Oceanic and Atmospheric Research

Total Request: $340,798,000

ORF: $330,188,000
PAC: $10,610,000

The Office of Oceanic and Atmospheric Research (OAR), frequently called "NOAA Research," conducts the scientific research, environmental studies, and technology development needed to improve NOAA's operations and broaden our understanding of Earth's atmospheric and marine environmental systems. NOAA Research currently contributes directly to the attainment of six of the seven goals of NOAA's strategic plan, which articulates NOAA's mission to support the Nation's economic growth in an environmentally sound manner.

The NOAA Research budget activity supports joint programs with other Federal agencies, including the U.S. Weather Research Program, U.S. Global Change Research Program, Health of the Atmosphere, and Ocean Exploration. NOAA Research is also active in High Performance Computing and Communications, the Climate and Global Change Program, and efforts to sustain our coral reefs.

A coordinated national network of Federal laboratories and university partnerships carries out the NOAA research mission. Located in NOAA Research Laboratories, Office of Global Programs, Undersea Research Centers, Sea Grant Colleges, and university-based Joint and Cooperative Institutes, NOAA Research personnel are internationally recognized for their contributions to such fields of science as oceanography, climatology, and meteorology. These dedicated scientists translate new discoveries and technological developments into improvements to

NOAA's operations in weather, climate, and solar-terrestrial forecasting; coastal resource conservation; fisheries enhancement; and other areas. NOAA Research provides the sound science upon which decision makers can frame effective regulations to solve such environmental problems as the rehabilitation of the ozone layer. NOAA Research promotes economic growth by developing new products and techniques in marine biotechnology and aquaculture and improving economic resilience by improving the lead-time, accuracy, and specificity of climate and weather predictions. Ultimately, NOAA Research is dedicated to promoting the environmental sustainability of our Nation's economic competitiveness and well-being.

The total request of $340.8 million for the OAR Budget Activity represents a level of funding of $9.6 million less than the FY 2001 Enacted level. This continued investment will provide the resources necessary to continue vital research in fields ranging from climate and air quality to the oceans and Great Lakes. This request consists of program increases of $26.0 million, a reduction of $28.9 million for program terminations, $0.7 million to restore the FY 2001 rescission, and a decrease of $7.4 million in adjustments-to-base which include transferring Acquisition of Data to Program Support, and a $2.0 million transfer to the new Ocean Exploration line item.

Significant Adjustments-to-Base

A key component of this request is an increase of $5.5 million in base adjustments to cover the increased costs of pay, benefits, and other objects. Failure to receive these adjustments in any given year results in program dislocations and minor cutbacks. Failure to receive these adjustments over time has a cumulative impact that is programmatically devastating. Over the past six years, NOAA Research has received only 3 percent of the cumulative adjustments required to keep pace with inflation (or $1.1 million of $33 million required). Many laboratories can no longer cover their payroll out of base funding and have been forced to seek ever increasing amounts of reimbursable funding. Although this work supports NOAA missions, its shorter time frame does not fund the long-term focus needed to improve NOAA service delivery and provide the scientific input required to support our Nation's major environmental policy decisions.

Detailed Program Changes by Sub-Activity

Operations, Research and Facilities (ORF)

Climate and Air Quality Research: $158.5 million

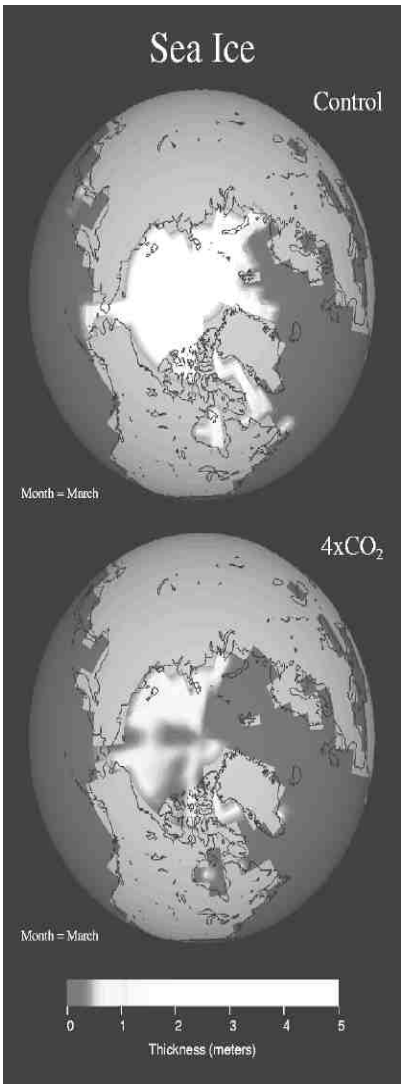
The total request of $158.5 million for this subactivity represents an increase of $14.4 million over the FY 2001 Enacted level. This continued investment in Climate and Air Quality Research focuses on learning the physical processes of the ocean and atmosphere to increase

modeling accuracy, thus furthering NOAA's predictive capabilities. Within this total, the following increases are included:

Climate Observations & Services: $24.0 million (and $3.6 million in PAC)

NOAA requests an increase of $13.0 million for a total of $24.0 million to advance the Climate Services Program (an additional $1.6 million increase for a total $3.6 million is requested in PAC for the Comprehensive Large Array data Stewardship System Initiative). The NOAA Climate Services program was initiated in FY2001 with the request of a new line under the OAR Climate and Air Quality subactivity and $12.2 million was enacted. NOAA plans to develop complete climate services with initial emphasis on building an ocean observing system to address scientific and operational aspects of climate. The funds will be jointly managed by OAR, NESDIS, and NWS, with the specific increases as described below.

Regional Assessments, Education and Outreach: $1.9 million



NOAA requests a total of $1.9 million for investments in regional assessments, education and outreach. The impacts of climate variability from season-to-season or year-to-year manifest themselves on regional and local levels. The goal is utilization of climate variability information by regional and local managers and decision-makers to maximize economic gain and mitigate potential harmful impacts. This initiative addresses all aspects of the process by: (1) strengthening existing successful university-based, regional integrated assessments and creating new ones, (2) initiating an ambitious education and training program for NWS and private sector field meteorologists, hydrologists, and climatologists, (3) developing the tools, materials, and mechanisms for an effective NWS customer/decision-maker outreach program, (4) effecting the transition of the Pacific ENSO Applications Center from demonstration project to long-term operational status.

Climate Change Assessments: $0.7 million

NOAA requests a total of $0.7 million for climate change assessments. This investment will expand and improve the accessability and availability of weather, water, and climate information to the American people and high-risk communities. The environmental assessments have become the primary tool to deliver information and knowledge on decadal-to-centennial climate change to governments, industry, the scientific community and the general public. Over the past two years we have led and contributed to Ozone, IPCC and US National Assessments. Other assessments being proposed are: Arctic Change, and Science of North American Fine Particles (Canada, US, Mexico). NOAA will: contribute a leadership role in the North American Research Strategy for Tropospheric Ozone (NARSTO) Assessment of Surface-level Ozone and fine particles for Canada, U.S., and Mexico; complete the first draft of the circum-Arctic assessment of what is known about climate variability in the Arctic and how this variability affects

ecosystems and human activities; interpret for key U.S. regions the major findings on fine-particle and ozone levels and how choices associated with one influence the others; provide governments, industry, and the general public a summary of the major findings of the IPCC assessments on climate change; and contribute to a follow-on to the current U.S. National Assessment.

Weather-Climate Connection: $0.9 million

NOAA requests $0.9 million for the weather-climate connection. This investment will enable NOAA to expand its diagnostic and modeling efforts to understand the relationship between sub-seasonal tropical variability and changes in the frequency, location, and intensity of extreme weather events over the United States. Observational and modeling efforts will aim to document the pattern of variations in tropical rainfall on weekly-to-monthly time scales as well as air-sea interactions both in tropical systems and in mid-latitude oceanic and land-falling storms. During El Niño, shifts in the Pacific storm track affect the paths of storms approaching the U.S. west coast and influence weather across the entire country. Other tropical fluctuations at sub-seasonal scales can also lead to similar effects on U.S. weather. At present, operational forecast models do not simulate these week-to-week tropical fluctuations well, if at all.

Carbon Cycle: $2.3 million

NOAA requests $2.3 million for this activity. This investment will enable NOAA to establish a network of more densely spaced airborne and tall-tower-based sampling sites over North America as part of a multi-agency effort to quantify, understand, and project the evolution of global carbon sources and sinks in order to better predict future climate. This sampling program will complement local-scale process research managed by other agencies and provide an estimate of the magnitude of regional terrestrial sinks on a continental scale. Finally, data obtained through process studies and observational networks must be analyzed. These studies include analyzing the causes of variability of carbon sinks from year to year and decade to decade, understanding the feedbacks between the carbon cycle and the physical climate system and quantifying and incorporating the effects of human land-use change into climate models.

Ocean System for Improved Climate Services: $7.3 million

NOAA requests $7.3 million for ocean system for improved climate services. This investment will enable NOAA to implement and maintain a global operational ocean observing system by enhancing its present components and establishing new ones. The system is based on a firm scientific foundation and closely coupled to other U.S. and international observing efforts. The National Ocean Research Leadership Council has recently created an office under the National Oceanographic Partnership Program (NOPP) whose function will be to integrate existing and new ocean observational efforts of the NOPP agencies and their international, state, local, and private-sector partners. The integration effort will facilitate broad user access to ocean knowledge, data, tools, and product specific components, such as networks and other aspects of the observing system. Additional components are briefly described below:

- ***Argo Floats*** ($3.2 million): Funding supports the U.S. commitment to provide and maintain one-third of the global array of 3,000 profiling floats to observe the ocean's upper layer in real time. These floats, together with satellites, will be the oceanic equivalent of today's operational observing system for the global atmosphere. This is a truly international effort with 7 nations plus the European Union currently providing floats and 4 additional nations planning to provide floats in the very near future. The additional funds will permit NOAA to reach an annual deployment level of about 280 floats, which should be sufficient (given an annual expected loss rate of about 10 percent) to reach an array of 1,000 floats during FY 2005. After this point, new floats deployed would be replacements (since the design lifetime of an Argo float is 4-5 years).

- ***Ocean Reference Stations*** ($0.9 million): NOAA will implement a global network of ocean reference station moorings, expanding from the present two pilot stations to a permanent network of 16 by 2010. These have been a cornerstone of decadal-to-centennial documentation of changes in ocean properties and will also improve seasonal-to-interannual forecasting ability by providing calibration/validation data for remote sensing of surface-flux fields.

- ***Volunteer Observing Ships (VOS)*** ($0.5 million): The global atmospheric and oceanic data from ships of opportunity have been the foundation for understanding long-term changes in marine climate and are essential input to climate and weather forecast models. In order to satisfy climate-prediction needs, NOAA will increase the quality of these data by adding new sensors for surface-flux observations as well as bio-geochemical sensors.

- ***Ocean Carbon*** ($0.9 million): Projecting decadal-to-centennial global climate change is closely linked to assumptions about feedback effects between the ocean and atmosphere related to additional input of carbon dioxide into the atmosphere. NOAA will add autonomous carbon-dioxide sampling instruments to the moored arrays and the VOS fleet and will begin to implement an ongoing ocean-carbon inventory that will survey the globe once every ten years.

- ***Arctic Ocean Fluxes*** ($0.5 million): Over the past 20 or more years, significant changes have been noted in the Arctic, such as thawing of permafrost, earlier break-up of ice on rivers, and thinning of the ice cover on the Arctic Ocean. Recent studies conclude that changes seen in the extent of Arctic ice are unlikely to have been caused by natural variability, and substantial decreases in sea-ice thickness and extent are predicted to occur in the 21st century. NOAA proposes to join with other Federal agencies and international collaborators to begin a long-term effort to quantify the flux of fresh water from the Arctic to the North Atlantic. The initial steps will be made through deployment of moorings at critical locations in the Arctic.

- ***Data Management & Data Assimilation*** ($1.3 million): A robust and scalable data management infrastructure is essential to the vision of a sustained ocean-observing system. The data must be retained and made available for retrospective analyses to understand climate change and for managing observing system operations and improvements. To utilize effectively the new observations, NOAA will expand the current ocean analyses to the global domain and develop and implement improved assimilation systems that can more effectively use the new data types that are being collected. Our participation in the Global Ocean Data Assimilation Experiment (GODAE) is one vehicle for doing this, involving both national and international communities, producing a variety of marine products, and using these observations in forecast systems.

Atmospheric Programs: $51.8 million

The total request of $51.8 million for this sub-activity represents an increase of $3.7 million over the FY 2001 Enacted level. This continued investment in Atmospheric Programs supports improvements in weather, solar-terrestrial, and air-quality monitoring and prediction. Within this total, the following program increases are included:

U.S. Weather Research Program: $3.7 million

NOAA requests a total of $3.7 million for USWRP, an increase of $2.2 million over the FY 2001 Enacted level. This investment continues the cooperative effort among OAR, NWS, and NESDIS within NOAA, three other USWRP agencies (NSF, NASA, and the Navy), and the university community. The USWRP will conduct research and development on experimental numerical model algorithms, provide field observational support, and strive for information and technology transfer to operations and services in order to reach performance goals defined for the following high priority areas:

- *Hurricanes at Landfall* - USWRP will focus on extending hurricane track predictions up to five days, improving the accuracy of the hurricane landfall location and improving the forecasts of hurricane intensity at landfall, surface wind forecasts, and providing more precise quantitative precipitation forecasts in conditions under which precipitation may lead to inland flooding. Field observations are planned during hurricane seasons in the western Atlantic, Carribean, and Gulf of Mexico. The NOAA P3 and Gulfstream IV as well as NASA aircraft, each with state-of-the-art instrumentation, will be deployed in coordinated campaigns. Observations from NOAA, NASA, and Defense Meteorological Satellite Program (DMSP) satellites will be combined with other data sources to provide information for: hurricane process studies, assimilation into operational and experimental numerical models, and real-time use at national and local forecast offices.

- *Optimal Mix of Observations/Quantitative Precipitation Forecasts (QPF)* - This effort, also coordinated between the four agencies, will improve our understanding of the use of data from advanced observing systems which will improve numerical weather prediction. Although its initial focus will be mostly on hurricane landfall research, the USWRP will, over time, focus increasingly on accelerated research to improve quantitative precipitation forecasts. The goals of this effort are to improve the forecasts of winter coastal storms and severe winter weather (e.g., blizzards, ice storms, and winter flooding in the southern portions of the U.S.) and to extend these weather forecasts out to day 7 with acceptable skill. Research will also be directed toward better representation of convection in forecast models through the storm-scale experiments, understanding orographic effects, and development of coupled atmospheric and hydrologic models to better represent runoff and flooding potential.

Critical to USWRP success in meeting its goals is its ability to transfer research results to operations. This will be done in the form of weather prediction test beds, including Joint Hurricane Test Bed; the regional weather prediction test bed in Boulder, Co, for QPF; and the NOAA-NASA Joint Center for Satellite Data Assimilation.

Oceans and Great Lakes Programs: $119.8 million

The total request of $119.8 million for this subactivity represents a decrease of $2.5 million from the FY 2001 Enacted level. This continued investment enhances our knowledge of ocean and Great Lakes environments so that they can be managed in a sustainable manner, promoting economic growth in marine industries while conserving the underlying environments and resources upon which these industries depend. Because of its record in generating critically needed research, educational, and advisory services in a successful partnership between the Administration, Congress, and academia , the National Sea Grant College Program is supported at the FY 2001 Enacted level level plus a small adjustment to base for a total funding level of $62.4 million. The National Undersea Research Program (NURP) also is supported at slightly above the FY 2001 Enacted level level for a total funding level of $13.8 million. This will help ensure that NURP will be able to play a role in the new Ocean-Exploration Initiative. Future plans include strengthening the partnership with the Congress in shaping NURP and continuing important undersea research in fisheries habitats, coral-reef ecosystems, and fisheries management issues. Finally, the program expects in future years to encourage new research related to understanding deep-ocean environments. Within the total sub-activity level are requests for the following program increases:

Marine Environmental Research: $22.6 million

NOAA requests a total $22.6 million for marine environmental research. Details of the program changes are as follows:

Marine Environmental Research and Coral Reef Watch: $11.6 million.

NOAA requests an increase of $0.5 million for ongoing Marine Environmental Research. This investment will allow:

- NOAA's Atlantic Oceanographic and Meteorological Laboratory's (AOML) Remote Sensing Division to reactivate its field measurements that provide data critically needed for major community health-related decisions in contaminant-release emergencies in Florida and elsewhere as well as resource management decisions related to releases of dredged material.

- PMEL's Fisheries Oceanography program would be able to restore its ocean measurements program in the Gulf of Alaska and Bering Sea. In these areas, recent climate changes have led to shifts in the species composition of these ecosystems. Using an integrated system of moored buoys and other oceanographic platforms, measurements will be collected to help develop models to better assess climate variability in the north Pacific.

NOAA requests an increase of $0.5 million for Coral Reef Watch. This investment will improve the understanding of coral reef ecosystems through monitoring and predicting changes in coral reef ecosystems. The AOML laboratory in Miami, FL, will manage this research effort in

coordination with NURP field observations at Caribbean Marine Research Center (Lee Stocking Island (LSI), Bahamas) to better understand ecosystem response. This investment will allow AOML to:

- Predict coral bleaching episodes through Coral Reef Early Warning System (CREWS) software in support of the *in-situ* field monitoring station and to further develop the collaborative NESDIS/OAR Coral Reef Watch early-warning system.

- Establish an additional *in-situ* monitoring station in the U.S. Virgin Islands and provide continuing support for CREWS stations already established (e.g., LSI, NW Hawaiian Islands), providing near-real-time data to predict coral bleaching and other coral phenomena. The U.S. Virgin Islands site is one of twenty recommended by the U.S. Coral Reef Task Force/Monitoring Working Group.

- Provide long-term, near-real-time data and data interpretation, upon which sound coastal and coral-reef management decisions can be made. The data will also be used to ground-truth NESDIS' satellite monitoring of coastal health and corals.

- In addition, AOML will continue to maintain the Coral Health and Monitoring Program Web page and its international coral-list server and will collaborate with National Oceanographic Data Center and other NOAA Line Offices in support of NOAA's Coral Reef Data and Information Management System.

NOAA Marine Aquaculture Program: $3.6 million

NOAA requests $3.6 million for marine aquaculture. This continued investment is designed to meet the new DOC Aquaculture Policy Goals and conform to the National Aquaculture Development Plan soon to be released by the Joint Subcommittee on Aquaculture. NOAA will proceed with its Competitive Grants Program that funds projects to: expand the appropriate regional and issue efforts in selecting new species for aquaculture; test new production systems under actual field conditions; improve and clarify the regulatory framework and coastal zoning for aquaculture; support hatchery development technology; conduct environmental research relative to aquaculture; provide the regulatory, environmental, developmental, and scientific base for U.S. aquaculture; and support the more basic research in genetics, disease diagnosis and control, nutrition, hormonal manipulation, and biotechnology. The projects funded are expected to help lead this industry toward becoming an environmentally sustainable industry.

Ocean Exploration $14.0 million

The total request of $14.0 million represents an increase of $10.0 million over the FY 2001 Enacted level. This continued investment will allow OAR, NOS, NMFS, NESDIS, and external partners (e.g. EPA, NASA, NSF, MMS, DOE, Navy, USGS, and universities) to join together in a cross-agency, multi-institution partnership with a common goal of discovery and exploration of the last major frontier on Earth. This activity is NOAA's investment in undersea exploration, research, and technology in both the deep ocean and areas of special concern, such as the National Marine Sanctuaries (NMS). This

proposal supports NOAA's Sustain Healthy Coasts, Recover Protected Species, and Build Sustainable Fisheries goals and is fully consistent with the recommendations of the President's Panel on Ocean Exploration.

NOAA proposes to embark on a national endeavor; build on our initial efforts in ocean research; partner with existing public, private, and academic ocean exploration programs and promote undersea exploration and research. This proposal calls for an aggressive plan of action to build our National understanding of ocean systems and processes and to develop partnerships for sharing information through education, outreach, and communications. This exploration effort will focus in five areas:

- **New Ocean Resources** ($1.4 million). The oceans hold vast untapped economic potential beyond fishing. Ocean floor energy-resource deposits, such as methane hydrates may revolutionize patterns of current fossil fuel consumption. Microbial organisms that thrive in deep-sea vents have already been found to have significant biotechnological potential. Medical science is struggling to find new chemical compounds for pharmaceutical applications derived from land-based plants and animals, while the wealth of marine-based counterparts has scarcely begun to be explored and discovered. While it is reasonable to expect significant economic payback from exploration of new ocean resources, it is initially risky and unlikely that the private sector would fund early-phase exploration. NOAA proposes to undertake the early-phase exploration that may lead to the discovery of new resources in which the private sector will be interested. As a follow-up to initial exploration, we do expect both federal agencies and private-sector stakeholders to support research on the development and sustainable use of these resources. Government funding will also ensure that we take steps from the beginning to protect new resources from over exploitation.

- **Exploring Ocean Acoustics** ($1.4 million). This program will begin to: (1) create a network for monitoring marine sound of natural and human origin in the Pacific and North Atlantic Oceans and (2) determine the effects of this noise on marine mammals and turtles. Some sound producing underwater objects can be detected thousands of miles away. Until recently, this sound has been monitored only by the military. There are, however, important civilian uses for these technologies, such as locating earthquakes, tracking whale migrations, and assessing the impact of noise on marine animals. Finally, NOAA needs to understand the normal hearing of many marine species and determine if behavioral disruption is caused by noise to provide an information base for management of these species.

- **America's Maritime Heritage** ($1.3 million). The U.S. maritime historical record is largely underwater and awaiting discovery and documentation. This initiative will create a meaningful national effort to survey, locate, map, inventory, and explore historic shipwrecks and archeological sites, principally within U.S. jurisdiction and sanctuaries. Experts estimate that 50,000 shipwrecks are in U.S. waters. This effort will push the development and application of deep ocean technology. By understanding the location, condition and value of such underwater treasures, sound public policy decisions can be made about commercial, academic, and stewardship opportunities.

- **Exploring Ocean Frontiers** ($5.0 million). The sea floor, from the upper edge of the continental shelf to the bottom of the ocean's deepest trenches, covers approximately two-thirds of Earth's surface, most of which is still unexplored and un-surveyed. The overlying oceans cover more than 140 million square miles and constitute the largest habitat by volume on our planet. Yet, it is estimated we know fewer than 25% of the species that live in the oceans. This initiative will focus

initially on expeditions planned for such areas as the Gulf of Mexico, South Atlantic Bight, NW Hawaiian Islands, North East Pacific, California, and Gulf of Alaska. Future expeditions will include the Gulf of Maine, the Arctic, the Blake Plateau, the Caribbean, and the Central West Pacific. These have been chosen because of their unique features, processes, and information gaps. This work will focus on: water masses and ocean fronts, benthic life, submarine trenches and canyons, submarine volcanoes, polar seas, sea-mounts, hydrocarbon seeps and hydrate beds, and living and working in the sea. NOAA and its partners will explore and characterize areas where the habitats are not well known or understood (e.g., deep canyons, deep-reef ecosystems).

- **Census of Marine Life** ($0.9 million): The Census of Marine Life is an emerging international research program conceived by the broad marine science community and initially supported by the Sloan Foundation. The Census will support studies over the next 5-10 years to examine the diversity, distribution, and abundance of marine organisms. NOAA's proposed Census activities will: (1) fund inclusion of the U.S. fisheries data in the Census of Marine Life's International Ocean Biogeographical Information System (OBIS - envisioned as a data system of global marine animal and plant distributions, which is critical to understanding the global and regional patterns in marine diversity); (2) initiate the development of new technologies to more efficiently assess marine fisheries and their habitats (emphasis on emerging optical and acoustical technologies); and (3) improve the classification of marine fishes.

Acquisition of Data

All funding for this program has been transferred to the Office of Marine and Aviation Operations (OMAO) under the Marine Operations subactivity. The transfer of these activities to OMAO will allow for the management of the fleet operations as a NOAA-wide asset. The NOAA fleet and charter vessels provide NOS with collection of hydrographic and coastal assessment data through days-at-sea for programs of significant National interest.

Procurement, Acquisition, and Construction (PAC)

The total request of $10.6 million represents a decrease of $12.5 million from the FY 2001 Enacted level.

High-Performance Computing & Communications at the Geophysical Fluid Dynamics Laboratory (GFDL) — $7.0 million

NOAA requests $7.0 million for GFDL, which represents an increase of $3.0 million from the FY 2001 Enacted level. This continued investment supports the full-year lease and provides software support for the supercomputer located at the GFDL in Princeton, NJ. The computer will be used full-time to address some of the most difficult but critical obstacles to developing and testing new and more realistic models for predicting climate variability, detecting climate change, and forecasting hurricanes.

Comprehensive Large-Array data Stewardship System (CLASS) $3.6 million

The total request of $3.6 million represents an increase of $1.6 million over the FY 2001 Enacted level. As part of NOAA's Climate Services initiative begun in FY 2001, this continued investment will provide a data system to manage the high volumes (petabytes) of data critical to USGCRP and the scientific community. NOAA is enhancing its current archiving capabilities into a Comprehensive Large Array-Data Stewardship System that is fully operational and managed at the enterprise level. This system will afford efficient management of high volumes of data that are critical to the U.S. Global Change Research Program (USGCRP) and the scientific community. The target data originates from the National Polar-orbiting Environmental Satellite System, the Defense Meteorological Satellite Program, the Department of Commerce Next Generation Weather Radar, and Polar-orbiting Operational Environmental Satellite. Management of these data can be accomplished only through a rapid expansion in storage capacity at the Data Centers and automating the means of data ingest, quality control, and access through a phased systems buy. The early implementation of this archive and access system will pave the way to accommodate additional massive data volumes from the EOS satellites.

Detailed information regarding adjustments to base, program reductions and terminations are shown in Section 4:Supplementary Information.