

# DIRECTORATE FOR GEOSCIENCES (GEO)

**\$955,290,000**  
**+\$65,650,000 / 7.4%**

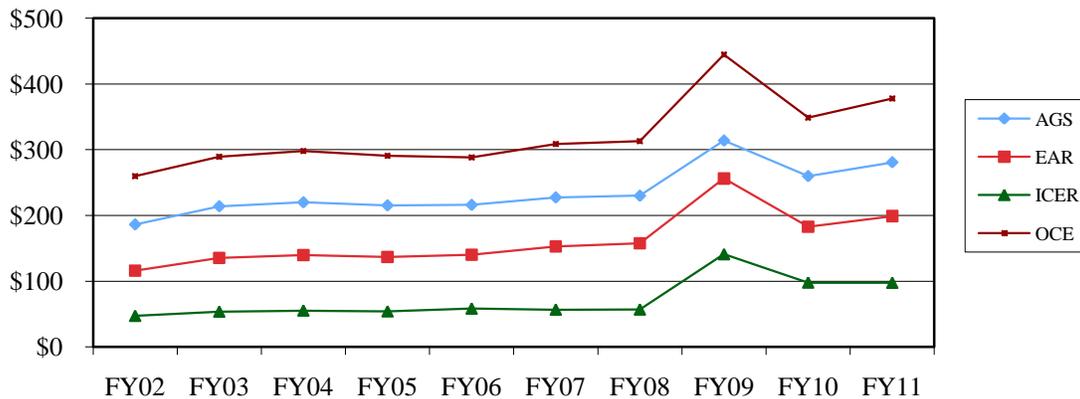
## GEO Funding (Dollars in Millions)

	FY 2009	FY 2009	FY 2010 Estimate	FY 2011 Request	Change Over	
	Omnibus Actual	ARRA Actual			FY 2010 Estimate	FY 2011 Request
Atmospheric and Geospace Sciences (AGS)	\$245.54	\$68.20	\$259.80	\$280.80	\$21.00	8.1%
Earth Sciences (EAR)	171.01	85.22	183.00	199.00	16.00	8.7%
Integrative and Collaborative Education & Research (ICER)	61.47	79.58	97.92	97.60	-0.32	-0.3%
Ocean Sciences (OCE)	330.51	114.00	348.92	377.89	28.97	8.3%
<b>Total, GEO</b>	<b>\$808.53</b>	<b>\$347.00</b>	<b>\$889.64</b>	<b>\$955.29</b>	<b>\$65.65</b>	<b>7.4%</b>
Research	389.11	224.69	464.12	505.17	41.05	8.8%
Education	31.82	35.98	41.40	44.68	3.28	7.9%
Infrastructure	374.10	86.34	367.79	387.60	19.81	5.4%
Stewardship	13.51	-	16.33	17.84	1.51	9.2%

Totals may not add due to rounding.

As the principal source of federal funding for university-based fundamental research in the geosciences, the Directorate for Geosciences addresses the Nation’s need to understand, predict, and respond to environmental events and changes. GEO-supported research also advances our ability to predict natural phenomena of economic and human significance, such as climate changes, hurricanes, and earthquakes.

## GEO Subactivity Funding (Dollars in Millions)



## GEO in Context

GEO provides about 63 percent of the total federal funding for university-based, basic research in the geosciences. In addition to playing a critical role in addressing the Nation's need to understand, predict, and respond to environmental events and changes, GEO 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. GEO investments include many environmental studies coordinated through the U.S. Global Change Research Program.

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. 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, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of, or adaptation to, the effects of these and other disruptive natural events.

The FY 2011 Request for GEO includes \$8.0 million to leverage activities across the directorate aimed at increasing support for transformative research, including highly innovative research and education projects across the entire range of geoscience interests. Special attention will be paid to challenges associated with understanding the dynamic processes impacting the physical earth system. GEO will also utilize NSF's innovative processes for identifying potentially transformative research, such as special competitions and increased use of specialized funding mechanisms, notably NSF's EAGER (EARly-concept Grants for Exploratory Research) grants.

### **Factors Influencing the Allocation Across Divisions and Major Programs**

In consultation with the Advisory Committee for Geosciences, GEO developed a set of principles to guide budget allocations and decisions. These are:

#### Advance science

- Foster generation of new ideas and innovative science, including those that cross traditional programmatic boundaries;
- Provide adequate resources to accomplish project goals;
- Assure appropriate program balance and diversity in the portfolios;
- Identify and nurture partnerships within NSF, with other Federal agencies, and internationally to leverage GEO research funding and support GEO goals;
- Maintain flexibility to pursue new lines of research by continuing to avoid over committing resources in future years;
- Involve the community in long-term planning and maintain effective and timely communications with the community; and
- Be mindful of societal needs to ensure that fundamental research serves the Nation.

#### Maintain and enhance the health of the scientific community

- Ensure that the intellectual capital of research communities is maintained and renewed;
- Develop a diverse geoscience community;
- Promote innovative approaches to geoscience education and outreach; and
- Communicate GEO-supported activities in order to promote public awareness of the geoscience enterprise.

#### Preserve and invest appropriately in infrastructure

- Continue to plan in order to take advantage of new opportunities as they arise;
- Maintain productive scientific infrastructure, including cyberinfrastructure, and avoid irreversible losses to capabilities;
- Provide new research tools and facilities, assure that they are maintained, and support the science that exploits these tools;

- Consider full life-cycle costs of infrastructure, including the costs of associated science; and
- Consider infrastructure implications when committing to a major science program.

Major investments in FY 2011 that shaped the distribution of funds across the divisions include continued investment in the NCAR-Wyoming supercomputer center and increased emphasis on climate research. The new supercomputer center will enable expansion of the computational resources available to the community, and is expected to cost approximately \$70.20 million - \$25.0 million in 2010, \$19.2 million in 2011, and \$6.0 million in 2012 from NSF, and an additional \$20.0 million from the State of Wyoming. This activity is inherently multidisciplinary and plays an important role across the geosciences; therefore, support for the center is provided through AGS, EAR and OCE in FY 2011. Supporting the increase in operations funds needed for the Ocean Observatories Initiative (OOI) being constructed through the MREFC Account was also a significant consideration.

## GEO Funding for Centers and Facilities

### GEO Funding for Centers and Facilities

(Dollars in Millions)

	FY 2009	FY 2009	FY 2010 Estimate	FY 2011 Request	Change Over		
	Omnibus	ARRA			FY 2010 Estimate	FY 2011 Estimate	Percent
	Actual	Actual				Amount	
<b>Centers</b>	<b>\$18.51</b>	<b>-</b>	<b>\$14.89</b>	<b>\$13.57</b>	<b>-\$1.32</b>	<b>-8.9%</b>	
<i>Nanoscale Science and Engineering Centers (ICER)</i>	0.25	-	0.25	0.25	-	-	
<i>STC -- Coastal Margin Observation and Prediction (OCE)</i>	4.00	-	4.00	4.00	-	-	
<i>STC -- Earth Surface Dynamics (EAR)</i>	3.60	-	3.32	2.66	-0.66	-19.9%	
<i>STC -- Integrated Space Weather Modeling (AGS)</i>	4.00	-	3.32	2.66	-0.66	-19.9%	
<i>STC -- Multi-scale Modeling of Atmospheric Processes (AGS)</i>	4.00	-	4.00	4.00	-	-	
<i>STC --Sustainability of Semi-Arid Hydrology and Riparian Areas (EAR)</i>	2.66	-	-	-	-	N/A	
<b>Facilities</b>	<b>\$374.10</b>	<b>\$86.34</b>	<b>\$367.79</b>	<b>\$387.60</b>	<b>\$19.81</b>	<b>5.4%</b>	
<i>National Astronomy and Ionosphere Center (AGS)</i>	-	-	2.20	3.00	0.80	36.4%	
<i>National Center for Atmospheric Research (AGS)</i>	106.79	13.20	97.00	108.00	11.00	11.3%	
<i>National Nanotechnology Infrastructure Network (ICER)</i>	0.60	-	0.60	0.60	-	-	
<i>Academic Research Fleet (OCE)</i>	88.95	18.00	80.00	77.00	-3.00	-3.8%	
<i>Integrated Ocean Drilling Program (OCE)</i>	47.95	25.00	43.40	46.41	3.01	6.9%	
<i>Incorporated Research Institutions for Seismology (EAR)</i>	12.00	-	12.36	12.73	0.37	3.0%	
<i>EarthScope (EAR)</i>	24.29	9.00	25.05	26.00	0.95	3.8%	
<i>Ocean Observatories Initiative (OCE)</i>	17.84	-	16.50	27.50	11.00	66.7%	

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual Facilities, please see the Facilities chapter.

### Centers

- GEO oversees the activities of five Science and Technology Centers (STCs). In accordance with NSF guidance, several of these centers are reaching the end of their planned period of support and their funding is beginning to ramp down or has ceased. FY 2011 will be the final year of support for

the Center for Integrated Space Weather Modeling at Boston University and the Center for Earth-Surface Dynamics at the University of Minnesota.

**Facilities**

- Funding for the National Astronomy and Ionosphere Center (NAIC) is increasing to provide support for upper atmospheric observing infrastructure located at the facility.
- Support for the National Center for Atmospheric Research (NCAR) will increase by \$11.0 million in FY 2011. This augmentation will enable increased support for climate change activities as well as preparation for the transition of computing operations to the new Wyoming Supercomputer Center.
- Support for the operation of the Academic Research Fleet decreases by \$3.0 million from the FY 2010 estimate. Construction funding for the replacement human occupied submersible is ramping down in accordance with plans.
- Operations support for the Integrated Ocean Drilling Program (IODP) is planned to increase in FY 2011, allowing enhanced investment in downhole instrumentation to study the deep, sub-seafloor biosphere, in partnership with a private foundation.
- Operation of the Incorporated Research Institutions for Seismology (IRIS) facility will be maintained, with a small increase for costs associated with personnel and equipment.
- Operation of EarthScope will continue with approximately the same level of activity as in FY 2010; with a small increase for costs associated with personnel and equipment.
- Operations support for the Ocean Observatories Initiative (OOI), being constructed through the MREFC account, will increase significantly in FY 2011 in order to prepare for the maintenance of in-water assets being deployed in FY 2012.

**GEO Administration Priority Programs and NSF Investments**

**GEO Administration Priority Programs and NSF Investments**

(Dollars in Millions)

	FY 2009	FY 2009	FY 2010 Estimate	FY 2011 Request	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	Percent
	Actual	Actual			Request	Amount
Faculty Early Career Development (CAREER)	\$12.45	\$9.60	\$12.60	\$13.00	\$0.40	3.2%
Graduate Research Fellowships (GRF)	-	8.99	1.00	2.74	1.74	174.0%
Climate Change Education Program	-	-	1.50	1.50	-	N/A
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	195.50	230.70	35.20	18.0%

GEO’s FY 2011 budget will significantly expand key NSF programs that support students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in global climate change.

In FY 2011, GEO will invest \$230.70 million in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering. GEO will initiate additional research competitions to study regions that are highly susceptible to the impacts of environmental changes, such as coastal areas subject to sea-level rise, the Arctic where permafrost is changing rapidly, and the Antarctic where sub-ice sheet conditions are being explored and modeled. GEO will also provide support for the new NCAR-Wyoming Supercomputer Center, which will enable a significant expansion of the U.S. academic community’s capability to model the climate system, is also included.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-Wide Investments chapters.

## Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

### Number of People Involved in GEO Activities

(Dollars in Millions)

	FY 2009			
	FY 2009 Estimate	ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	4,780	2,006	5,200	5,600
Other Professionals	2,553	824	2,800	3,000
Postdoctorates	524	210	600	600
Graduate Students	2,166	1,854	2,400	2,500
Undergraduate Students	1,150	898	1,300	1,300
<b>Total Number of People</b>	<b>11,173</b>	<b>5,792</b>	<b>12,300</b>	<b>13,000</b>

### GEO Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
<b>Statistics for Competitive Awards:</b>			
Number of Proposals	4,166	4,400	4,600
Number of New Awards	1,840	1,200	1,250
Regular Appropriation	1,067	1,200	1,250
ARRA	773	-	-
Funding Rate	44%	27%	27%
<b>Statistics for Research Grants:</b>			
Number of Research Grant Proposals	3,609	3,800	4,000
Number of Research Grants	1,421	900	950
Regular Appropriation	813	900	950
ARRA	608	-	-
Funding Rate	39%	24%	24%
Median Annualized Award Size	\$124,399	\$125,000	\$130,000
Average Annualized Award Size	\$173,377	\$175,000	\$180,000
Average Award Duration, in years	2.8	3.0	3.0





- Funding NCAR to enhance scientific and engineering support for making high end computing available to more new university investigators and research teams.

**DIVISION OF EARTH SCIENCES (EAR)**

**\$199,000,000**  
**+\$16,000,000 / 8.7%**

**EAR Funding**  
(Dollars in Millions)

	FY 2009	FY 2009	FY 2010	FY 2011	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	FY 2011 Request
	Actual	Actual	Estimate	Request	Amount	Percent
<b>EAR</b>	<b>\$171.01</b>	<b>\$85.22</b>	<b>\$183.00</b>	<b>\$199.00</b>	<b>\$16.00</b>	<b>8.7%</b>
Research	98.27	65.52	113.08	121.79	8.71	7.7%
<i>Center for Earth Surface Dynamics</i>	3.60	-	3.32	2.66	-0.66	-19.9%
<i>Center for Sustainability of Semi-Arid Hydrology of Riparian Areas</i>	2.66	-	-	-	-	N/A
Education	3.49	2.07	4.93	4.97	0.04	0.8%
Infrastructure	65.91	17.63	61.59	68.64	7.05	11.4%
<i>Incorporated Research Institutions for Seismology</i>	12.00	-	12.36	12.73	0.37	3.0%
<i>EarthScope</i>	24.29	9.00	25.05	26.00	0.95	3.8%

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained, over the four and a half billion years of Earth history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

Through its Surface Earth Processes section, EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, and sedimentary geology and paleobiology. The Division's Deep Earth Processes Section maintains programs in geophysics, tectonics, petrology and geochemistry, and continental dynamics. The newest program in EAR is EarthScope, a \$200 million facility and science program focused on studying the structure and tectonics of the North American continent. In addition to these core programs, EAR has an Instrumentation and Facilities program that supports community-based, shared use facilities and the acquisition and development of instrumentation by individual investigators, and an education program that funds a number of activities to attract and support students and young investigators to the field of Earth science.

Approximately 62 percent of EAR's budget is used to support individuals and small groups of researchers while about 35 percent of the budget goes to instrumentation and facilities. The two largest facilities supported by EAR are EarthScope and IRIS, a community-based seismic instrumentation facility. In general, 20 percent of EAR's portfolio is available for new research grants. The remaining 80 percent funds continuing grants made in previous years.

**Factors Influencing the Allocation Across EAR Programs**

- Maintaining a healthy portfolio of core science programs and the critical facilities and instrumentation needed to support those programs;
- Participation in SEES through EAR's continued support of NSF's Climate Research investment (CRI), EAR's Critical Zone Observatory program, and supporting the NCAR-Wyoming Supercomputer Center construction at a level of \$5.0 million;
- Expanding support for research into Earth's Dynamic Systems, especially for large, interdisciplinary projects that cannot be supported through EAR's core programs;

- Expanding support for EarthScope science, including collaboration with the Division of Ocean Sciences on ocean-land experiments along the margins of the North American continent (e.g. Cascadia);
- Supporting development of advanced geoinformatics, computational infrastructure, and models to facilitate the dissemination and utilization of data acquired by Earth scientists;
- Increasing support for REU, EAR post-doctoral fellowships, and CAREER awards to attract and retain a new and more diverse generation of students to pursue careers in Earth science.

**INTEGRATIVE AND COLLABORATIVE  
EDUCATION AND RESEARCH (ICER)**

**\$97,600,000**  
**-\$320,000 / 0.3%**

**ICER Funding**  
(Dollars in Millions)

	FY 2009		FY 2010 Estimate	FY 2011 Request	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	
	Actual	Actual			Amount	Percent
<b>ICER</b>	<b>\$61.47</b>	<b>\$79.58</b>	<b>\$97.92</b>	<b>\$97.60</b>	<b>-\$0.32</b>	<b>-0.3%</b>
Research	38.95	38.93	41.65	64.14	22.49	54.0%
Education	19.55	31.17	26.97	28.71	1.74	6.5%
Infrastructure	2.24	-	27.60	2.60	-25.00	-90.6%
<i>National Nanotechnology Infrastructure Network</i>	<i>0.60</i>	-	<i>0.60</i>	<i>0.60</i>	-	-
<i>Academic Research Fleet</i>	<i>1.64</i>	-	<i>2.00</i>	<i>2.00</i>	-	-

ICER 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 FY 2011, the division will make strategic investments in climate research, high-risk/high-reward science, and education, diversity, and human resource development.

In general, 54 percent of the ICER portfolio is available for new research grants. The remaining 46 percent funds continuing grants made in previous years.

**Factors Influencing the Allocation Across ICER Programs**

Investments made through ICER typically cut across disciplines – both within GEO and across the Foundation. In FY 2011, the increase in ICER represents increased investment in climate modeling associated with NSF’s SEES investment and increased support for the Graduate Research Fellowship program. In FY 2010, \$25.0 million to support construction of the NCAR-Wyoming supercomputer center was included in ICER; support for the center is provided through AGS, EAR and OCE in FY 2011, freeing up funds for investment in climate change research as well as studies of other dynamic earth processes.



**DIVISION OF OCEAN SCIENCES (OCE)**

**\$377,890,000**  
**+\$28,970,000 / 8.3%**

**OCE Funding**  
(Dollars in Millions)

	FY 2009		FY 2010 Estimate	FY 2011 Request	Change Over			
	Omnibus	ARRA			FY 2010 Estimate	FY 2011 Request	FY 2010 Estimate	Percent
	Actual	Actual			Amount	Amount	Amount	Percent
<b>OCE</b>	<b>\$330.51</b>	<b>\$114.00</b>	<b>\$348.92</b>	<b>\$377.89</b>	<b>\$28.97</b>	<b>8.3%</b>		
Research	144.21	63.21	181.32	188.87	7.55	4.2%		
<i>Center for Coastal Margin Observation and Prediction</i>	4.00	-	4.00	4.00	-	-		
Education	7.84	2.00	8.37	9.77	1.40	16.7%		
Infrastructure	172.76	48.79	152.90	172.11	19.21	12.6%		
<i>Academic Research Fleet</i>	87.31	18.00	78.00	75.00	-3.00	-3.8%		
<i>Integrated Ocean Drilling Program</i>	47.95	25.00	43.40	46.41	3.01	6.9%		
<i>Ocean Observatories Initiative</i>	17.84	-	16.50	27.50	11.00	66.7%		

Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource, as recognized in the White House Council on Environmental Quality’s *Interim Report to the President on A National Ocean Policy*. OCE supports interdisciplinary research of the water column to better understand changing ocean circulation and temperature, the health of marine ecosystems, and changing ocean chemistry with implications for ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, stability of methane hydrates, natural hazards associated with earthquakes and volcanic eruptions, and microbial life deep below the seafloor. Ocean education, formal and informal, draws on the interdisciplinary nature of ocean sciences, sophisticated visualization capabilities and the impact of the oceans on environmental change. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2011, OCE will emphasize research on environmental sustainability, including marine biodiversity and the impact of increased atmospheric CO<sub>2</sub> on ocean acidification, construction of the NCAR Wyoming Supercomputer (\$8.20 million in FY 2011) and ramping up operations and maintenance for the Ocean Observatories Initiative (OOI).

In general, 31 percent of the OCE portfolio is available for new research grants. The remaining 69 percent funds continuing grants made in previous years.

**Factors Influencing the Allocation Across OCE Programs**

- OCE gives high priority to participating in NSF’s SEES program, including ocean acidification, addressing the role of the oceans in climate change, the integration of marine ecosystem models with climate change models, interactions between warming oceans and ice-sheets, and integrated social and natural science models of our coasts. Building the next generation computational capacity at the NCAR Wyoming supercomputer to advance such research is a new and high priority for OCE.
- Under ARRA, construction of OOI began in FY 2009, with a contract to lay a cable of the Pacific Northwest and development of prototype instrumentation for highly capable tethered moorings. In FY 2011, OOI operations and maintenance costs will ramp up to allow mooring infrastructure and instruments for post-construction use to be built in parallel with construction to maximize savings on later operations and maintenance (O&M) costs. First data flow from an OOI mooring is expected in FY 2013.

- Increased funds are requested for the Integrated Ocean Drilling Program, to allow enhanced investment in downhole instrumentation to study the deep, sub-seafloor biosphere, in partnership with a private foundation.
- Despite significant investments in new enabling technology and infrastructure, research support will also grow modestly. Emphases will include the Dynamic Earth and climate change, incorporating topics highlighted in the interim report of the National Ocean Policy Task Force, such as changing ocean-ice interactions, the impact of climate change on the oceans and vice-versa, the impact of ocean acidification, and dynamics of marine ecosystems.
- OCE will continue its partnership with the National Oceanographic and Atmospheric Administration (NOAA) on programs such as the Comparative Analysis of Marine Ecosystem Organization and with the National Institute of Environmental Health Sciences on Oceans and Human Health.
- In FY 2011, OCE will complete a full-scale assessment of the Academic Research Fleet. This assessment includes: a recently completed National Research Council (NRC) study on the fleet of the future sponsored by Office of Naval Research (ONR) and NSF; the impact of Navy decisions regarding ocean class ships on fleet size; and systematic inspections on each ship by OCE staff together with NSF contractors to determine the potential to extend ship life in science- and cost-effective ways. The apparent reduction in fleet support is related to the conclusion of planned funding for the replacement human occupied vehicle. Additional information on the academic research fleet is contained in the Facilities chapter.
- In FY 2011, OCE will receive the results of an NRC study evaluating the impact of scientific ocean drilling on the geosciences and assessing a new Science Plan, developed by the international community, for a possible new ocean drilling program post-FY 2013.
- Increasing ocean and earth system literacy for the general public, enhancing the diversity of the ocean sciences, and supporting the development of a technologically savvy work force remain a priority, as reflected in the increases requested for education activities.
- GEO will continue to invest in Ocean Research Priority Plan (ORPP) near-term activities in FY 2011 with the Comparative Analysis of Marine Ecosystem Organization (CAMEO) program and Atlantic Meridional Overturning Circulation (AMOC) investments being comparable to FY 2010, up to \$5.0 million and \$4.0 million, respectively. Investment in sensors is expected to be approximately \$3.0 million in FY 2011, up from zero in FY 2010. Support for the longer-term ORPP priority of Ocean Acidification will be up to \$8.0 million in FY 2010 and FY 2011.