2 - Atlantic and Indian Oceans)
- Geosat Altimeter Data (T2 GDRs) from the Exact Repeat Mission (6 discs)
- Geosat Altimeter Crossover Differences from the Geodetic Mission (8 discs)
- Geosat Altimeter Data (T2 GDRs) from the Geodetic Mission, 30°S-72°S (2 discs)
- Oceanographic Station Profile Time Series (1 disc)
- NOAA Marine Environmental Buoy Database (14 discs organized by ocean area)



## NODC Publications

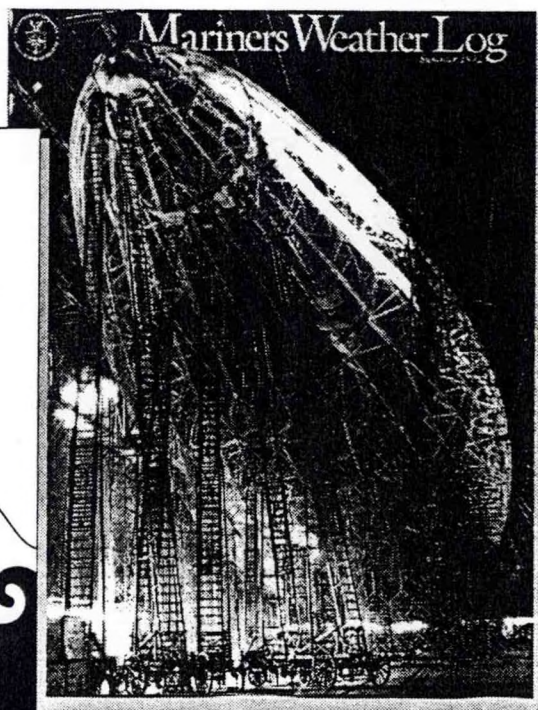
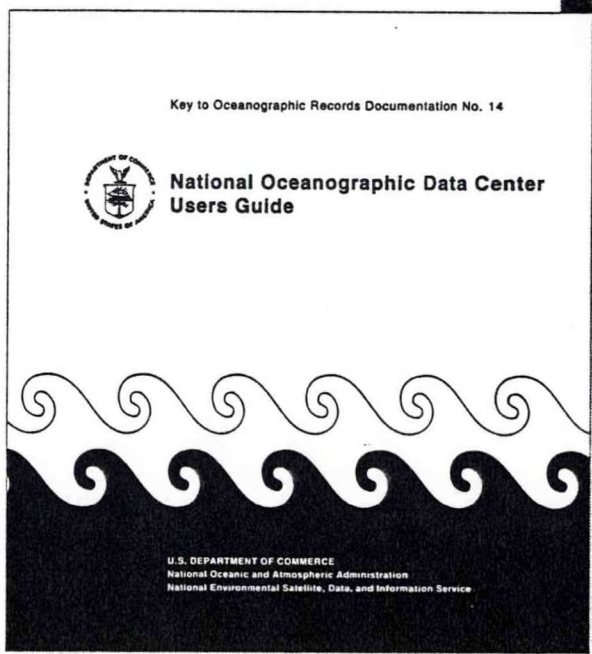
NODC publications describe its data holdings, products, and services; provide summaries or analyses of marine environmental data; document its data processing formats, procedures, and systems; or provide general marine science information of value to NODC users.

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, yachtsmen, and other maritime interests.

In support of NOAA's Environmental Services 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.



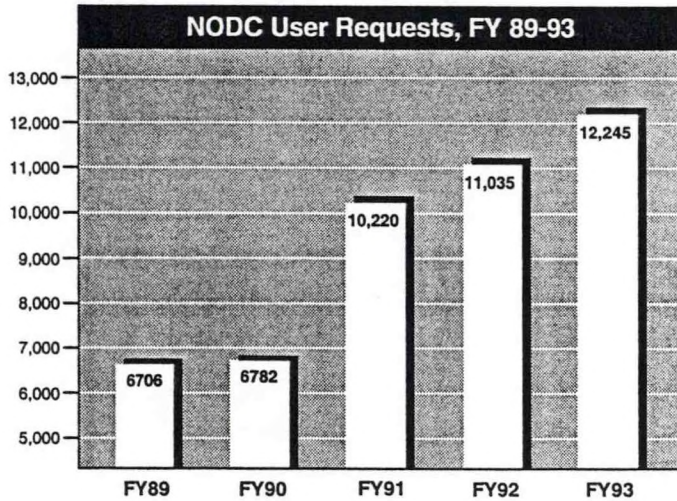
## NODC Users and User Requests

During fiscal year 1993, the NODC fulfilled an all-time record number of 12,245 user requests (not including information requests processed by the NOAA Central Library). NODC received requests from users in about 60 different countries around the globe. Applications of NODC data are as varied as its customers and include research and development activities related to ocean minerals and energy; ocean engineering of ships, submarines, 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.

A significant factor contributing to the steady increase in NODC user requests is advances in technology that are making it easier to provide large NODC data sets to users. This is most clearly seen in the large jump in

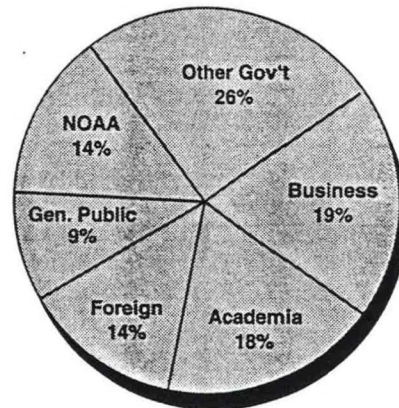
user requests where data is provided over computer networks or on CD-ROM. During FY 1993 the NODC fulfilled 374 user requests where data were sent over computer networks compared to only 51 such requests in FY 1992. During FY 1993 the NODC also set records for both the number of new CD-ROMs produced and for the number of CD-ROM discs provided to customers. During the year the NODC produced 21 CD-ROMs, including a 14-discs set holding 7.6 gigabytes of data from NOAA marine environmental buoys and C-MAN (Coastal-Marine Automated Network) stations. The number of CD-ROM discs distributed during the year totaled 1,176.

In fiscal year 1993, the largest percentage of NODC users were from non-NOAA government agencies (26%), followed by users from business (19%), academia (18%), foreign countries (14%), NOAA (14%), and the general public (9%).



**NODC Requests by User Class, FY 93**

(Total Requests = 12,245)



*Section 6*

**LIBRARY AND INFORMATION SERVICES**

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## 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), and
- 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	<b>Survey of the Coast</b>
1811	Coast & Geodetic Library created
1870	<b>U.S. Weather Bureau U.S. Fisheries Commission</b>
1871	Weather Bureau Library started
1965	<b>ESSA/Environmental Data Service (EDS)</b>
1966	Scientific Information Documentation Division
1970	<b>NOAA</b>
1977	Atmospheric Sciences and Marine & Earth Sciences Libraries merged
1978	<b>EDS renamed Environmental Data and Information Service (EDIS)</b> Library and Information Services Division (LISD) established to manage NOAA Library System
1982	<b>EDIS merged into National Environmental Satellite, Data, and Information Service (NESDIS)</b>
1988	Library operations contract awarded
1989	LISD becomes a component of the NODC
1993	NOAA Central Library moves to NOAA office complex in Silver Spring, Md.

## NOAA Library and Information Network

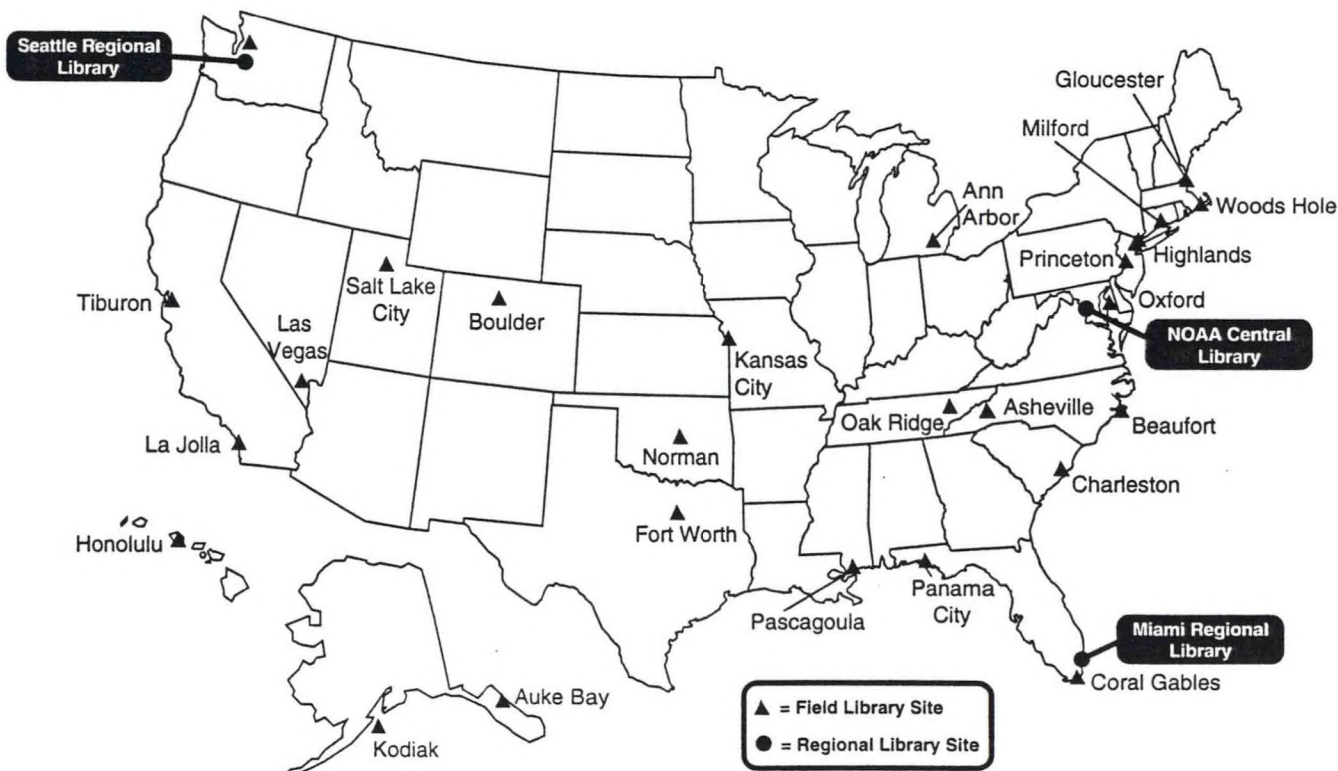
The NOAA Library and Information Network (NLIN) administered by the Library and Information Services Division (LISD) consists of three components:

- the Central Library in Silver Spring, 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 Spring, Miami, and Seattle sites
- National Climatic Data Center, Asheville, N.C.
- Mountain Administrative Support Center, Boulder, Colo.

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



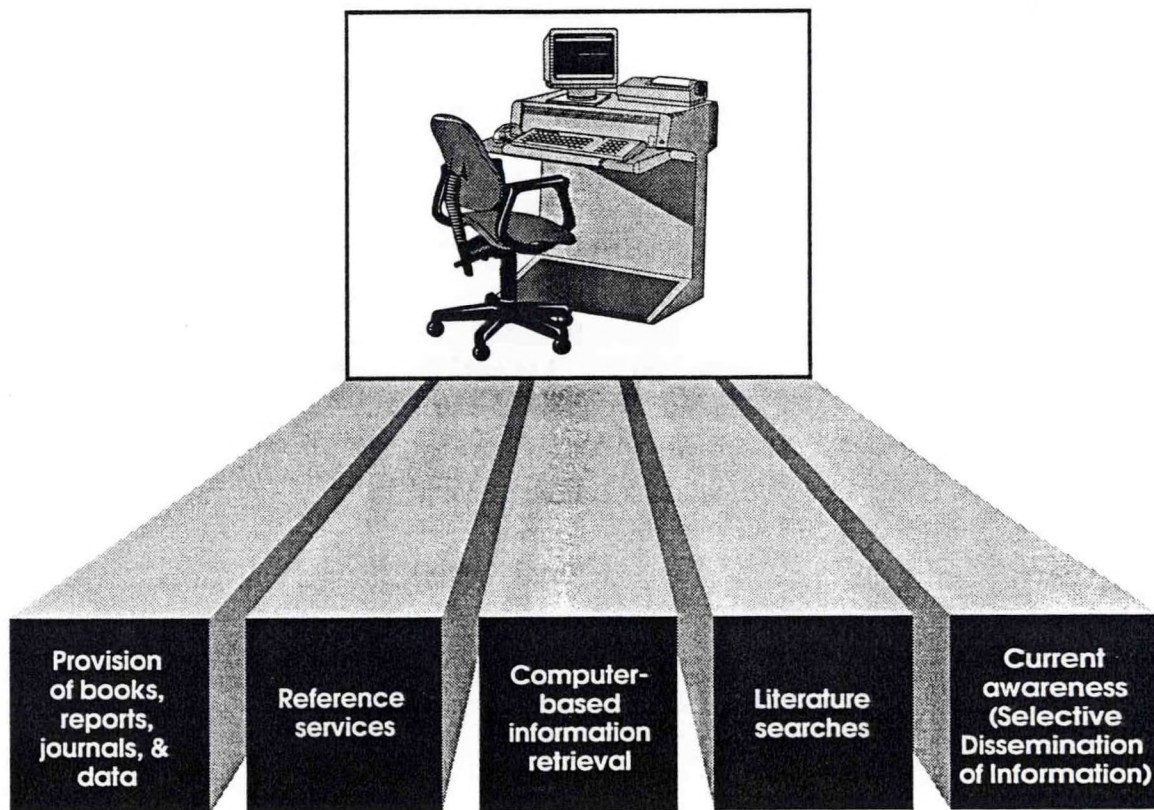
## NOAA Central Library Services

In June 1993 the NOAA Central Library moved to the NOAA office complex in Silver Spring, Md. This state-of-the-art facility makes the collection more readily accessible to both NOAA and non-NOAA users. The NOAA Central Library is located on the second floor of Silver Spring Metro Center 3 (1315 East-West Highway), the centerpiece building of the NOAA Silver Spring complex. The NOAA buildings are immediately adjacent to the Silver Spring station on the Washington, D.C. Metro (subway) Red Line, a 20-minute ride from downtown Washington.

The facilities and collection of the NOAA Central Library 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, interoffice 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*

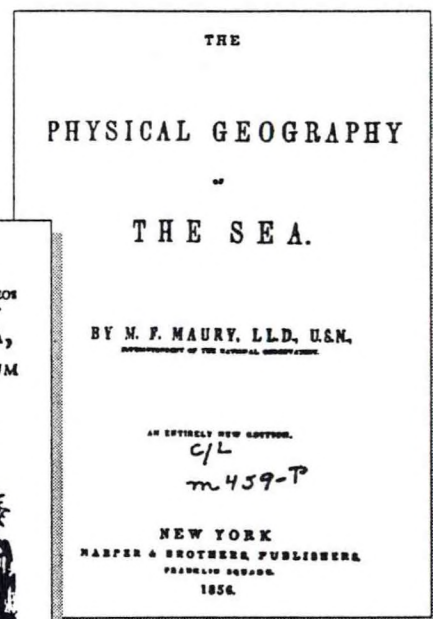
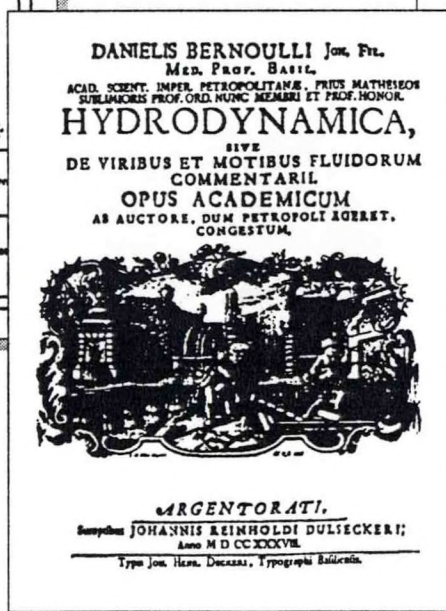
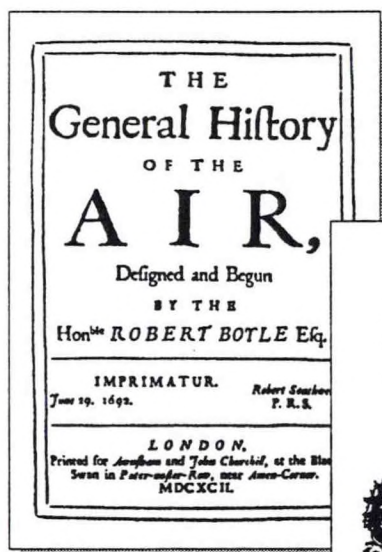
## Rare Book Collection

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, 1692
- 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)

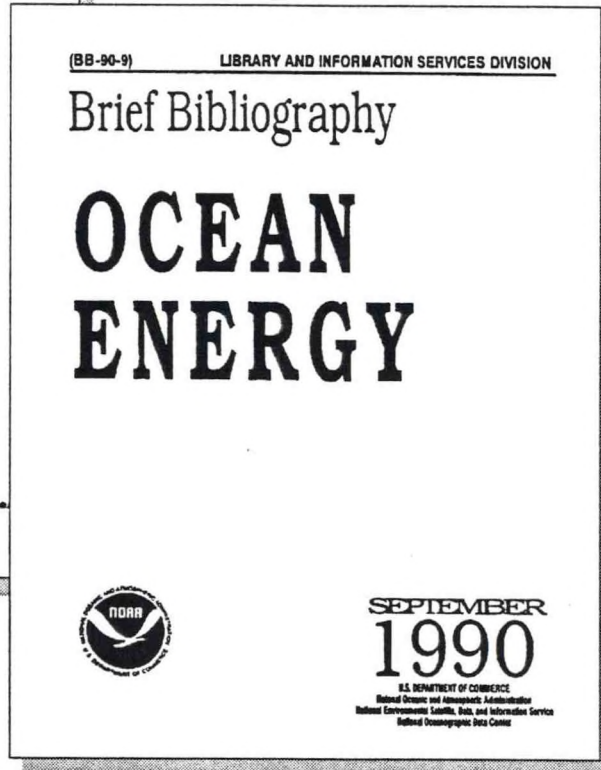
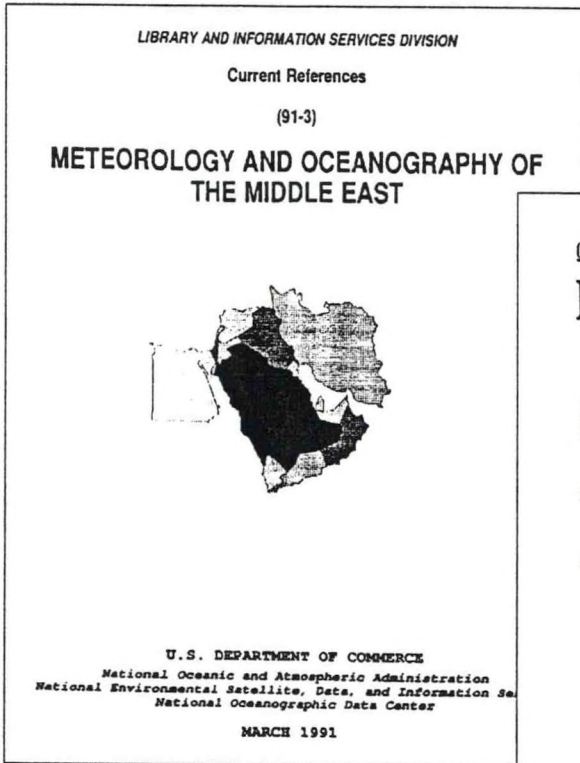
- 19th and 20th century works including  
*The American Coast Pilot*, Edmund M. Blunt, 1817  
 Complete works of Benjamin Franklin, 1825 edition  
*The Physical Geography of the Sea*, M. F. Maury, 1856  
 Record set of coast surveys, including monumental 1899 Pacific Coast Pilot by George Davidson  
 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*.



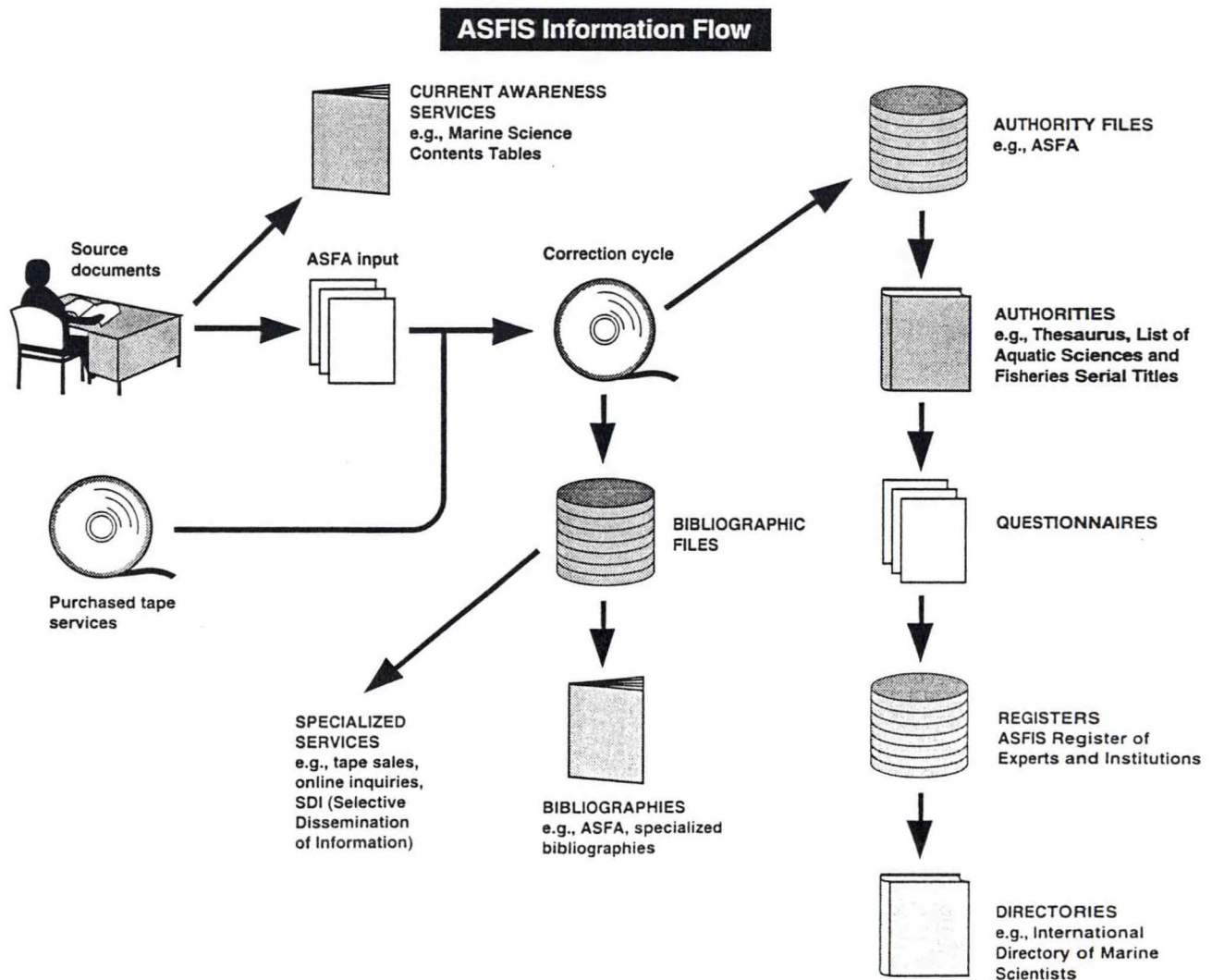
## Marine Information Management

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.





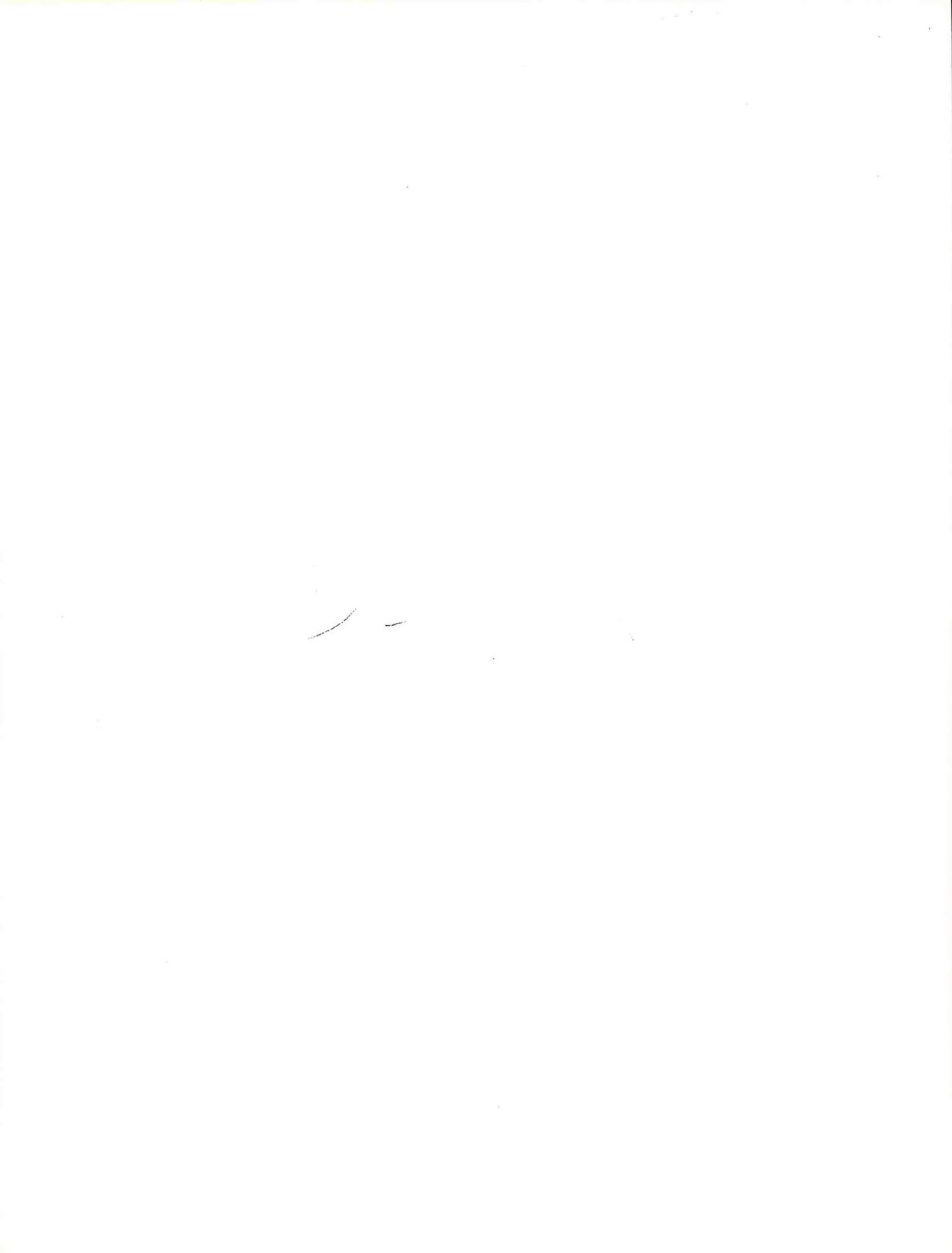


*Section 7*

**OCEAN PROJECT DATA MANAGEMENT**

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## Ocean Data Management for Global Change

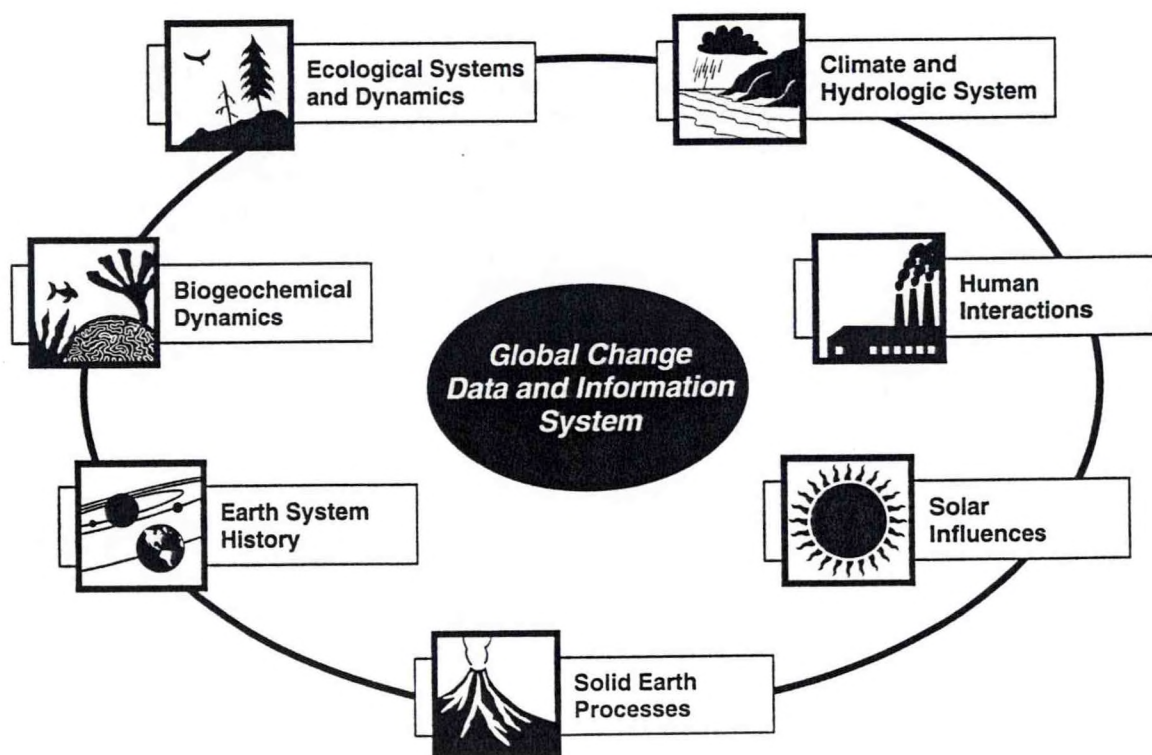
To be able to understand and predict long-term changes in the atmosphere and oceans, researchers must learn more about many elements of earth science. These include: biogeochemical cycles, ecological systems and their dynamics, climate and the hydrologic cycle, human interactions with the environment, 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 academia 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. As its contribution to this project, the NODC transcribed AVHRR satellite data from 1985 through 1987 from approximately 2,500 magnetic tape reels and 2,600 cartridge tapes to 105 12-inch optical platters. Each platter holds about 6.4 gigabytes of data, or about 10 days worth of data from one satellite.

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



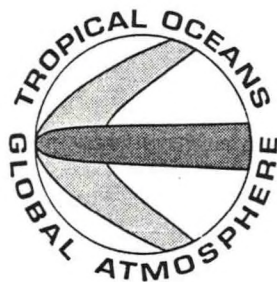
## Global Ocean Science Projects

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 numerous working groups and scientific panels, the NODC is

helping to plan for management of ocean data from these projects and 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.

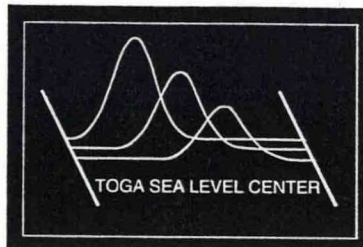
**World Ocean Circulation Experiment (WOCE)**  
long-term monitoring and research in ocean circulation using current drifters, hydrographic measurements, satellite observations, and sea level data.



**J G O F S**  
JOINT GLOBAL OCEAN FLUX STUDY

**Joint Global Ocean Flux Study (JGOFS)**  
study of biogeochemical cycles in the oceans.

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



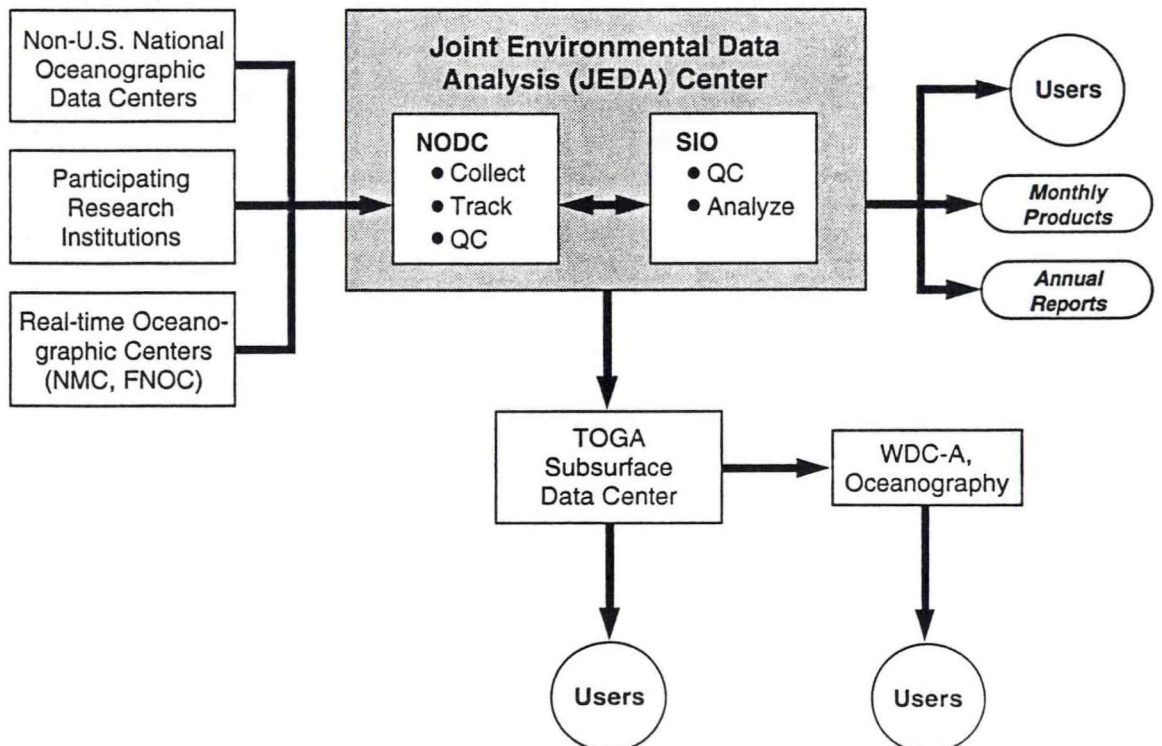
## Joint Environmental Data Analysis (JEDA) Center

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. Subsequently, however, the Center extended its task of intake, quality control, and analysis of available upper ocean thermal data to include first the entire Pacific Ocean, 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.



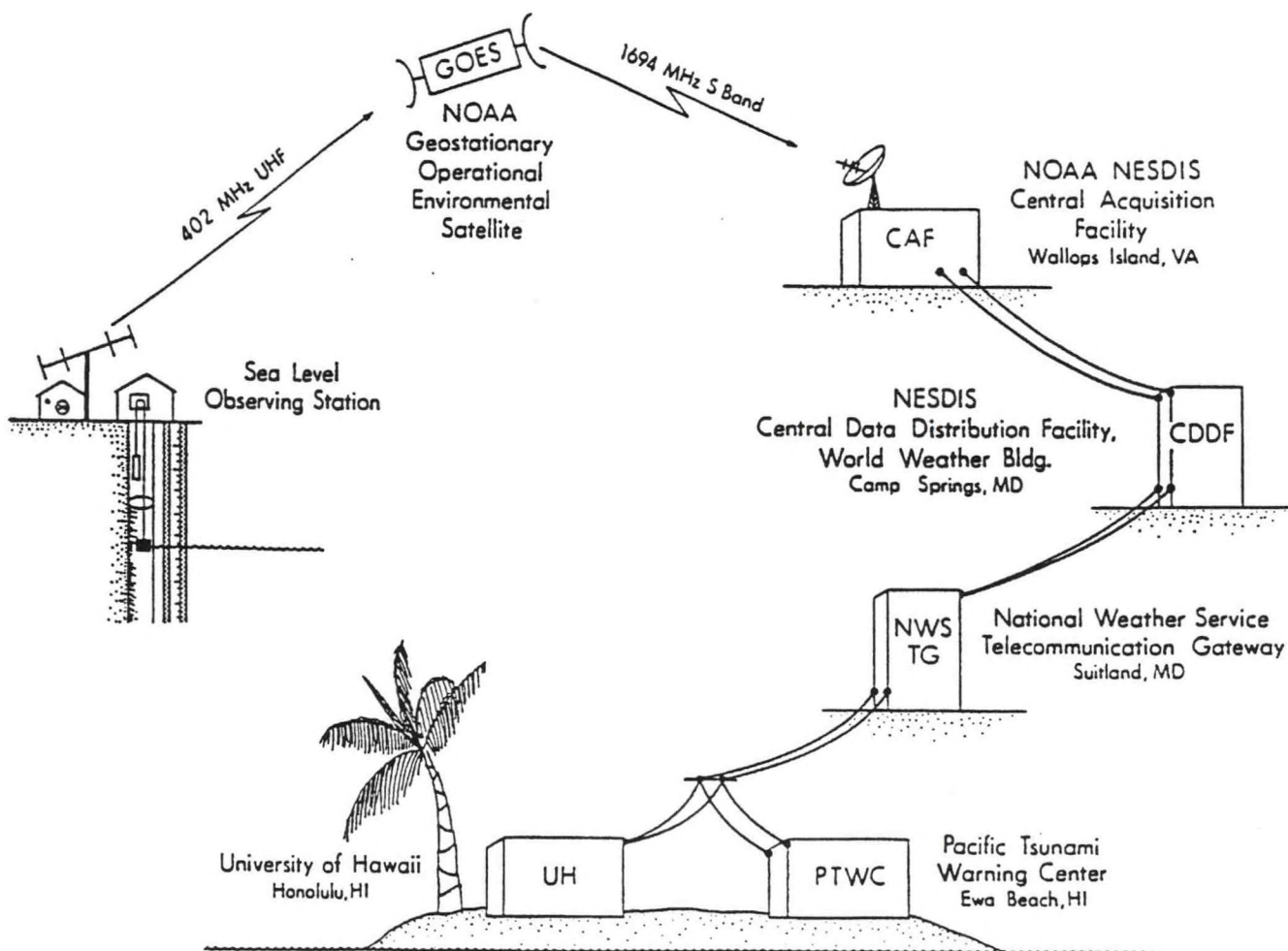
## Joint Archive for Sea Level

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 116 stations in the Pacific Ocean, 49 stations in the Indian Ocean, and 26 stations in the Atlantic 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. The Network has been extended to other ocean basins and has grown into the Global Sea Level Observing System (GLOSS).



## **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, Delaware.

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 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 JCRMOD 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.

### **JCRMOD 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

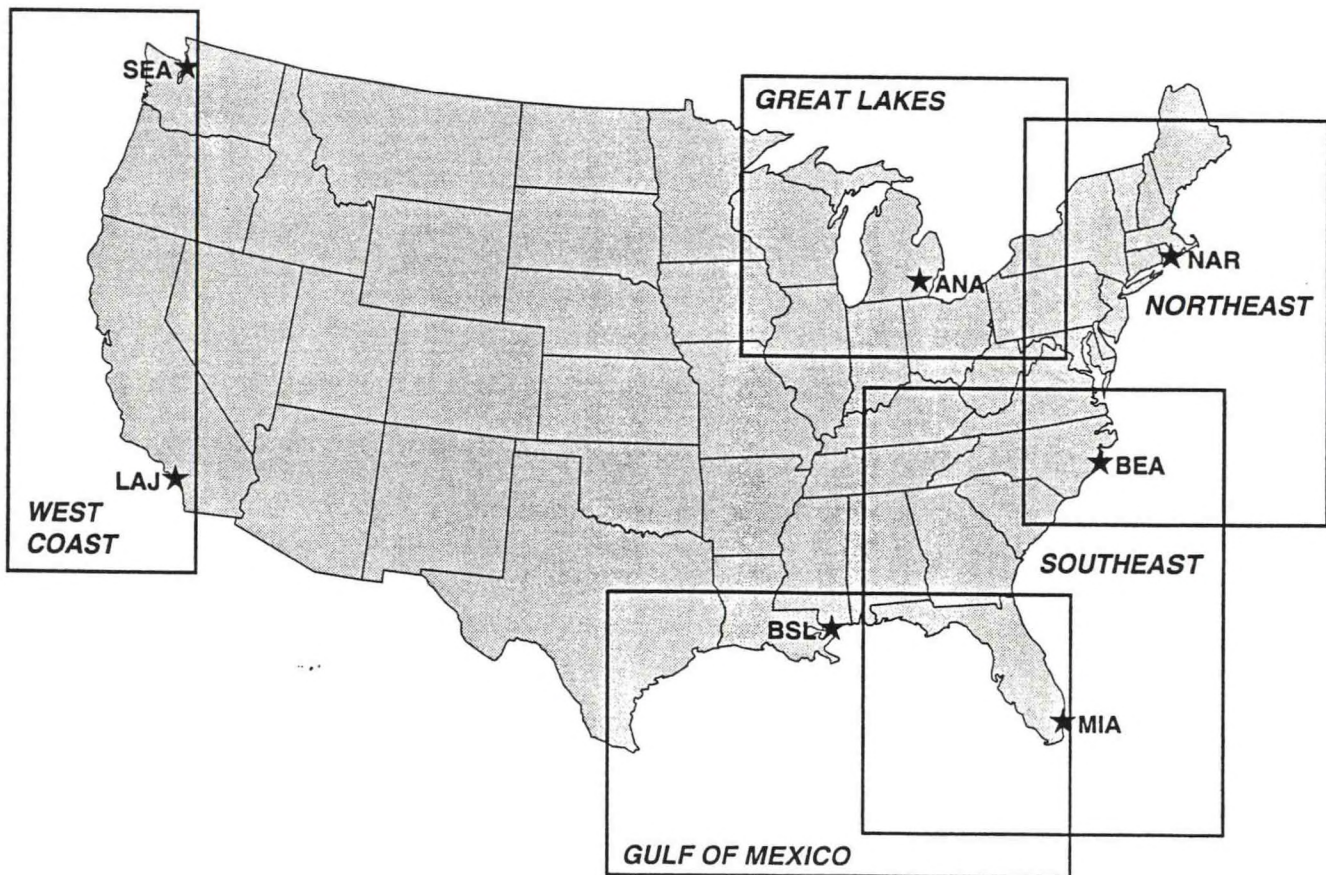
To address critical coastal environmental problems, the National Oceanic and Atmospheric Administration has established the Coastal Ocean Program. Within this program NOAA CoastWatch is designed to provide Federal and state decision makers and researchers with rapid access to satellite data and imagery 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) and accumulating algal biomass (that contributes to oxygen depletion).

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

of the NOAA CoastWatch Archive and Access System (NCAAS). NCAAS provides for the archival of all CoastWatch products and supports online access to data and data products following their near-real-time release by the NOAA Ocean Products Center. The NODC archives CoastWatch data on optical platters on a "jukebox" system installed on the NODC 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





*Section 8*

**OCEAN DATA RESEARCH**

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## NODC Ocean Climate Laboratory

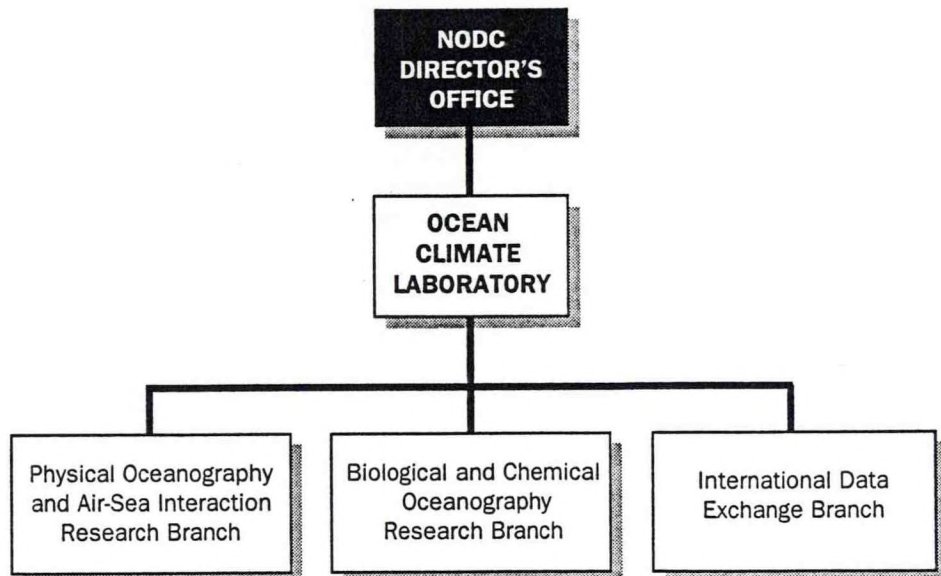
In October 1993 the developing research group at the National Oceanographic Data Center was designated as the Ocean Climate Laboratory with the status of a new NODC division. Two branches within the new division reflect the main areas of the laboratory's research: (1) physical oceanography and marine meteorology and (2) biological and chemical oceanography. Through the International Data Exchange Branch the division conducts programs related to international affairs and oceanographic data exchange. It also operates the World Data Center A (WDC-A) for Oceanography, one of the U.S. discipline subcenters within the World Data Center system. Sydney Levitus, Director of WDC-A, Oceanography, heads the new laboratory.

The primary objectives of the new Ocean Climate Laboratory are to:

- develop improved ocean climatologies and study interannual to decadal-scale ocean climate variability using historical oceanographic data,

- improve the quality of the NODC's oceanographic data archives by using the data to perform scientific analyses,
- augment the historical ocean data record through efforts to locate, digitize, and quality control data not yet included in the NODC database.

The Ocean Climate Laboratory directs the international Global Oceanographic Data Archaeology and Rescue (GODAR) Project. Initiated by NODC and WDC-A, Oceanography, this project was endorsed by the Intergovernmental Oceanographic Commission and is receiving worldwide support. It has already resulted in the submission to the NODC of nearly 1 million additional ocean temperature or temperature-salinity profiles from nine countries. The Ocean Climate Laboratory will play a major role in the quality control and analysis of these data sets and others that are expected to be submitted to the NODC in the future.



## Global Ocean Variability

Decadal-scale variability of the oceans is a major area of investigation by the NODC Ocean Climate Laboratory. Earlier studies have documented gyre and ocean basin scale changes in the thermohaline structure of the North Atlantic Ocean between the two pentadal periods, 1955-1959 and 1970-1974 (Levitus, 1989a; Levitus, 1989b; Levitus, 1989c; Levitus, 1990). These studies were conducted by compositing and objectively analyzing historical hydrographic data from the NODC oceanographic station data file for the two five-year periods.

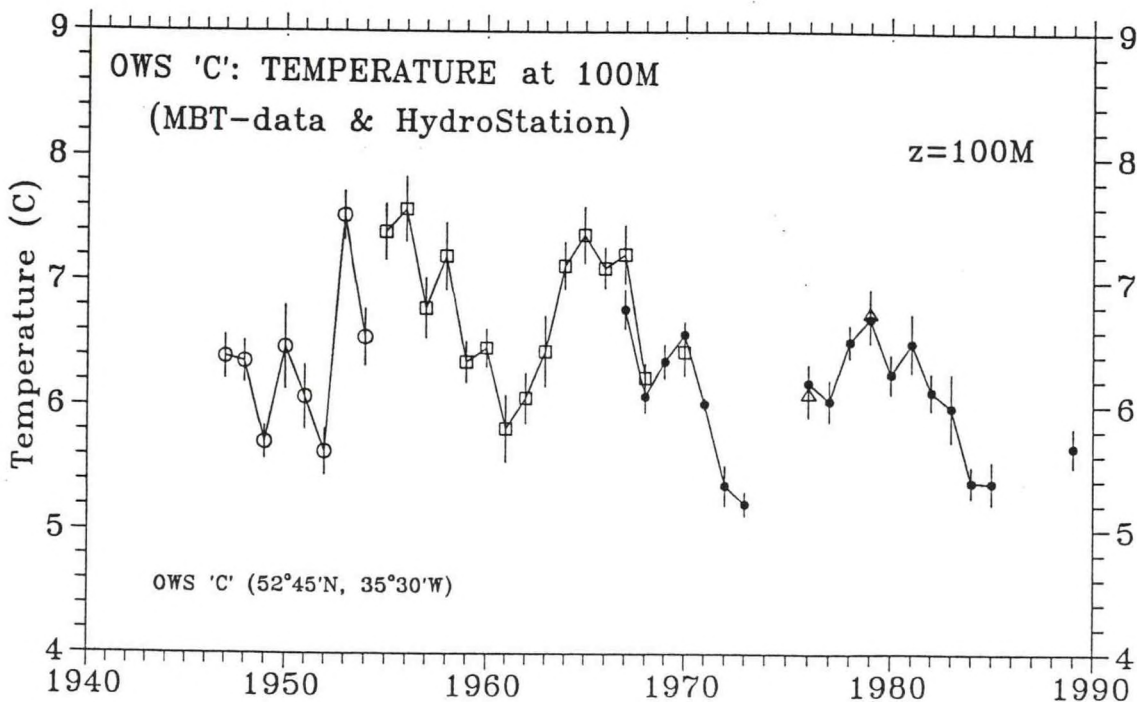
The data provide evidence of ocean variability on this time scale. For example, at intermediate depths (500-1300 m), the subtropical gyre in the North Atlantic Ocean was colder and fresher during 1970-1974 compared to 1955-1959. At these depths the eastern portion of the subarctic gyre was also colder and fresher during the 1970-1974 period, while the western portion was warmer and saltier. These changes in heat and salt are in turn associated with substantial changes in steric sea level and geopotential thickness.

Recent studies have analyzed temperature-salinity time series from Ocean Weather Station "C" (52.45°N, 35.30°W) and Station "S" (32.16°N, 64.5°W) (Levitus et al., 1993, in preparation). At these locations the data show decadal-scale variability in the deep ocean as well as

the upper ocean. At Station "S" annual mean temperature at 1750 m depth increased by 0.3°C from 1960 to 1990 with salinity also increasing. At OWS "C" annual mean temperature and salinity in the 1000-1500 m layer increased on the order of tenths of a degree centigrade and 0.2-0.4 practical salinity units between 1966 and 1974. From 1975 to 1985 both these parameters decreased by somewhat larger amounts than the earlier increase.

### References

- Levitus, S., 1989a. Interpentadal variability of temperature and salinity at intermediate depths of the North Atlantic Ocean, 1970-74 versus 1955-59. *J. Geophys. Res.-Oceans*, 94, 6091-6131.
- Levitus, S., 1989b. Interpentadal variability of salinity in the upper 150 m of the North Atlantic Ocean, 1970-74 versus 1955-59. *J. Geophys. Res.-Oceans*, 94, 9679-9685.
- Levitus, S., 1989c. Interpentadal variability of temperature and salinity in the deep North Atlantic Ocean, 1970-74 versus 1955-59. *J. Geophys. Res.-Oceans*, 94, 16125-16131.
- Levitus, S., 1990. Interpentadal variability of steric sea level and geopotential thickness of the North Atlantic Ocean, 1970-74 versus 1955-59. *J. Geophys. Res.-Oceans*, 95, 5233-5238.
- Levitus, S., J. Antonov, X. Zhou, H. Dooley, K. Selemenov, and V. Tereschenkov, 1993. Decadal-scale variability of the North Atlantic Ocean. *Natural climate variability on decade-to-century time scales*. National Academy of Sciences Press.



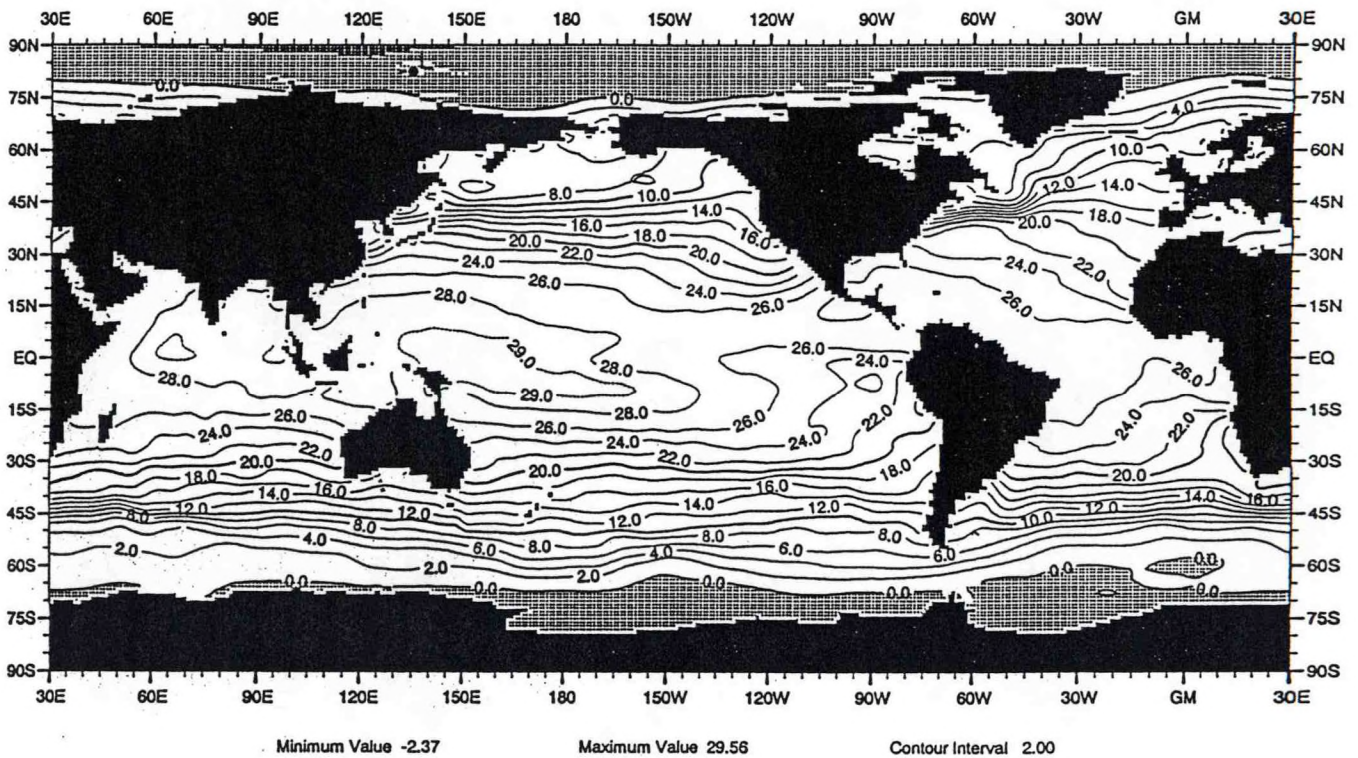
Time series of annual mean temperature (°C) at a depth of 100 m from Ocean Weather Station "C" data. The vertical bars centered at each annual mean data point represent plus and minus one standard error of the monthly means for that year about the annual mean for that year.

## Distribution of Ocean Temperature, Salinity, and Oxygen

In 1993 the Ocean Climate Laboratory completed a major reanalysis of ocean temperature, salinity, and oxygen data held in NODC's major global ocean databases. All available data for these parameters from the NODC oceanographic station, bathythermograph, and CTD data files were quality controlled and objectively analyzed. This project was undertaken to refine and update the ocean climatology published a decade earlier in the *Climatological Atlas of the World Ocean* (Levitus, 1982).

Results of the new analysis include annual and seasonal mean fields of ocean temperature,

salinity, and oxygen on a one-degree latitude-longitude grid at standard depth levels. The analyses of oxygen include annual and seasonal distributions of dissolved oxygen, apparent oxygen utilization, and percent oxygen saturation in the world ocean. Seasonal anomalies, basin mean profiles, and zonal averages of all three parameters were also determined. The results of this project will be published in the multivolume *World Ocean Atlas 1993*. Volume 2 will present the analyses of oxygen, Volume 3 the analyses of salinity, and Volume 4 the analyses of temperature.



Annual mean temperature (°C) at the surface

## Distribution of Ocean Nutrients

As part of its reanalysis of physical-chemical parameters in the NODC's major global ocean databases, the Ocean Climate Laboratory also completed quality control and analysis of phosphate, nitrate, and silicate data from the NODC oceanographic station data file. The quality control procedures involved five steps:

- (1) determining ranges and seasonal variations of the parameters for different depths and ocean basins or ocean areas (Antartic, Arctic, Pacific Ocean, Indian Ocean, and North, equatorial, and South Atlantic Ocean);
- (2) preparing property-property plots such as nitrate versus depth and nitrate versus phosphate;
- (3) computing parameter means, standard deviations, and variance; and
- (4) performing objective analysis of mean one-degree latitude-longitude parameter values to identify "bulleyes" or extreme values within a one-degree square. Data quality problems are

noted in the data records by setting flags.

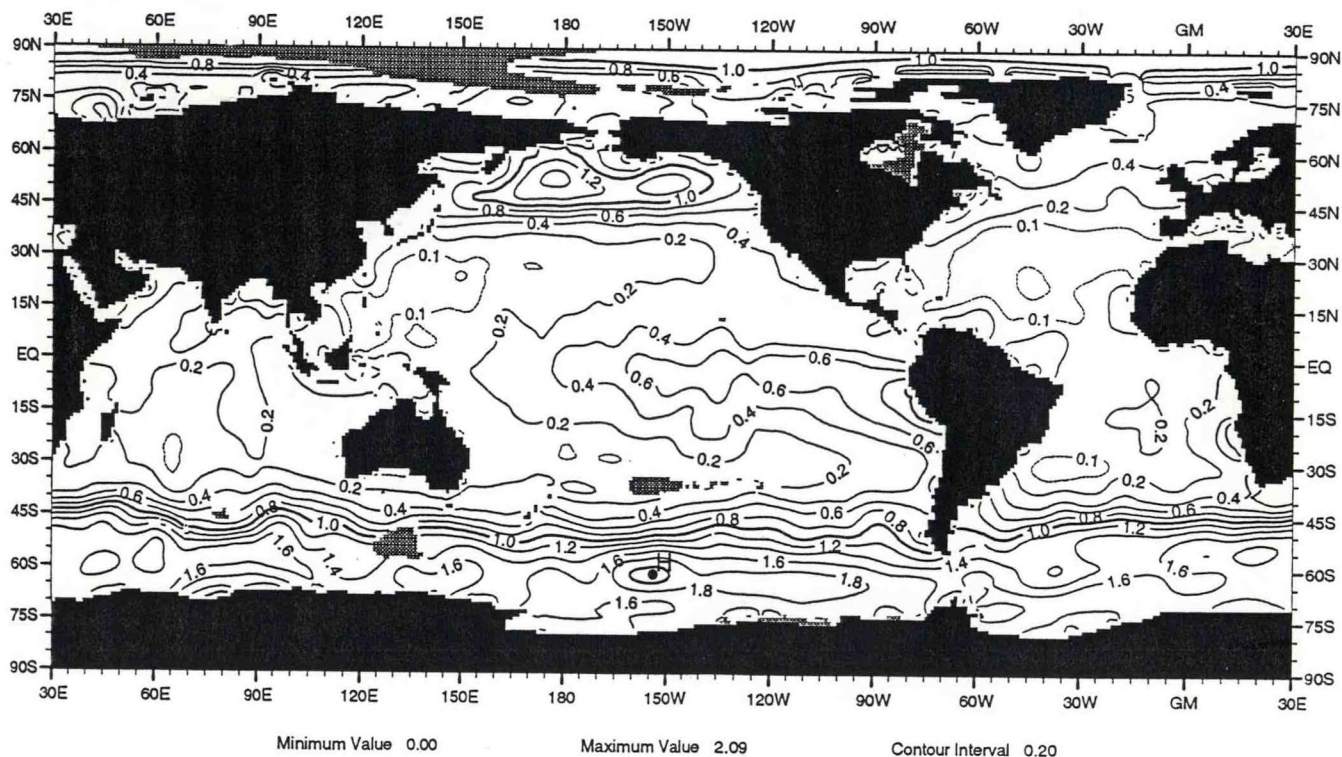
Data products resulting from this work include the observed and standard depth level flagged nutrient data set and the objectively analyzed mean one-degree latitude-longitude nutrient fields at standard depths. These data sets will be made available from the NODC on a variety of media including CD-ROM and anonymous FTP transfer over the Internet.

### Publications

Levitus, S., M. E. Conkright, J. L. Reid, R. G. Najjar, and A. Mantyla, 1993. Distribution of nitrate, phosphate and silicate in the world oceans. *Progress in Oceanography*, 31, 245-273.

Conkright, M. and S. Levitus, in press. Distribution of nutrients: Zonal averages and basin means. *Progress in Oceanography*.

Conkright, M. E., S. Levitus, and T. Boyer, in preparation. World Ocean Atlas 1993, Vol. 1: Nutrients. *NOAA Atlas Series*.



Annual mean phosphate ( $\mu\text{M}$ ) at the Surface