

## Atmospheric Sciences and Climate Change Programs in the FY 2007 Budget

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### HIGHLIGHTS

- Budget requests for major agencies that fund atmospheric sciences and climate change are mixed. As part of the American Competitiveness Initiative (ACI), the National Science Foundation's (NSF) request would increase 7.9 percent to \$6.0 billion. The National Oceanic and Atmospheric Administration's (NOAA) total budget would decrease by 5.8 percent below FY 2006, but with increases in an expanded tsunami warning network, climate research, extreme weather warnings and forecasts, and weather satellites. The National Aeronautics and Space Administration's (NASA) overall budget would increase by 3.2 percent (excluding the one-time Hurricane Katrina supplement of \$350 million in FY 2006) with Exploration Systems rising by 30.0 percent and the Science mission by 1.5 percent. The Department of Energy's (DOE) overall budget would remain essentially level while the Biological and Environmental Research (BER) core portfolio would increase by 13.1 percent.

- The U.S. Global Change Research Program (USGCRP) and the Climate Change Research Initiative (CCRI) have been merged into what is now known as the Climate Change Science Program (CCSP). The CCSP would increase by \$4 million to \$1.7 billion (see Table I-9). The Climate Change Technology Program (CCTP) that parallels the CCSP would receive \$3.0 billion, an increase of \$210.1 million or 7.4 percent.

- The Space Studies Board of the National Academy of Science (NAS) is developing a decadal strategy for research in the Earth Sciences. The report, *Earth Sciences and Applications from Space: A Community Assessment and Strategy for the Future* will influence the direction of

future research especially in NASA. The final report will be available late in 2006.

- Nearly 60 countries and the European Commission meeting in February 2005 in Brussels agreed to a plan that, over the next 10 years, will revolutionize understanding of the Earth. Agreement on the plan for a Global Earth Observation System of Systems (GEOSS) was reached by member countries of the international Group on Earth Observations (GEO). Some 43 international organizations also support the emerging global network.

- The National Space Weather Program (NSWP) would continue in FY 2006 with a decrease in NASA's Living with a Star Program and potential growth in NSF's solar-terrestrial programs. The Advanced Modular Incoherent Scatter Radar (AMISR) would approach full operation by the end of 2006. NASA's Solar Dynamics Observatory (SDO) would enter integration and test in 2006. NSF would continue support for a center for research on space weather at Boston University. The NAS report, *Sun to the Earth and Beyond: A Decadal Research Strategy in Solar and Space Physics*, published in 2004, continues to influence the direction of future solar-terrestrial research. Space weather research results and applications are now covered in the journal *Space Weather Quarterly*.

#### **INTRODUCTION AND POLITICAL ENVIRONMENT**

The Kyoto Protocol legally entered into force on February 16, 2005. The Protocol was adopted at the Conference of the Parties 3 (COP 3) in Kyoto, Japan on December 11, 1997. The Protocol set binding targets to reduce certain greenhouse gas emissions 5.2 percent below 1990 levels by 2012. More than 100 nations have ratified the Protocol and many developed countries have begun efforts to meet their emission targets. The U.S. supports many R&D activities important to emission reductions, but has not signed the Protocol.

Research on and operational forecasting of tropical conditions and storms would not be well served in the FY 2007 budget request. This would be due to delayed NASA missions such as the Global Precipitation Mission (GPM), a follow-on to the successful Tropical Rainfall Measurement Mission (TRMM); likely delays in NOAA operational polar orbiting satellite missions; and scaled back budgets for NOAA and NASA research. All of this would occur with a weak La

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Niña pattern in the Pacific and a persistent phase of a long-term climate cycle in the Atlantic, both of which would provide favorable conditions for Atlantic tropical cyclones.

In 2005 NOAA provided critical information and support before and after Hurricane Katrina. Some of these responses were accurate track forecasts before landfall, detailed photography of damage, surveys to open ports and rivers, and water quality and fisheries assessments. The hurricanes exposed limitations with the observing infrastructure that need to be addressed in the very near future.

NASA currently operates three major Earth Observing System (EOS) spacecraft (TERRA, AQUA and AURA) and a considerable number of smaller missions aimed at specific Earth processes. The three EOS spacecraft would not be replaced at the end of their missions. Weather and climate researchers would have to rely increasingly on NOAA's future operational missions for long term, continuous, global data. Researchers already make use of the current NOAA meteorological spacecraft, but recognize there are limitations with the instruments.

NOAA, jointly with NASA and the Department of Defense (DOD), is developing the National Polar-Orbiting Environmental Satellite System (NPOESS). Major cost growth and schedule delays in the program, primarily in new instrument development, have triggered the provisions of the Nunn-McCurdy Act requiring a stringent program certification process to avoid cancellation. At best, the program is likely to be descope and delayed.

A delay in the imager instrumentation also would affect NASA's NPOESS Preparatory Mission (NPP) that was intended to bridge the gap between EOS and the beginning of NPOESS.

NOAA has begun the study phase with industry for the geostationary GOES-R program. The advanced spacecraft in these programs would carry greatly improved instruments based on the heritage of the current EOS instruments. These would be the backbone of future weather and climate observations. NASA would continue to operate individual research missions aimed at specific processes and technology demonstrations. NASA would begin to develop a new Landsat Data Continuity Mission in 2006.

The President's Vision for Space Exploration continues to shape the NASA budget. NASA would cut Science program growth to 1.5 percent in the FY 2007 request and would reduce growth to 1.0 percent in future years. This would allow for the budget increases required by the exploration program. Some science missions of significance to atmospheric sciences and climate research would be delayed and others such as the Hydrosphere State mission (Hydros) would be cancelled. Other issues facing NASA are returning the Space Shuttle to operation and either servicing or de-orbiting the Hubble Space Telescope. (For more on the NASA budget, see Chapter 10.)

Globally, 2005 was the second warmest year on record since 1880. Moderate to extreme drought continued to affect large parts of the Western U.S. For the U.S., the year was dominated by the devastating Atlantic hurricane season that broke records for the number of tropical cyclones, major hurricanes making landfall, and category 5 hurricanes. China endured the worst flooding in 100 years and other disastrous flooding occurred in Guatemala and India

With the threat of materials released into the atmosphere, research on atmospheric diffusion and transport of such materials has become increasingly important. Agents that enter the atmosphere may interact not only with each other, but chemically and biologically with the media that transport them. The burgeoning commercial importance of weather, climate, and space weather information is illustrated by the increasing use of such knowledge by the reinsurance industry and futures markets. The growth of private weather and climate services and their partnerships with universities and users is further evidence.

#### **NATIONAL SCIENCE FOUNDATION (NSF)**

NSF's total budget would increase to \$6.0 billion, an increase of \$439.0 million or 7.9 percent (see Table II-7). Research and Related Activities would increase by 7.7 percent to \$4.7 billion. Major Research Equipment and Facility Construction (MREFC) would increase by 26.0 percent to \$240.5 million. This includes two new starts with the Alaska Region Research Vessel (ARRV) and the Ocean Observatories Initiative (OOI). (For more on the NSF budget, see Chapter 7.)

NSF's Geosciences Directorate (GEO) would receive an increase of \$42.0 million or 6.0 percent for a total of \$744.9 million. The OOI represents part of GEO's contribution to the GEOSS. OOI would cost

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\$309.5 million over six years with initial construction costs of \$13.5 million in FY 2007. Two new Science and Technology Centers would be funded. These are a center for Multi-Scale Modeling of Atmospheric Processes at Colorado State University and a center for Coastal Margin Observation and Prediction at Oregon Health and Science University.

The Atmospheric Sciences Subactivity (ATM) would increase by \$10.8 million or 5.0 percent to \$226.9 million. Atmospheric Sciences Research Support would increase by 5.4 percent to \$141.1 million. The National Center for Atmospheric Research (NCAR) would increase by 4.2 percent to \$85.7 million. These increases would target full operation of the HIAPER aircraft, operation of the Advanced Modular Incoherent Scatter Radar (AMISR), and improved cyberinfrastructure and numerical models.

NSF's Office of Polar Programs (OPP) would receive \$438.1 million in FY 2007, an increase of \$48.8 million above the FY 2006 current plan. The OPP supports atmospheric science and climate research together with oceanographic and biological research in the Arctic and Antarctic regions. The budget would allow completion of South Pole Station and continued funding of the icebreakers. In addition there would be \$47.3 million in support of the International Polar Year (IPY), a major part of NSF's total support of \$61.6 million for the IPY.

#### **NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)**

NOAA's total budget would decrease by 5.8 percent or \$227.0 million below the FY 2006 budget, which includes congressional add-ons. Reductions would be made in all offices except the National Environmental Satellite, Data, and Information Service (NESDIS) and the National Weather Service (NWS). NOAA couches its budget request in terms of a FY 2007 base that reflects the FY 2006 program without the one-time Congressional additions. In these terms the request would be an increase of 10.3 percent above the FY 2007 base. It includes additions for Global Earth Observations, Climate Research, an expanded Tsunami Warning Network, and full funding for NOAA satellite systems.

NESDIS would increase by 12.8 percent above the FY 2007 base to \$1.03 billion, an increase of \$117.4 million which would be an increase of \$81.7 million over the FY 2006 enacted level. \$149.6 million would be for satellite and information services and \$884.3 million would be for satellite and data acquisition. In 2005 NOAA successfully launched the

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polar-orbiting satellite NOAA-N. This began NOAA and European cooperation in the Initial Joint Polar System (IJPS). The next generation polar-orbiting meteorological satellites, NPOESS, would increase by \$20.3 million to \$337.9 million in FY 2007, an amount matched by the DOD. This budget does not address program cost and schedule overruns identified in 2005 that have triggered a Nunn-McCurdy certification process. The program's Executive Committee is evaluating options to meet this certification requirement.

The next generation geostationary satellites, now under study by industry teams beginning with GOES-R, would be funded at \$332.4 million with a launch date in 2012. The first of the predecessor series GOES-N is expected to be launched in May 2006 enabling the current GOES-11 to be moved to provide better coverage of Latin America. The NESDIS budget would include \$16.9 million for data systems enhancements including \$6.5 million for the Comprehensive Large-Array Stewardship System (CLASS).

The Office of Oceanic and Atmospheric Research (OAR) would increase by 12.3 percent above the FY 2007 base to \$348.7 million which is \$30.9 million below the FY 2006 enacted level. New climate reanalysis data sets would be developed. Research in aerosols, clouds, and climate change as well as phased array radar and high performance computing efforts would be expanded.

NOAA's climate efforts would seek \$230.1 million, an increase of \$24.1 million over the FY 2007 base. This includes US Integrated Earth Observation System activities, the implementation of the National Integrated Drought Information System (NIDIS), the Global Ocean Observing System component of GEOSS, climate reference networks and climate research.

The NWS would seek \$20.4 million to strengthen the tsunami warning program and \$1.4 million for hurricane buoy maintenance and operations. NWS would receive an increase of \$2.4 million for a total of \$7.5 million for the U.S. Weather Research Program aimed at improving global weather forecasts and forecasts for severe storms, particularly hurricanes. Funding for the Space Environment Center would be restored to \$7.3million.

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Most of the research laboratories in Boulder have been consolidated into the Earth System Research Laboratory under the direction of a Deputy Assistant Administrator for Oceanic and Atmospheric Research (OAR).

#### **NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)**

NASA's budget would increase by 3.2 percent (excluding the one-time Hurricane Katrina supplement in FY 2006) to \$16.8 billion (see Table II-11).

The new Science Mission Directorate would be funded at \$5.3 billion, within which the Earth-Sun Systems program would receive \$2.2 billion, a marginal increase over FY 2006. Future growth for science programs would be held at 1.0 percent according to NASA's latest long-range plan. In FY 2007 Earth-Sun programs would include \$166.0 million to complete integration and test for the Solar Dynamic Observatory (SDO) with a delay of 3 months in the launch in 2008, \$98.1 million for the Landsat continuity mission, \$70.1 million for the NPP mission whose launch date is slipping further, continuing development for the Glory aerosol mission, Orbiting Carbon Observatory, the Aquarius ocean salinity mission and \$189.4 million for research and analysis. The Global Precipitation Mission would be delayed and Hydros cancelled. The Living with a Star Program would lose \$14.1 million or 5.0 percent.

Two missions to study the structure of clouds globally would be launched in 2006. CloudSat, a cooperative mission with Canada, would use as advanced radar to observe the vertical structure of clouds and the Cloud-aerosol Lidar and Infrared Pathfinder Satellite Observations mission (CALIPSO), a cooperative study with France will look at the composition and structure of clouds and aerosol layers with lidar and infrared instruments.

One of NASA's most successful research satellites was decommissioned in 2005. The Upper Atmosphere Research Satellite (UARS) was launched in 1991 with a suite of instruments that provided over 14 years of unique measurements of the chemistry of the atmosphere. Towards the end of the mission the instruments were cycled to save power thus allowing a one-year overlap with the EOS chemistry mission AURA. (For more on the NASA budget, see Chapter 10.)

## **OTHER AGENCIES**

As part of the American Competitiveness Initiative, the Department of Energy's (DOE) Office of Science (SC) budget would increase by \$505.3 million or 14.1 percent to \$4.1 billion (see Table II-11). The Biological and Environmental Research (BER) office's core (non-earmarked) budget would be increased \$59.1 million or 13.1 percent to \$510.3 million. Congressionally mandated earmarks in BER in FY 2006 were \$128.7 million, leaving the non-earmarked budget at \$451.1 million. The climate change research program that is an integral and vitally important component of the Climate Change Science Program (CCSP) would be maintained at nearly level funding, a reduction of \$5.0 million or 4 percent to \$126.0 million. Emphasis still would be on the role of clouds and aerosols in an effort to parameterize better their effects in climate change prediction models used in international assessments. Global carbon cycle and basic research on the biological sequestration in the biosphere would be continued with some support coming from the Climate Change Technology Program (CCTP).

The DOD's Science and Technology programs would decrease by 16.3 percent to \$11.1 billion. The aggregate basic research ("6.1") funding would decline by 3.3 percent to \$1.4 billion, aggregate applied research ("6.2") would decline by 13.4 percent to \$4.5 billion, and aggregate advanced technology development ("6.3") would decline by 21.5 percent to \$5.2 billion. Army and the Air Force have been traditional sponsors of atmospheric research and have a significant interest in the CCTP.

EPA's total budget would decrease from \$7.6 billion to \$7.3 billion, a decrease of 4.0 percent. The S&T programs in clean air and global change would be increased by 3.9 percent to \$215.0 million. This would support research on air pollution and risk assessment methodologies. (For more on EPA programs, see Chapter 13.)

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The USGCRP, an interagency climate research program, was codified by the Global Change Research Act of 1990. Its goal is to increase understanding of the Earth system and provide a sound scientific basis for national and international decision making on global change issues. That program has produced a large body of important and useful research that now needs to be used especially in the developing world. In June

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2001 the President established two climate initiatives: the Climate Change Research Initiative (CCRI) that focuses on areas of uncertainty and reduction of those uncertainties and the National Climate Change Technology Initiative (NCCTI) whose aim is to strengthen and coordinate the federal leadership of climate change related technology R&D.

### **CLIMATE CHANGE SCIENCE PROGRAM (CCSP)**

The USGCRP and the CCRI have been merged into a CCSP. The program, consisting of 13 departments and agencies, is coordinated through an interagency program office located within NOAA. The CCSP would increase by \$4.0 million or 0.2 percent for a total of \$1.7 billion (see Table I-9). Expenditures for NASA satellites are the largest item in the CCSP budget, consuming about 60 percent of that budget.

The CCSP released its Strategic Plan in July 2003 that was reviewed by NAS/NRC. Research efforts are coordinated through a set of seven linked interdisciplinary research elements: Atmospheric Composition, Climate Variability and Change, Global Water Cycle, Land Use and Land Cover Change, Global Carbon Cycle, Ecosystems, and Human Contributions and Responses.

During FY 2007, CCSP will continue research into important scientific uncertainties and preparation of Synthesis and Assessment reports. These reports would be reviewed by the NAS/NRC under the terms of a continuing advisory agreement.

### **CLIMATE CHANGE TECHNOLOGY PROGRAM (CCTP)**

The CCTP is composed of two parts, a climate change technology related research and development program and the NCCTI. The program is extensive in its scope and involves nine federal departments and agencies. Since it is scattered throughout the Executive Branch and crosses program boundaries, it is difficult to discuss an integrated program. In FY 2007 the CCTP would receive \$3.0 billion, an increase of \$210.1 million or 7.4 percent.

The CCTP is guided by the United Nations Framework Convention on Climate Change of 1992 of achieving stabilization of greenhouse gas concentrations in the atmosphere that would prevent dangerous

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anthropogenic interference with the climate system, yet within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.

In 2005 the CCTP published a Vision and Framework for Strategy and Planning. It also released a draft Strategic Plan and asked the scientific community to review the document. Upon completion of the review, a final Plan will be published and released in 2006.

That Plan will contain several chapters that are related directly to atmospheric sciences and climate. The first is a chapter on Carbon Sequestration, a large part of which already is supported by CCTP through DOE's BER. The second chapter deals with non-CO<sub>2</sub> Greenhouse Gases (GHG) that are involved with atmospheric chemistry. The third chapter contains work on the measuring and monitoring GHG emissions. Many elements of this program feed directly into GOESS.