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EARTH SYSTEM MONITOR

A guide to NOAA's data and information services

INSIDE

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

Coastal Studies, Information, and Data for the Ecosystem Website Now Live

Russell Beard
NCDDC Chief of Scientific Services

Eric Roby
NCDDC Web Technical Lead

After the devastation caused by Hurricane Katrina, the National Coastal Data Development Center (NCDDC) received hundreds of questions from the public about the environmental and physical impact of the disaster and several requests from local and national organizations for assistance in gathering impact data. In response to this call for information, NCDDC created the Katrina Impact Assessment Project website. The objective of this cooperative effort is to assess and monitor the environmental and physical impact of Hurricane Katrina on the ecosystems and infrastructure of the Mississippi Gulf coast.

In preparation for this year's hurricane season, this valuable resource was renamed and expanded into a comprehensive information center called the Coastal Studies, Information, and Data for the Ecosystem (C-SIDE) website.

C-SIDE provides direct links to local, state, and federal information pertaining to severe weather preparation, monitoring, and impact across the Gulf of Mexico coastal region. This website includes recommendations for home preparation and evacuation as well as time-sensitive data, weather products, and storm surge information as it becomes available. It will also include post-storm assessment, response, and recovery products, information, and services for Gulf Coast residents.

The C-SIDE website provides quick access to near-real-time feeds detailing information such as hurricane status, evacuation routes, and state-specific warnings. In addition, this website contains links to satellite and radar products from the National Oceanic and Atmospheric Administration (NOAA) that compliment the information feeds, creating a complete picture of the environment of each state as well as along evacuation corridors.

The C-SIDE website is intended to be a permanent presence and a central location for coastal storm-related information and data. NCDDC hopes that this resource will help to curb some of the impacts of severe weather and will aid recovery efforts.

For more information about C-SIDE, visit http://ecowatch.ncddc.noaa.gov/c-side. ■

▲ C-SIDE website includes an active map with links to state-specific resources such as evacuation routes, radio broadcasts, and environmental hazard impact maps.

Letter from the Director


Zdenka S. Willis

Oceanographic data are precious resources that must be not only collected and grouped efficiently but also managed and shared effectively. Through a combination of archiving and stewardship, the National Oceanographic Data Center (NODC) strives to help scientists, decision makers, and the user community answer the questions of today and anticipate the questions of tomorrow.

As the Director of NODC, I feel privileged to have been given the opportunity to facilitate the pursuit of these goals, and I believe that by looking at data collection in a holistic manner rather than piecemeal, NODC will be able to paint pictures of the ocean and the coastal environment that will be useful.

NODC consists of the National Oceanic and Atmospheric Administration (NOAA) Central Library, began in 1871; the NODC, originated in 1961; the National Coastal Data Development Center (NCDDC), operational in 2001; and the World Data Center for Oceanography, formed in 1957.

NODC manages over 20,000 unique accessions ranging from individual data sets to large collections amassed through major projects. Well managed and reliable data are essential to developing and maintaining an environmental database and to disseminating useful information products such as climate change prediction, ocean and coastal analysis and assessment, living marine resource status, ecosystem health documentation, and habitat and endangered species protection.

NODC is also cooperating with other NOAA offices, other U.S. agencies, and the international community. Data sharing is an immensely valuable tool, requiring diligent management and universal data standards. Using these parameters, we can compile and manipulate data sets from other sources thus creating a more complete world view.

Our NOAA Central Library is more than just books on a shelf, though we do have over 1.5 million volumes. This facility has put together critical online libraries to support the Corals, Marine Protected Areas, and Aquaculture programs. Further, our library leads an integrated project team for the Ocean Exploration program that is working to develop standards for ocean video. The NOAA Central Library also manages two regional libraries in Seattle and Miami and provides critical support in making 250 e-journals accessible online and granting NOAA-wide access to 300 e-books.

NCDDC rounds out the team by supplying support to ecosystem stewardship and providing access to the Nation's coastal data resources. NCDDC achieves this stewardship through the integration of diverse coastal data and provides these data to users via the Internet. We also maintain a searchable metadata catalog of coastal data, developing gateways to data repositories and using middleware technology that provides data in user specified formats.

In this new era of national and international cooperation and data sharing, NODC is also working with the partners of the NOAA National Integrated Ocean Observing System (IOOS), a cooperative effort to consolidate and provide easy access to ocean data. In addition, NODC is supporting the activities of the U.S. Group on Earth Observations (USGEO) as it works with nearly 60 other nations to create a Global Earth Observation System of Systems (GEOSS).

As we look ahead, NODC plans to continue its efforts to share, protect, and preserve data resources. In addition, NODC will work to acquire and archive new data types, such as undersea video data, and to fill the gaps in both foreign and domestic historical data. Through cooperation, ingenuity, and management, NODC will continue to serve and predict the data needs of decision makers, scientists, and the public. ■

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The mailing address for the *Earth System Monitor* is:
National Oceanographic Data Center
NOAA/NESDIS E/OC1
SSMC3, 4th Floor
1315 East-West Highway
Silver Spring, MD 20910-3282

Editors
R. Torstenson
Telephone: 301-713-3281 ext. 107
Fax: 301-713-3302
E-mail: rtorstenson@nodc.noaa.gov

Tara Mairs
Marc Pulliam

U.S. DEPARTMENT OF COMMERCE
Carlos M. Gutierrez, Secretary

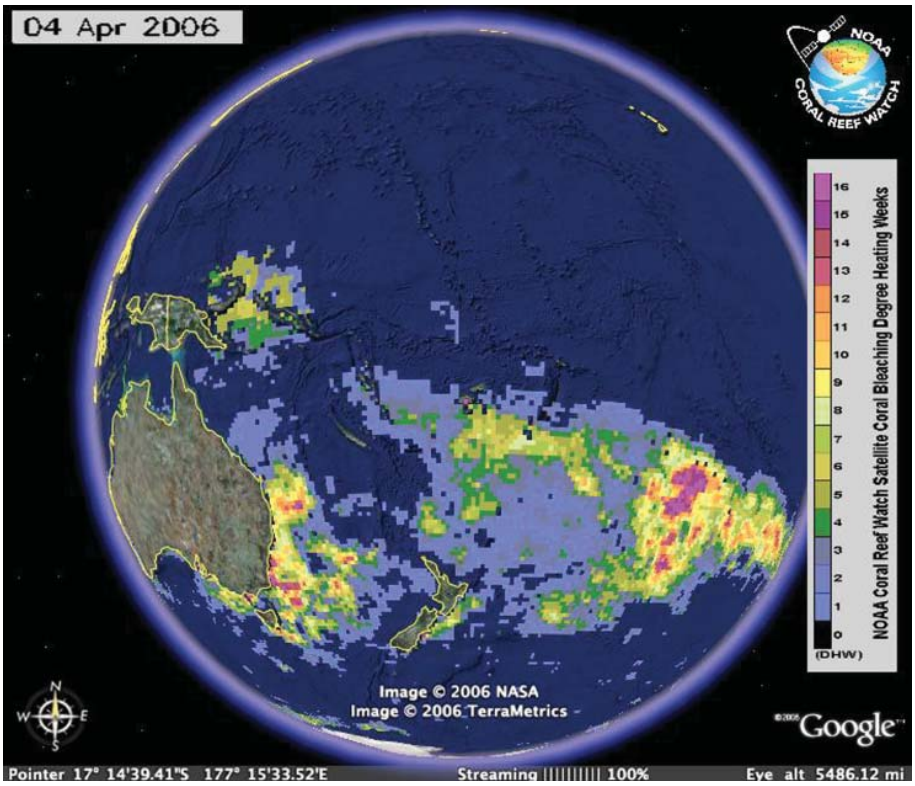
National Oceanic and Atmospheric Adminstration
Conrad C. Lautenbacher, Jr.,
Under Secretary and Administrator

News Briefs

NOAA Satellite Data on Google Earth

For years now, images of NOAA Coral Reef Watch (CRW) satellite monitoring data have been available online in near real-time. Now, reef managers and scientists around the world can access the latest data on thermal stress that can lead to coral bleaching at their reef locations in Google Earth format. Once you have installed the free Google Earth software, you have access to the latest CRW monitoring data and can see it overlaid on the globe; you can also zoom in, overlay other datasets, or pan around the entire earth. This is an excellent visualization tool that helps bring CRW data to life. To access the CRW data in this format, please visit http://coralreefwatch.noaa.gov/satellite/ge/.

For more information on the entire suite of NOAA Coral Reef Watch satellite products, see http://coralreefwatch.noaa.gov/.



▲ NOAA Coral Reef Watch data formatted for use with Google Earth, showing a bleaching event now ongoing around Fiji and Tonga in the South Pacific.

NOAA Mississippi Offices Focus on Gulf of Mexico "Dead Zone"

NOAA offices in Mississippi are teaming up to provide near-real-time data about dissolved oxygen from the seasonal hypoxic area, or "dead zone," in the Gulf of Mexico. From June 9 through mid-July, scientists from NCDDC and NOAA Fisheries Service at Stennis Space Center and Pascagoula posted online maps of dissolved oxygen near the sea floor, from Texas to Louisiana.

Mostly a summertime phenomenon, this "dead zone" begins forming in June and extends from the mouth of the Mississippi River westward to Texas. Hypoxia occurs when the amount of dissolved oxygen in the water becomes too low to support most marine life, including shrimp, crabs, and fish. Though hypoxia in the

Gulf of Mexico has appeared naturally for thousands of years, its geographic area has increased significantly since researchers began measuring it in the mid-1980s.

Scientists believe the increase could stem from the growing use of nitrogen fertilizers in the Mississippi River watershed. In 2001, NOAA scientists in Mississippi began the Hypoxia Watch Project, which provides near-real-time, web-based maps of dissolved oxygen near the sea floor over the Texas-Louisiana continental shelf from mid-June to mid-July.

NOAA's Hypoxia Interactive Map: http://www.ncddc.noaa.gov/website/Hypoxia/viewer.htm

Gulf of Mexico Hypoxia Watch Page: http://www.ncddc.noaa.gov/ecosystems/hypoxia

Geostationary Operational Environmental Satellite Series-N (GOES-N) Launched

On June 4, GOES-N reached final orbit and was designated GOES-13. It will supply data critical for fast, accurate forecasts and warnings for severe

▲ On May 25, 2006, GOES-N successfully reached orbit after it was launched from the Cape Canaveral Air Force Station in Florida the day before.

weather, including thunderstorms, winter storms, and hurricanes. Additionally, it will detect solar storm activity, relay distress signals from emergency beacons, monitor the oceans, and scan the landscape for the latest drought and flood conditions.

GOES-13, the first spacecraft in the new GOES-N/O/P series, features a highly stable pointing platform, which will improve the performance of the imager and sounder instruments. GOES-13 will also expand measurements for the space and solar environment monitoring instruments. The satellite also features a new dedicated broadcast capability to be used by the Emergency Managers Weather Information Network and a new digital weather facsimile capability for higher quality transmissions of data and products.

The first image from GOES-13 was received on June 22, and the satellite is currently undergoing a series of tests as part of its "check-out" phase that will last approximately six months. After check-out, GOES-13 is expected to be put into a storage mode at 105 degrees west. It will be ready to replace one of the two existing NOAA GOES spacecraft should either experience trouble.

The National Geophysical Data Center (NGDC) Develops New Cape Hatteras, North Carolina Tsunami Inundation Elevation Grid

The NGDC has developed a high-resolution coastal elevation grid of Cape Hatteras, North Carolina for the Pacific Marine Environmental Laboratory (PMEL), NOAA Center for Tsunami Inundation Mapping Efforts. This bathymetric/topographic grid is part of a series that is being developed by NGDC to be used as input for a model developed by PMEL to simulate tsunami generation, propagation, and inundation. The new grid covers an area of approximately one-degree square centered on Cape Hatteras, at a grid spacing of 1/3 arc-seconds. This endeavor will improve tsunami propagation, run up, and inundation predictions, forecasts, and warning capacity.

NOAA Central Library Marine Protected Areas (MPA) Virtual Library Now Available

The NOAA Central Library developed and maintains the "Marine Protected Areas (MPA) Virtual Library" in support of NOAA's National Marine Protected Areas Center and the website www.mpa.gov.

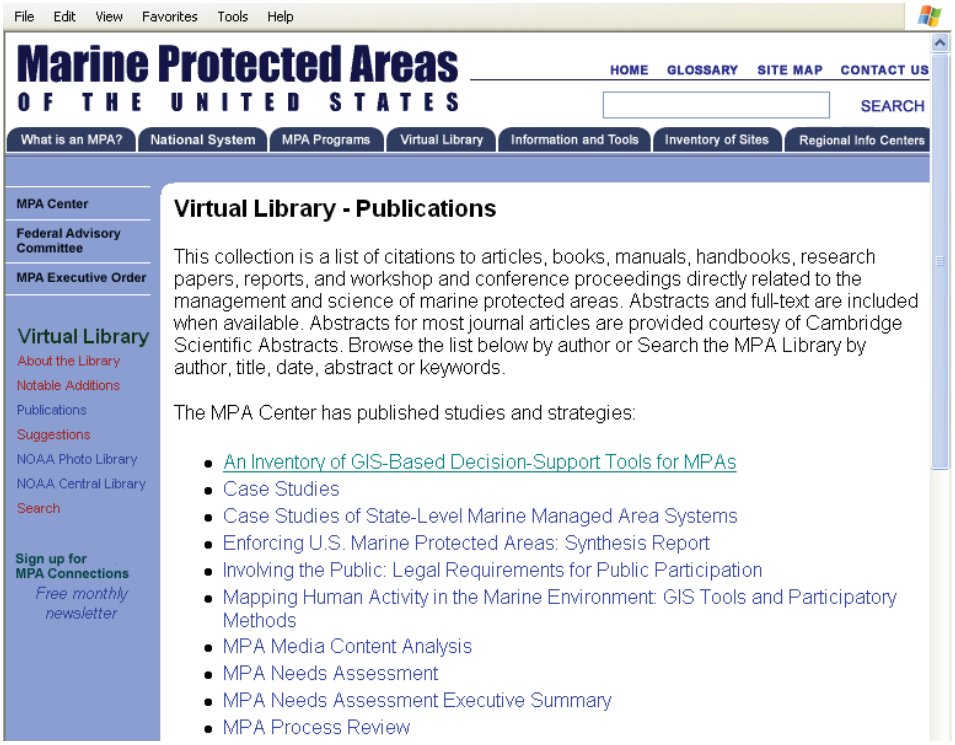
The MPA Virtual Library is a searchable database covering electronic, print, and Internet resources, including publications (print and online), websites, photos, video, and projects. The resources cover the United States and territories as well as other countries around the world. The library offers the public and other stakeholders wide access to information on the science, policy, and management of marine protected areas.

Search the MPA Library by author, title, abstract, keyword, or browse the 16 major topical theme bins. See http://www3.mpa.gov/mpa_lib/virtual_library.aspx. ■

NOAAWatch Website Now Live

The NOAAWatch Website offers information about ongoing environmental events and an explanation of the role of NOAA in the prediction and monitoring of and recovery from environmental hazards. This resource provides public access to current information on a number of environmental threats ranging from oil spills and wild fires to hurricanes and tsunamis.

NOAAWatch integrates NOAA data, products, observations, satellite images, and other information pertaining to environmental hazards so users can get all the information related to a storm or event from one website. This site (www.noaawatch.gov) went live on the first day of the 2006 hurricane season—June 1, 2006. Contact the NOAAWatch Team for more information at NOAAWatch@noaa.gov. ■



▲ MPA Virtual Library homepage.

World Ocean Database 2005 Now Available

Sydney Levitus, Tim Boyer, Hernan Garcia, Ricardo Locarnini, Igor Smolyar, Alexey Mishonov, Daphne Johnson, and John Antonov
OCL, NODC

The Ocean Climate Laboratory (OCL) of NOAA's National Oceanographic Data Center (NODC) has completed and released a major upgrade to its World Ocean Database product. World Ocean Database 2005 (WOD05) (Boyer et al., 2006; Johnson et al, 2006) is the largest collection of quality-controlled ocean profile data available internationally without restriction. Data for 29 ocean variables including plankton data are included in WOD05. WOD05 includes an additional 900,000 temperature profiles not available in its predecessor, WOD01, as well as modern and historical data for all the other variables. Data for chemical tracers are also now included, and all data are available on-line. Previous releases of this database series and products based on the database have proven invaluable to the scientific community.

The ocean and climate scientific communities need research quality ocean profile data sets in order to describe the temporal and spatial variability of physical, chemical, and biological parameters in the ocean. Operational forecasting centers use such databases to perform quality control of real-time oceanographic data. OCL has been supported by the NOAA Climate and Global Change program in producing such scientifically quality-controlled oceanographic profile-plankton databases.

Profile data in WOD05 are available at both observed depth levels and at as many as 33 standard depth levels in the vertical. The observed level values in WOD05 are measurements that are a function of depth or pressure submitted by data originators. The profiles at standard levels in WOD05 are the observed level data that have been vertically interpolated to standard depth levels. The profiles include quality flags for observed and standard depth level data as well as metadata.

WOD05 contains small amount of data from a new instrument type known as a glider (GLD). Table 1 is a list of instrument types from which data are available in WOD05.

Comparison of WOD05 with Previous NODC Global Ocean Profile Databases

During the past thirteen years, the archives of historical oceanographic data have grown due to special data management and data observation projects (discussed shortly), as well as increases due to normal submissions by scientists and operational ocean monitoring programs. With the distribution of WOD05, there are now approximately 7.9 million temperature profiles and 2.7 million salinity profiles (as well as other profile data and plankton data) available to the

Table 1. Instrument types in the WOD05

DATASET	SOURCE
OSD	Bottle, low-resolution Conductivity-Temperature-Depth (CTD), low-resolution XCTD data, and plankton data
CTD	High-resolution CTD data and high-resolution XCTD data
MBT	Mechanical Bathythermograph (MBT) data, Digital Bathythermograph (DBT), micro-BT
XBT	Expendable (XBT) data
SUR	Surface only data (bucket, thermosalinograph)
APB	Autonomous Pinniped Bathythermograph—Time-Temperature-Depth recorders attached to elephant seals
MRB	Moored buoy data from Tropical Atmosphere-Ocean (TAO), PIRATA (a moored array in the tropical Atlantic), MARNET (a German network of moored buoys that measure ocean and atmospheric conditions in the North Sea and Baltic sea), and TRITON (a Japanese network of moored buoys in the western tropical Pacific that measures ocean and atmosphere conditions.)
PFL	Profiling float data
DRB	Drifting buoy data from surface drifting buoys with thermistor chains
UOR	Undulating Oceanographic Recorder data from a Conductivity/Temperature/Depth probe mounted on a towed undulating vehicle
GLD	Glider data

Table 3. Variables present in the Oceanographic Station Data (OSD) and low-resolution Conductivity-Temperature-Depth (CTD) dataset.

Variable [nominal abbreviation]
Temperature [t]
Salinity [S]
Dissolved oxygen [O_2]
Phosphate [HPO_4^{-2}]
Silicate [$Si(OH)_4$]
Nitrate [NO_3]
pH [pH]
Total Chlorophyll [Chl]
Total Alkalinity [TALK]
Partial pressure of carbon dioxide [pCO_2]
Dissolved inorganic carbon [DIC]
Tritium [^3H]
Helium [He]
Delta Helium-3 [Δ^3He]
Delta Carbon-14 [$\Delta^{14}C$]
Delta Carbon-13 [$\Delta^{13}C$]
Argon [Ar]
Neon [Ne]
Chlorofluorocarbon-11 [CFC-11]
Chlorofluorocarbon-12 [CFC-12]
Chlorofluorocarbon-113 [CFC-113]
Delta Oxygen-18 [($\Delta^{18}O$]
Pressure [P]
Plankton taxonomy and Biomass

Table 2. Comparison of the amount of data in WOD05 with previous ocean databases.

Dataset	NODC (1974)[1]	NODC (1991)[2]	WOA94	WOD98	WOD01	WOD05
OSD [3]	425,000	783,912	1,194,407	1,373,440	2,121,042	2,258,437
CTD [4]	na	66,450	89,000	189,555	311,943	443,953
MBT [5]	775,000	980,377	1,922,170	2,077,200	2,376,206	2,421,935
XBT	290,000	704,424	1,281,942	1,537,203	1,743,590	1,930,399
MRB	na	na	na	107,715	297,936	445,371
DRB	na	na	na	na	50,549	108,564
PFL	na	na	na	na	22,637	168,988
UOR	na	na	na	na	37,645	46,699
APB	na	na	na	na	75,665	75,665
GLD	na	na	na	na	na	338
Total Stations	**1,490,000**	**2,535,163**	**4,487,519**	**5,285,113**	**7,037,213**	**7,900,349**
Plankton				83,650	142,900	150,250
SUR [6]	na		na	na	4,743	9,178

[1] Based on statistics from *Climatological Atlas of the World Ocean* (1982).
[2] Based on NODC Temperature Profile CD-ROM.
[3] WOD05 OSD dataset includes data from 121,625 low-resolution CTD casts and 864 low-resolution XCTD casts.
[4] WOD05 CTD dataset includes data from 2,478 high-resolution XCTD casts.
[5] WOD05 MBT dataset includes data from 80,212 DBT profiles and 5,659 Micro-BT profiles.
[6] Surface data are represented differently from profile data in the database – all observations in a single cruise have been combined into one "station" with zero depth, value(s) of variable(s) measured, latitude, longitude, and Julian year-day to identify data and position of individual observations.

international research community in a common format with associated metadata and quality control flags. There has been a net increase of about 0.9 million temperature profiles since publication of World Ocean Database 2001.

Variables included in WOD05

WOD05 contains data for new variables, such as chemical tracers, not included in earlier versions of the WOD. The Ocean Station Data component of WOD05 includes a large number of the most frequently measured in situ physical (temperature, salinity), chemical (dissolved gases, carbon variables, nutrients, tracers), and biological (total chlorophyll and plankton) historical oceanographic observations as a function of depth or pressure. Each oceanographic station data record may contain simultaneous profiles of one or more of these variables as a function of depth or pressure. The user can extract data from the OSD dataset both at observed depths and up to 33 nominal standard depth levels. The observed level values in the OSD dataset are the measurements submitted by the data originator as a function of depth or pressure. The profiles at standard levels in the OSD dataset are the measurements submitted by the data originator vertically interpolated to selected depth levels. In addition, the profiles include quality flags for observed and standard depth level data. (Johnson et al. (2006) describe the WOD05 data format.)

DATA SOURCES

The oceanographic data that comprise WOD05 were acquired through many sources and projects as well as from individual scientists. The international data exchange organizations include:

- **International Council for the Exploration of the Sea (ICES):** This council was established in 1902 and began collecting and distributing oceanographic data at that time.
- **Intergovernmental Oceanographic Commission (IOC):** Through the International Oceanographic Data Exchange (IODE), IOC developed a network of National Oceanographic Data Centers in many countries. This network facilitates international ocean data exchange. The IOC was established to support international oceanographic scientific needs including data exchange on an intergovernmental basis (UNESCO, 1979). Additional information about IODE can be found on their Web Page, http://www.iode.org/.
- **World Data Center (WDC) System:** This system was set up during the International Geophysical Year (I.G.Y.) under the auspices of the International Council of Scientific Unions (ICSU). The WDC System was originally intended to archive data gathered during the I.G.Y. but has since expanded to include data from all years. The contributions of data from scientists, oceanographic institutions, and countries have been sent to WDC for Oceanography since its inception. Additional information about the WDC System can be found at http://www.ngdc.noaa.gov/wdc/ hosted by the National Geophysical Data Center located in Boulder, Colorado.
- **Marine Science and Technology (MAST) Programme:** This European programme promoted international oceanographic data exchange by emphasizing that MAST funded projects must contribute data to appropriate data centers.

It has become more common for all data from a particular project to be released on CD-ROM as a project data set. We have incorporated data from these CD-ROMs into the WOD05. Examples include: the British Ocean Flux Study (BOFS) and Ocean Margins Experiment (OMEX) datasets produced by the British Oceanographic Data Center and the North Sea Project Database sponsored by the MAST programme.

IOC Global Oceanographic Data Archaeology and Rescue Project

NODC and several other oceanographic data centers initiated data archaeology and rescue projects around 1991. Based on the success of these projects, the Intergovernmental Oceanographic Commission of the United Nations Education, Scientific, and Cultural Organisation (UNESCO) initiated a project in 1993 known as the Global Oceanographic Data Archaeology and Rescue (GODAR) project with the goal of locating and rescuing oceanographic data that are stored in manuscript and/or digital form and at risk of being lost due to media decay. The international scientific and data management communities have strongly supported this project. (Results from this project are described by Levitus et al. 2005.) With the publication and distribution of WOD05, approximately 3.7 million temperature profiles taken prior to 1991 have been added to the historical archives of oceanographic data since inception of various national data archaeology and rescue projects and GODAR.

Quality Control

The quality control procedures used to assign quality control flags to the data in WOD05 are documented (Boyer and Levitus, 1994; Conkright et al., 1994), so individual investigators can choose for themselves whether to accept the results of the quality control criteria we have developed or use their own criteria for quality control.

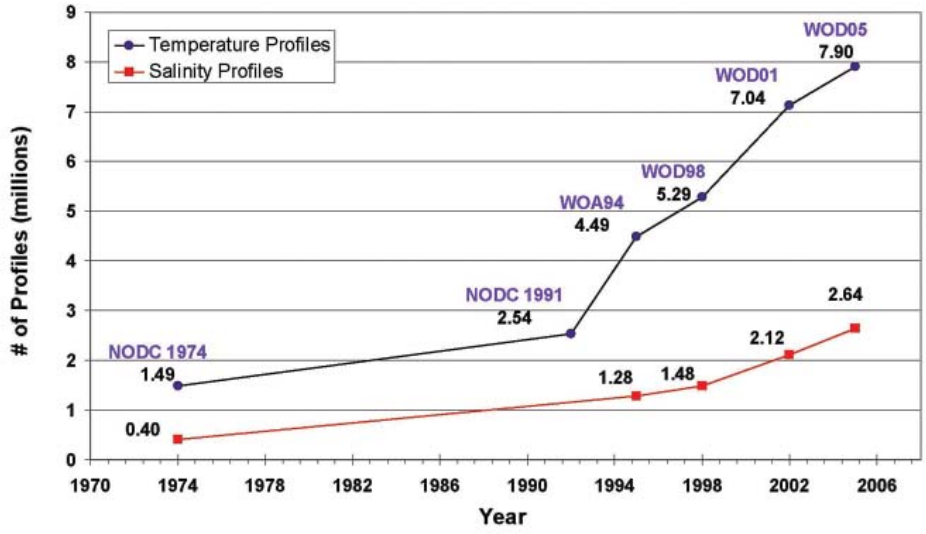
Accessing the *World Ocean Database 2005*

All data and documentation for the *World Ocean Database 2005* data products are available via the Internet on the NODC Home Page (at www.nodc.noaa.gov). In the near future a DVD containing all data will be produced and will be available from NODC.

ACKNOWLEDGEMENTS

Data Archaeology and Rescue projects at NODC/WDC were funded by the NOAA Climate and Global Change (CGC) Program and the NOAA Environmental Science Data and Information Management (ESDIM) Program.

The IOC/IODE Global Oceano-



▲ **Figure 1**. Growth of the NODC/WDC archive of temperature and salinity profiles as a function of time.

graphic Data Archaeology and Rescue project has been responsible for the location and "rescue" (digitization) of substantial amounts of historical oceanographic data. We would like to acknowledge and thank both the international community of scientists who have submitted their data to national and regional data centers and the data managers at the various data centers who have prepared data for international exchange.

International exchange of most of the oceanographic data in WOD05 occurred under the auspices of the IOC/IODE and the ICSU WDC System and we acknowledge the staff of both of these organizations.

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