

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE
SUBCOMMITTEE ON SPACE AND AERONAUTICS**

HEARING CHARTER

NASA Earth Sciences

April 28, 2005

10:00 a.m. – 12:00 p.m.

2318 Rayburn House Office Building

Purpose

On Thursday, April 28, at 10:00am, the Committee on Science will hold a hearing to examine the state of Earth science programs of the National Aeronautics and Space Administration (NASA).

NASA proposes to spend about \$1.37 billion on Earth science research in Fiscal Year (FY) 2006, a cut of about \$120 million, or 8 percent, from FY2005 (or about \$180 million, or 12 percent, below the FY04 request).

In a report to be released this week, the National Academy of Sciences concludes that the budget cutbacks threaten the vitality of NASA's Earth science research, as many Earth science missions have been downsized, delayed or cancelled. The report is part of the "Decadal Survey" being conducted by the Academy at NASA's request to help the agency set priorities in the Earth sciences. The final report is due in late 2006.

The primary activities of NASA's Earth science program are to develop and launch research satellites designed to improve understanding of the land, oceans and atmosphere. In the past, NASA missions have helped gain new knowledge and create new capabilities that have led to advances in weather forecasting, storm warnings, and the ability to more efficiently manage agricultural and natural resources.

But the National Academy of Sciences report warns that U.S. leadership in developing such capabilities is threatened by the drop in support for NASA's Earth science research. Because at the time of this writing the report has yet to be released, NASA has not issued a response.

NASA's new Administrator, Michael Griffin, in his public statements has expressed general support for Earth science at NASA.

Overarching Questions

The Committee plans to explore the following overarching questions at the hearing:

1. What is NASA's long-term strategic vision for conducting Earth science observations from space? How does the current budget reflect that vision?
2. What are or what should be the top priority missions for Earth science? How would these priorities benefit society?
3. What are the implications of NASA's recent actions to cancel or reduce funding for several Earth science missions? How would the proposed cuts affect inter-agency programs such as those on climate science and Earth observations?

Witnesses

Alphonso Diaz is the Associate Administrator at NASA for the Science Mission Directorate, which includes Earth sciences.

Dr. Berrien Moore is the Co-Chairman the National Academy of Sciences Decadal Survey, "Earth Observations from Space: A Community Assessment and Strategy for the Future." Dr. Moore is also the Director for the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire.

Dr. Tim Killeen is the Director of the National Center for Atmospheric Research in Boulder, Colorado.

Dr. Marcia McNutt is the President and Chief Executive Officer of the Monterey Bay Aquarium Research Institute in Moss Landing, California.

Dr. Sean Solomon is the Director of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington.

Dr. Ray Williamson is a Research Professor in the Space Policy Institute at The George Washington University.

Background

Recent Developments: National Academy report

At NASA's request, the National Academy of Sciences (NAS) Committee on Earth Science Applications from Space is currently conducting a "Decadal Survey" for Earth science observations from space. Similar to the decadal surveys conducted with great success in astronomy and the planetary sciences, the Earth science decadal survey is expected to establish a prioritized list of research projects that the entire Earth sciences community agrees should be funded for the next ten years.

This will be the first time a decadal survey has been conducted for Earth science. It is a challenging undertaking because the field is broader and deals with more Federal

agencies than astronomy does. The NAS Committee chair, Dr. Berrien Moore, will be testifying at the hearing.

The NAS Committee this week is releasing an interim report titled “Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation.” The report states that “recent changes in federal support for Earth observation programs are alarming.” The report’s Executive Summary states:

At NASA, the vitality of Earth science and application programs has been placed at substantial risk by a rapidly shrinking budget that no longer supports already approved missions and programs of high scientific and societal relevance. Opportunities to discover new knowledge about the Earth are diminished as mission after mission is cancelled, de-scoped, or delayed, because of budget cutbacks, which appear to be largely the result of new obligations to support flight programs that are part of the Administration’s vision for space exploration.

The NAS Committee specifically recommends that NASA launch on schedule two Earth science missions that have been threatened with delays or cancellations. It also recommends that NASA request brief studies of its plans for three other missions. NASA has said that those missions could be launched on board the NPOESS satellite rather than as independent missions. (NPOESS stands for National Polar-orbiting Operational Environmental Satellite System and is being launched by the National Oceanic and Atmospheric Administration (NOAA) and the Department of Defense.) Finally, the NAS Committee recommends that NASA “reinvigorate” several smaller Earth science programs. (The Executive Summary of the NAS report is attached, and more information on specific missions is included below.)

Earth Sciences

NASA’s mission statement begins with the goal, “To understand and protect our home planet.” NASA research in Earth science has thus focused on understanding how the Earth’s atmosphere, oceans, and land interact and operate as a whole, with an eye toward direct societal applications.

Within the Earth sciences program, one of NASA’s primary roles is to build and launch research satellites to provide a deeper understanding of the basic processes governing the Earth’s physical system. Capabilities and discoveries from NASA’s program are often later incorporated by other agencies into the satellites they use in their ongoing operational programs, such as weather or geographic imaging satellites.

One example of how the NASA program works and contributes to operational programs is its Tropical Rainfall Measuring Mission (TRMM), which NASA launched in 1997 and is now scheduled to end operations this summer. TRMM provides data that was never before available on tropical precipitation patterns to help scientists study the water cycle and related issues including climate change. But unexpectedly, TRMM has also given researchers new insights into determining the track and intensity of hurricanes, which

could contribute to future efforts to predict the landfall of hurricanes, which is the responsibility of NOAA. NOAA could place instruments based on TRMM on future weather satellites.

The Global Precipitation Mission (GPM), the planned follow-on mission to TRMM, would continue to provide further improvements in the observation of rainfall by, among other things, expanding rainfall information to the entire globe. NASA has delayed the launch of GPM several times. (See below.)

In another example, NASA researchers are also exploring whether data from Earth observing satellites can be used to track ocean pollution from runoff. (See attached article from Space News).

NASA satellites have made substantial contribution to a variety of areas, such as documenting the existence of a hole in the ozone layer in the upper atmosphere. Future NASA missions could potentially provide useful information for a number of important societal needs. For example, interferometric synthetic aperture radar (InSAR) technology that some scientists have suggested for a future NASA mission could be able to detect small changes in surface of Earth to presage volcanic eruptions or landslides. Also, NASA’s Glory mission, which has recently been downscaled (see below), was developed to help resolve one of the largest uncertainties in scientists’ understanding of climate change, the effects of the variable output of the sun and of atmospheric aerosols (black soot and carbon).

NASA’s Goddard Space Flight Center (MD), Jet Propulsion Lab (CA), and Ames Research Center (CA) each contribute substantially to Earth sciences research at NASA.

NASA Earth Sciences Budget

Funding for the Earth sciences has declined each year since FY2004, and the President’s FY2006 budget submission continues this reduction. The table below compares the last three budget requests (including the accompanying runout for the four following years) for NASA’s Earth science programs:

NASA Earth Science Funding (\$=Billions)

	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
2004 Request	1.55	1.53	1.6	1.7	1.73		
2005 Request		1.49	1.39	1.37	1.34	1.47	
2006 Request			1.37	1.35	1.33	1.47	1.44

The budget for the Earth sciences programs at NASA was cut sharply in FY2005, with reductions in the run-out for the years 2005-2009 totaling over \$1 billion as compared to the planned budget for these years at the time of the FY2004 budget submission. The FY2006 budget request reduces this amount slightly further.

In the FY2006 budget request, NASA has made it difficult to determine Earth science funding by consolidating the Earth science programs and several space science programs into a new “Earth-Sun System” theme within the new Science Mission Directorate. (Earth sciences had previously been a separate directorate from space sciences. The Science Committee was able to get the Earth science figures only after repeated requests.) The Earth-Sun theme also includes the “Sun-Earth Connections” programs, such as the Voyager mission, which continues to send back data from the outer limits of the solar system. The funding table above includes only funding for Earth sciences. For information regarding funding for the entire Earth-Sun System theme as a whole see Appendix B.

Effect of Budget Reductions

The budget reductions have led NASA to delay, cancel or scale back most Earth science missions. Furthermore, NASA has few if any additional Earth science missions in the planning pipeline beyond the missions that have been in the works for years. Also, NASA does not appear to have sufficient funds to launch some of the missions that it describes as being on schedule.

For example, the NASA Global Precipitation Measurement (GPM) satellite, which is to be coordinated with launches of related satellites by other nations, was first scheduled to be launched in 2007. Currently, launching in 2010 would be considered “on schedule.” In its FY2005 budget request, NASA delayed the launch until 2012. In the FY2006 request, the date has been shifted back to 2010, but it is unclear whether NASA has requested sufficient funding to make that date.

The NAS Committee interim report recommends that the GPM mission be launched without further delays, citing its international nature and the importance of understanding “the availability of fresh water.”

Another mission affected by the budget cutbacks is Glory, which is designed to study one of the highest priority questions in climate change science. Glory was originally intended to fly as a stand-alone mission in 2008. But in 2005, NASA began talking instead about just building the instruments for Glory and then looking to see if they could be launched on another satellite, such as NPOESS. NASA has not been able to say when or even if Glory would be able to be launched if it “piggy-backed” on another mission. Under pressure from the Science Committee and the House Appropriations Committee, NASA has extended the contract to build a launch vehicle for an independent Glory mission, but the future of the mission is still in doubt.

The NAS Committee interim report recommends that NASA commission an independent review to determine the “suitability, capability and timeliness” of placing the Glory instruments on another satellite.

The table below summarizes the status of all of NASA’s currently planned large Earth science missions:

(Adapted from TABLE 3.1 from the NAS report: “Cancelled, De-scoped, or Delayed Earth Observation Missions)

Mission	Measurement	Societal Benefit	Current status
Global Precipitation Measurement (GPM) mission	Precipitation	Reduce vulnerability to floods and droughts; manage water resources in arid regions; improve forecasts of hurricanes	Unclear
Atmospheric Soundings from Geostationary Orbit (GIFTS)	Temperature and water vapor	Protect life and property through improved weather forecasts and severe storm warnings	Cancelled
Ocean Vector Winds	Wind speed and direction near the ocean surface	Improve severe weather warnings to ships at sea; improve crop planning and yields through better predictions of El Nino	Cancelled
Landsat Data Continuity	Land cover	Monitor deforestation; find mineral resources; track the conversion of agricultural land to other uses	Reformulated (instruments to be included on NPOESS)
Glory	Optical properties of aerosols; solar irradiance	Improve scientific understanding of factors that force climate change	Unclear
Wide Swath Ocean Altimeter (on the Ocean Surface Topography Mission)	Sea level in two dimensions	Monitor coastal currents, eddies, and tides, which affect fisheries, navigation, and ocean climate instrument	Overall mission on schedule. Altimeter instrument not included in mission

In addition to reducing funding for specific large missions, NASA has sharply reduced the Earth System Science Pathfinders (ESSP), a research program to launch small, experimental satellites that can test ideas for future larger missions. ESSP missions are not allowed to cost more than about \$230 million over the life of the mission (as opposed to close to \$1 billion for GPM). NASA now plans to delay for a year the ESSP proposal solicitation that was scheduled for this summer. The NAS Committee interim report calls for NASA to go forward with the solicitation this summer.

(ESSP launches approved from previous solicitations are on schedule. Two should launch this year.)

NASA has also substantially cut its Earth science research and analysis program, which focuses on developing the tools and techniques to interpret Earth science data. The program also helps scientists determine how to prioritize potential future research missions. These cuts particularly affect graduate student funding. According to the NAS Committee interim report, the research and analysis programs at NASA have suffered disproportionately large cuts.

The NAS Committee interim report also notes that the Earth science reductions could jeopardize NASA’s ability to fulfill its obligations to interagency initiatives, such as the

development of a Global Earth Observing System of Systems (GEOSS). This international effort will develop a comprehensive and coordinated earth observing system. Earlier this year, Secretary of Commerce Carlos Gutierrez represented the United States at the meeting in Brussels where the GEOSS plan was adopted.

The NAS Committee interim report also calls into question NASA's ability to fulfill its commitments to the Climate Change Science Program (CCSP). NASA's Earth Science program represents the largest portion of the CCSP budget, (62 percent in the President's FY2006 budget request).

Questions for the Witnesses

The witnesses were asked to address the following questions in their testimony:

Questions for Alphonso Diaz

Please briefly explain the President's FY06 budget request for NASA Earth sciences and answer the following questions:

- What missions that were in the planning process as of the FY2004 budget submission have been delayed, cancelled or re-formulated? What criteria have NASA used in determining which missions to delay, cancel or re-formulate? How do these criteria relate to NASA's larger vision for its Earth science programs?
- Given the FY06 budget run-out, to what extent will NASA have to limit its contributions to multiple agency programs such as the Climate Change Science Program (CCSP) and the Global Earth Observing System of Systems (GEOSS)?

Questions for Dr. Berrien Moore

Please summarize the NRC report, and answer the following questions:

- What are the Committee's greatest concerns for the funding outlook for NASA Earth sciences?
- How should NASA prioritize currently planned and future missions? What criteria should NASA use in doing so?
- What are the highest priority unaddressed or unanswered questions in Earth science observations from space?

Questions for Dr. Tim Killeen

- How should NASA prioritize currently planned and future missions? What criteria should NASA use in doing so?
- What are the highest priority unaddressed or unanswered questions in Earth science observations from space?
- What have been the most important contributions to society that have come from NASA Earth sciences over the last decade (or two)?

- What future benefits to the nation (societal applications) are possible that NASA Earth sciences could provide? What gaps in our knowledge must we fill before those future benefits are possible?

Questions for Dr. Marcia McNutt

- How should NASA prioritize currently planned and future missions? What criteria should NASA use in doing so?
- What are the highest priority unaddressed or unanswered questions in Earth science observations from space?
- What have been the most important contributions to society that have come from NASA Earth sciences over the last decade (or two)?
- What future benefits to the nation (societal applications) are possible that NASA Earth sciences could provide? What gaps in our knowledge must we fill before those future benefits are possible?

Questions for Dr. Sean Solomon

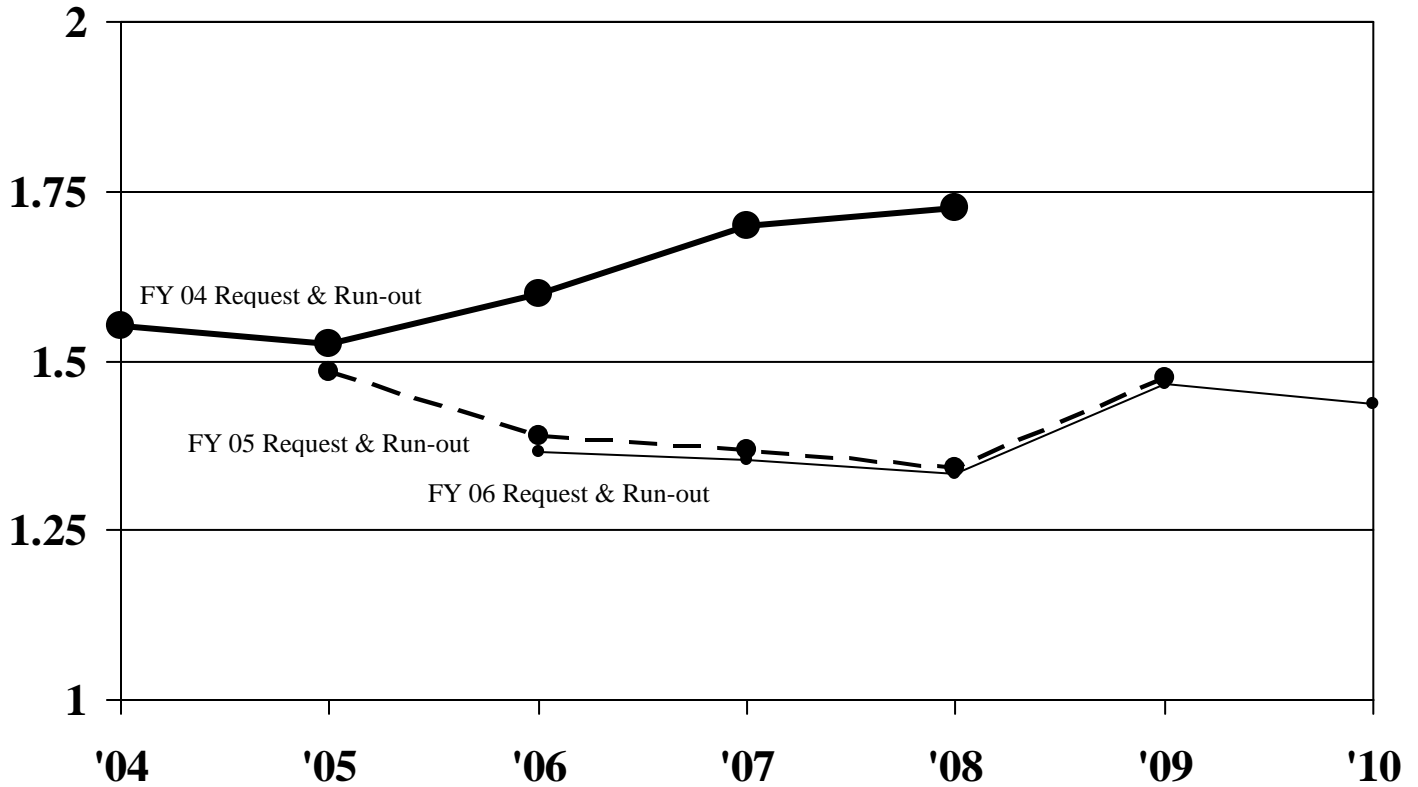
- How should NASA prioritize currently planned and future missions? What criteria should NASA use in doing so?
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- What future benefits to the nation (societal applications) are possible that NASA Earth sciences could provide? What gaps in our knowledge must we fill before those future benefits are possible?

Questions for Dr. Ray Williamson

- How should NASA prioritize currently planned and future missions? What criteria should NASA use in doing so?
- What are the highest priority unaddressed or unanswered questions in Earth science observations from space?
- What have been the most important contributions to society that have come from NASA Earth sciences over the last decade (or two)?
- What future benefits to the nation (societal applications) are possible that NASA Earth sciences could provide? What gaps in our knowledge must we fill before those future benefits are possible?

Appendix A

NASA Earth Science
 Budget Request and 5-Year Run-outs
 (In Billions of Dollars)



Thick solid line (top – beginning in '04): FY2004 request and 5-year run-out
 Dashed line (middle – beginning in '05): FY2005 request and 5-year run-out
 Thin solid line (bottom – beginning in '06): FY2006 request and 5-year run-out
 (For FY2006, this is the Earth science portion of the “Earth-Sun System” theme – see below)

NASA Earth-Sun System Funding (\$=millions)

	FY05	FY06	FY07	FY08
FY05 President's Budget	2231.3	2171.0	2155.2	2301.3
FY06 President's Budget	2155.8	2063.6	2081.2	2132.2
Change	-75.5	-107.4	-74.0	-169.1

