

OFFICE OF POLAR PROGRAMS**\$490,970,000**

The FY 2009 Budget Request for the Office of Polar Programs (OPP) is \$490.97 million, an increase of \$48.43 million, or 10.9 percent, over the FY 2008 Estimate of \$442.54 million.

Office of Polar Programs Funding

(Dollars in Millions)

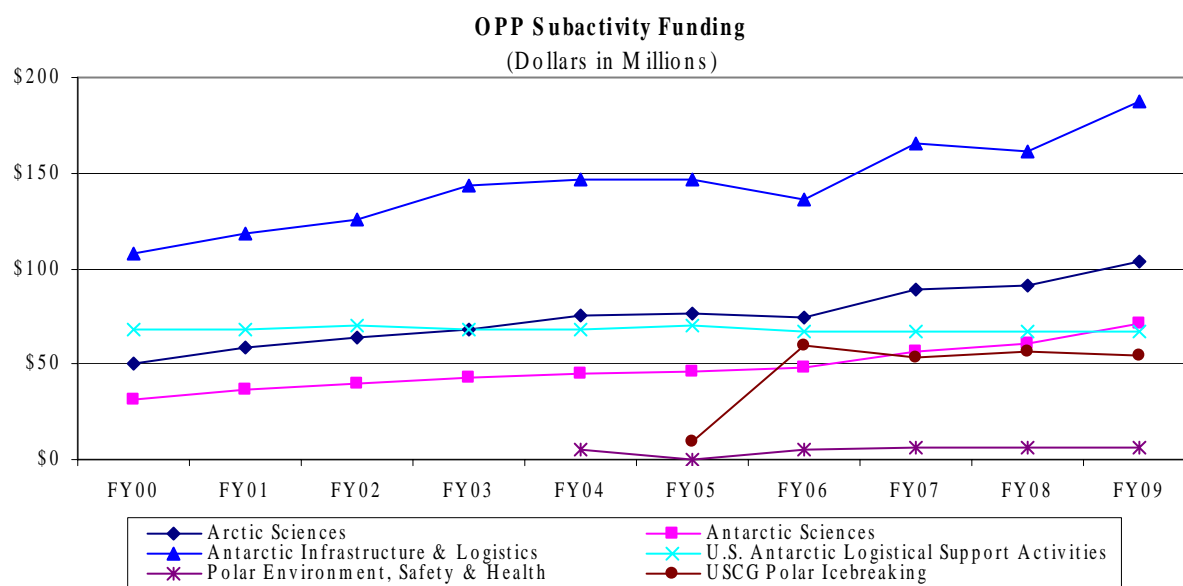
	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over	
				FY 2008 Estimate Amount	Percent
Arctic Sciences (ARC)	\$89.27	\$90.85	\$103.97	\$13.12	14.4%
Antarctic Sciences (ANT)	56.65	60.35	71.24	10.89	18.0%
Antarctic Infrastructure & Logistics (AIL)	233.76	228.36	255.02	26.66	11.7%
<i>U.S. Antarctic Logistical Support Activities</i>	67.52	67.52	67.52	-	-
Polar Environment, Safety & Health (PESH)	5.79	5.98	6.74	0.76	12.7%
USCG PolarIcebreaking ^{1/}	52.96	57.00	54.00	-3.00	-5.3%
Total, OPP	\$438.43	\$442.54	\$490.97	\$48.43	10.9%

Totals may not add due to rounding.

^{1/} Represents all funding to U.S. Coast Guard. In FY 2007, NSF chartered the icebreaker *Oden* as a back-up to the USCG's *Polar Sea*. The *Oden* will again be chartered for FY 2008 and FY 2009. Funds may become available from this line to contribute to defraying the costs of back-up icebreakers.

The Office of Polar Programs supports most of the research in polar regions funded by NSF. The Arctic and Antarctic are premier natural laboratories whose extreme environments and geographically unique settings enable research on phenomena and processes not feasible elsewhere. For example, the cold, dry environment and high altitude at the South Pole make it the world's best location for key astrophysics measurements. Polar research provides insights into earth systems – the atmosphere, oceans and solid earth – that cannot be gained elsewhere, and study of the polar ice sheets reveals how the Earth's climate has changed in the past and provides information essential to predicting future change. Polar regions also offer unusual opportunities for environmental research, as the sensitivity of polar ecosystems to small changes in climate renders them important bellwethers for abrupt or potential future change. An additional area of forefront research probes how organisms have adapted to the extreme polar environment using recently-developed techniques of molecular biology.

Since FY 2006, NSF has funded the operation and maintenance of the United States Coast Guard's (USCG) three polar icebreakers: *Polar Sea*, *Polar Star*, and *Healy*. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling. It sets forth the terms and conditions for reimbursement to the USCG from NSF. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements. NSF is responsible for ascertaining the needs of other federal agencies, and for securing USCG program plans to accommodate them, on a reimbursable funding basis. Effective with the FY 2009 budget, NSF will no longer provide funds to maintain the *Polar Star* in caretaker status because NSF does not envision current or future use of this vessel in support of its mission.



NOTE: US Antarctic Logistical Support Activities are shown separately from the Antarctic Infrastructure & Logistics Division, where it is administered.

RELEVANCE

Research in polar regions offers opportunities for fundamental advances in each of the disciplinary sciences, ranging from the behavior of the Earth’s inner core, the formation of galaxies, the biology of life in the cold and dark, and how Arctic residents and institutions are affected by environmental change. In addition, it addresses polar aspects of the global earth system – glacial and sea ice, terrestrial and marine ecosystems, the ocean, and the atmosphere – that help shape the global environment and climate. OPP continues to make these investments in climate change research and environmental observations a high priority. OPP funding will continue to support development and implementation of the enhanced observation systems needed to trace these shaping influences on a regional basis. It will also support research to elucidate the interactions among them and how they impact the polar environment. The work will include studies of the natural climate records from the past contained in ice cores and earth sediments. Much of this research will be carried out in collaboration with scientists in other countries, promoting international partnerships.

NSF provides interagency leadership for U.S. activities in both polar regions. In the Arctic, NSF leads research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee (IARPC) created for this purpose. In addition, per Presidential Decision Directive, NSF manages all U.S. activities in the Antarctic as a single, integrated program, making research possible in Antarctica by scientists supported by NSF and by U.S. mission agencies. The latter include the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Smithsonian Institution, and the Department of Energy. The U.S. Antarctic Program supports the U.S. governance role through the Antarctic Treaty.

International Polar Year:

In FY 2009, NSF will continue funding for research, education, and infrastructure projects initiated during International Polar Year (IPY) 2007-2009. The vision for IPY established by the National Academy of Sciences/Polar Research Board includes an "... intense, coordinated campaign of polar observations, research, and analysis that will be multidisciplinary in scope and international in participation.... that will benefit society by exploring new frontiers and increasing understanding of the key roles of the polar regions in globally linked systems."

As the lead agency supporting polar research, NSF is providing U.S. leadership in IPY through the work of its grantees. In coordination with other agencies, NSF is also providing the associated logistics and infrastructure support that is essential to conducting that research, and is developing partnerships with other nations that leverage NSF resources. In FY 2006, emphasis was placed on establishing an Arctic Observing System in support of the Study of Environmental ARctic CHange (SEARCH), on Polar Ice Sheet Dynamics and Stability, and on studies of Life in the Cold and Dark, particularly at the genomic level. Work in FY 2007 and FY 2008 builds on these themes and expands to new ones identified in research community planning activities. These include understanding and characterizing environmental change through studies of systems and drivers, impacts on subsystems, and interactions among components of Earth's systems.

While IPY will officially close in March 2009, OPP will continue to leverage these investments to further our knowledge and understanding of climate history and change, of the resulting human impacts, of ice sheet dynamics and history, and of life in the cold and dark. In FY 2009, funding will support IPY synthesis activities that will bring U.S. researchers, the international science community, and students from all disciplines together to address interdisciplinary challenges such as obtaining an integrated understanding of environmental change in the Arctic, and advancing understanding of the Antarctic system in a global context as well as advancing understanding of biotic systems during times of change.

IPY and its legacies involve people of all ages, from all walks of life, and from diverse backgrounds – from teachers to students and artists to scientists – engaging them in the scientific discoveries that will evolve from this international, collaborative research. Through education and outreach, the importance of science and engineering in understanding earth systems will be showcased. IPY provides an ideal opportunity to advance this goal by involving students in the international research venture and by enabling U.S. scientists to maintain a leadership role in a wide range of international activities.

Summary of Major Changes by Division ***(Dollars in Millions)***

FY 2008 Estimate, OPP.....**\$442.54**

Arctic Sciences **+\$13.12**

Funding increases for a broad range of activities to provide an integrated understanding of environmental change in the Arctic, including study of significant, system-scale environmental change and its human dimension. Other priorities include investments to improve access and capacity and to introduce alternative energy solutions – e.g., wind power generation and energy efficient construction materials – at Summit Station, Greenland, and other Arctic stations. The program will investigate the use of over-snow traverses to mitigate the rising cost of aviation support.

Antarctic Sciences +\$10.89

Support increases for synthesis activities to advance understanding of the Antarctic system in a global context as well as advancing understanding of biotic systems during time of change. Other priorities that have had to be deferred from FY 2008 include funds to enable Antarctic Sciences to explore, in collaboration with Swedish scientists, research questions related to oceanography in the Southern Ocean; funds to support development of instrumentation and equipment for making critical scientific observations with the potential to transform data collection, monitoring and modeling for marine, terrestrial, cryospheric, atmospheric, biotic, and system science; and operations and research funding for the IceCube Neutrino Observatory.

Antarctic Infrastructure and Logistics +\$26.66

Funding is provided to continue implementation of critical infrastructure projects necessary to diversify and improve the resupply capability to support McMurdo and South Pole Stations, and to ensure the continuity of pier-side cargo and personnel embarkation and debarkation at Palmer Station. Other priorities include improving the efficient use of utilities and capturing heat generated from station generators at McMurdo Station, Antarctica, and continuing replacement of inefficient legacy software systems with more supportable and secure systems designed for the more sophisticated computer operating systems in use today. Funding increases for costs associated with military aircraft and resupply and research vessel operations.

Polar Environment, Safety and Health +\$0.76

Funding will increase for safety and health program oversight, and measures to safeguard the health and safety of researchers and support personnel. Increased funding will continue recognized environmental leadership in the international community through development of stewardship material, training, and management plans.

U.S. Coast Guard Polar Icebreakers -\$3.00

Since FY 2006, NSF has been responsible for funding the USCG's three polar icebreakers. Beginning in FY 2009, NSF will no longer fund costs associated with maintaining the USCG's *Polar Star* in caretaker status since it serves no current or foreseeable future purpose with regard to NSF's needs.

Subtotal, Changes +\$48.43

FY 2009 Request, OPP.....\$490.97

Summary of Major Changes in Office-wide Investments *(Dollars in Millions)*

FY 2008 Estimate, OPP.....\$442.54

Discovery +\$16.65

In the Arctic, completed funding commitments (Shelf Basin Interactions – \$2.0 million; tundra manipulation project in Barrow – \$1.0 million) and reallocation of funding (\$16.60 million, from prior year ending awards) will allow OPP to build upon the success of IPY by expanding investigation into additional areas of critical importance. For example, in FY 2009: providing research and logistics support for ice and sediment coring projects (\$6.0 million); enhancing the Arctic Observing Network (AON) (\$12.0 million), an internationally-supported, sustainable network to provide critical observations of the Arctic environment and using cyberinfrastructure

tools to form a true network from the existing sites; documenting endangered languages (\$600,000); and studying humans in a changing ecosystem (\$1.0 million). These areas address R&D priorities related to “climate change” and “environment”.

In the Antarctic, reallocation of funding and shifts in priorities (ANDRILL – \$1.50 million; GPS Network – \$1.0 million; AGO – and \$1.50 million; Transantarctic Mountains Camp – \$3.0 million) will allow OPP to build upon the success of IPY by expanding investigation into additional areas of critical importance. For example, in FY 2009: initiating a new program in Antarctic Integrated and System Science (\$3.0 million); continuing the second phase of a sediment coring project (\$2.0 million); and emphasizing development of prototype gliders and related oceanographic instruments to develop a long-term record of environmental conditions in the Southern Ocean and associated atmosphere (\$2.0 million). These areas address R&D priorities related to “climate change” and “understanding complex biological systems”. The amounts shown below do not include offsets of \$890,000 for OPP’s investments under the Learning and Stewardship goals.

Climate Change Research (+\$7.02 million).

Accelerate climate change research and the associated observing and modeling systems, with increased emphasis on human impacts. These projects foster advancement, collaboration and innovation on the complex scientific inquiry into climate change, involving and strengthening international partnerships to accelerate the progress of science worldwide.

IPY Synthesis (+\$1.97 million).

While analysis of data sets associated with IPY projects will be ongoing beyond FY 2009, a key goal of IPY is to create a lasting legacy of data, knowledge, and new scientists. In FY 2009, funds will support IPY synthesis activities that will bring U.S. researchers, the international science community, and students together to provide an integrated understanding of environmental change in the Arctic, and to advance understanding of the Antarctic system in a global context as well as advancing understanding of biotic systems during time of change. The IPY synthesis activity supports the ACI goal of enabling scientific advancement through modeling and simulation across a broad range of scientific disciplines.

IceCube Neutrino Observatory research (+\$2.79 million).

Construction is sufficiently advanced that initial research activities are underway; hence, operations funding is ramping up toward the steady state. In FY 2007 and FY 2008, funds were provided from core programs to begin science operations and research exploitation in anticipation of reaching full steady state operations in FY 2009. A targeted investment in this area is critical to allow IceCube to be successful in achieving its research goals while maintaining reasonable opportunities in core research programs.

Oden Science (+\$350,000).

Funds will enable Antarctic Sciences to explore, in collaboration with Swedish scientists, research questions related to oceanography in the Southern Ocean. These include, for instance, processes related to sea ice formation and formation of Antarctic bottom water, as well as processes related to primary productivity and carbon sequestration. These activities exploit the capabilities of the research platform *Oden*. The *Oden* is capable of working in ice-covered waters not accessible to NSF’s other research platforms (the *Nathaniel B. Palmer* and the *Laurence M. Gould*). The new Implementing Arrangement with Sweden that brings *Oden* to the Southern Ocean opens up new opportunities for research ranging from physical oceanography to

the study of ice-covered ecosystems. Funds to charter *Oden* are provided through the Division of Antarctic Infrastructure and Logistics.

Remote Sensing Instrumentation (+\$5.41 million).

Emerging and important research subjects in Antarctica cannot be readily investigated in the traditional “boots on the ground” manner owing to questions of accessibility. In order to advance scientific discovery, investments in instrumentation for remote sensing will be essential. In FY 2009, funds will support development of instrumentation (sensors, communications, etc.) and equipment for making critical scientific observations, either as remote installations, as sensors mounted on vehicles or aircraft, or as instruments critical for the scientific analysis of these observations. These investments have the potential to transform data collection, monitoring and modeling for marine, terrestrial, cryospheric, atmospheric, biotic, and system science. System science, an interdisciplinary approach with the potential to further understanding of Antarctic climate change, emerged from the FY 2007 IPY solicitation as a forefront research frontier that merits significantly increased funding. The portfolio would make extensive use of cyberinfrastructure, allowing a larger research community to participate in the research and enabling opportunities to increase the outreach activities of polar scientists.

Learning

+\$0.39

Integrative Graduate Education and Research Traineeships (IGERT) increase, providing partial support for an additional IGERT award.

Research Infrastructure

+\$30.12

Through funds made available from projects expected to be completed in FY 2008 (Microwave Landing System – \$1.0 million; Fuel Tanks and Refueling Station – \$2.50 million; and McMurdo Power Plant – \$1.50 million), OPP will continue to enhance the critical infrastructure required to conduct research in Antarctica. For example, in FY 2009: install the shield for the South Pole 10M Telescope (\$2.0 million); and fund increases in the cost of fuel (\$3.0 million). The amounts shown below do not include offsets of \$770,000 for OPP’s investments under the Learning and Stewardship goals.

IceCube Neutrino Observatory operations (+\$650,000).

Construction is sufficiently advanced that initial research activities are underway; hence, operations funding is ramping up toward the steady state. In FY 2007 and FY 2008, funds were provided from core programs to begin science operations and research exploitation in anticipation of reaching full steady state operations in FY 2009. A targeted investment in this area is critical to allow IceCube to be successful in achieving its research goals while maintaining reasonable opportunities in core research programs.

U.S. Antarctic Program Resupply (+\$22.66 million).

Significant funding above the FY 2008 appropriation is essential to diversify and improve the resupply capability to support McMurdo Station, and to ensure the continuity of pier-side cargo and personnel embarkation and debarkation at Palmer Station. The present pier is nearing the end of its useful life, and without these investments it could represent a safety hazard. FY 2009 investments include initiation of contracts to replace the Palmer Station Pier (+\$8.0 million), continuing construction of additional fuel storage capacity at McMurdo Station (+\$4.0 million), initial procurement of a second heavy traverse for resupply of South

Pole Station (\$2.0 million), and consolidation of the McMurdo area runways into a single operational site at the Pegasus Airfield (+\$2.5 million). Additional funding for increases in costs, principally fuel, associated with military aircraft and re-supply and research vessel operations (\$5.39 million) is provided.

Energy Efficiency and Fuel Conservation (+\$8.82 million).

Investments to improve year-round access, capacity, effectiveness and energy efficiency at NSF-supported field stations in the Arctic (\$5.82). At McMurdo Station, Antarctica, investments (\$3.0 million) will be made to improve the efficient use of utilities and to capture heat generated from station generators. Major investments include: extension of the waste-heat loop; replacement of heat-trace piping; installation of energy monitoring equipment and instrumentation; and upgrades to the power, water, and utility distribution systems.

USAP IT Network (+\$1.0 million).

Funding will continue replacement of legacy software systems. These systems are used to manage the requisitioning of supplies and the tracking of cargo, as well as for managing personnel movements. Designed decades ago and inefficient, OPP can benefit from systems since developed by companies such as FedEx and DHL, and from systems designed for the more sophisticated computer operating systems in use today. Early estimates indicate that the total cost of this project could reach \$12 million over a five-year period.

Environment, Safety & Health (+\$760,000 million).

Funding will increase for safety and health program oversight, and measures to safeguard the health and safety of researchers and support personnel. Increased funding will be used for additional health and safety measures to support IPY “winter science”, acquiring state-of-the-art oxygen regulators for the scientific diving program, electronic information technology and protection of confidential health information, as well as enhancements to the environmental stewardship program to continue recognized environmental leadership in the international community.

U.S. Coast Guard Polar Icebreakers (-\$3.0 million).

Since FY 2006, NSF has been responsible for funding the USCG’s three polar icebreakers. Beginning in FY 2009, NSF will no longer provide funds for maintaining the USCG’s *Polar Star* in caretaker status.

Stewardship +\$1.27

A number of activities are funded directly from NSF’s programs to advance NSF’s Stewardship goal. These include Intergovernmental Personnel Act appointments, NSF-wide studies and evaluations, and mission-related information technology investments. As is discussed further in the Stewardship chapter of this Request, in FY 2009 NSF has realigned IT investments to tie mission-related activities more directly to NSF’s programs.

Subtotal, Changes +\$48.43

FY 2009 Request, OPP.....\$490.97

NSF-WIDE INVESTMENTS

In FY 2009, OPP will support research and education efforts related to broad, Foundation-wide investments in a number of areas including the Administration's interagency R&D priorities.

OPP NSF-wide Investments (Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate	
				Amount	Percent
Climate Change Science Program	10.50	\$10.50	\$18.30	\$7.80	74.3%
Cyberinfrastructure	43.70	26.24	26.24	-	-
Human and Social Dynamics	0.20	0.20	-	-0.20	-100.0%
International Polar Year	48.48	47.27	1.69	-45.58	-96.4%
Mathematical Sciences	0.10	-	-	-	N/A

Human and Social Dynamics and Mathematical Sciences: With the conclusion of these priority areas in FY 2007 or FY 2008, key components of these investments will be retained through core programs.

Climate Change Science Program (CCSP): CCSP provides the Nation and world with the science-based knowledge to predict change, manage risk, and take advantage of opportunities resulting from climate change and climate variability. OPP focuses on climate change in the polar regions, as well as interactions with the global climate. In FY 2009, investments increase for IPY activities associated with CCSP.

Cyberinfrastructure (CI): CI support will be provided for the Arctic System Science (ARCSS) Data Coordination Center that serves as a central point for deposition of data deriving from ARCSS-funded research. Support is also provided for Arctic modeling, distributed field sites, and autonomous flux towers. In the Antarctic, funds support data center/data repositories, 3-D bathymetric data fusion, and environmental monitoring, both marine and terrestrial. In addition, support is provided for the engineering, operations and maintenance, and security of information technology systems.

International Polar Year (IPY): With the conclusion of this event in March 2009, continued funding for International Polar Year activities will, as described throughout this chapter, be provided from core programs. In FY 2009, OPP will support IPY synthesis activities.

QUALITY

OPP maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The share of research funds that were allocated to projects that undergo external merit review was approximately 86 percent in FY 2007, the last year for which complete data exist. OMB's definition of competitive, merit-based review does not include contracts, therefore the U.S. Antarctic Program support contract, although a competitively bid contract that undergoes a high degree of review, both internal and external, is not considered competitive, merit-based review for this calculation. If included, it would raise the percentage significantly.

To ensure the highest quality in processing and recommending proposals for awards, OPP convenes Committees of Visitors (COV), 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 Antarctic programs providing infrastructure, logistics, and environment, health and safety support will be reviewed in FY 2008. The science programs were reviewed in FY 2006, and the overall determination was that they are operating well. They will be reviewed again in FY 2009.

OPP also receives advice from its Advisory Committee (AC) on issues such as: the mission, programs, and goals that can best serve the scientific community; how OPP can promote quality graduate and undergraduate education in the sciences it supports; and priority investment areas in polar research. The AC meets twice a year. Members represent a cross-section of polar research, with representatives from different disciplines, and include a balanced representation of gender, members of underrepresented groups, and geographic regions.

PERFORMANCE

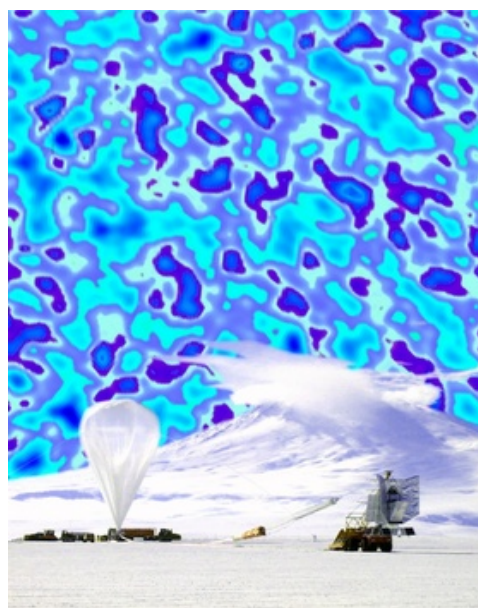
The FY 2009 Budget Request is aligned to reflect funding levels associated with the four strategic outcome goals stated in the Foundation's FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education, and facilitate budget and performance integration.

Office of Polar Programs by Strategic Outcome Goal (Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over	
				FY 2008 Amount	Estimate Percent
Discovery	\$107.77	\$104.04	\$120.69	16.65	16.0%
Learning	3.88	5.19	5.58	0.39	7.5%
Research Infrastructure	324.24	331.02	361.14	30.12	9.1%
Stewardship	2.53	2.29	3.56	1.27	55.5%
Total, OPP	\$438.43	\$442.54	\$490.97	\$48.43	10.9%

Recent Research Highlights

► **Balzan Prize Awarded for BOOMERANG:** Andrew Lange of the California Institute of Technology shared the 2006 Balzan Prize for Astronomy and Astrophysics – worth 1 million Swiss francs--with an Italian colleague. The pair received the honor for their pioneering work in using a balloon-based observatory to study the Cosmic Microwave Background radiation, which is essentially the afterglow of the "Big Bang," the primordial expansion that marks the beginning of the universe. The atmospheric circulation over Antarctica allows balloons that are released near McMurdo Station, NSF's logistics hub in Antarctica, to circle the continent and return to be retrieved almost at the point of launch. Lange's experiment, BOOMERANG (Balloon Observations Of Millimetric Extragalactic Radiation and Geomagnetics), took advantage of these unique conditions to obtain important clues to the processes that were active at the beginnings of the universe. (ANT)



The sky above Mt Erebus, Antarctica, as it would appear if one had eyes sensitive to the microwave energy measured by the Boomerang telescope. Long Duration Balloon Launch underway in foreground. *Credit: BOOMERanG Team.*

► **Inuit and Scientific Studies of the Narwhal: Connecting Parallel Perceptions:** A team of researchers led by an NSF-funded scientist from the Harvard School of Dental Medicine has discovered that the spiral tusk of the narwhal – a creature that has long been reputed to have magical properties – actually does have some extraordinary abilities that rival the myths and lore. The tusk acts as a sensor, allowing the animal to sample water temperature, pressure, the presence of particles, and motion. The tusk was previously believed by scientists solely to be a weapon for aggressive males seeking to establish social hierarchy. The new findings open a myriad of possibilities for future study and more than 60 scientists have joined in the research into the tusk's properties. The study also is novel in that the principal researcher incorporates traditional knowledge from indigenous people into their research about narwhal behavior. (ARC)



Narwhal come up for air in an ice lead during spring. *Credit: (c) Glenn Williams.*

► **Understanding the Arctic Freshwater Cycle:** A new analysis of 50 years of changes in freshwater flows into the Arctic Ocean and North Atlantic may help shed light on what is causing a recently observed freshening of the North Atlantic. NSF-funded research resulted in a big-picture view of Arctic hydrologic trends, the first effort of its kind. The analysis revealed that freshwater increases from Arctic Ocean sources appear to be strongly linked to changes in the North Atlantic. The researchers noted a relationship between increases in freshwater inputs, rising air temperatures, and a climate phenomenon known as the North Atlantic Oscillation and the associated Northern Annular Mode index. While they said the complex interaction of these phenomena will determine whether the oceans continue to freshen, they also cautioned it is difficult to predict future trends. (ARC)

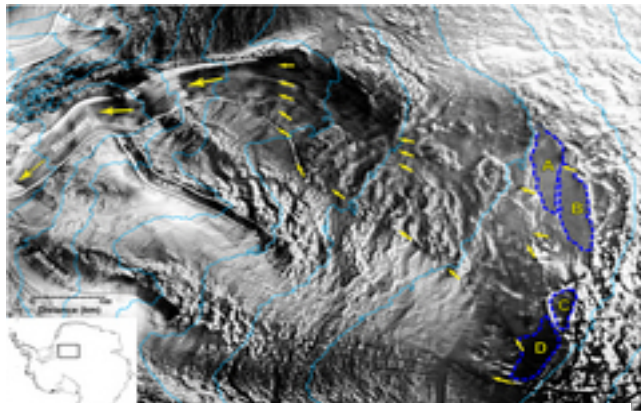
► **Geological Drilling in the Antarctic for Climate History:**

The Antarctic Geological Drilling (ANDRILL) program, an international paleoclimate project, has drilled to a record depth of 1284.87 meters (4,200 feet). Researchers recovered sediment cores from beneath the Ross Ice Shelf and underlying waters that represent a nearly unbroken geological history reaching back 5 million years. The cores revealed that the ice shelf and adjoining ice sheet advanced and retreated more than 50 times during that time. A team of 58 scientists, technicians, educators, and support staff from the U.S., New Zealand, Italy, and Germany spent three months at McMurdo Station studying the core and documenting how Antarctic ice sheets behaved during periods when the globe was much warmer. Additional study of the core will hopefully provide a picture of how the ice sheets might react to increasing global temperatures. (ANT)



Photo of ANDRILL drill system on McMurdo Ice Shelf during the austral summer of 2006/2007. Credit: Peter Rejcek.

► **Discovery of a Possible Link Between Subglacial Lakes and Ice Streams:** An NSF-funded research team at Columbia University's Lamont-Doherty Earth Observatory has discovered a possible link



Combined RADARSAT (RAMP) imagery and ICESat elevation data showing the Recovery Ice Stream (arrows) and location of four new subglacial lakes (A, B, C and D) that lie at the head of the stream. Credit: Christopher Shuman and Vijay Suchdeo, NASA.

between the lakes that are known to exist beneath the miles-thick Antarctic ice sheets and the sources of ice streams that drain the East Antarctic ice sheet. The research team believes that the lakes provide a source of water that lubricates the bed of the glaciers and, in turn, speeds up the flow of ice. Working with NASA scientists, the researchers also found four new subglacial lakes that coincide with the origin of tributaries of Recovery Glacier ice stream. This work follows from their previous pioneering research on Lake Vostok, a subglacial lake the size of Lake Ontario, by providing a better understanding of subglacial lakes and how they work. (ANT)

► **Stellar Axis: Antarctica:** An NSF Antarctic Artist and Writers Grant recipient has conceived of Stellar Axis: Antarctica, an art expedition to Antarctica that entails a tracing of the stars above the North and South Pole onto the ice at both poles. The grantee, along with an international team of scientists and journalists, positioned ninety-nine blue spheres in alignment to the stars over the South Pole onto the Ross Ice Shelf. A performance indicating the motion of the stars at the poles was filmed to share with audiences upon their return. An arts educator, grantee Lita Albuquerque's work impacts her students and the public through lectures and exhibits. "By doing a star alignment on the ice at both poles, it engages



Blue spheres secured into the Ross Ice Shelf represent the stars above in Stellar Axis. In the distance, the artist and a team member survey their work. Credit: Jean de Pomereu.

the whole planet," says Albuquerque. "I'm interested in creating a mental image of the patterns aligning. It's like taking a snapshot of a moment in time when the stars are aligned to the pattern on the ground, so that the "picture" is an accurate picture of a vast circulatory system of stars of which we are a part." (ANT)

► **Discovery of a baby plesiosaur in**

Antarctica: A new fossil of a baby plesiosaur, the sea reptile considered the prototype of the mythical Loch Ness Monster, has been discovered in Antarctica. The skeleton had a long neck and a hydro-dynamically shaped body propelled by four paddles and dates to the end of the Age of Dinosaurs, about 70 million years ago. It's one of only a handful known worldwide and is so well preserved that stomach ribs and stomach stones are in life position. Stomach stones are thought to have been utilized for aid in digestion and/or for diving. The specimen indicates these stones were ingested while the creatures were very young, a question scientists have pondered for years. The hardening of the bones was not yet completed when the baby died, and premature death may have come through volcanism. Large chunks of pumice and volcanic ash were found with debris of a tree entombed with the plesiosaur, suggesting a blow-down of vegetation may have occurred similar to that documented during the eruption of Mt. St. Helens. (ANT)



A researcher carefully excavates a fossilized juvenile plesiosaur on Vega Island, Antarctica. *Credit: James E. Martin, South Dakota School of Mines and Technology.*

Other Performance Indicators

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

Number of People Involved in OPP Activities

	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Senior Researchers	1,140	1,170	1,190
Other Professionals	739	760	770
Postdoctorates	142	145	150
Graduate Students	427	440	450
Undergraduate Students	265	270	280
Total Number of People	2,713	2,785	2,840

OPP Funding Profile

	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Statistics for Competitive Awards:			
Number	372	396	402
Funding Rate	31%	32%	32%
Statistics for Research Grants:			
Number of Research Grants	325	341	350
Funding Rate	28%	29%	29%
Median Annualized Award Size	\$167,025	\$173,825	\$178,025
Average Annualized Award Size	\$238,398	\$245,198	\$249,398
Average Award Duration, in years	2.7	3.0	3.0

NOTE: FY 2008 estimates are based on the expected impact of IPY on OPP's funding profile.

Arctic Sciences

\$103,970,000

The FY 2009 Budget Request for Arctic Sciences (ARC) is \$104.12 million, an increase of \$13.12 million, or 14.4 percent, over the FY 2008 Estimate of \$90.85 million.

Arctic Sciences Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate	
				Amount	Percent
Arctic Sciences	\$89.27	\$90.85	\$103.97	\$13.12	14.4%
Major Components:					
Research & Education Projects	52.85	52.67	59.97	7.30	13.9%
Facilities					
Research Support & Logistics	36.42	38.18	44.00	5.82	15.2%

Totals may not add due to rounding.

About Arctic Sciences:

In the 1990's, global atmospheric models began to converge in their predictions that the Arctic would be at the forefront of global climate change. It now appears that those models were reasonably accurate in that regard. Observations have revealed an estimated 14 percent per decade reduction in summer sea ice extent in the Arctic, and significant summer melting of the Greenland Ice Sheet. These and many other phenomena are forcing change and uncertainty in traditional Arctic populations, present challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level.

Arctic Sciences is organized into several programs that support social science, earth system science and a broad range of natural science. Educational projects are also supported. The Research Support and Logistics program assists researchers with access to the Arctic, improves safety and environmental stewardship, and increases the ability of researchers to share plans and results with local Arctic communities.

The goal of ARC is to gain a better understanding of the Earth's physical, biological, geological, chemical, social, and cultural processes, and the interactions of ocean, land, atmosphere, biological, and human systems in the Arctic. ARC and other NSF programs support projects that contribute to the development of the next-generation of researchers and scientific literacy for all ages through education, outreach, and broadening participation in science, technology, engineering and mathematics. Program representatives from OPP and other NSF programs that support arctic research coordinate across NSF, including joint review and funding of arctic proposals and mutual support of special projects with high logistical costs.

In general, 59 percent of the ARC portfolio is available for new research grants. The remaining 41 percent funds continuing grants made in previous years, and research support and logistics.

Arctic Sciences Priorities for FY 2009:

- **Understanding Environmental Change in the Arctic** — Increase the use of modeling and synthesis to determine the nature and extent of current Arctic-system scale changes and the role of these changes as part of the global system.
- **Arctic Observing Network** — Continue to enhance an internationally supported, sustainable network to provide critical observations of the Arctic environment and use cyberinfrastructure tools to form a true network from the existing group of sites.
- **Bering Sea Ecosystem Study** — The eastern Bering Sea supports highly productive marine ecosystems that annually generate roughly 50 percent of all fish and shellfish landings in the United States. Models and observations suggest that the ecosystem will experience change. The Bering Sea Ecosystem Study is designed to develop an understanding of the effects of a varying sea-ice cover on the shelf ecosystem, project the potential changes in response to anticipated climate variations on decadal time scales, and assess the vulnerability and sustainability of local communities to such changes.
- **Human Systems in Polar Regions** — Humans have been an integral part of the arctic polar environment for the last 10,000 or more years. Indigenous peoples as well as recent migrants into the region have influenced and been influenced by the natural environment. IPY will encourage studies that advance the understanding of our species' place in the complex system of polar phenomena.
- **Improve Research Infrastructure** — Improve year-round access, capacity, and effectiveness of research sites in Alaska and throughout the Arctic.

Changes from FY 2008:

- In the Arctic, completed funding commitments (Shelf Basin Interactions – \$2.0 million; tundra manipulation project in Barrow – \$1.0 million) and reallocation of funding (\$16.60 million, from prior year ending awards) will allow OPP to build upon the success of IPY by expanding investigation into additional areas of critical importance. For example, in FY 2009: providing research and logistics support for ice and sediment coring projects (\$6.0 million); enhancing the Arctic Observing Network (AON) (\$12.0 million), an internationally-supported, sustainable network to provide critical observations of the Arctic environment and using cyberinfrastructure tools to form a true network from the existing sites; documenting endangered languages (\$600,000); and studying humans in a changing ecosystem (\$1.0 million).
- An increase of \$7.02 million to accelerate climate change research using both modeling and observational systems including the human aspects of the change.
- An increase of \$280,000 to support additional integration of education with research during IPY.
- An increase of \$5.82 million to improve year-round access, capacity, effectiveness, and energy efficiency at NSF-supported field stations in the Arctic.

Antarctic Sciences

\$71,240,000

The FY 2009 Budget Request for Antarctic Sciences (ANT) is \$71.24 million, an increase of \$10.89 million, or 18 percent, over the FY 2008 Estimate of \$60.35 million.

Antarctic Sciences Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over	
				FY 2008 Estimate Amount	Percent
Antarctic Sciences	\$56.65	\$60.35	\$71.24	\$10.89	18.0%
Major Components:					
Research & Education Projects	52.20	55.90	67.24	11.34	20.3%
Centers Programs					
STC: Center for Remote Sensing of Ice Sheets	4.45	4.45	4.00	-0.45	-10.1%

Totals may not add due to rounding.

About Antarctic Sciences:

The Antarctic continent and the Southern Ocean constitute about 7 percent of the surface of Earth and are important components of the Earth system. The continent contains records of geological processes that reveal the role of the Antarctic in the long-term evolution of the planet including records of the evolution of life on Earth. The region hosts organisms and ecosystems that have evolved and adapted to survive and thrive in extreme cold and long periods of darkness. The ice sheets hold detailed records of past climatic conditions, including direct samples of the atmosphere, that reach back 800,000 years, and perhaps more. The annual formation and breakup of sea ice around the continent is a major phenomenon that drives ocean circulation and has a major impact on Earth's heat budget. The ice sheets, surrounding ocean, and atmosphere are also key systems that must be understood in order to advance our understanding of sea level change and its role in climate change. In addition to these aspects of understanding the Antarctic and its role in Earth processes, the high plateau of East Antarctica, and South Pole Station in particular, are unrivaled with respect to the conditions they offer for a wide array of astronomy and astrophysical research.

The goal of Antarctic Sciences is to enable research in all areas of science that can only be done, or is best done, in Antarctica. This is done through funding disciplinary and cross-disciplinary programs that encompass the geosciences, biosciences, and physical sciences. ANT enables research on Earth's physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica as well as on interactions between the ice sheets, the underlying continent, the surrounding ocean, and the overlying atmosphere toward a comprehensive understanding of Antarctica's role in the evolution of Earth and life on Earth, as well as the Antarctic environment's role in the whole Earth system. In particular, a new programmatic emphasis fosters linkages across the disciplines in order to better advance understanding of Antarctic climate as a system. ANT also enables research in astronomy and astrophysics to advance understanding about high energy phenomena such as supernovae and events associated with black holes, about the nature of dark energy and dark matter which is now known to be a major component of the universe, as well as advance general understanding about the origin and evolution of the universe.

In general, 40 percent of the ANT portfolio is available for new research grants. The remaining 60 percent is used primarily to fund continuing grants made in previous years.

Antarctic Sciences Priorities for FY 2009:

- **International Polar Year (IPY)** — Building on partnerships developed during the early stages of IPY, Antarctic Sciences has the following priorities:
 - **East Antarctic Ice Sheet and lithosphere system** — The goal is to achieve a basic understanding of both the ice sheet and underlying lithosphere in central East Antarctica, as well as an understanding of the major processes and interactions that control ice sheet change.
 - **Life in the polar night** — The goal is to advance understanding of seasonal environmental change during the transitions between relative warmth and abundant light of summer and the extreme cold and dark of winter, and to advance knowledge about how organisms and ecosystems have adapted and evolved to survive and thrive.
 - **Paleoclimate records from central West Antarctica** — The goal is to exploit the deep ice core recovered from the WAIS (West Antarctic Ice Sheet)-Divide site for climate records that can be compared to the Greenland Ice Core record to advance understanding of polar climate change, particularly the processes and timing of abrupt climate change.
- **Astronomy and Astrophysics** — Increase the research exploitation phase for two major new discovery instruments – the IceCube Neutrino Observatory and the 10m South Pole Telescope. These two projects are expected to enable discovery of new phenomena and to achieve understanding about the origin and evolution of the universe.

Changes from FY 2008:

- In the Antarctic, reallocation of funding and shifts in priorities (ANDRILL – \$1.50 million; GPS Network – \$1.0 million; AGO – and \$1.50 million; Transantarctic Mountains Camp – \$3.0 million) will allow OPP to build upon the success of IPY by expanding investigation into additional areas of critical importance. For example, in FY 2009: initiating a new program in Antarctic Integrated and System Science (\$3.0 million); continuing the second phase of a sediment coring project (\$2.0 million); and emphasizing development of prototype gliders and related oceanographic instruments to develop a long-term record of environmental conditions in the Southern Ocean and associated atmosphere (\$2.0 million).
- **Remote Sensing Instrumentation** – an increase of \$5.41 million to support development of instrumentation and equipment required for critical observations in all areas of Antarctic science.
- **IceCube Neutrino Observatory** – an increase of \$3.44 million to enable early science operations (\$650,000) for the part of the detector array that has been completed (25 of 70 detector strings) and research (\$2.79 million) to exploit data returned from the growing array. This represents ANT's contribution to joint funding for IceCube science operations and research with the Division of Physics within the Directorate for Mathematical and Physical Sciences.
- **International Polar Year** – an increase of \$1.69 million to support IPY synthesis activities that will bring U.S. researchers, the international science community, and students together to advance understanding of the Antarctic system in a global context as well as advancing understanding of biotic systems during time of change.
- **Oden Science** – an increase of \$350,000 will enable Antarctic Sciences to explore, in collaboration with Swedish scientists, research questions related to oceanography in the Southern Ocean.

Antarctic Infrastructure & Logistics

\$255,020,000

The FY 2009 Budget Request for Antarctic Infrastructure & Logistics (AIL) is \$255.02 million, an increase of \$26.66 million, or 11.7 percent, over the FY 2008 Estimate of \$228.36 million.

Antarctic Infrastructure & Logistics Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate	
				Amount	Percent
Antarctic Infrastructure & Logistics	\$233.76	\$228.36	\$255.02	\$26.66	11.7%
Major Components:					
Facilities					
Operations & Science Support	166.24	160.84	187.50	26.66	16.6%
U.S. Antarctic Logistical Support Activities	67.52	67.52	67.52	-	-

Totals may not add due to rounding.

About Antarctic Infrastructure & Logistics:

Operations & Science Support

Antarctic Infrastructure & Logistics supports research through a network of stations, labs, equipment, and logistics that enable research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole (90° south latitude); two year-round coastal research stations (McMurdo at 78°S and Palmer at 64°S) with extensive laboratory, transportation, housing, communication, and computing capabilities; summer camps (as required for research); icebreaking research ships—the *Laurence M. Gould* and the *Nathaniel B. Palmer*; a fleet of ski-equipped LC-130 airplanes operated and maintained by the Air National Guard; U.S. Air Force inter-continental transport; small fixed winged aircraft and helicopters; and icebreakers for channel breaking and ship escort at McMurdo Station.

AIL uses a mix of government and civilian contract service providers to conduct oversight and research support activities in Antarctica. The largest of these contracts is an operations and maintenance contract with Raytheon Polar Services Company of Centennial, Colorado.

Back-up Icebreakers. Since 2004, AIL has contracted with civilian operators to provide back-up icebreaking support to the U.S. Coast Guard due to heavy ice conditions in the McMurdo Sound region and maintenance issues with the USCG polar icebreakers. During FY 2005 and 2006, AIL contracted with FESCO, a Russian company, for the icebreaker *Krasin*. During FY 2007, AIL was able to contract for the services of the Swedish research icebreaker *Oden*. Ice conditions in the McMurdo Sound region appear to be returning to “normal”. The USCG, however, continues to recommend that back-up icebreakers be available. This recommendation, together with continuing concerns over the reliability of the USCG polar class icebreakers, makes it prudent to plan to continue to secure back-up icebreaking services in FY 2008 and FY 2009. This cost (approximately \$9.0 million) is in addition to the cost of “United States Coast Guard Polar Icebreaking” discussed later.

Transportation and Fuel Cost Increases. Since 2005, AIL has experienced steady increases in the cost of both aviation and vessel operations due to a variety of factors. Aircraft flight hour cost increases for both the Air National Guard and U.S. Air Force, combined with personnel cost increases have

significantly increased the cost of services. Charter costs for vessel operations, both through Military Sealift Command and for the icebreaking research ships, have also continued to rise steadily. The USAP is also impacted by market conditions associated with the price of fuel, which is the major contributor to the increase in operations costs.

U.S. Antarctic Logistical Support Activities

The U.S. Antarctic Logistical Support Activities budget line funds support provided by the U.S. Department of Defense (DoD). DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and electronic equipment maintenance; the charter of Air Mobility Command Airlift and Military Sealift Command ships for the re-supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

Antarctic Infrastructure & Logistics Priorities for FY 2009:

- A major focus for AIL in FY 2009 is support of legacy IPY activities, including continuing extensive field efforts in West Antarctica for studies of Ice Sheet Dynamics.
- The ability to resupply McMurdo and South Pole stations will be diversified and strengthened as the fuel storage capacity at McMurdo station is increased and the surface traverse to South Pole becomes operational.
- Two additional capital infrastructure projects include increasing the high bandwidth communication capability at the South Pole to support the 10m South Pole Telescope and IceCube, and the initiation of contracts for construction to replace the pier at Palmer Station which is critical to allow resupply ships to dock at the station.
- Due to the strong effect of market forces on the cost of fuel, major emphasis will be put towards improving fuel and energy efficiency at Antarctic stations.

Changes from FY 2008:

- Through funds made available from projects expected to be completed in FY 2008 (\$5.0 million), OPP will continue to enhance the critical infrastructure required to conduct research in Antarctica. For example, install the shield for the South Pole 10M Telescope; and fund increases in the cost of fuel.
- An increase of \$4.0 million to restore funding for the procurement and construction of additional fuel tanks at McMurdo Station.
- An increase of \$8.0 million to construct the Palmer Station Pier.
- An increase of \$2.0 million to restore funding for the South Pole heavy traverse swing.
- An increase of \$2.50 million to consolidate the McMurdo area runways into a single operational site at the Pegasus Airfield.
- An increase of \$3.0 million to improve the efficient use of utilities and to capture heat generated from McMurdo Station generators.
- An increase of \$1.0 million to continue replacement of legacy software systems to improve supportability and security.
- Additional funding for increases in costs associated with military aircraft and re-supply and research vessel operations (\$6.16 million).

Polar Environment, Safety & Health

\$6,740,000

The FY 2009 Budget Request for the Polar Environment, Safety & Health (PESH) is \$6.74 million, an increase of \$760,000, or 12.7 percent, over the FY 2008 Estimate of \$5.98 million.

About Polar Environment, Safety & Health:

Polar Environment, Safety & Health Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate	
				Amount	Percent
Polar Environment, Safety & Health	\$5.79	\$5.98	\$6.74	\$0.76	12.7%

Established in December 2005, the Polar Environment, Safety & Health Office within OPP manages and oversees the environmental, safety, and health aspects of research and operations conducted in polar regions. PESH has overall responsibility for guiding the implementation of both environmental protection and stewardship to minimize the environmental impact of OPP-supported activities in polar regions. PESH also develops and oversees programs to ensure the safety and health of all participants. PESH ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements.

Polar Environment, Safety & Health Priorities for FY 2009:

- **Environment** – develop environmental stewardship material, training, and management plans.
- **Safety & Health** – review, update, and complete a USAP Safety Manual; revise the USAP Medical Screening Guidelines to reflect advances in medicine and on-ice diagnostic and treatment capabilities; and identify and address health and safety risk factors responsible for illnesses and injuries in the polar regions.

Changes from FY 2008:

Increased funding will be used for additional health and safety measures to support IPY “winter science”, acquiring state-of-the-art oxygen regulators for the scientific diving program, electronic information technology and protection of confidential health information, as well as enhancements to the environmental stewardship program.

United States Coast Guard Polar Icebreaking

\$54,000,000

The FY 2009 Budget Request for United States Coast Guard (USCG) Polar Icebreaking is \$54.0 million, a decrease of \$3.0 million, or 5.3 percent, from the FY 2008 Estimate of \$57.0 million.

USCG Polar Icebreaking Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over	
				FY 2008 Estimate Amount	Percent
USCG Polar Icebreaking	\$52.96	\$57.00	\$54.00	-\$3.00	-5.3%

About U.S. Coast Guard Polar Icebreaking:

Since FY 2006, NSF has funded the operation and maintenance of the USCG’s three polar icebreakers: *Polar Sea*, *Polar Star*, and *Healy*. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling. It sets forth the terms and conditions for reimbursement to the USCG from NSF. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements. NSF is responsible for ascertaining the needs of other federal agencies and for securing USCG program plans for accommodating them, on a reimbursable funding basis. Effective with the FY 2009 budget, NSF will no longer provide funds to maintain the *Polar Star* in caretaker status because NSF does not envision current or future use of this vessel in support of its mission.

NSF convened an external expert review of the USCG’s requests for maintenance funding for the *Polar Sea* and the *Healy*. The review may validate a requirement to perform more or less maintenance on the ships pending a national policy determination.

This USCG icebreaking cost is in addition to the cost of back-up icebreakers discussed in “Antarctic Infrastructure & Logistics.”

