Vol. 4, No. 4 • June 1994

EARTH SYSTEM MONITOR

NOAA's Satellite Active Archive goes online

SAA is set to serve the global environmental science community

A guide to NOAA's data and information services

INSIDE

2
"GOLD rush" for Internet access to the National Geophysical Data Center

3
News briefs

4
GTSPP builds a global ocean temperature-salinity database

6
Object-oriented database management systems and their application to oceanography

10
Coral reef preservation project in Belize gets support from NODC

15
Data products and services

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

Alan Mark Dwyer, Hughes STX
Richard A. Bolton, Office of Satellite Data Processing and Distribution, NOAA/NESDIS

Users around the world are now able to access data easily from NOAA's polar-orbiting satellites via NOAA's new Satellite Active Archive (SAA). The SAA system enables users on the Internet to quickly search, browse, order, and receive satellite data. The data can be delivered over the network or be mailed to users on various media. Initially, AVHRR (Advanced Very High Resolution Radiometer) data are available via SAA (Table 1). In coming months, additional satellite and ground truth data will become available through the SAA.

Although users can interact with the SAA through an ASCII interface, an X Windows interface is necessary to use SAA's full functionality. SAA is based on client/server technology, resides on a cluster of IBM RS/6000 workstations, and uses the UNIX/AIX operating system and Informix DBMS. StorageTek 4400 and IBM 3495 robotic mass storage systems are connected by fiber optics to NOAA's primary satellite product generation system, CEMSCS (Central Environmental Satellite Computer System), for the primary storage of up to 7 terabytes of near online data.

Office of Satellite Data Processing and Distribution
NOAA/NESDIS
1825 Connecticut Avenue, NW
Washington, DC 20235
E-Mail: adwyer@nesdis.noaa.gov
rbolton@nesdis.noaa.gov

The SAA is also a node on the World Wide Web (WWW) on the Internet. Mosaic client software developed by the National Center for Supercomputing Applications is an effective tool for navigating the Internet and accessing the ever-expanding universe of WWW hypertext and hypermedia information resources. WWW users will be able to access the SAA from the SAA home page and thereby greatly increase the number of its potential users. SAA will also be accessible from the NESDIS and OSDPD home pages.

The development and management of the SAA is being led by the Office of Satellite Data Processing and Distribution (OSDPD) within the NOAA National Environmental Satellite, Data, and Information Service (NESDIS). User assistance and data order distribution functions are supported by the Satellite Data Services Division of NOAA's National Climatic Data Center (NCDC). NCDC's accounting system is also being integrated into SAA to provide a robust user registration and accounting capability. Development of the SAA has also been coordinated with the NCDC, the National Geophysical Data Center (NGDC), the National Oceanographic Data Center (NODC), and NASA's EOSDIS program.

One of the methods by which NOAA, NASA, and other partners in the U.S. Global Change Research Program are addressing the need to gain a greater understanding of the planet Earth is by participating in the Earth Observing System (EOS) program. Interoperability between the SAA and EOSDIS will enable NESDIS to make its data

– *continued on page 12*

Table 1. Data sets initially available in SAA.

Data Set	Source	Sensor	Process Level	Spatial Coverage	Temporal Coverage	Granule Spatial Coverage
AVHRR-LAC	NOAA 11 and 12	AVHRR	1B (raw)	1 km	3/1/94 to present	4 corner points
AVHRR-GAC	NOAA 11 and 12	AVHRR	1B (raw)	4 km	3/1/94 to present	Orbital swath
AVHRR-HRPT	NOAA 11 and 12	AVHRR	1B (raw)	1 km	3/1/94 to present	4 corner points

"GOLD rush" for Internet access to the National Geophysical Data Center

To provide Internet users with ready access to its data and information resources, the National Geophysical Data Center has created GOLD, the Geophysical OnLine Data system. The purpose of GOLD is to facilitate dissemination of data, metadata, and information to customers on the Internet via Mosaic (*http://www.ngdc.noaa.gov/*), Gopher (*gopher.ngdc.noaa.gov*), and anonymous FTP (*ftp.ngdc.noaa.gov*).

NGDC manages environmental data in the fields of solar-terrestrial physics, solid earth geophysics, marine geology and geophysics, paleoclimatology, and glaciology (snow and ice). In each of these fields, it also operates discipline centers of World Data Center A. In addition, NGDC maintains the Defense Meteorological Satellite Program Data Archive and integrates global ecological and environmental data.

NGDC has long served its customers via the Internet, installing anonymous FTP services for colleagues and customers in 1986. In the past few years, NGDC has increased its commitment to providing Internet services. In December 1992, NGDC implemented the Washington University (St. Louis) version of anonymous FTP, which provides user authentication, automatic compression and "tar"-ing of files, and expanded accounting capabilities. Over the last year, GOLD/anonymous FTP customer usage, as measured in host accesses, has increased 1200 percent.

In October 1993, the NGDC announced its Gopher services, providing a graphical, menu-driven interface to the Center's anonymous FTP system. Although Gopher is much easier to use than anonymous FTP, NGDC has seen a steady increase in usage of both services. Over the last six months, GOLD/Gopher usage—measured in host-accesses—has increased 400 percent.

Continuing to build momentum, on February 5, 1994, the NGDC announced its World Wide Web (WWW) server, providing some of the first Mosaic access to information and data in NOAA. As part of the NGDC's strategy of complementary GOLD components, linkages to both NGDC's Gopher and anonymous FTP are provided within the WWW server. In addition, there are GOLD links to other servers at NOAA headquarters, other NOAA line offices, and other sources of geophysical data within government, industry, and academia. Clearly, NGDC's GOLD is an active element in the World Wide Web. To provide the human touch to NGDC's customers, however, GOLD also provides point-of-contact information for NGDC personnel such as name, phone number, and electronic mail address. Over the last four months, GOLD/WWW has logged an average of almost 1000 host accesses per week.

Recent GOLD/WWW efforts at NGDC have been directed towards providing interactive applications online. Current online applications include:

- Full menu-driven access to the Index to Marine Geological Samples database and NGDC's Marine Geological Digital Inventory (GEOLIN) using a fill-in, forms-based user interface with an underlying commercial, cross-platform search and retrieval library developed cooperatively by NGDC and Dataware Technologies, Inc.
- The NGDC HDF (Hierarchical Data Format) Translation Demonstration, which translates data into HDF using the FREEFORM Data Description Language and "makeHDF."

Planned GOLD/WWW interactive online applications include:

- Access to metadata using the interactive, platform-independent, GeoVu compatible menu systems.
- Dynamic retrievals from point/image data sets in many formats.

On March 25, 1994, NGDC announced the creation of the "NOAA-Online" mail list, a forum for NOAA administrators of online services to exchange information quickly and consult with their peers on the issues of the World Wide Web installation, configuration, security, and innovations. To request a subscription to this list, send an electronic mail message to:

listproc@ngdc.noaa.gov

with the message body (beginning in column 1) containing the following:

– continued on page 9

EARTH SYSTEM MONITOR

The *Earth System Monitor* (ISSN 1068-2678) is published quarterly by the NOAA Environmental Information Services office. Questions, comments, or suggestions for articles should be directed to the Editor, Richard J. Abram. Requests for subscriptions and changes of address should be directed to the Assistant Editor, Nancy O'Donnell.

The mailing address for the *Earth System Monitor* is:

Environmental Information Services
NOAA/NESDIS Ex2
Universal Building, Room 506
1825 Connecticut Avenue, NW
Washington, DC 20235

EDITOR
Richard J. Abram
Telephone: 202-606-4561
Fax: 202-606-4586
Internet: rabram@nodc.noaa.gov

ASSISTANT EDITOR
Nancy O'Donnell
Telephone: 202-606-4549
Fax: 202-606-4586
Internet: services@nodc.noaa.gov

U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

National Oceanic and Atmospheric Administration
D. James Baker,
Under Secretary and Administrator

State climatologist exchange program at NCDC

Four applicants have been chosen to participate in the 1994 State Climatologist Exchange Program at the National Climatic Data Center. The participants and their planned research projects are:

- Dr. Donald T. Jensen, Utah State Climatologist: historic severe storms in the western United States and long-term Utah climate stations; comparison of quality control programs and of CD-ROM mastering techniques.
- Dr. Wayne M. Wendland, Illinois State Climatologist: quantity and quality of hourly wind observations for upper Midwest stations; development of a modeling routine to generate mssing hourly observations; and development of a program to summarize hourly wind data.
- Dr. Aulis Lind, Vermont State Climatologist: urban heat island research and development of a new system for describing station site and situation features using detailed orthophoto maps tied to the UTM (Universal Transverse Mercator) grid.
- Dr. John F. Griffiths, Texas State Climatologist: investigation of data from pre-1880 military forts in and around Texas to determine extreme cold and warm episodes and to propose synoptic conditions that may have led to them.

First test images received from new GOES satellite

NOAA and NASA satellite controllers have received the first visible and infrared engineering test images from the nation's newest Geostationary Operational Environmental Satellite, GOES-8, which was launched from Cape Canaveral Air Force Station on April 13.

"The first [visible] image was right on target—sharp, crisp, and clear," said Gary Davis, geostationary programs manager for NOAA. "All our expectations have been met. We are pleased." After receiving the first infrared image, Davis said: "The difference between the capabilities of the current GOES satellite and this satellie are now well-demonstrated. We are extremely excited about the newest image."

After a 180-day test and evaluation period is completed, the satellite will become operational in mid-October. While the GOES series of satellites is owned and operated by the NOAA National Environmental Satellite, Data, and Information Service, NASA manages the design, development, and launch of the spacecraft.

News briefs

NOAA will assume responsibility for command and control, data receipt, and product generation and distribution from GOES-8 after the test and evaluation period is completed.

After it becomes operational, GOES-8 will be positioned at 75°W. At that time GOES-7 will be moved from 112°W to 135°W. Launched seven years ago, GOES - 7 is still operational but has outlived its expected lifetime. GOES-J, the next satellite in the series is planned for launch in April 1995 as a replacement for GOES-7.

NCDC system nominated for "Best of the Web"award

The interactive monthly temperature anomaly product developed by the National Climatic Data Center using its Global Climate Perspectives System and available through NCDC's Mosaic Home Page was nominated for a technical merit award as part of the Best of the Web '94 competition. This program recognizes new resources made available on the World Wide Web over the Internet.

Although not selected as the final winner, which was announced on May 26, 1994, at the first Conference on the World Wide Web in Geneva, Switzerland, the NCDC system was one of the select few recognized for technical innovation in the use of Internet resources. "We think it's an honor to be nominated," said system developers Danny Brinegar and Bruce Baker of NCDC.

The award nomination stated: "These are the truly impressive services . . . These sites demonstrate the unlimited potential for what can be done on the Web."

U.S. NODC hosts data center director and visiting scientist from India

During May 16-26, Dr. R.M.S. Bhargava, Head of the Indian National Oceanographic Data Center (INODC), visited the U.S. National Oceanographic Data Center and World Data Center A, Oceanography. During his visit, discussions were held concerning increased data exchange activities between the two NODC's, possibilities for joint cooperative research between INODC scientists and NODC's Ocean Climate Laboratory staff, and the proposed creation by the two NODCs of a joint oceanographic database for the Indian Ocean.

On May 23, Mr. J.S. Sarupria, a research scientist from INODC, arrived to begin a three-month stay at the NODC. He will participate in cooperative research activities with the NODC Ocean Climate Laboratory.

Global Climate Observing System Newsletter available

The first issue of a newsletter about the Global Climate Observing System (GCOS) has been published by the GCOS Joint Planning Office in Geneva, Switzerland. This new publication is designed to provide the worldwide environmental science community with information about the activities of the GCOS Joint Planning Office and national and international activites related to GCOS.

In cooperation with Dr. Thomas Spence, Director of the GCOS Joint Planning Office, a copy of the inaugural issue of the *GCOS Newsletter* was distributed with the March 1994 issue of the *Earth System Monitor* to the *Monitor's* external (primarily non-NOAA) mailing list. Subscriptions to the *GCOS Newsletter* are available from: Joint Planning Office, Global Climate Observing System, c/o WMO, P.O. Box 2300, CH-1211, Geneva 2, Switzerland.

NOAA names new Deputy Chief Scientist

Dr. Derek Winstanley has been named Deputy Chief Scientist of the National Oceanic and Atmospheric Administration. He was previously Director of the U.S. National Acid Precipitation Assessment Program and member of the U.S. delegation to United Nations/Economic Commission for Europe Negotiations on a Second SO_2 Protocol.

Dr. Winstanley brings 20 years of international experience in environmental research and assessment to his new position in NOAA. His international experience encompasses long-term global and regional environmental issues and energy development, including water supply, hydroelectricity development, and inland fisheries in Africa; world food situation; environmental impact assessment; and climate change. He received his B.A. in Geography from Oxford University in 1966, his M.A. from Oxford in 1970, and his Ph.D. in Climatology from Oxford in 1970.

GTSPP builds an ocean temperature-salinity database

Technology and international cooperation improve access to global ocean data

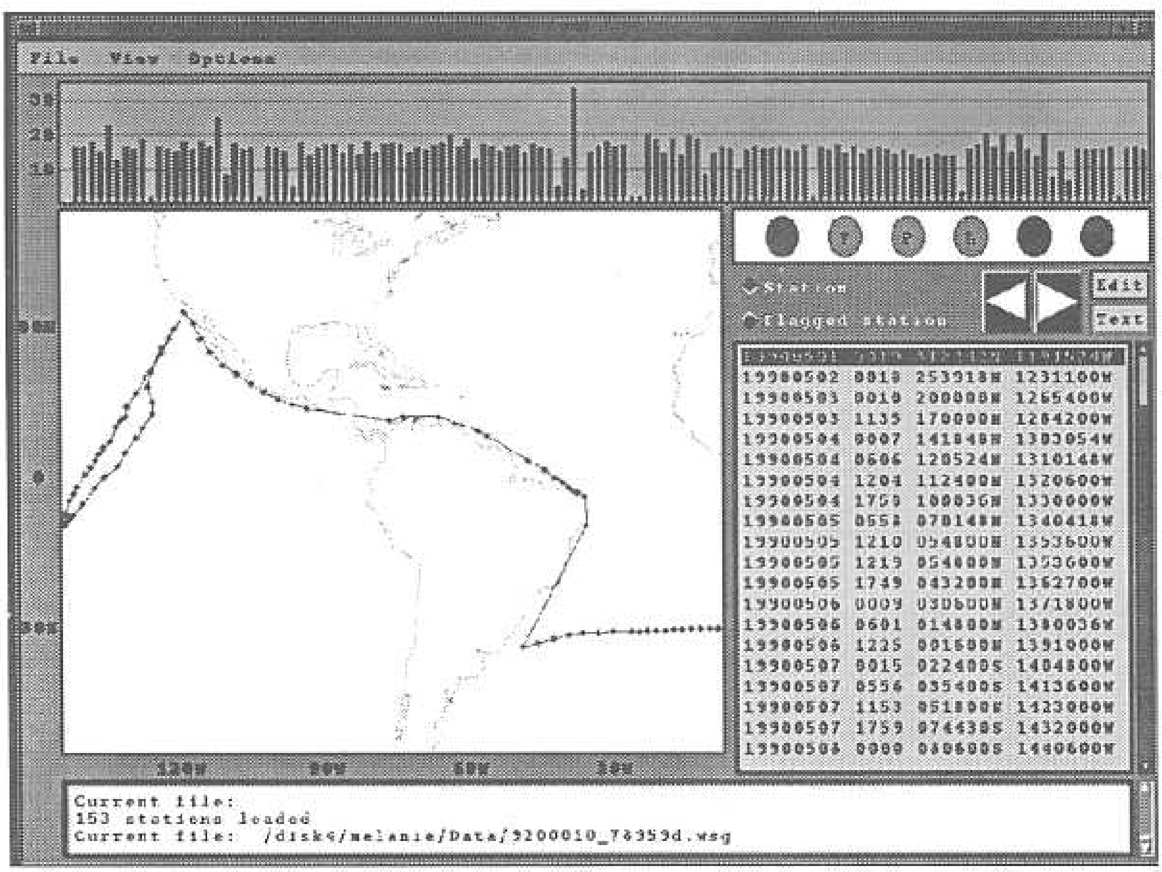
Douglas Hamilton
Chief, Database Management Division
National Oceanographic Data Center
NOAA/NESDIS

Right now around the globe measurements of ocean temperature and salinity (T-S) are being taken by shipboard observers or automated instruments. Sensors are lowered into the sea, towed from ships, or attached to drifting or moored buoys to obtain these measurements. The data are then forwarded through radio or satellite transmitters to receiving stations and transmitted in "real time" to operational users around the world. Some measurements, however, are not transmitted in real time, but are brought back to shore for use by the scientists who collected them, then later forwarded to oceanographic data centers in many different countries.

National Oceanographic Data Center
NOAA/NESDIS E/OC1
1825 Connecticut Avenue, NW
Washington, DC 20235
E-mail: dhamilton@nodc.noaa.gov

Making these data quickly and easily accessible to users is the primary goal of the Global Temperature-Salinity Pilot Project (GTSPP). A cooperative international project, the GTSPP seeks to develop and maintain a global ocean T-S resource with data that are as up-to-date and of the highest quality as possible. Countries contributing to the project are Australia, Canada, France, Germany, Japan, Russia, and the United States.

Before the GTSPP was in place, researchers who wanted to obtain a complete set of ocean temperature-salinity data had to contact many people at numerous institutions around the world. Data were recorded in a confusing array of data formats and were often available only many years after observation. Today, a global ocean T-S database is available from the U.S. National Oceanographic Data Center (NODC) as a result of NODC participation in the GTSPP.



▲ **Figure 1.** Window display for quality control of GTSPP data. A plot of the cruise track and landmass outlines is shown in the large panel (left center); values of date, time, latitude, and longitude of individual stations are shown in the panel to the right; vertical bars indicating ship speed between succcessive stations are shown in the top panel; and information about the data file being processed is shown in the bottom panel. Buttons below the speed bars show the results of tests applied to the current station (green for passed test, red for failed). The tests are (left to right buttons): ship identification, impossible date/time, impossible latitude/longitude, position on land, ship speed greater than 30 knots, and impossible bottom depth.

NODC's role in the GTSPP

The NODC fulfills three major functions for the GTSPP:

1. **Data communications support.** The Internet is used daily to transmit and receive data and project information. Real-time data are relayed from the NOAA National Weather Service and the Navy Fleet Numerical Oceanography Center to Canada's Marine Environmental Data Service (MEDS). In addition, monthly files are transmitted to oceanography centers in Hobart, Australia; Brest, France; La Jolla, Calif.; Miami, Fla.; and other locations in the United States. Each month approximately 30 megabytes of GTSPP data are received or transmitted using FTP (file transfer protocol) over the Internet.
2. **Data quality control.** All GTSPP data are passed through stan-

Table 1. Quality control tests performed on GTSPP data.

A. Position and Identification Tests
1. Platform identification (real-time data)
2. Impossible date or time
3. Impossible geographic position
4. Position on land
5. Impossible ship speed between stations
6. Impossible bottom depth report

B. Subsurface Data Profile Tests
1. Global impossible parameter value
2. Regional impossible parameter value (Red Sea, Mediterranean Sea)
3. Increasing depth values
4. Profile envelope (specific to parameter)
5. Constant profile (iso-valued)
6. Freezing point of sea water
7. Spike
8. Gradient
9. Water density inversion

C. Climatology Test
1. Comparison to ocean climatologies published by S. Levitus

D. Visual Inspection
1. Ship track
2. Individual profile plots

dard data quality tests, which are documented in the *GTSPP Real-Time Quality Control Manual* (Intergovernmental Oceanographic Commission Manuals and Guides No. 22, Unesco, 1990). In early 1994, the NODC implemented two systems to apply quality tests to data destined for the GTSPP database. The systems were written in C++ and operate on UNIX-based workstations that are part of NODC's new client/server computing environment.

One system displays geographic positions of observations along with landmasses, and shows the ship speed between observations as a check on positions, dates and times (Figure 1). The second system applies tests to subsurface temperature and salinity data, setting flags to reflect test results. A summary of the data quality tests performed by the GTSPP system is presented in Table 1.

3. **Database maintenance.** GTSPP data are maintained in a relational database that is managed by commercial software on a UNIX work station. Real-time data are added automatically, as they arrive from Canada's Marine Environmental Data Service three times per week. Higher quality delayed mode data are now being quality controlled and added to the database. As these observations are added, the matching real-time data are tagged to avoid sending two copies of the same data. The database makes it possible to quickly load and retrieve data, as well as statistics about the number of observations per geographic region,time period, ship, or data type.

GTSPP data

Data in the GTSPP database are generated by ships or buoys from all regions of the world's oceans. Instruments used to collect the data include thermistor chains (on buoys), expendable bathythermographs (XBTs), digital bathythermographs (DBTs), bottle samplers, and CTDs (conductivity-temperature-depth sensors). The data are sent in real-time (by radio or satellite transmission) and later in delayed mode when ships return to port.

Delayed-mode records are generally of higher resolution than records sent in real time. Therefore, the NODC acquire delayed mode data (usually several months after data were collected) and merges them into the database. To avoid duplication of real-time and delayed mode observations, real-time records are matched to corresponding delayed mode records in the database. In that way, the GTSPP data resource is built quickly from real-time records and also with high quality, high resolution delayed mode records. As of April 1994 the GTSPP database contained 243 MB of real-time, global T-S data (Table 2)

Support to climate research

GTSPP data are used by Australia's Commonwealth Scientific and Industrial Research Organization, Scripps Institution of Oceanography, and NOAA's Atlantic Oceanographic and Meteorological Laboratory. Each of these centers uses the data in ocean climate research as part of the World Ocean Circulation Experiment. Results of their scientific analyses are fed back into the GTSPP database to help improve data quality.

Conclusion

Experience gained from GTSPP has revealed the beginnings of what can become a global ocean network of data management and science centers. Scientists are able to obtain global ocean data needed for their ongoing research, and data management centers have learned that the work can be done more efficiently when working together. The end product, a global ocean temperature-salinity database, will be useful for future scientists considering questions about global climate.

The project has demonstrated that technology now in place, both computers and networks, is sufficient for sustaining cooperative work such as that being done in GTSPP. Lessons learned in GTSPP will be useful to future global ocean data management projects, such as the Global Ocean Observing System (GOOS).

Funding for NODC particpation in the Global Temperature-Salinity Pilot Project is provided by the NOAA Environmental Services Data and Information Management program. ■

Table 2. GTSPP real-time data (as of April 1994).

Ocean	Year					TOTAL
	1990	1991	1992	1993	1994	
Atlantic	17,733	15,558	13,093	19,117	4,623	70,124
Indian	3,137	2,447	3,008	5,216	2,616	16,424
Pacific	26,615	24,043	34,280	43,470	11,663	140,071
TOTAL	47,485	42,048	50,381	67,803	18,902	226,619

Object-oriented database management systems and their application to oceanography

James C. Hendee
Ocean Chemistry Division
Atlantic Oceanographic and Meteorological Laboratory
NOAA/ERL/OAR

The increasing complexity of software systems and the time required to develop them has resulted in the emergence of a programming paradigm called object-oriented programming (OOP). Probably the primary reason for its gaining popularity is that the system allows more rapid software development by encouraging re-use of pre-existing bug-free modules, or objects, thus eliminating so much of the "reinventing the wheel" effort that goes into much of today's procedural oriented programs.

This article reviews the history of OOP, the fundamental characteristics of OOP languages, the use of OOP in object-oriented database management systems (OODBMS), and will illustrate the use of OOP principles in a powerful OODBMS language.

The roots of OOP lie in Simula 67, an extension of Algol 67 designed in 1967 by Ole-Johan Dahl and Kristen Nygaard from the University of Oslo and the Norwegian Computing Center. Although Simula never really caught on in a big way, the Xerox Corporation's Palo Alto Research Center (PARC) carried the torch forward when the Smalltalk research project, initiated by Alan Kay, set as its goals a complete integrated environment, including an object-oriented language, development tools, and a graphical interface. Some features of today's more familiar graphical user interfaces—windows, icons, and the mouse—have their origins in that project. All of today's object-oriented languages, including C++, Microsoft Windows, DESQview/X, Motif, and Open Look, are based on the concepts first used in Smalltalk, which still deals exclusively with objects. As much as the language itself, the development tools in Smalltalk, including browsers and object inspectors, have proven invaluable (van Straaten, 1992).

So if Smalltalk and OOP are so great, what took so long for them to catch on? The primary reason is that Simula 67 and Smalltalk-80 were relatively inaccessible to North America when they were first introduced. For example, Smalltalk-80 development was kept as a close secret until its debut in the August 1981 issue of *BYTE*. In 1984, OOP languages such as Objective-C, C++ and Eiffel didn't even exist, and it wasn't until 1986 that the first conference on Object-Oriented Programming Languages, Applications, and Systems (OOPSLA) was held (Thomas, 1989).

From a programming point of view, an object is a collection of data and the procedures that operate on it.

Another reason is that many of those who were first introduced to Smalltalk thought of it only as a windowing environment, rather than a powerful programming environment. And while many emerging software programs copied the windowing system, many could not approach the flexibility of Smalltalk, which required powerful hardware. It has only been in the last several years that powerful processors such as the 80386 and the 68020 have become available (Thomas, 1989).

Before delving into the heart of what is or is not an OODBMS, it is helpful to review just what constitutes a database management system.

Atlantic Oceanographic and Meteorological Laboratory
NOAA/ERL/OAR
4301 Rickenbacker Causeway
Miami, FL 33149
E-mail: hendee@aoml.erl.gov

Principles of an Object-Oriented Database Management System

As there are criteria for OOP, so too are there criteria for an OODBMS. Atkinson *et al.* (1989), Zdonik and Maier (1990) have summarized the salient points, which are discussed in the following sections. The literature on this subject is large and growing and interesting further discussions may be found in Bertino and Martino (1991); Cattell (1991); Hurson, Pakzad, and Cheng (1993); Kim (1991); Nahouraii, and Petry (1991); Premerianai *et al.* (1990); and, Wells, Blakeley, and Thompson (1992).

An OODBMS must be a database management system first, and be object-oriented, second. A convenient system for discussing the qualities of a database management system is given by Zdonik and Maier (1990). They distinguish among features that are essential, frequent, and less frequent.

Essential features

- *Model and Language.* Foremost of all an OODBMS has a language that enables it to manipulate structured data, for instance, arrangement of data into records, and grouping of records into sets, trees, or lists. Operations on the data include modification of records (editing), inserting and deleting of records, and searching of records for specific values or information. In contrast to the mere filing of raw data, incoming information that is to be stored must be interpreted so that it can be stored in the form of records.
- *Relationships.* Names may be assigned to relationships among the data and the language can interrogate or query those relationships. Although there are many ways relationships may be organized, a common method is through physical or logical links. A physical link is one in which one data item points to another data item in storage. A logical link exists between a data item and another data item that describes its properties.
- *Permanence.* Data are persistent and stable. In other words, when the procedure or process that creates or manipulates data is finished, the data will still be accessible at a later time. Storage of the data is stable in the face of program or media failure. In other words, the data may be backed up to an alternative media or a separate device.
- *Sharing.* Data should be accessible by more than one user at the same time.

However, a form of concurrency control may be in existence in which a record or a file may be locked while a user is updating it, then unlocked when the edit is completed. Data should be transferable among work sites.

■ *Arbitrary size.* Size of the database and operation of the DBMS should not be limited by the amount of main memory. The database should be allowed to grow from zero records to a very large amount.

Frequent features

The following elements are common among most commercial mainframe and many PC based database management systems.

■ *Integrity constraints.* Integrity constraints (statements which must always be true for records in the database) are enforced. Examples are domains, ranges of values for a field, keys (unique field or combination of fields), and referential integrity constraints, that is, a reference in one data item points to another data item.

■ *Querying.* There should be a facility to easily query the database without being concerned about how the system acquires the data for the query. Queries are associative, that is the request is based on properties or relationships among the properties. Queries are of two types, one for queries within programs, and another for users to type in directly into the system, the so-called *ad hoc* query.

■ *Separate schema.* There are usually different groups of schema in a database.

■ *Views.* Data are presented not as actual stored values but generally as computed values from the stored values, and/or as relations.

■ *Database administration.* A special interface is present in which the database administrator can perform certain database maintenance functions. For example, these functions include: a) reorganizing the data structure, b) gathering statistics on types of queries, c) keeping track of users, d) maintaining a user list, and e) making additions or deletions to the database.

Less frequent features

■ *Report and form management.* The capability to readily generate reports and forms, as well as display or print tables and graphs, is becoming increasingly common.

■ *Data dictionary.* Descriptions of field and record formats, documentation on the source and reliability of the data, information on validation schemes, output schemes, and auxiliary programs are presented to facilitate handling of the data.

■ *Distribution.* Distributed databases allow access by many computers which may be spread over very large distances. Usually, shared data are localized at areas where the specific type of data is used more often; however, access is granted to the whole database, involving all sites. External databases may also be supported.

An OODBMS is essentially an object-oriented programming language overlying a database management system. The next section reviews the characteristics of object-oriented programming languages.

Characteristics of object-oriented programming languages

OOP languages generally have at least five traits in common—objects, classes, inheritance, polymorphism, and dynamic binding—but there are other characteristics, as well. The description below is drawn from a number of sources (e.g., Korson and McGregor, 1990; Ledbetter and Cox, 1985; Thomas, 1989; van Stratten, 1992; Wegener, 1989).

What is an object? The real world is made of objects, so a programming language based on the concept of representation of events as objects is intuitively appealing. From a programming point of view, an object is a collection of data and the procedures that operate on it—they are the fundamental run-time elements of an object-oriented system. What makes this property confusing, however, is that most well-structured programs could be said to possess these characteristics. While this may be true, object-oriented languages enforce this approach, rather than just encourage it. The enforcement is achieved by requiring that the compiler or interpreter be informed which procedures (or methods, see below) are allowed to operate on an object's data (Korson and McGregor, 1990; van Stratten, 1992).

This arrangement between data and code can be clarified by a more detailed discussion of basic OOP concepts.

■ *Classes, instances, and instance variables.* A class can be thought of as a collection of similar objects sharing a common set of attributes. In this vein, you can think of a class as a template or skeleton for creating an object, or as a set of possible objects. A class therefore is composed of details of structures of objects and programming procedures permitted to operate on objects of that class. An object is thus an instance of a class, and a class can have many instances, that is, many objects.

The structure of an object is determined by its class, but objects are distinguished from each other by the data they contain, which are stored in instance variables. Instance variables differ from regular variables in that they are contained in objects and are not directly accessible outside of the objects. However, they can be accessed by sending messages to the objects.

■ *Messages and methods.* Objects were previously defined as a collection of procedures and data. These procedures are known as methods in the object-oriented programming paradigm. The terminology is different because procedures are not associated with objects, and there are basic differences between the two terms. In a pure object-oriented system such as Smalltalk, there are no procedures, only methods. In a combined system, such as C++, both procedures and methods can co-exist.

Contrary to standard procedures, you don't call methods, you send messages to objects which then execute the appropriate method. Valid operations upon data can only be initiated by the sending of messages, and each object is self-contained, so that what happens in one object is not known or affected by the operations in another object. Each object is a self-contained entity, and while this concept may be considered analogous, even reachable in procedurally oriented systems, it is the active encouragement, support, and enforcement of this concept in object-oriented systems which distinguishes them. This notion of an isolated routine in object-oriented systems is called encapsulation, and characterizes one of the most powerful features of OOP.

■ *Inheritance, superclasses, and subclasses.* When classes share many prop-

– continued on page 8

OODBMS from page 7

erties, they may be grouped together to form a superclass. For instance, an Exploding Window, a Shrinking Window, and a Moving Window might all share the same attributes (e.g., window coordinates, screen color) and therefore be considered as having Window as its superclass. Exploding Window, Shrinking Window, and Moving Window are therefore considered as subclasses of the Window class. This property is known as inheritance. In other words, the subclasses inherit common properties, and then add properties of their own. Additionally, you may have subclasses within subclasses, creating class hierarchies, which is a common feature of object-oriented systems.

Because inheritance allows reuse of code segments, rapid prototyping of software becomes possible under the object-oriented paradigm. Minor differences between classes may be easily accommodated in the subclasses, while the superclass remains intact and available for use by other subclasses at a future time, or in other areas of the same software package.

■ *Polymorphism.* In the context of object-oriented programming, the term polymorphism means that the same message can have different behaviors when sent to different objects. Sending the message to a window object would have a different consequence than sending the same message to, say, a graph object. Under the traditional procedural approach, however, the programmer must differentiate between procedure names, for instance DeleteWindow or DeleteGraph. In an object-oriented language, this is unnecessary, and is, in fact, not considered good OOP practice.

The above example shows that a benefit derives from the fact that the programmer can use the same message for conceptually similar operations in different classes. However, there is an even more significant benefit. A message can be sent to an object whose class is not known—all the programmer needs is the library and knowledge of what the message does. It is not necessary to test for the type of the variable—for example, using CASE statements, which would be necessary under a procedure-oriented approach—before sending the variable to the procedure. With the object-oriented paradigm the message is sent without testing and the appropriate method is invoked accordingly.

Taken together with inheritance, then, polymorphism becomes even more powerful. This means that messages with standardized names can be sent to superclasses and their subclasses, thus enabling generic methods to be developed and used by any of those classes which support the required messages.

■ *Dynamic or late binding.* Binding refers to the binding of a procedure call to the code to be executed in response to the call. Dynamic or late binding means the code associated with a given procedure call is not known until the time of the call at run time (Korson and McGregor, 1990). For an object-oriented language the "procedure call" translates to "message send," and the dynamic bind is a direct consequence of the properties of polymorphism and inheritance, described above.

Characteristics of an Object-Oriented Database Management System

In addition to the qualities of OOP, an OODBMS must at least support the concepts of complex objects and object identity (Khoshaflan and Copeland, 1990; Atkinson *et al.*, 1992; Zdonik and Maier, 1990), in addition to the qualities mentioned above for OOP languages.

■ *Complex objects.* A complex object is simply a collection of simpler objects, put together with constructors. Examples of simple objects are integers, characters, and strings. The constructors may be, for example, sets, tuples, lists, or arrays. Any constructor should apply to any object, and operators must be provided for handling complex objects. In other words, an operation on a complex object must also work on all component objects.

■ *Object identity.* Under this concept, an object has an independent existence unrelated to the value of the object. Two objects may be identical or they may have the same value (equality). Identical objects may be distinguished from equal objects by virtue of object sharing or object updates. Identical objects may share components, and a change to a component will be evidenced in both objects.

OODBMS in oceanography

Like many others, oceanographers and marine scientists are beginning to realize the benefits of OOP. Although their numbers are few, there are programmers who were marine scientists first, and computer programmers second. There are also some who fit the opposite bill. Either way, because their numbers are relatively few, there has not been widespread communication among them so that advances in techniques have been developed independently, resulting in duplication of effort.

Since there are many routine calculations in oceanography, it would be helpful if a class library of these could be developed for use by all oceanographers and marine scientists who conduct programming regularly. The problem here is that there are several programming languages that purport to be OO languages, and class libraries developed for one language may not be easily linked with another. As long as the code is in one language, and the routines are short, though, it should be fairly easy to port the code to the other language.

One of the programs we use extensively is OODB.EXE, an object-oriented program to manipulate dBase III+ and dBase IV files. Some of the routines used in OODB were used with little modification in the construction of yet another program called Ocean Profiler, an at-sea data management program; hence, development of Ocean Profiler was rather rapid. Some of the routines common between the two include facilities for the temporary or permanent deletion of duplicate entries, merging of data from one dBase file into a master dBase file, adding of a new field to a dBase file, appending data from one dBase file onto another, range checking, and more. The program OODB.EXE uses these routines in a command line mode, whereas Ocean Profiler uses them interactively. The code, however, is basically the same.

The utilities as represented in OODB.EXE are especially useful in PC batch mode. The box on the facing page, for example, presents a short segment of a large batch file (RANGES.BAT) for checking ranges of some common oceanographic parameters. In the first line of this example, the method "rangecheck" within the program

```
REM This is RANGES.BAT for checking ranges of
REM     oceanographic parameters.
oodb rangecheck eq92sprj press 0 6000 pressure.txt -9.9 samp_no
oodb rangecheck eq92sprj ctd_sal 32 38 ctd_sal.txt -9.999 samp_no
oodb rangecheck eq92sprj bot_sal 32 38 bot_sal.txt -9.999 samp_no
oodb rangecheck eq92sprj temp 0 30 temp.txt -9.999 samp_no
[ etc. ]
```

OODB.EXE operates on the dBase file eq92sprj.dbf (".dbf" file extent is default), and checks the range of values between 0 and 6000 in the field "press" (pressure). The text file called "pressure.txt" lists all pressure values and associated sample numbers which fall outside of the range 0 to 6000, except any values with a -9.9 in the field, as that is the default null value in this database. The field "samp_no" (sample number) is the unique key used to index the file. When the batch file is finished running, the data manager can review all of the text files generated to see which values lie outside of the prescribed ranges. Necessary changes to the master database can be made in a similar fashion using the same program. Other parameters checked in the example above are CTD (Conductivity-Temperature-Depth) salinity, Niskin bottle salinity, and temperature.

The programming language used for the program above was Clipper 5.2c with the Class(y) class library extension. This language supports all the characteristics of an OOP system (e.g., objects, classes, instance variables, encapsulation, methods and messages, inheritance, polymorphism, late binding) and supports data persistence and the other characteristics a OODBMS system should have, as discussed above.

At our laboratory we will begin to learn other OODBMS systems, develop class libraries, and share these with the rest of the oceanographic community. To facilitate the open exchange of oceanographic class libraries, we have set up an anonymous Internet FTP (File Transfer Protocol) site for the public domain uploading and downloading of these libraries. The Internet address is *manoa.aoml.erl.gov*. Log-on as "anonymous" and use your real Internet address as the password. Change directory to */pub*, then to the computer platform of choice, then to the programming language of interest, for example, C++, Smalltalk, or Clipper.

Bibliography and References

Atkinson, M., F. Banchilhon, D. DeWitt, K. Dittrich, D. Maier, and S. Zdonik, 1992. The object-oriented database system manifesto. *Proc. First Conf. Deductive and Object-oriented Databases, Kyoto, Japan, 1989.*

Bancilhon, F., C. Delobel, and P. Kanellakis, eds. 1992. *Building an object-oriented database system: the story of O2.* Morgan Kaufmann Publishers; San Mateo, CA.

Bertino, E. and L. Martino, 1991. Object-oriented database management systems: concepts and issues. *Computer*, 24(4): 33-47.

Bihari, T.E. and P. Gopinath, 1992. Object-oriented real-time systems: concepts and examples. *Computer*, Dec. '92: 25-32.

Booch, G., 1991. *Object-oriented design, with applications.* The Benjamin/Cummings Publishing Comp., Inc.; New York, NY.

Cattell, R.G.G., 1991. *Object data management: object-oriented and extended relational database systems.* Addison-Wesley Publishing Company; Reading, MA.

Cox, B. J., 1986. *Object-oriented programming: an evolutionary approach.* Addison-Wesley. Reading, Mass.

Hurson, A.R., S.M. Pakzad, and J. Cheng. 1993. Object-oriented database management systems: evolution and performance issues. *Computer*, Feb. '93: 48-60.

Khoshaflan, S.N. and G.P. Copeland, 1990. Object identity. In: *Readings in object-oriented database systems.* S.B. Zdonik and D. Maier, eds. Morgan Kaufmann Publishers, Inc.; San Mateo, CA.

Kim, W., 1991. *Introduction to object-oriented databases.* MIT Press. Cambridge, MA.

Korson, T. and J.D. McGregor, 1990. Understanding object-oriented: a unifying paradigm. *Commun. ACM* 33 (9): 40-60.

Ledbetter, L. and B. Cox, 1985. Software-ICs. *BYTE*, June '85: 28-36.

Meyer, B., 1988. *Object-oriented software construction.* Prentice Hall; New York, NY.

Nahouraii, E. and F. Petry, 1991. *Object-oriented databases.* IEEE Computer Society Press; Los Alamitos, CA.

Peterson, G.E., 1987. *Object-oriented computing. Vols. 1 and 2.* Computer Society Press of the IEEE; Washington, D.C.

Pikula, L., 1993. Object-oriented databases, (Apr. 92 - Present). *Citations from the Information Services for the Physics and Engineering Communities.* AOML/NOAA Library. 4301Rickenbacker Causeway, Miami, FL.

Premeriani, W.J., M.R. Biaha, J.E. Rumbaugh, and T.A. Varwig, 1990. An object-oriented relational database. *Commun. ACM* 33 (11): 99-109.

Thomas, Dave, 1989. What's in an object? *BYTE*, March '89: 231-240.

van Straaten, Anton, 1992. *Class(y). The Object-Oriented Language Extension for CA-Clipper. Version 2.0.* ObjecTech, Inc.; Suite 108, 266 Harristown Road, Glen Rock, NJ.

Wegener, Peter, 1989. Learning the language. *BYTE*, March '89: 245-254.

Wells, D.L., J.A. Blakeley, and C.W. Thompson, 1992. Architecture of an open object-oriented database management system. *Computer*, Oct. '92: 74-81.

Zdonik, S.B. and D. Maier, 1990. Fundamentals of object-oriented databases. In: *Readings in object-oriented database systems.* S.B. Zdonik and D. Maier, eds. Morgan Kaufmann Publishers, Inc., San Mateo, CA. ■

NGDC GOLD system, from page 2

subscribe noaa-online Your Name
where *Your Name* is your given name, e.g., Jane A. Doe.

For more information about any of the services described here, contact: Marc Ertle (Telephone: 303-497-6139).

For general questions about NGDC, contact:

National Geophysical Data Center
NOAA/NESDIS/NGDC E/GC
325 Broadway
Boulder, CO 80303-3328
Phone: (303) 497-6826
Fax: (303) 497-6513
Internet: info@ngdc.noaa.gov

— Marc Ertle
National Geophysical Data Center
NOAA/NESDIS
Boulder, CO 80303
E-mail: mertle@ngdc.noaa.gov ■

Coral reef preservation project in Belize gets support from NODC

Data exchange planned for ecosystem data from the Belize Barrier Reef

Dr. Anthony R. Picciolo
National Oceanographic Data Center
NOAA/NESDIS

Under a proposed NOAA initiative to improve global management of coral reefs and associated coastal ecosystems, the National Oceanographic Data Center (NODC) has established a working relationship with the government of Belize, University College of Belize, and the Coral Cay Conservation, an independent and non-profit organization based in the United Kingdom. The focus of this cooperative project is the protection and preservation of the Belize Barrier Reef and its associated ecosystem.

The Belize Barrier Reef lies offshore Belize (formerly British Honduras) along the Caribbean coast of Central America (see map). At 180 miles long, it is second in size only to the Australian Great Barrier Reef. Scientists of the U.S. National Museum of Natural History have described the Belize Barrier Reef as a "pristine system, with only minimal disturbances from the distant landmass, such as silting and run-off nutrients and pollutants and only moderate fishing activities by natives and a few tourists" (NMNH CCRE Program announcement, undated).

In recent decades, however, many coral reefs around the world—especially those near populated areas— have shown significant degradation. Overfishing, nutrient enrichment, siltation, sewage pollution, coral mining, shoreline development, human invasion by water sports enthusiasts, coral diseases, and predation have all taken their toll. Coral bleaching—possibly an indicator of global warming—is also a cause for concern.

In the near future, the Belize Barrier Reef may face many of these same threats. If not properly managed, Belize industrial and agricultural development, along with a growing tourist industry may put the reef in danger.

Tourists are attracted to Belize's many natural and cultural resources—virgin rain forests, a jaguar preserve, Mayan temples, and, of course, the longest continuous barrier reef in the Western Hemisphere. Compared to the scuba-diving industry in other parts of the Caribbean (e.g., Cozumel, the Cayman Islands), the Belize reef is visited by relatively few divers. Articles about Belize appearing in scuba-diving magazines, however, are beginning to beckon more divers to the offshore cays and live-aboard dive vessels. While most divers and dive operations care about reef protection, the increased number of divers and possible construction of additional facilities on the fragile cays can have harmful effects on the environment.

Like most developing countries, Belize lacks sufficient financial and technical resources needed to assess and manage their coastal ecosystem, which includes the Belize Barrier Reef. Through a program of technical cooperation, the U.S. National Oceanographic Data Center plans to assist the government of Belize (GOB) in resource management by transferring information via training programs in data management, including data analysis, and by involvement with global networks enabling the country to exchange marine biological and environmental data with global databases.

Research infrastructure

A great deal of research on the reef has already been conducted by scientists of the National Museum of Natural History of the Smithsonian Institution, which maintains a research field station on Carrie Bow Cay, a one-acre island on the southern Belize Barrier Reef. The research program, Caribbean Coral Reef Ecosystems (CCRE), includes reef, mangrove swamp, seagrass, and plankton community studies. Studies have been conducted for 22 years by approximately 50 scientists a year, resulting in nearly 400 scientific publications, Ph.D. dissertations and many papers at scientific meetings. This center is directed by Dr. Klaus Ruetzler of the Natural History Museum.

The Belize government with the aid of foreign agencies such as the Coral Cay Conservation (CCC) have joined in an ecological initiative to create a database of baseline data and information that will form the basis for determining the health of the reef over time.

Since 1986, the CCC has provided the government of Belize with scientific expertise and resources to assist in the development of plans for the protection and sustainable use of Belize's coastal marine resources. Over 1000 surveys of the barrier reef have been conducted to date. The driving forces behind the conservation group are its Directors Peter Raines and John Ridley. Both divide their time between the London office, their office at the University College of Belize (UCB), and the Calabash Cay Marine Research Center. Susan Wells, well known for her contributions to coral reef research and conservation, recently joined the CCC as Science Coordinator.

National Oceanographic Data Center
NOAA/NESDIS
1825 Connecticut Avenue, NW
Washington, DC 20235
E-Mail: apicciolo@nodc.noaa.gov

CCC utilizes a mixed workforce of volunteer divers to collect baseline biological and environmental data on the reef and associated mangrove and sea grass environments. On a yearly basis, about 300 divers participate in these biological surveys, most of them from the United Kingdom.

In 1992, UCB and the CCC began a formal collaboration towards the development of a Marine Research Center (MRC) in Belize. The fruits of this relationship have included: development of a self-financing research center to complement UCB's marine studies program; continuation of CCC's work in support of the government's Coastal Zone Management initiatives; provision of an institutional mechanism for interministerial cooperation with training, research and coastal resources issues; collection, analysis and synthesis of data used to manage Belize's coastal marine resources; provision of educational programs for citizens of Belize in managing their marine resources; and the establishment of collaborative links with foreign research and educational agencies, including research and educational exchanges (CCC Newsletter, No.4, July/August 1993).

The location chosen for the site of the MRC is Calabash Cay on Turneffe Atoll. At 200 square miles, it is the largest of the offshore atolls and composed of sand and mangrove cays which are mostly uninhabited and a complex central lagoon system. It is bounded by an extensive fringing coral reef. Beside the expected coral reef, mixed wetlands, and lagoon communities, Turneffe also supports manatee, dolphin and North American crocodile populations.

The Calabash Cay Marine Research Center field station is staffed with an Expedition Leader, Science Officer, and Diving Officer. Martin Spragg, the Expedition Leader, manages the day to day operations and logistics of maintaining the Center. Science Officer John Hocivar trains and oversees the volunteers in species identification, research techniques, and data collection.

At the invitation of the GOB and CCC, I observed and evaluated during a 4–day expedition the scientific procedures employed in reef surveys and the science training given to the divers. Some in the scientific community question the use of non–scientists to make scientific observations and measurements. In my evaluation, however, the science survey techniques used by the CCC are standard and sound ecological approaches, and the volunteers were well trained by scientific experts. They approached the expedition as a serious scientific venture and not as an exotic vacation. The data they collect (recorded underwater on waterproof data forms) are carefully preserved. While processing the data into a database is now done in the United Kingdom, it will soon be performed in Belize.

The MRC is guided by an Advisory Council comprised of representatives from the Government, the Coastal Zone Management Unit, UCB, and the CCC. In meetings with the Advisory Counsel, an overview of NOAA and NODC operations and interests were given with specific discussion centering on ocean data management. A draft of a NODC-UCB/GOB/CCC data exchange agreement was introduced for their consideration. Also discussed was the possibility of providing training in data management and analysis for personnel from Belize, as well as a collaborative research project. The details of the agreement will be worked out over the next few weeks.

The GOB/CCC has already contributed five years of survey data to the NODC and its collocated World Data Center A for Oceanography. The surveys were conducted along 100 m east-west transects along different reef zones, with positions fixed using the Global Positioning System (GPS). Data consist of a habitat description, which includes substratum characteristics, biological cover, species present, and their approximate abundance. These data are from the previous CCC field station south of their present location.

Data collection activities

CCC volunteers, all certified scuba divers, pay to join an expedition. I arrived in Belize simultaneously with a new group of volunteers. Careers represented included university students (mostly marine biology majors), engineering, law, financial management, medicine, physical therapy, and a variety of other occupations. Applicants receive personal interviews and only those are selected who meet standards for intelligence, dedication, and physical fitness, and who are judged likely to be full and useful participants in an expedition.

The minimum time commitment for a CCC volunteer is approximately one month, and the first 8 days are given to intense training on the environment and identification of the species that inhabit the study area. Training consists of daily lecture and laboratory sessions, followed by dives on the reef to observe the organisms *in situ*. Two to three classroom sessions and two to three dives on the site are the norm for the day. The volunteers are continually tested on species identification and data observation. Quality control procedures are followed for accuracy and precision of the data.

Volunteers participate in all aspects of an expedition. They cook and clean, work on building construction, facilities maintenance, loading and off loading boats, piloting dive boats, ensuring diver equipment safety, and retrieving divers from the water.

The present MRC site is temporary and very basic. It consists of a one-room building on stilts, which functions as a classroom, laboratory, communications center, library, and dining room. The MRC will soon move to the adjoining stretch of land where permanent facilities will be constructed. Accommodations for 40 people are planned, as well as a main science building and canteen. CCC will manage it for an initial period of 10 years, then turn the management over to the UCB/GOB.

In addition to the development of the MRC and the marine studies program of the UCB, the CCC conducts expeditions on other parts of the reef. In collaboration with the Coastal Zone Management Unit (CZMU), the CCC will develop management plans for establishment of other marine reserves in the area.

CCC continues to need volunteers with construction skills and experience, such as carpenters, electricians and engineers. Further information about the CCC and its programs is available from:

Coral Cay Conservation
"The Ivy Works"
154 Clapham Park Road
London SW4 7DE
United Kingdom
Telephone: 44(0)71-498-6248
Fax: 44(0)71-498-8447 ■

SAA online, from page 1

available to EOSDIS researchers. SAA will also be a vehicle for NESDIS to provide real-time satellite data to EOSDIS for the generation of EOS standard products.

Future enhancements to SAA include a full graphical user interface (GUI) which is now being developed by a joint NESDIS and U.S. Geological Survey team at the EROS Data Center in South Dakota. As the Satellite Active Archive grows and develops, additional data sets are planned to be available in the future (Table 2).

SAA's user friendly interface

SAA's main menu is tailored to allow users to choose whether to learn a great deal about the platforms, instruments and data in the SAA through the *Directory* and *Guide* options, or to go directly to the *Inventory* option to search for, view and then *Order* data of interest. In addition, the menu has options providing *News* of general interest (such as the addition of a new data set), linking to *Remote* computer systems, and personalized *UserInfo* where registered user's addresses and preferred format for specifying coordinates and such are stored. Below are brief descriptions of each SAA menu option.

■ DIRECTORY provides brief high-level information about any existing SAA data set selected by the user. Information includes instrument description, temporal and geographic coverage, parameters, channel spectral ranges, orbital information, and data types. The purpose of the *Directory* is to help the user determine the existence and nature of each data set in the SAA.

■ GUIDE gives detailed information concerning each data set to help the user determine its usefulness. Included is data set background, processing history, geographic positional accuracy, data set size, type, format, resolution, and other details.

■ INVENTORY presents a screen for specifying image search criteria. You may select geographic area by pointing and clicking on a globe within a graphical coverage display window, or enter single point, 4-corner range, or up to 7-point polygon coordinates. Other search criteria are field matches on fields common to all data sets such as data type and acquisition date, and fields specific to your selected data set such as satellite number, orbit number, and start time.

The results of a search are presented in a list where each entry, or scene, is a separate line item. Each line item's search area may be graphically superimposed over the original search area on a globe allowing users to select the best positioned image for browsing and ordering. The graphical features offer the ability to rotate the globe, zoom in and out, and optionally display political boundaries and rivers. To expedite future searches, SAA gives users the option of saving search criteria.

How to log in to the NOAA Satellite Active Archive

1. Telnet to the SAA host name using the command:

   telnet saa.noaa.gov

If the message "hostname not found" is displayed, try the telnet command again using the IP address instead of the Internet name:

   telnet 140.90.232.101

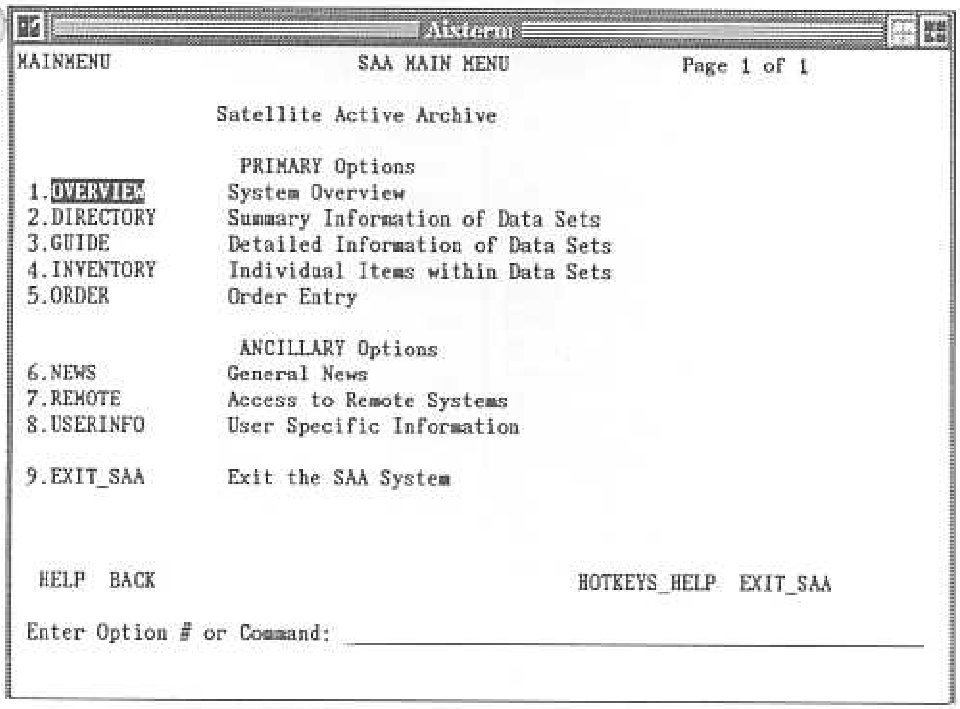
2. At the log-in screen, you have the choice of logging on as a guest, logging in as a guest and then registering, or logging in as a user who is already registered. If you log in as a guest, you are only able to use a reduced set of SAA functions (for example, you won't be allowed to order data.)

3. At this point you will be asked to enter a display variable that tells SAA where to display any graphical windows that are created. For the graphical portions of the SAA, your computer terminal must be capable of running X Windows. The display variable is made up of the host name or IP address of your machine and the screen ID separated by a colon. In most cases, you are at a terminal with only one screen and the screen ID will be zero. So, the following format is used:

mypc.noaa.gov:0	(your hostname:0) or
140.90.232.222:0	(your IP address:0)

Table 2. Additional datasets to be available later in SAA

Data Set	Source	Sensor	Process Level
TOVS Pathfinder	Tiros-N series	TOVS	Gridded datasets
TOVS Products	NOAA 11, 12	TOVS	L 1B (raw)
SSM/I Products	DMSP	SSM/I	L 1B (raw)
AVHRR GAC	NOAA 11, 12	AVHRR	L 2 (gridded)
SSM/T Products	DMSP	SSM/T	L 1B (raw)
SSM/T2 Products	DMSP	SSM/T2	L 1B (raw)



▲ Figure 1. Functions provided by the SAA main menu.

■ ORDER allows users to flag one or more items on the search results list for ordering. Each item of 5 MB or less can be electronically delivered at no cost to the user. Items over 5 MB (or, on request, those under 5 MB) are delivered on physical media at the cost of reproduction through the NCDC/SDSD.

■ NEWS currently displays information about SAA and will be used to notify users about enhancements to SAA as well as the availability of new data sets.

■ REMOTE allows linking to the following remote computer systems:

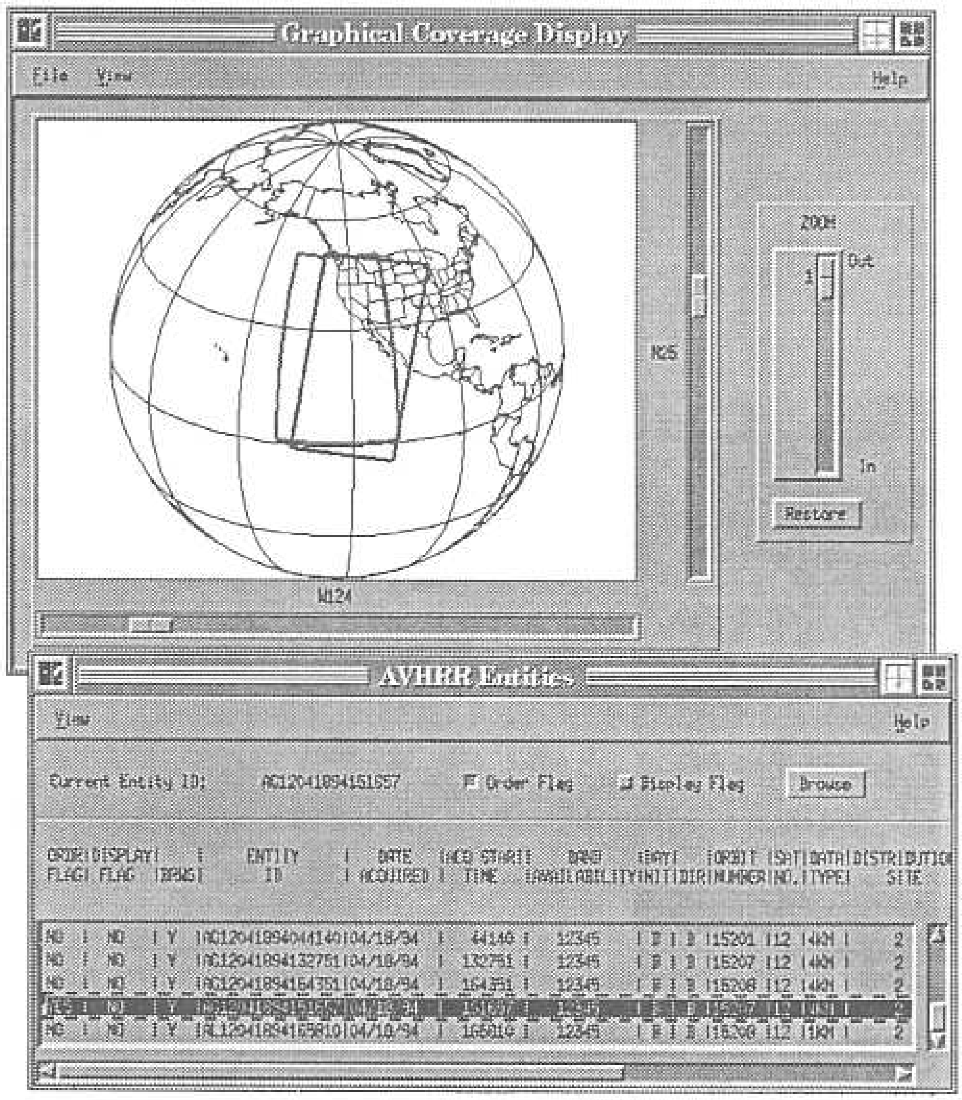
– *Global Change Master Directory (GCMD).* NASA's GCMD is a multidisciplinary database of information about environmental science data. It contains high level descriptions of data set holdings of many agencies participating in the U.S. Climate and Global Change Research Program..

– *NOAA's Environmental Services Data Directory (NOAADIR).* The NOAADIR is GCMD-compatible and contains information about NOAA's data sets and data systems that support environmental science studies. NOAA data descriptions are also transferred and available in the GCMD.

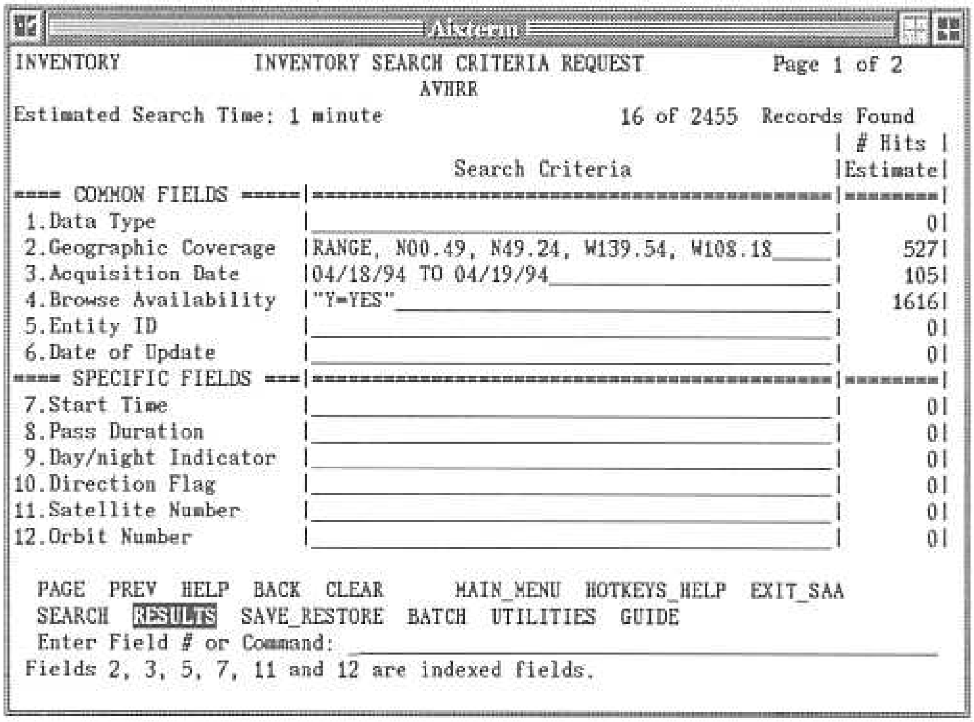
– *National Technical Information Service's FedWorld.* FedWorld is an online public interface to over 100 online systems and bulletin boards, plus thousands of scientific and technical information products.

– *IMS V0 Client (IMS).* NASA's EOSDIS Information Management System (IMS) enables users to identify, locate, and obtain access to environmental science data through an integrated view of Distributed Active Archive Centers (DAACs) at the Alaska SAR Facility, EROS Data Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, National Snow and Ice Data Center, Marshall Space Flight Center, and the Oak Ridge National Laboratory, as well as at the NOAA Satellite Active Archive.

– *continued on page 14*



▲ Figure 2. Geographical range selection tool and resulting list of scenes.



▲ **Figure 3.** Optional temporal, spatial, and parameter-oriented query criteria.

SAA online, from page 13

■ USERINFO allows users to display and modify the e-mail and postal address, phone number, and preferred date and coordinate formats entered when registering with the SAA. When users order data, their e-mail address is used to notify them of the order, and their postal address is used for shipping the media.

Example of using the SAA

The easiest way to describe how the Satellite Active Archive works is to consider a typical user facing a specific research problem. Suppose an SAA science user wants to determine likely breeding grounds for fish in the vicinity of Baja, California. This researcher selects SAA and its AVHRR data as a source of information to analyze temperature differences within the water on a given day.

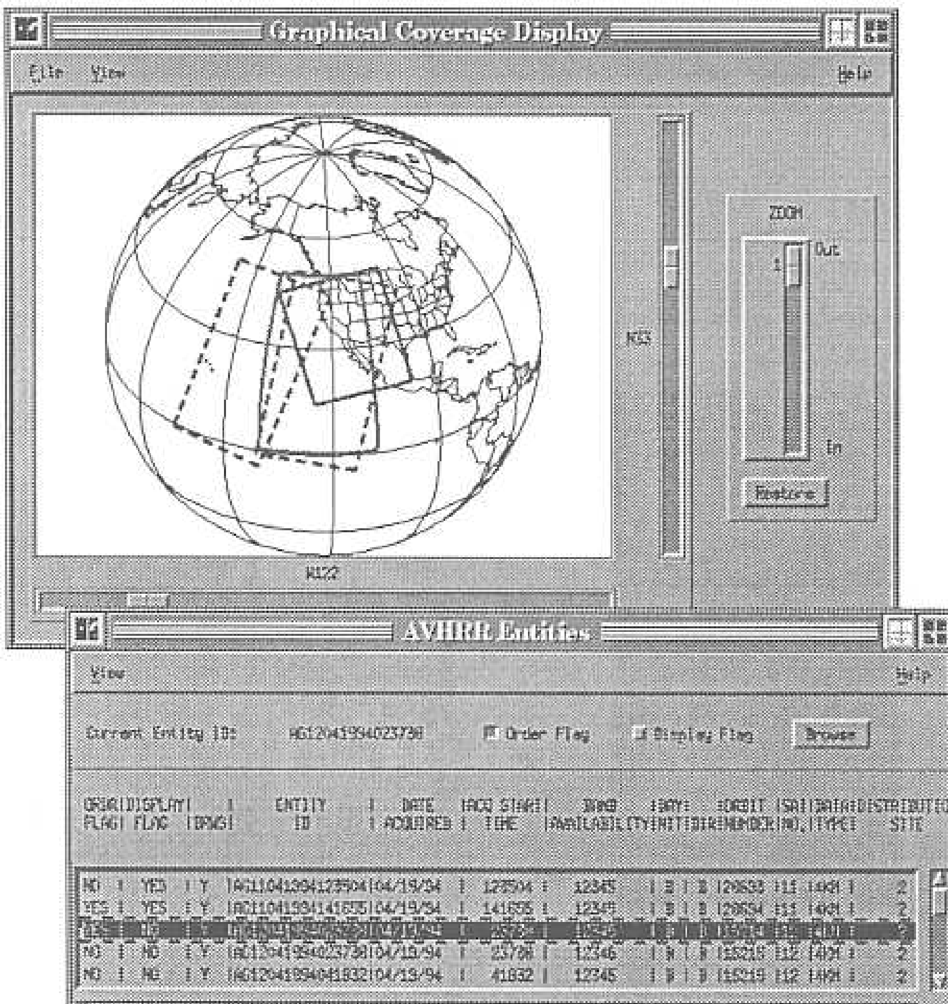
The researcher logs into the SAA and registers as a privileged user in order to be able to order data and have it sent for use in various data analyses.

Using the SAA Main Menu (Figure 1) the researcher selects the Inventory Option. The AVHRR and Graphical Area Selection options are then selected on the Search Criteria Screen windows.

When the globe appears in the graphical Geographic Area Selection window, the researcher zooms in on the U.S. area. The Range Selection option is then selected, and the mouse is used to draw a rectangle over the western United States (Figure 2). The four corner points of the rectangle are automatically inserted as geographic coverage latitudes and longitudes on the Inventory Search Criteria Request (Figure 3). The acquisition dates of choice are entered. Then the Search option is selected and after a few seconds the Search Results screen display (Figure 4) is available and many scenes, or line items, are shown.

By selecting the Graphic option on the Search Results-Summary screen, the user is able to superimpose the boundaries of each browse image upon the

– *continued on page 16*



▲ **Figure 4.** Search results superimposed over original search area.

First update CD-ROM of NOAA environmental buoy data

The National Oceanographic Data Center has released the first in a planned series of updates to its 14-disc set of NOAA environmental buoy data CD-ROMs. The original set of 14 CD-ROMs holds wind, wave, and related marine meteorological data from moored environmental buoys and C-MAN (Coastal-Marine Automated Network) stations through July 1992. These discs are organized by geographic region. For example, data for the Atlantic Ocean are on four discs, and Gulf of Mexico data are on two discs. The first update disc holds data for the remaining five months of 1992 (August-December) from all ocean areas.

This series of environmental buoy data CD-ROMs will continue with the issuance of three discs per year, each holding four months of data for all ocean areas. The discs holding data for 1993 and 1994 will be released over the coming months. Subsequent discs will be released as the data continue to be received and archived by the NODC.

Contact: NODC

Computer-generated relief map of the surface of the Earth

The Marine Geology and Geophysics Division of NOAA's National Geophysical Data Center has released a new color relief map of the surface of the Earth. This 31"x 43" full-color poster was generated from digital databases of land and sea floor elevations on a 5-minute latitude/longitude grid. A Mercator projection was used for world image, which spans 390° of longitude from 270°W around the world to 120°E. The latitude range is ± 80°.

The resolution of the gridded data varies from true 5-minute for the ocean floors, the U.S.A., Europe, Africa, Japan, and Australia to 1 degree in data-deficient parts of Asia, South America, northern Canada, and the Arabian subcontinent. The image was compiled from data contributed by numerous agencies and organizations in the United States and many other countries.

Contact: NGDC

Report on Second NOAA Data Quality and Continuity Worshop

A limited number of copies of the *Report on the Second NOAA Data Quality and Continuity Workshop* held on April 19-20, 1993, in Rockville, Md. is now available from the National Climatic Data Center. The workshop was organized by NCDC and sponsored by the Data Quality and Continuity Project of NOAA's Environmental Services Data and Information Management (ESDIM) program.

Contact: NCDC

Data products and services

Global maximum-minimum temperature data set

Using the Global Perspectives System, the National Climate Data Center has produced a Global Maximum-Minimum Temperature Data Set. This monthly data set consists of 3,180 stations from 22 countries and will be updated as additional data becomes available. Currently, the most common period of record is 1951-1990, with some countries having a longer time span.

The 9.5 megabyte data set consists of four files: the data format, an index range by country, an inventory file, and the data file. A copy of this data set, *mxmn.tar.Z*, may be obtained from NCDC via Mosaic, or through anonymous FTP using:

Directory: *pub/datasets/maxmin*
File: *mxmn.tar.Z*

Contact: NCDC

CONTACT POINTS

National Climatic Data Center (NCDC)
Climate Services:
704-271-4682
Fax: 704-271-4876
Internet: orders@ncdc.noaa.gov
Satellite Services:
301-763-8399
Fax: 301-763-8443
Internet: sdsdreq@ncdc.noaa.gov

National Geophysical Data Center (NGDC)
303-497-6958
Fax: 303-497-6513
Internet: info@ngdc.noaa.gov

National Oceanographic Data Center (NODC)
202-606-4549
Fax: 202-606-4586
Internet: services@nodc.noaa.gov

NOAA Environmental Services Data Directory
202-606-5012
(Gerald Barton)
Fax: 202-606-0509
Internet:

NOAA Central Library
Reference Services:
301-713-2600
Fax: 301-713-4599

GEODAS CD-ROM, Version 3

The National Geophysical Data Center announces an update to its GEODAS CD-ROM set of worldwide marine geophysical data. The total amount of new data covers 744,000 nautical miles of bathymetry, magnetics, and gravity from 336 cruises and includes over 5 million miles of additional digital records that were acquired and assimilated by the NGDC in 1993.

Version 3 of the GEODAS CD-ROM contains all of NGDC's digital marine geophysical trackline data, including vertical beam data from 264 National Ocean Service multibeam bathymetry surveys. This CD-ROM set allows inventory searches for multibeam bathymetry and analog data, which are now available from NGDC.

The data set consists of two CD-ROM discs and includes custom, menu-driven, access software developed by NGDC. The software provides access to over 4.8 gigabytes of marine geophysical trackline data, including bathymetry, magnetics, gravity, and seismic-shot navigation. The access programs allow data searches by a combination of criteria.

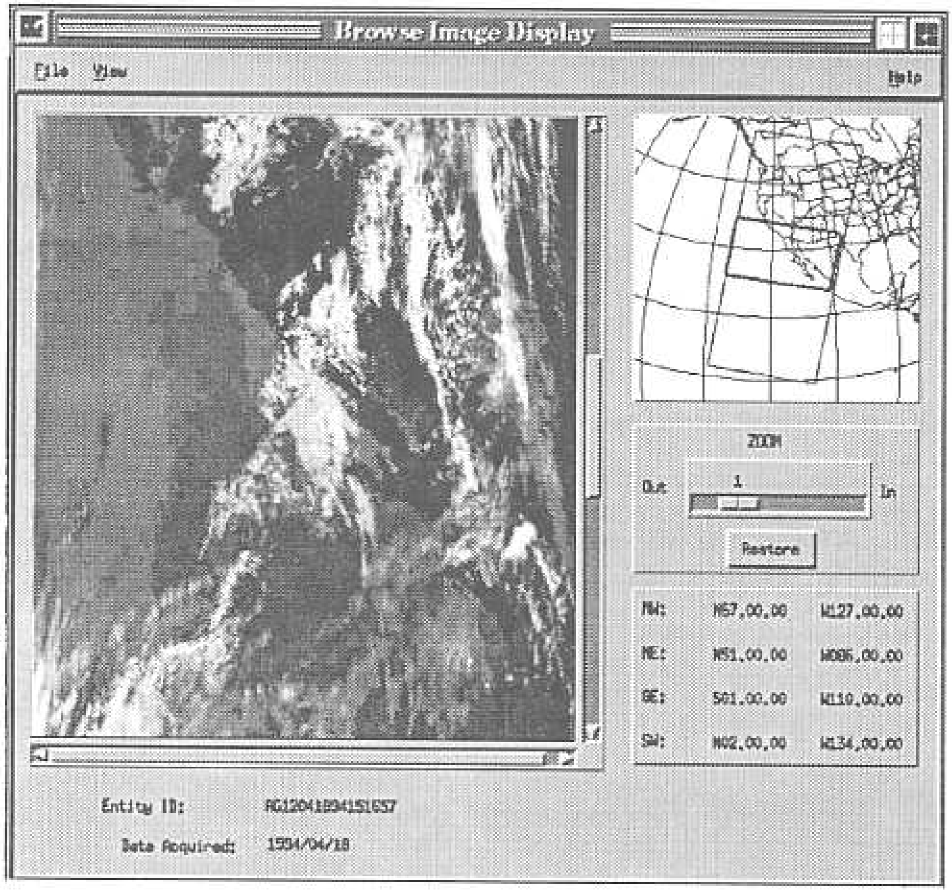
Contact: NGDC

Image of Southern Ocean gravity field from Geosat

Seafloor topography beneath the Southern Atlantic, Indian, and Pacific Oceans, as well as the Scotia and Tasman Seas and the smaller seas around Antarctica, is detailed in this marine gravity field. The 30" x 40" color image was produced by the Geosciences Laboratory of NOAA's National Ocean Service and is available from the National Geophysical Data Center. It is possible to "see" the seafloor in image because gravity and topography are highly correlated in the 20-200 km waveband.

The complex history of seafloor spreading that formed these ocean basins is recorded in the tectonic fabric of the ocean floor and can be seen in the features depicted in the image. This gravity field was computed from sea-surface height measurements collected by the U. S. Navy Geosat altimeter between March 1985 and January 1990.

Contact: NGDC



▲ **Figure 5.** Browse image display along with geographic location of image.

SAA online, from page 14

original search area and decide which one to browse. Then, by selecting the Browse option, the Browse image will appear on a screen (Figure 5) which also has vertical and horizontal sliders, a map display of the Browse image location, and the image's latitudes and longitudes. For those images showing the desired area of interest and not covered by clouds, the researcher may choose to order the data immediately by selecting the Order option.

SAA's data order and delivery system then confirms the data order details, processes the order, and delivers it either electronically or on tape. On arrival the ocean temperatures are analyzed using the researcher's own local software and applied to solving the scientific problem at hand.

For further information

The primary contact points for information about NOAA's Satellite Active Archive and assistance in using it are provided in the accompanying box.

Comments and questions about the SAA may also be directed to the SAA Manager Robert Mairs (E-mail: rmairs@nesdis.noaa. gov) or the SAA Technical Director Richard Bolton (E-mail: rbolton@nesdis.noaa.gov). ■

How to contact SAA

Telephone	(301) 763-8400
Fax	(301) 763-8443
Electronic mail	saainfo@nesdis.noaa.gov
Postal Mail	NOAA/SAA User Assistance 5627 Allentown Road Suite 100, PES Suitland, MD 20746

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Publication Distribution Facility
1315 East-West Highway
Silver Spring, MD 20910
ATTN: Earth System Monitor

Address Correction Requested
OFFICIAL BUSINESS
Penalty for Private Use $300

40

Third Class Rate