

## GEOSCIENCES

**\$744,850,000**

The FY 2007 Budget Request for the Directorate for Geosciences (GEO) is \$744.85 million, an increase of \$42.02 million, or 6.0 percent, over the FY 2006 Current Plan of \$702.83 million.

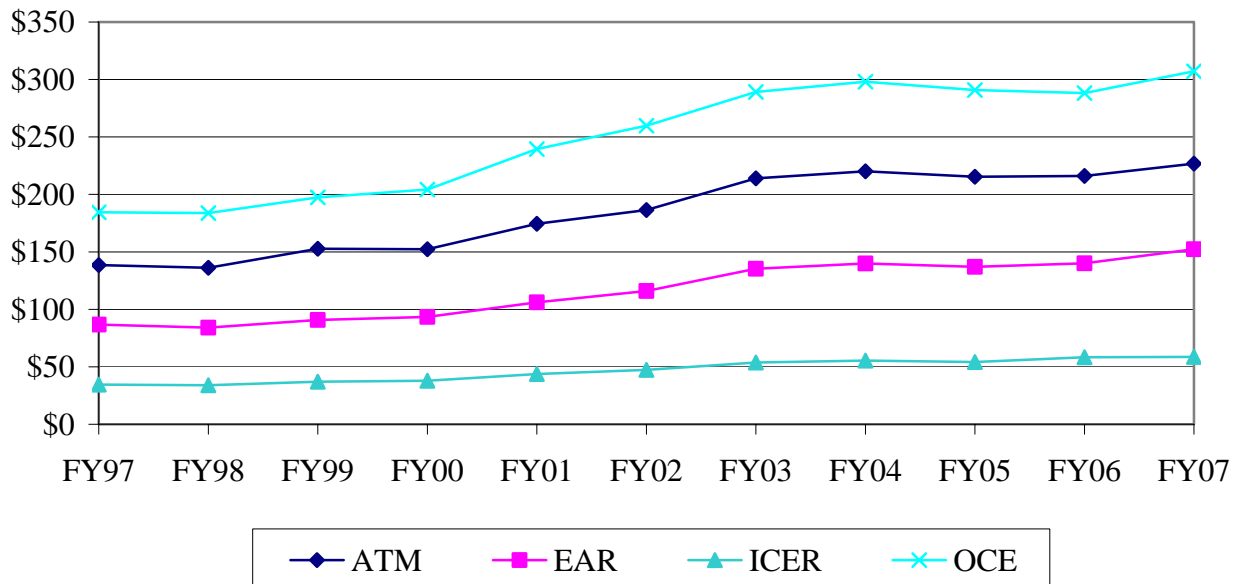
### Geosciences Funding (Dollars in Millions)

	FY 2006		FY 2007 Request	Change over FY 2006	
	FY 2005 Actual	Current Plan		Amount	Percent
Atmospheric Sciences (ATM)	215.32	216.09	226.85	10.76	5.0%
Earth Sciences (EAR)	136.95	140.12	152.30	12.18	8.7%
Innovative & Collaborative Education and Research (ICER)	54.11	58.37	58.57	0.20	0.3%
Ocean Sciences (OCE)	290.79	288.25	307.13	18.88	6.5%
<b>Total, GEO</b>	<b>\$697.17</b>	<b>\$702.83</b>	<b>\$744.85</b>	<b>\$42.02</b>	<b>6.0%</b>

Totals may not add due to rounding.

The Directorate for Geosciences (GEO) supports research, infrastructure, and education in the atmospheric, earth, and ocean sciences needed to advance our understanding of the integrated Earth system.

### GEO Subactivity Funding (Dollars in Millions)

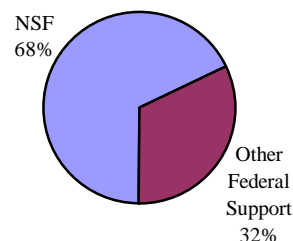


**RELEVANCE**

GEO supports basic research that contributes to a better understanding of the many processes that affect the global environment such as the role of the atmosphere and oceans in climate, the planetary water cycle, and the relative importance of natural variability and the effects of increased concentrations of greenhouse gases in the atmosphere. Support is provided for interdisciplinary studies that contribute directly to national research priorities: hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, solid earth processes, and solar influences on the Earth system. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornadoes, hurricanes, and tsunamis. Basic research supported by the Directorate for Geosciences enables preparation for and subsequent mitigation of the effects of these and other inevitable natural events. Associated with these studies is the need for databases and cyberinfrastructure to provide the scientific community with the resources to assemble and utilize data and information efficiently and effectively, consistent with the Administration’s priorities for research and development.

GEO is the principal source of federal funding for university-based basic research in the geosciences, providing about 68 percent of the total federal support in these areas. Not only does GEO play a critical role in addressing the nation's need to understand, predict, and respond to environmental events and changes, but also helps to determine the best use of Earth's resources. Fundamental research in the geosciences advances scientific knowledge of resources such as fresh water, energy, minerals, and biological diversity, leading to improved future quality of life. Activities supported by GEO are well aligned with the Administration’s research and development priorities, including investments in high-end computing and nanotechnology. GEO investments include many environmental studies coordinated through the U.S. Climate Change Science Program. GEO-supported activities contribute to national and global observational capabilities and research infrastructure for land, ocean, and atmospheric processes.

**Federal Support for Basic Research in Geosciences at Academic Institutions**



*Summary of Major Changes by Division*

*(Dollars in Millions)*

**GEO FY 2006 Current Plan .....\$702.83**

**Atmospheric Sciences (ATM) .....+10.76**

Increased support will target the following areas: the operation of the High-performance Instrumented Platform for Environmental Research (HIAPER), which sees its first full year of operation in FY 2007; the operation of the Advanced Modular Incoherent Scatter Radar (AMISR); support for a new Science and Technology Center, the Center for Atmospheric Process Modeling; and improved cyberinfrastructure and numerical models that will allow new discoveries, greater access to atmospheric data, and improved understanding of the atmospheric environment.

**Earth Sciences (EAR) .....+\$12.18**

Increased funding focuses on operational and scientific support of the EarthScope facility, which is being constructed through the MREFC account, and improving the cyberinfrastructure available to earth scientists.

**Innovative & Collaborative Education and Research (ICER)** +\$0.20  
 In FY 2007, support for international collaborative activities will increase slightly after several years of level funding.

**Ocean Sciences (OCE)** +\$18.88  
 Areas receiving increased funding support include developmental activities related to the Ocean Observatories Initiative, operation of the academic research fleet, and development of advanced ocean research cyberinfrastructure.

Subtotal, Changes +\$42.02

**GEO FY 2007 Request .....\$744.85**

*Summary of Major Changes by Directorate-wide Investments*

**GEO FY 2006 Request .....\$702.83**

Advancing the Frontier

**Disciplinary and Interdisciplinary Research** +\$19.74  
 Support for research activities across the geosciences will increase, resulting in about 65 additional research grants and maintaining present funding rates.

**Science and Technology Centers** +\$8.00  
 The Center for Atmospheric Process Modeling at Colorado State University and the Center for Coastal Margin Observation/Prediction at the Oregon Health and Science University were selected in the FY 2005 STC competition. Initial FY 2006 funding is through Integrative Activities; FY 2007 funding is through GEO at \$4.0 million for each STC.

Education and Workforce

**Enhancing K-12 Education** +\$0.47  
 GEO will expand support for the successful network of Centers for Ocean Science Education Excellence.

Facilities and Infrastructure

**Academic Research Fleet** +\$4.50  
 GEO is the primary supporter of operations of the national academic research fleet. Overall, operational support is projected to increase by \$4.50 million or about 6 percent enabling continued operation of the fleet at approximately the same level as in FY 2006.

In addition, several augmentations and acquisitions are underway to improve the capability of the fleet. These include: acquisition of the first in a planned series of Regional-class Research Vessels (+\$11.50 million to a total of \$15.10 million) to replace aging and less capable ships, development and construction of a next-generation human-occupied research submersible to replace the aging A.L.V.I.N. (-\$400,000 to a total of \$5.10 million), and the completion in FY 2006 of outfitting a newly-acquired seismic research vessel.

Advanced Modular Incoherent Scatter Radar (AMISR)	-\$8.00
Construction of AMISR is scheduled to be completed in FY 2006. Operation is supported at a level of \$2.70 million.	
EarthScope Operation	+\$4.89
Operational support of the EarthScope facility being constructed through the MREFC account is supported at a level of \$11.61 million in FY 2007, enabling full operation of completed facility elements.	
Ocean Drilling Activities	-\$3.20
The Integrated Ocean Drilling Program, including operation of a new Scientific Ocean Drilling Vessel acquired and outfitted with support from the MREFC account, will decrease by \$3.20 million to a total of \$25.80 million. This reduction reflects the decrease in anticipated ship operation support required during the vessel conversion activities being supported through the MREFC account.	
Ocean Observatories	+\$3.10
Support for activities to prepare for the Ocean Observatories Initiative, one of GEO's contributions to the Global Earth Observation Systems of Systems (GEOSS) and proposed as a new MREFC start in FY 2007, will increase by \$3.10 million to a total of \$8.30 million. This will finalize developmental work in advance of the beginning of the construction phase of the project requested in the MREFC section of this document.	
National Center for Atmospheric Research (NCAR)	+\$3.49
Research activities across the National Center for Atmospheric Research will increase by \$3.49 million, or by about 3.0 percent.	
Net, all other program changes	+\$9.03
Subtotal, Changes	+\$42.02
<b>GEO FY 2007 Request .....</b>	<b>\$744.85</b>

**NSF-WIDE INVESTMENTS**

In FY 2007, the Directorate for Geosciences will support research and education efforts related to broad, Foundation-wide investments in a number of areas including NSF's three multidisciplinary Priority Areas; the Administration's four interagency R&D priorities; and other priorities of high and specific interest to the Administration.

**GEO NSF-wide Investments**

(Dollars in Millions)

	FY 2006			Change over	
	FY 2005	Current	FY 2007	FY 2006	
	Actual	Plan	Request	Amount	Percent
Biocomplexity in the Environment	\$37.22	\$36.85	\$26.11	-\$10.74	-29.1%
Human and Social Dynamics	1.35	1.35	1.35	-	-
Mathematical Sciences	7.07	7.00	3.53	-3.47	-49.6%
Climate Change Science Program	150.35	149.35	157.72	8.37	5.6%
Cyberinfrastructure	71.35	71.35	75.00	3.65	5.1%
International Polar Year	-	-	5.00	5.00	N/A
National Nanotechnology Initiative	7.94	9.00	9.65	0.65	7.2%
Networking and Information Technology R&D	14.56	14.56	14.56	-	-

**Biocomplexity in the Environment:** Consistent with plans to phase out the Biocomplexity priority area after FY 2007, GEO will support a set of coordinated activities in environmental science, engineering and education that advance scientific knowledge about the connection between the living and non-living Earth system. In FY 2007 the second year of a special focus on integrated natural cycles will be supported, as will the second year of support for an emphasis on coupled natural and human systems.

**Human and Social Dynamics:** GEO continues funding of \$1.35 million to engage the social science community in understanding and predicting behavior in response to extreme events (earthquakes, tsunamis, hurricanes, tornadoes, solar disruptions, etc.) and other natural processes affecting society.

**Mathematical Sciences:** GEO will support multidisciplinary research involving the partnering of mathematicians and geoscientists to investigate topics spanning the earth, atmospheric, and ocean sciences at a level of \$3.53 million. This 49.6 percent reduction from the FY 2006 Current Plan is consistent with plans to transfer the activities of the priority area after FY 2007 into the core.

**Climate Change Science Program (CCSP):** GEO leads NSF efforts in the interagency CCSP to enhance understanding of the dynamics among natural and human systems, generate the knowledge needed to preserve, manage, and enhance the environment, as well as to support national and international policy-making activities. Specific activities include programs focused on understanding past climate variability, elucidating how carbon and nitrogen cycle through the earth, atmosphere and oceans, and efforts to develop and refine computational models of earth system processes.

**Cyberinfrastructure:** Research advances in the geosciences increasingly depend on the presence of underlying cyberinfrastructure to bridge systems and make data interoperable across platforms. In FY 2007, GEO will continue to invest aggressively in the cyberinfrastructure required to maintain the pace of discovery in the geosciences.

**International Polar Year (IPY):** As part of NSF's IPY activities, GEO will focus on modeling in the polar regions, including ocean currents, climate, and extent of sea ice coverage. Also, research activities associated with the Integrated Ocean Drilling Program are planned in the Arctic during FY 2007.

**Networking and Information Technology R&D (NITRD):** Within NITRD, GEO focuses on the development and enhancement of computational modeling capacity and capability. One flagship activity is the Climate Simulation Laboratory at the NCAR, located in Boulder, CO, which serves a broad

community of researchers utilizing advanced computational techniques to model atmospheric processes ranging from projections of future climate to forecasting hurricane intensity and landfall.

**National Nanotechnology Initiative (NNI):** GEO contributions to NNI include studies of natural nanoscale processes in the environment and utilizing nanoscale phenomena as catalysts for environmental remediation.

## **QUALITY**

GEO maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The share of basic and applied research funds that were allocated to projects that undergo merit review was 76 percent in FY 2005, the last year for which complete data exist. OMB's definition of competitive, merit-based review does not include Federally Funded Research and Development Centers. Therefore, support for the National Center for Atmospheric Research, although regularly merit-reviewed, is not considered as funding that undergoes competitive, merit-based review for this calculation. If included, the merit-reviewed share of GEO funding would rise to 87 percent.

To ensure the highest quality in processing and recommending proposals for awards, GEO convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

The directorate also receives advice from the Advisory Committee for Geosciences (AC/GEO) on such issues as: the mission, programs, and goals that can best serve the scientific community; how GEO can promote quality graduate and undergraduate education in the geosciences; and priority investment areas in geoscience research. The AC/GEO meets twice a year and members represent a cross section of the geosciences, with representatives from many different sub-disciplines within the field; a broad range of academic institutions and industry; broad geographic representation; and balanced representation of women and under-represented minorities.

**PERFORMANCE**

NSF's FY 2007 budget is also aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

**Geosciences**  
**By Strategic Outcome Goal and Investment Category**  
(Dollars in Millions)

	FY 2006		FY 2007 Request	Change over FY 2006	
	FY 2005 Actual	Current Plan		Amount	Percent
<b><i>Ideas</i></b>					
Fundamental Science and Engineering	350.70	351.08	370.32	19.24	5.5%
Centers Programs	10.69	10.58	18.68	8.10	76.6%
Capability Enhancement	-	-	-	-	N/A
	<u>361.39</u>	<u>361.66</u>	<u>389.00</u>	<u>27.34</u>	<u>7.6%</u>
<b><i>Tools</i></b>					
Facilities	154.98	148.91	158.80	9.89	6.6%
Infrastructure and Instrumentation	60.12	64.02	64.85	0.83	1.3%
Federally-Funded R&D Centers	81.54	83.94	87.43	3.49	4.2%
	<u>296.64</u>	<u>296.87</u>	<u>311.08</u>	<u>14.21</u>	<u>4.8%</u>
<b><i>People</i></b>					
Individuals	27.02	27.90	27.90	-	-
Institutions	3.50	3.46	3.46	-	-
Collaborations	4.53	7.53	8.00	0.47	6.2%
	<u>35.05</u>	<u>38.89</u>	<u>39.36</u>	<u>0.47</u>	<u>1.2%</u>
<b><i>Organizational Excellence</i></b>					
	<u>4.09</u>	<u>5.41</u>	<u>5.41</u>	<u>-</u>	<u>-</u>
<b>Total, GEO</b>	<u>\$697.17</u>	<u>\$702.83</u>	<u>\$744.85</u>	<u>\$42.02</u>	<u>6.0%</u>

Totals may not add due to rounding.

GEO will continue its commitment to education, training, and increasing diversity in FY 2007. The FY 2007 budget will maintain award size and continue to focus on multidisciplinary research activities, inter-agency partnerships, and international activities with special attention given to broadening participation at all levels. In addition, development of new infrastructure remains a priority, with ongoing support for the acquisition of new regional research vessels and increased support for the operation of the EarthScope facility being constructed through the MREFC account.

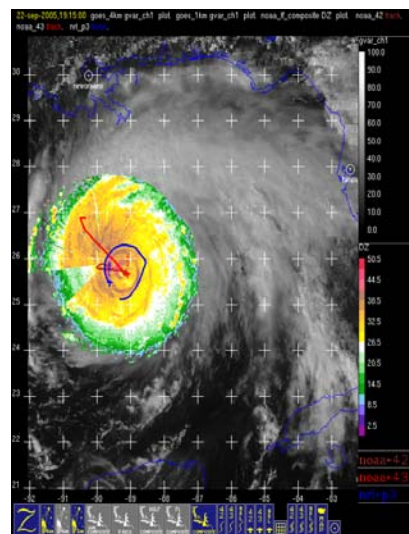
## Recent Research Highlights

### ► A New Tool to Better Predict Hurricane Intensity:

Hurricanes Katrina and Rita caused incalculable misery and devastation throughout the Gulf Basin area, but data gathered by the Hurricane Rainband and Intensity Change Experiment (RAINEX) could lead to much more effective strategies for mitigating such damage in the future.

RAINEX, which is jointly sponsored by NSF and the National Oceanic and Atmospheric Administration, flew multiple aircraft through both Katrina and Rita as the storms approached landfall in August and September of 2005. The research planes were able to take wind, pressure, moisture and temperature readings in different parts of the hurricanes at the same time, allowing researchers to form a complete picture of how the storms developed. A main focus of RAINEX has been to study how the rainbands and eyewalls interact to affect storm intensity.

Hurricane Rita, shown in a visible satellite image with Doppler radar overlay, on September 22, 2005. Three aircraft simultaneously sampled the inner structure of the hurricane, including the primary and secondary concentric eyewalls. The three solid colored lines represent aircraft tracks.



► **Nanoparticles in the Real World:** Many people associate nanoparticles – objects on the scale of atoms or molecules – with artificial creations in the new fields of nanoscience and nanotechnology. But some nanoparticles are created and exist naturally in the air, water, and soil. Jillian Banfield, Professor of Earth and Planetary Science at the University of California – Berkeley, studies nanoparticles that form in the environment through processes such as the weathering of rocks or the formation of tiny mineral clusters by microbes. Nanoparticles can be highly reactive and may provide ideal transportation for toxic metals and other contaminants passing through the environment. Fundamental questions about how these natural nanoparticles form, their structure, and their role in environmental processes remain to be answered. In her studies, Dr. Banfield has learned many of the details about how particle size influences the way ions are attached to and incorporated into crystalline minerals. Understanding these processes could lead to more effective and cleaner methods of manufacturing and energy production. Nanotechnology could also help develop the microscopic sensors needed to understand complicated fine-scale interactions between biological and inorganic substances in the environment.



Dr. Fred Sundberg and another earth science teacher examine electronic rain gauge. *Credit: The Navajo County Star January 2006*

► **Saturday Scientists:** Thanks to support from an NSF program, high-school students in Arizona can conduct real, hands-on primary research. Fred Sundberg’s earth science students spend their Saturdays in the field constructing and maintaining silt fences to collect erosion runoff, analyzing rain data and soil samples, and surveying and analyzing vegetation in the course of conducting experiments to determine if logging activity on burned areas increases soil erosion. Sundberg’s innovative class project lets students experience being earth scientists. They completely run the project and maintain and post their results on a website. Even the “project manager” is a student. Similar to any project manager, his or her responsibilities include managing resources, delegating tasks, maintaining a time schedule, and developing the final report for the client agencies.



► **Can that Buoy Hear You?** NSF-supported researchers recently developed and successfully deployed a novel, buoy-based ocean observatory that uses acoustic communication to wirelessly retrieve data from sensors at various depths in the water and on the seafloor. The system offers exciting new opportunities to monitor both episodic events and long-term changes in the oceans. For 13 months, this system was deployed off Vancouver Island in the Northeast Pacific to study a seep area (where underground fluids emerge) along the Nootka fault.

Equipped with a satellite link, the buoy system can provide near-real-time data, is easily expandable to accommodate additional sensors, and is fitted with two-way communication capabilities that enable sensors to be controlled from shore. This platform vastly increases the potential for observing periodic events, such as earthquakes, volcanic eruptions, and phytoplankton blooms, as well as changing ocean conditions over seasons and years, or during times of the year when measurements from shipboard platforms are simply not possible because of weather and other factors. Advanced ocean observation technology such as this is leading to a new era of exploration in the world's oceans.

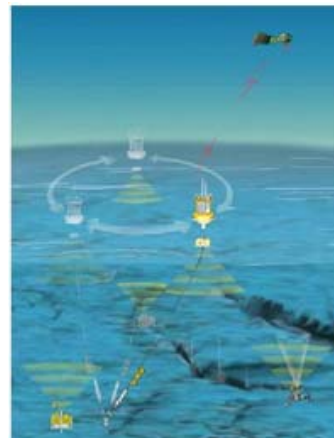


Diagram showing acoustically-linked moored buoy observatory deployed at the Nootka fault for 13 months in 2004-2005, recording data from an ocean bottom seismometer (lower left) and a suite of hydrothermal sensors (lower right). This system uses acoustic modems to send data from the seafloor to a surface buoy, and from the buoy to shore via an Iridium satellite link.

**Other Performance Indicators**

The tables below show the number of people benefiting from GEO funding, and trends in award size, duration, number of awards, and funding rates.

**Number of People Involved in GEO Activities**

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Request
Senior Researchers	4,016	4,000	4,200
Other Professionals	2,549	2,550	2,700
Postdoctorates	557	550	600
Graduate Students	2,153	2,150	2,300
Undergraduate Students	1,171	1,200	1,300
<b>Total Number of People</b>	<b>10,446</b>	<b>10,450</b>	<b>11,100</b>

**GEO Funding Profile**

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Request
<b>Statistics for Competitive Awards:</b>			
Number	1,321	1,300	1,350
Funding Rate	28%	27%	28%
<b>Statistics for Research Grants:</b>			
Number of Research Grants	1,002	1,000	1,050
Funding Rate	25%	24%	25%
Median Annualized Award Size	\$116,337	\$116,500	\$117,000
Average Annualized Award Size	\$147,857	\$148,000	\$149,000
Average Award Duration, in years	3	3	3

**Changes in Budget Structure**

The Geosciences Activity is restructured in FY 2007 to include an additional subactivity, Integrative & Collaborative Education and Research (ICER), which will support multidisciplinary research and education activities arising from advances in disciplinary research as well as crosscutting international activities. A crosswalk of the FY 2006 Current Plan is shown below.

**GEO Reorganization Crosswalk  
FY 2006 Current Plan  
(Dollars in Millions)**

Current Structure	New Structure				Total, Current Structure
	ATM	EAR	ICER	OCE	
Atmospheric Sciences (ATM)	216.09	-	19.38	-	235.47
EarthSciences (EAR)	-	140.12	12.75	-	152.87
Ocean Sciences (OCE)	-	-	26.24	288.25	314.49
<b>Total, New Structure</b>	<b>\$216.09</b>	<b>\$140.12</b>	<b>\$58.37</b>	<b>\$288.25</b>	<b>\$702.83</b>

**ATMOSPHERIC SCIENCES**

**226,850,000**

The FY 2007 Request for the Division of Atmospheric Sciences (ATM) is \$226.85 million, an increase of \$10.76 million, or 5.0 percent, over the FY 2006 Current Plan of \$216.09 million.

**Atmospheric Sciences Funding**

(Dollars in Millions)

	FY 2005	FY 2006	FY 2007	Change over	
	Actual	Current Plan	Request	Amount	Percent
Atmospheric Sciences Research Support	135.68	133.85	141.12	7.27	5.4%
National Center for Atmospheric Research	79.64	82.24	85.73	3.49	4.2%
<b>Atmospheric Sciences</b>	<b>\$215.32</b>	<b>\$216.09</b>	<b>\$226.85</b>	<b>\$10.76</b>	<b>5.0%</b>
Major Components					
Research and Education Grants	96.45	95.55	106.41	10.86	11.4%
Centers Programs					
Center for Integrated Space Weather Modeling	4.00	3.96	4.00	0.04	1.0%
Center for Atmospheric Process Modeling	-	-	4.00	4.00	N/A
Facilities					
National Center for Atmospheric Research (NCAR)	79.64	82.24	85.73	3.49	4.2%
Research Resources and Infrastructure	35.23	34.34	30.71	-3.63	-10.6%

**About ATM:**

The extreme weather events of 2005 remind us that weather and climate affect every aspect of our daily lives. Tropical storms over the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico can develop into fierce hurricanes that pound the East Coast, spawning tornadoes and producing torrential rains and floods, and resulting in large numbers of fatalities and billions of dollars in damage to property. In the upper reaches of the Earth’s atmosphere, huge solar storms can damage satellites, disrupt communication and navigation systems, and cause widespread failures in the electrical power grid. The human impacts of urban pollution and extreme weather can be severe and costly. In order to improve our ability to predict and mitigate these events, we need to further our understanding of the physics, chemistry, and dynamics of the Earth’s atmosphere, from the Earth’s surface to the sun, on timescales ranging from minutes to millennia. We need to better understand the underlying trends, the impact of man-made changes, the complex interactions between systems, and the coupling among the atmosphere, the biosphere, and the oceans. The Division of Atmospheric Sciences supports such research through the provision of large, complex facilities, community modeling projects, cyberinfrastructure, and individual research grants, providing about 60 percent of the total federal support for academic atmospheric research.

ATM provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day atmospheric science research activities.

For the science activities supported by ATM, a variety of modes of support are used. Although the majority of this support is through the traditional “individual investigator” merit-reviewed, multi-year grants, ATM also supports: small scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted by NSF’s National Center for Atmospheric Research (NCAR) which extends and enhances research at universities.

Facility funding is provided through cooperative agreements to NCAR and several other institutions to acquire, maintain, and operate specific observational and cyberinfrastructure facilities that support the research and educational activities of NSF-sponsored projects, scientists, and students.

Facilities are approximately 45 percent of the ATM portfolio. Of the remaining funds, approximately 45 percent of funds support new awards and 55 percent are committed to funding awards made in previous years.

**ATM priorities for FY 2007:**

- **Natural Hazards:** Building on years of research to understand and predict weather and space weather phenomena, these research activities will be augmented to better understand and predict extreme events such as cyclone formation and life cycle;
- **Biogeochemical Cycles:** including emphasis on understanding the sources, sinks, and processes which control the atmospheric abundance and distribution of carbon, water, and other environmentally important elements;
- **Environmental Modeling:** Support for new data assimilation and innovative mathematical and statistical techniques to improve predictions of fundamental space, atmospheric, and Earth system processes;
- **Cyberinfrastructure and Numerical Models:** Improvements which will allow new discoveries, greater access to atmospheric data, and improved understanding of the atmospheric environment; and
- **Interagency and International Programs:** Continued support of these programs, including the U.S. Weather Research Program, the National Space Weather Program and cooperative international science programs.

**Changes from FY 2006:**

- Research and education grants and centers increase by \$14.90 million, to a total of \$122.44 million, and include:
  - an increase of \$4.04 million in research activities at Science and Technology Centers;
  - an increase of \$3.0 million in research on natural hazards (i.e. severe weather and space weather);
  - an increase of \$2.0 million for cyberinfrastructure investments; and
  - an increase of \$5.86 million in other disciplinary programs.
- Facilities decrease by \$4.14 million to a total of \$104.41 million, and include:
  - a planned decrease of \$8.0 million for construction costs of the Advanced Modular Incoherent Scatter Radar (AMISR); and
  - an increase of \$3.86 million across several NCAR and other facility programs.

Additional information on major ATM-supported facilities is available in the Facilities chapter.

**EARTH SCIENCES**

**\$152,300,000**

The FY 2007 Request for the Division of Earth Sciences (EAR) is \$152.30 million, an increase of \$12.18 million, or 8.7 percent, over the FY 2006 Current Plan of \$140.12 million.

**Earth Sciences Funding**

(Dollars in Millions)

	FY 2005	FY 2006	FY 2007	Change over	
	Actual	Current Plan	Request	Amount	Percent
Earth Science Project Support	103.67	106.46	115.90	9.44	8.9%
Instrumentation and Facilities	33.28	33.66	36.40	2.74	8.1%
<b>Earth Sciences</b>	<b>\$136.95</b>	<b>\$140.12</b>	<b>\$152.30</b>	<b>\$12.18</b>	<b>8.7%</b>
Major Components:					
Research and Education Grants	87.17	87.51	93.38	5.87	6.7%
Centers Programs					
Sustainability of Semi-Arid Hydrology and Riparian Areas	3.32	3.29	3.32	0.03	0.9%
National Center for Earth-Surface Dynamics	3.37	3.33	3.36	0.03	0.9%
Facilities					
Incorporated Research Institutions for Seismology (IRIS)	11.90	12.00	12.90	0.90	7.5%
EarthScope Operations	4.69	6.72	11.61	4.89	72.8%
Other Earth Sciences Infrastructure	21.57	22.02	22.48	0.46	2.1%

**About EAR:**

The Earth functions as a complex system that affects every aspect of our daily lives. The clean water we require to sustain life is made available through the hydrologic cycle. Soil forming processes are absolutely essential to agriculture. Our energy is largely provided by fossil fuels discovered in the subsurface and pumped or mined. Earthquakes periodically result in devastating loss of property and lives and erupting volcanoes are fed by tectonic processes deep in the earth and may create great societal disruption. EAR supports the study of these and many other Earth processes by providing funds for research and education, instrumentation, cyberinfrastructure, and shared-use facilities.

EAR provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day Earth science research activities.

Earth science is moving into a new era as we deploy an unprecedented array of instrumentation to image the planet's interior, sense the tectonic motions of the surface (for example, with NSF's EarthScope project), and establish observatories for study of the Earth's environmental systems. One way of addressing the Earth's complexity is through geoinformatics, the collaboration between geoscientists and computer scientists to solve complex scientific questions. EAR has enhanced its support to link available data sets, standardize documentation, and provide easy-to-use access tools and computer modeling and analysis codes for scientists and educators alike. EAR supports geoinformatics research and activities devoted to analyzing, modeling, and developing interactive capabilities for extensive and diverse data sets. Projects currently supported include:

- Consortia of universities, such as the Incorporated Research Institutes for Seismology (IRIS), UNAVCO, Inc., and WInSAR maintain highly sophisticated seismic, geodetic, and satellite radar data

that are heavily used by the research and hazards community. For example, the seismic data provided by the IRIS system gave emergency personnel the first indication of the location and severe damage potential of the Great Sumatra earthquake and tsunami of December 2004.

- The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) is developing a hydrologic information system that will provide seamless access to a variety of datasets such as the National Water Information System, the Ameriflux tower network and the National Climatic Data Center. These systems are increasingly vital for decisions affecting water management in arid regions, flood mitigation, and groundwater pollution containment.
- In the developmental stages are projects linking data sets bearing on sedimentary sequences and geologic time. This will greatly improve our understanding of the Earth's surface environments.
- The Southern California Earthquake Center (SCEC) has been utilizing computational facilities at the University of California San Diego Supercomputer Center to build complex models of the crust of southern California. Their results are providing significant input to disaster preparedness and a better understanding of fundamental earthquake processes.
- The Geoscience Network (GEON) consortium is a collaboration of computer scientists and geoscientists working on a variety of fronts to create cyberinfrastructure of applicability to earth scientists. They are also working on a system that allow the user to create synthetic seismograms using the Terragrid, on services for processing LiDAR imagery, on three- and four-dimensional visualization and on educating the next generation of cyber-Earth scientists.
- The Computational Infrastructure for Geodynamics (CIG) project, headquartered at the California Institute of Technology, but with participation of at least 24 other research institutions, will focus on developing advanced software to enable individual Earth scientists to produce more realistic simulations in fields such as seismology, plate tectonics, volcanism, and geomagnetism.

#### **EAR priorities for FY 2007:**

- EarthScope Operations and Science Support: The new EarthScope facility, being constructed through the MREFC account, is continuing to ramp up operations and enabling new science at the intersection of several subfields within the earth sciences. Supporting the operation of the facility and the science it enables continues to be a high priority for EAR. Additional information can be found in the MREFC chapter.
- Maintaining a strong, flexible program of research and education grants to create new ideas and technologies and attract and train students is the primary focus in stewardship of the EAR portfolio. Emphasis will be given to increasing the support for theoretical research, including the biological geosciences, the hydrologic sciences and the study of natural hazards, such as earthquakes and volcanic eruptions. The key element across the EAR portfolio is expanding the science community's capability for computationally challenging global-scale research, such as dynamic modeling of Earth system processes, and managing and integrating very large data sets.

#### **Changes from FY 2006:**

- Research and education grants increase \$9.44 million, to a total of \$115.90 million. EAR will continue to support forefront areas of the Earth sciences, with continued emphasis on EarthScope science and operations, geohydrology, cyberscience, and geobiology. Education and outreach activities receiving continued emphasis include: enhancing science teacher training, expanding diversity within the research community, and integrating research and education.
- Facilities increase by \$2.74 million to a total of \$36.40 million. The increase is primarily for support of shared research facilities with a focus on geoinformatics.

**INNOVATIVE & COLLABORATIVE EDUCATION AND RESEARCH** **\$58,570,000**

The FY 2007 Request for the Division of Innovative & Collaborative Education and Research (ICER) is \$58.57 million, an increase of \$200,000, or 0.3 percent, over the FY 2006 Current Plan of \$58.37 million.

**Innovative and Collaborative Education and Research Funding**

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006	
				Amount	Percent
<b>Innovative &amp; Collaborative Education and Research</b>	<b>\$54.11</b>	<b>\$58.37</b>	<b>\$58.57</b>	<b>\$0.20</b>	<b>0.3%</b>
Major Components:					
Research and Education Grants	48.87	53.17	53.17	-	-
International Collaborations	5.24	5.20	5.40	0.20	3.8%

**About ICER:**

The Innovative and Collaborative Education and Research subactivity supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER’s principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts.

In general, awards in targeted education programs and international projects are managed in ICER and awards associated with NSF-wide efforts are managed in the GEO divisions. Approximately 70 percent of funds are available for new awards each year and the remaining 30 percent are committed to awards made in previous years.

**ICER Priorities for FY 2007:**

**Education and Broadening Participation in the Geosciences:** Cross-divisional education activities include investments in development of curricula and resources specific to broad geoscience education, a leadership activity for geoscience teachers, and support for internet capabilities for geoscience education. In FY 2007, resources will be targeted at increasing the diversity of the geoscience workforce and enhancing the linkages between existing education and diversity projects and LSAMP awards. In a partnership with NASA, NSF will continue support for the GLOBE program. GEO contributes to programs for interdisciplinary graduate education (IGERT) and outreach to students (GK-12).

**Interdisciplinary Research:** ICER supports a major competition on Carbon and Water in Earth Systems. This research is within the NSF-wide framework for Biocomplexity in the Environment and aims to increase fundamental understanding of the interrelation of physical, chemical, geological, hydrologic, atmospheric, and biological processes that comprise the Earth’s natural systems. In addition, ICER provides support to the NSF-wide investments in Mathematical Sciences, especially regarding modeling of complex systems; and Human and Social Dynamics, particularly regarding decision making and uncertainty.

**Ecology of Infectious Diseases.** Jointly with the Biological Sciences activity and the National Institutes of Health, ICER continues to support NSF's Ecology of Infectious Diseases program, which directly contributes to homeland security. The focus of the program is to explore the processes that govern relationships between human-induced environmental changes and the emergence and transmission of infectious diseases.

**International Collaborations.** ICER will continue support of targeted, catalytic international partnerships related to the broad interests of the geosciences, especially those that encourage global and regional scientific observations and information-sharing, and enable participation by U.S. investigators. One example is the Inter-American Institute for Global Change Research, a program that fosters research across the Americas.

**Changes from FY 2006:**

Funds for awards to international groups that support, plan, and coordinate a variety of geosciences activities around the world increase by \$200,000, to a total of \$1.50 million.



**OCEAN SCIENCES**

**\$307,130,000**

The FY 2007 Request for the Division of Ocean Sciences (OCE) is \$307.13 million, an increase of \$18.88 million, or 6.5 percent over the FY 2006 Current Plan of \$288.25 million.

**Ocean Sciences Funding**  
(Dollars in Millions)

	FY 2005 Actual	FY 2006	FY 2007 Request	Change over FY 2006	
		Current Plan		Amount	Percent
Ocean Section	99.72	107.58	114.62	7.04	6.5%
Integrative Programs Section	112.48	105.46	112.37	6.91	6.6%
Marine Geosciences Section	78.59	75.21	80.14	4.93	6.6%
<b>Ocean Sciences</b>	<b>\$290.79</b>	<b>\$288.25</b>	<b>\$307.13</b>	<b>\$18.88</b>	<b>6.5%</b>
Major Components:					
Research and Education Grants	144.97	139.57	141.85	2.28	1.6%
Long-term Ecological Research Centers Centers Program	3.63	3.00	3.50	0.50	16.7%
Center for Coastal Margin Observation/Prediction	-	-	4.00	4.00	N/A
Facilities					
Academic Research Fleet	70.97	73.00	77.50	4.50	6.2%
Integrated Ocean Drilling Program (IODP)	37.20	29.00	25.80	-3.20	-11.0%
Other Ocean Sciences Infrastructure	29.72	32.17	42.97	10.80	33.6%

**About OCE:**

The oceans play a pivotal role in climate, with the largest and most unexplored habitat for life on Earth and providing routes for commerce and sites for recreation. The oceans are also the source of important food and energy resources, and enormous reservoirs of heat and energy that spawn hurricanes and other cyclonic storms, sometimes with disastrous impacts on coastal and inland communities. Ocean scientists, through research supported by OCE, have made major advances in the understanding of ocean biology, chemistry, geology, and physics. Research and education supported by OCE improve understanding of the physical, chemical, and biological processes that characterize both coastal seas and deep ocean basins, and the geological and geophysical processes that shape the continental shelves and deep sea floor. Support is also provided for the facilities and infrastructure required to gain access to the ocean, including research vessels, manned and unmanned deep diving submersibles, and a wide range of technologically advanced sensors and observational instrumentation. Ocean science is a highly interdisciplinary research endeavor that is fundamental to the understanding of the Earth's climate, to resource and hazard assessment, and to the health of the ocean's complex and diverse ecological systems.

The OCE portfolio has three highly integrative programmatic areas of support: research grants, education grants, and facilities to serve research and education activities.

- OCE research grants range from awards to individual scientists, to small groups of collaborating scientists, to several large coordinated projects involving international partners and user facilities.
- OCE education grants support graduate students and undergraduate research experiences, K-12 educational activities, and informal education for the general public. The Centers for Ocean Science Education Excellence (COSEE) form a major education and outreach network that facilitates the dissemination of ocean-centered educational material and information.

- OCE also supports acquisition, operation, and maintenance of major world-class facilities required to provide access to the oceans in order to address the highest priority science questions. Additional information on OCE-supported facilities is available in the Facilities chapter of this document.

Facilities are approximately 43 percent of the OCE portfolio. Of the remaining 57 percent, approximately 65 percent of funds support new awards and 35 percent are for awards made in previous years.

### **OCE Priorities for FY 2007:**

Maintaining a strong, flexible program of research and education grants and facilities support to create new ideas and technology and attract and train students, is the highest priority in this portfolio.

- The Ocean Observatories Initiative (OOI) will address the growing need for sustained time-series observations. As our knowledge of the oceans has improved, the realization has grown that few characteristics of the ocean are in steady state – the ocean and the seafloor beneath are highly dynamic environments. If these processes are to be understood, if new insights are to be gained, if quantitative models are to be validated satisfactorily, then observations are needed over time scales appropriate to the dynamics of these processes.
- The Integrated Ocean Drilling Program (IODP) is an international partnership of scientists, research institutions, and agencies exploring the evolution and structure of Earth as recorded in the ocean basins utilizing ocean drilling.
- Natural Hazards: Hurricanes, earthquakes, and tsunamis can be better predicted with greater understanding of the mechanisms causing such events.
- A NSF Science and Technology Center (STC) for Coastal Margin Observation and Prediction will study coastal margins using integrated observation and prediction technologies. The STC will advance understanding of coastal margins by creating the scientific infrastructure necessary to obtain reliable quantitative descriptions and analyses of integrated physical, chemical, and biological variables in estuaries, freshwater plumes, and continental shelves.
- Non-Equilibrium Ecosystem Dynamics: Many oceanic processes are inherently nonlinear, so that small perturbations at one frequency can cause large-scale changes at another. The propagation of non-native species, the proliferation of harmful algal blooms, and the effectiveness of marine reserves are all examples where sophisticated ecosystem knowledge is required.
- The network of Centers for Ocean Science Excellence (COSEE) and other ocean education programs integrate ocean-science research in delivering high-quality education programs, and promote a deeper public understanding of the oceans and their influence on quality of life and national prosperity. COSEE partnerships foster interactions among research institutions, formal education organizations and informal education providers like museums.
- Providing scientists with access to the sea via modern infrastructure is essential for advancing our knowledge of the oceans. Building upon recommendations of the National Academy of Sciences and the Federal Oceanographic Facility Committee (FOFC), several projects will continue, including the construction of three regional-class research vessels to replace aging and less capable ships.

### **Changes from FY 2006:**

- Research and education grants increase by \$2.28 million, to a total of \$158.80 million. OCE will continue to support forefront areas of ocean science, with expanded emphasis on complex systems and the temporal exploration of the oceans. Education and outreach activities will receive continued emphasis: enhancing COSEE, expanding diversity within the research community, and integrating research and education, including the training of young ocean scientists.
- Support for facilities increases \$9.89 million, to a total of \$144.0 million.