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

HEARING CHARTER

NASA's Science Programs: Fiscal Year 2009 Budget Request and Issues

Thursday, March 13, 2008
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose:

On Thursday, March 13, 2008 at 2:00 pm, the House Committee on Science and Technology, Subcommittee on Space and Aeronautics will hold a hearing to examine the National Aeronautics and Space Administration's (NASA) Fiscal Year 2009 budget request and plans for science programs including Earth science, heliophysics, planetary science (including astrobiology), and astrophysics, as well as issues related to the programs.

Witnesses:

Witnesses scheduled to testify at the hearing include the following:

Dr. S. Alan Stern
Associate Administrator,
NASA Science Mission Directorate

Dr. Lennard A. Fisk
Chair, Space Studies Board, National Research Council

Dr. Berrien Moore III
Executive Director, Climate Central; Chair, Committee on Earth Studies, National Research Council

Dr. Steven W. Squyres
Professor of Astronomy,
Cornell University

Dr. Jack O. Burns
Professor, Center for Astrophysics and Space Astronomy,
University of Colorado

BACKGROUND

Overview

Over the last year, NASA's Science Mission Directorate launched the Dawn mission that will explore two large asteroids; the Phoenix Mars lander mission; the Solar Terrestrial Relations Observatory (STEREO) mission to study coronal mass ejections from the Sun; the Time History of Events and Macroscale Interactions During Substorms (THEMIS) mission, and the Aeronomy of Ice in the Mesosphere (AIM) mission.

In 2008, the Science Mission Directorate plans to launch the Interstellar Boundary Explorer (IBEX), the Solar Dynamics Observatory (SDO), the Gamma Ray Large Area Space Telescope (GLAST), the Ocean Surface Topography Mission (OSTM), the Orbiting Carbon Observatory (OCO), conduct a fourth Hubble servicing mission, and complete contributions to international and interagency partner missions that are planned for launch in 2008.

This hearing will examine NASA's science programs within NASA's Science Mission Directorate (SMD) and their status within the context of the Fiscal Year 2009 budget request. The science programs include the following theme areas:

- Earth science, which seeks to understand how and what is causing changes in the global Earth system, the effect of natural and human influences on the Earth system and the implications for society, and how the Earth system will change over time;
- Planetary science, which seeks to understand the origin and evolution of the solar system and the prospects for life beyond Earth;
- Astrophysics, which seeks to understand the origin, structure, evolution and future of the Universe and to search for Earth-like planets; and
- Heliophysics, which seeks to understand the Sun and its effects on Earth and the rest of the solar system;

Stakeholders in NASA's science programs include academic institutions; industry; NASA field centers, predominantly the Goddard Space Flight Center (GSFC) and

the Jet Propulsion Laboratory (JPL); and other government laboratories. There are a number of advisory panels that provide guidance on NASA's science programs and activities, including the National Academies, the Astronomy and Astrophysics Advisory Committee (AAAC), and the NASA Advisory Council (NAC) and its Science Subcommittees.

Fiscal Year 2009 Budget Request

The President's FY 09 budget requests $4.4 billion in direct program dollars to fund NASA's science programs—Earth science, heliophysics, planetary science, and astrophysics. The budget represents a $264.7 million decrease below the FY 08 appropriation. Most of this decrease is attributed to a transfer of the budget and management for the Deep Space Network and Near Earth Networks from the Science Mission Directorate to the Space Operations Mission Directorate. (Appendix A presents the President's FY 09 budget request for NASA's science programs.) NASA's science programs represent 25 percent of the President's total FY 09 budget request for NASA.

It should be noted that the FY 09 budget has been restructured pursuant to the Consolidated Appropriation Act, 2008, and is now presented in seven accounts. Science, which was previously part of the Science, Aeronautics and Exploration account, is broken out as a separate line. In addition, the budget estimates presented in the FY 09 request are in direct program dollars rather than in the full cost dollars used in previous Presidential budget requests.

Assumed Budget Growth for NASA Science FY 2009 – FY 2020

The President's budget request for NASA and for the Science Mission Directorate is assumed to grow at 1 percent through FY 11 and then at 2.4 percent thereafter, according to a Science Mission Directorate website [http://science.hq.nasa.gov/research].

Key Changes in FY 2009 Budget Request for Science Mission Directorate

- *Increases for research and analysis (R&A) grants.* Research and analysis grants fund theory, modeling, the analysis of mission data, technology development and research on concepts for future science missions. These grants are a principal source of funding and training for graduate students who will serve as the next generation of space scientists.

- *Increases intended to revitalize small science projects flown on suborbital rockets, aircraft, and balloons*. These small science activities provide frequent opportunities for science return and help train students and young researchers in spaceflights, systems integration, and project management.
- *Near-term increases for small scientist-led Explorer missions.* The FY 09 budget includes plans to select several new Small Explorer missions. This step helps fill what was expected to be a gap in science mission launches over the next few years. In addition, these opportunities help maintain the vitality of the science community and offer valuable training for scientists and engineers.
- *Initiates two of the 15 Earth Science missions recommended for NASA in the National Academies decadal survey*.
- *Proposes new science missions and projects*, including an "Outer Planets" flagship mission to either Jupiter's moon Europa, the Jupiter system, or Saturn's moon Titan; a Joint Dark Energy Mission (JDEM), which would examine fundamental questions about the Big Bang, black holes, and dark energy in the universe; a Solar Probe mission that would provide close-up measurements of the Sun and the solar wind; a potential small lunar orbiter that would study the lunar atmosphere and dust and two mini-landers that would be the initial nodes in an international geophysical network on the Moon; and a Mars Sample Return mission.
- *Makes extensive cuts to Mars Exploration and focuses future plans on a Mars Sample Return endeavor.*
- *Reduces funding for technology development programs and delays and reduces various programs across the Science Mission Directorate.*
- *No new funding is provided to the Science account relative to the five-year runout that accompanied the FY 08 budget request; thus, new funding initiatives in specific program areas are funded by transitioning money from other program areas.*

Potential Issues

The following are some of the potential issues that might be raised at the hearing:

- ***What are the goals of the Science Mission Directorate over the next five years? What are the challenges in meeting those goals?***
- ***What threat do the eight science missions exceeding Congressionally-set cost and schedule thresholds pose for NASA's FY 09 science budget and plans?***

- ***Can the ambitious program proposed in the FY 09 be executed on a budget assumed to grow at the rate of inflation? What is the contingency strategy?***
- ***Will NASA's approach to technology development provide adequate risk reduction for current projects and currently planned major new initiatives?***
- ***Are NASA's science programs balanced?***
- ***What is the status of NASA's planning to support launches of medium-class science missions? To what degree is the availability of launch vehicles affecting strategic plans for the Science Mission Directorate?***

Earth Science

- ***How sustainable is a budget wedge for Earth Science missions that is built on cuts to other NASA science programs?***
- ***What is the status of climate sensors removed from the NPOESS platform and how do those plans affect NASA's NPOESS Preparatory Project (NPP)?***
- ***What lessons have been learned from the challenges related to the NPP and NPOESS programs and the remanifesting of climate sensors that were removed from the NPOESS platform? How does NASA plan to apply those lessons to the new Earth Science missions being planned?***
- ***What is NASA's role in the Global Earth Observation System of Systems (GEOSS) and what are the benefits of GEOSS to the U.S? What should it be? What has been accomplished since the strategic plan for GEOSS was issued three years ago?***

Planetary Science

- ***Is the planetary science program proposed in the FY 09 budget executable?***
- ***What are the implications of the extensive budgetary cuts and proposed changes in the Mars Exploration Program?***
- ***Does NASA's FY 09 budget request and plan for the planetary science program provide the capability to support a Mars Sample Return mission?***

Astrophysics

- ***What are the implications of the lack of a budget wedge to support future "Decadal" priorities for astronomy and astrophysics?***
- ***What are the implications of reductions in the Physics of the Cosmos line?***
- ***What is NASA's rationale for proposing a Joint Dark Energy Mission budget that is considerably lower than the cost estimate in a National Academies report, which used an independent cost estimating process?***
- ***Are NASA's plans for an exoplanet mission to explore planets near stars like the Sun consistent with the findings of the Astronomy and Astrophysics***

Advisory Committee's (a Congressionally-chartered committee) Exoplanet Task Force?

Heliophysics

- ***Is NASA's plan and proposed budget for initiating a Solar Probe mission realistic?***
- ***How effective is the process of transferring NASA-funded research into operational space weather services?***
- ***What is needed to ensure the optimal use of NASA-funded research to improve space weather prediction?***

Cross-Cutting Issues for Science Programs

What threat do the eight science missions exceeding Congressionally-set cost and schedule thresholds pose for NASA's FY 09 science budget and plans? At the posture hearing on NASA's FY 09 budget request held by the Full Committee, Administrator Griffin testified that "*NASA's current development cost estimate of $325 million for the Glory Earth science mission has exceeded the 30 percent threshold and cost growth. Thus, it will require explicit authorization in the next 18 months to continue*." NASA's FY 09 budget documents report that a total of eight projects have exceeded Congressional schedule or cost thresholds—Herschel, Kepler, NPOESS Preparatory Project, Glory, Orbiting Carbon Observatory (OCO), Aquarius, GLAST, and the Stratospheric Observatory for Infrared Astronomy (SOFIA). (See Appendix B) Five of the missions on the list were added this year; three are carryovers from last year. What explicit steps is NASA taking to resolve the issues with these missions and to prevent a similar situation arising with future missions, especially the new science missions to be initiated with the proposed FY 09 budget?

Will NASA's approach to technology development provide adequate risk reduction for current projects and currently planned major new initiatives? The FY 09 budget reduces programmatic content for Earth science technology by $14.5 million through FY 12; reduces programmatic content for planetary science technology by $65.7 million through FY 12; and virtually eliminates the New Millennium flight technology validation program with reductions of $210 million through FY 12. NASA officials informed Committee staff that NASA plans to fund the technology required for individual missions through the mission project budgets. This approach differs from statements and advice provided through reports of the National Academies, which recommended that NASA support both

cross-cutting technology as well as mission-specific technology development. Is NASA taking the right approach to ensuring that technologies for new missions are mature and that their risks are understood? How does NASA plan to constrain technical risk on future missions while also reducing funding for technology development?

Earth Science

The President's FY 09 budget request provides $1.3675 billion for NASA's Earth Science program. The FY 09 budget represents a 6.8 percent increase over the FY 08 appropriation and provides a budget wedge of $910 million dollars over the five year run-out to initiate the first two Earth science missions recommended in the National Academies Earth Science decadal survey.

The Earth Science program funds:

- Science activities, including research on the processes related to the Earth's atmosphere, hydrosphere, biosphere, cryosphere, and land surface and their affects on the climate, weather, and natural hazards; airborne science; and supercomputing capabilities; among other focused research activities;
- The Earth System Science Pathfinder (ESSP) Program, which solicits proposals for scientists to propose small to medium-sized missions (Three missions are operating and two missions are planned for launch within the next 1-2 years. The FY 09 request does not include plans for future ESSP missions.);
- Technology, including the development of new instruments and measurement techniques, information technologies, and technologies for the Earth science program;
- Grants to support the applied use of NASA Earth science research to societal benefit areas including agricultural efficiency, air quality, aviation, carbon management, coastal management, disaster management, ecological forecasting, energy management, homeland security, invasive species, public health, and water management; and
- The Near-Earth Objects Observation program, which detects, tracks, and characterizes NEOs, as directed by Congress. (This program and the associated funding was moved from the Exploration Systems Mission Directorate to the Science Mission Directorate in 2007).

Key Issues for Earth Science

How sustainable is a budget wedge for Earth Science missions that is built on cuts to other NASA science programs? The FY 09 budget request includes $910 million in funds in FY 09 – FY 13 for NASA to implement the President's FY 09 budget requests new starts for the Soil Moisture Active Passive (SMAP) mission to measure soil moisture and the ICESat-II mission to measure changes in the height of ice sheets. NASA also plans to start three additional decadal missions within the 5-year plan presented in the President's FY 09 budget request.

Approximately $570 million of the wedge created for the decadal survey missions is funded through the transfer of funding from other science divisions, resulting in reductions in the Mars Exploration Program, a delay to the Solar Probe mission, and other programmatic cuts, according to NASA officials. Funds within the Earth Science division that were intended for a competitive selection of an Earth Science Pathfinder mission have been redirected to implement the decadal survey missions. The National Academies decadal survey report called for an increase of $500 million per year for NASA's Earth Science program (bringing the program back to the level at which it was funded in the year 2000) to enable the implementation of the decadal recommendations. While the FY 09 budget request enables a positive start on the initial two missions identified, what are the implications of the gap between the FY 09 plan and the resource requirements laid out by the Earth Science decadal survey? Is there sufficient funding in the five-year budget plan to permit any work on other decadal missions beyond the first two?

What is the status of climate sensors that were removed from the NPOESS platform and how do current plans for climate sensors affect NASA's NPOESS Preparatory Project (NPP)? In attempt to mitigate potential gaps in critical climate measurements that were to be part of the NPOESS program, the Office of Science and Technology Policy (OSTP), along with NOAA and NASA, agreed to sustain high priority climate measurements:

- Total solar irradiance (to be provided by the Total Solar Irradiance Sensor(TSIS))
- Earth radiation budget data (to be provided by the Clouds and Earth Radiant Energy System (CERES) sensor), and
- Ozone vertical profile data (provided by the OMPS-Limb sensor).

The President's budget requests $74 million per year through FY 13 in the NOAA budget for this purpose. CERES was added to NASA's NPP mission. OMPS-Limb was restored to the NPP platform, and TSIS has not yet been assigned to a satellite. NASA's NPP mission, which is intended to provide risk reduction for

sensors to fly on the NPOESS system, has been delayed 26 months due to poor contractor performance on the Visible/Infrared Imaging Radiometer Suite (VIIRS) sensor.

What is NASA's strategy for transferring Earth Science research and instruments into operational services? How are lessons learned from the interagency decision making process to fly high priority climate sensors being used to improve the movement of NASA-funded capabilities into ongoing operational services? Section 306 of the NASA Authorization Act of 2005 directs NASA and NOAA to establish a Joint Working Group to "*ensure maximum coordination in the design, operation, and transition of missions where appropriate.*" NASA and NOAA are coordinating NPOESS climate remanifestation, NASA's Quick Scatterometer mission, NOAA's GOES-R weather satellite program, and the series of NASA, NOAA, and French space agency missions to measure global sea level, among other activities. Does NASA have a plan and identified process for moving NASA research into operational services? What are the advantages and disadvantages of reviving the Operational Satellite Improvement Program (OSIP), which was the approach to NASA and NOAA coordination that existed during the 1970s? What are the challenges in planning and executing the transition of NASA research into operational services? What, if any, resources are required?

Over the last year, NASA has been working closely with NOAA and the Office of Science and Technology Policy on restoring high priority climate measurements that were originally planned for NPOESS. What can be learned from this process for improving the effectiveness of transitioning research into operations? The Earth Science decadal survey recommended that "*Socioeconomic factors should be considered in the planning and implementation of Earth observation missions and in developing an Earth knowledge and information system.*" Do NASA's plans for new Earth science missions include the applied uses of the data for societal benefit?

Does NASA have an implementation plan to address potential gaps in the Landsat data record? The Landsat Data Continuity Mission (LDCM) will continue the observation of the longest civil Earth observation data record, which began with the Landsat program in 1972. LDCM is expected to launch in 2011. The lifetime of the currently operating Landsat 7 is uncertain. LDCM will not include a thermal imaging capability (which has been part of the ongoing Landsat data record). This capability is of value, in particular, for the management of water resources. NASA has said that the cost of a thermal imaging capability exceeds

the budget that is available for LDCM. The explanatory language in the FY 08 appropriation directed NASA to "*provide a plan on all continuity of data for the Landsat Data Continuity Mission (LDCM) to the Appropriations Committees no later than 120 days after enactment of this Act*." A study team to consider options for addressing a potential data gap between Landsat 7 and LDCM was created well before the FY 08 appropriations direction. Is there an implementation plan in place? Will the plan include measures to acquire thermal infrared data to ensure continuity of this data?

What is NASA's role in the Global Earth Observation System of Systems (GEOSS) and what are the benefits of GEOSS to the U.S? What has been accomplished since the strategic plan for GEOSS was issued three years ago? In 2005, 55 nations "*endorsed a 10-year plan to develop and implement the Global Earth Observation System of Systems (GEOSS) for the purpose of achieving comprehensive, coordinated, and sustained observations of the Earth system.*" What benefits has GEOSS yielded for NASA's own applications projects, for U.S. researchers, and for users of Earth observation data? Are there any concrete examples of successes? What should NASA's role in GEOSS be?

Planetary Science

The President's FY 09 budget request provides $1.3342 billion to fund NASA's Planetary Science theme. The FY 09 budget represents an increase of $86.7 million, about 7 percent relative to the FY 08 appropriation for planetary science. Within the planetary budget, the programmatic content of the Mars Exploration Program is cut by $918 million through FY 12; the programmatic content of the Discovery program of competitive, scientist-led missions is cut by $57.9 million through FY 12; and the programmatic content of the planetary science technology program is reduced by $65.7 million through FY 12.

Planetary Science funds:

- Planetary Science research, which includes research and analysis, the lunar science research;
- The Discovery program of competitively-selected scientist-led missions (medium-class);
- The New Frontiers mission of competitively-selected scientist-led missions to designated planets, moons, or bodies;
- Mars Exploration Program consisting of competitively-selected, scientist-led Mars Scout missions, and landers, rovers, and orbiters developed by NASA

- A newly-created Outer Planets program to focus on developing the next planetary flagship mission to the solar system's outer planets; and
- A technology program to continue work on in-space propulsion and radioisotope power systems.

Key Issues for Planetary Sciences

Is the Planetary Science Program Proposed in the FY 09 Budget Executable? The planetary sciences program, as detailed in the FY 09 budget, would include several new initiatives:

Outer planets mission	NASA - estimated level of $2 billion for U.S. portion, and
New Frontiers mission	NASA - estimated level of $840 million

In addition, the program intends to fund additional Mars missions and maintain the Discovery and New Frontiers lines of competitive, scientist-led missions. The major planetary mission currently in development, a large rover that will identify possible Martian habitats for life (Mars Science Laboratory), has incurred a $165 million overrun, according to *Science* magazine, and has encountered technical challenges that could threaten the mission's 2009 launch opportunity.

- Are NASA's budgetary assumptions to support the proposed Mars Exploration Program realistic?
- Is the frequency of small and medium-class scientist-led missions appropriately balanced with the larger projects included in the plans?
- What additional steps is NASA taking to ensure robust budget estimates for the proposed program and what trade-offs will be considered?

Do NASA's FY 09 budget request and Planetary Science program provide the capability to support the proposed Mars architecture, including a future Mars Sample Return Mission? The Mars Exploration Program Analysis Group (MEPAG), a NASA-chartered group to support planning for the scientific exploration of Mars, endorsed NASA's Mars architecture, albeit with significant caveats. The group concluded that "*The proposed budget does not support the SMD [Science Mission Directorate] architecture*" and that "*NASA funding through FY 20 is $2-3 billion less than required for this architecture*." A Mars Architecture Tiger Team, which was assembled to assess the architecture, also endorsed the plan, but found that "*the SMD planning budget, which includes the President's 5-year decreasing budget, does not support this architecture, even with the planned rapid increase in funding beginning in FY17*." The proposed Mars Exploration Budget for FY 10-FY 12 is roughly half of the levels funded over the

last five years. The Tiger Team identified alternative options include a program focusing only on sample return; a program that excludes sample return, a program that delays sample return, or the current program (which would require additional resources).

- What should the future Mars program be? What are the advantages and disadvantages of the various options? How will this decision be made?
- What technical challenges must be overcome to support a Mars Sample Return mission and does the Planetary Science program, as proposed in the FY 09 budget, provide the vehicles to address those challenges?

What is the status of Astrobiology?

NASA's astrobiology program is an interdisciplinary program to study the origin and evolution of life on Earth and beyond Earth. The program funds competitively selected astrobiology research teams through the NASA Astrobiology Institute. Recent NASA budget requests significantly cut astrobiology (by as much as half). In January 2008, NASA issued a solicitation to support additional teams: according to the January cooperative agreement notice, "*NASA anticipates making $10-12M per year available for this selection, leading to at least 7 and possibly several more awards (approximately one-third or which will be focused on preparing strategic mission objectives) each of 5 years duration*." What, if any, future role could astrobiology play in a future Outer Planets mission, an exoplanet mission, and the future Mars Program, including a potential sample return mission? Is astrobiology research and the development of astrobiology instrumentation on track to contribute to these planned activities?

Lunar Science

The FY 08 budget request included funding for lunar science research within the planetary science research line to help support scientific research in view of future exploration of the Moon. The FY 09 budget continues the lunar science research program and requests $669 million for FY 09 – FY 13, which includes an increase of $250 million from the FY 08 budget request through FY 12, to develop a small lunar orbiter for launch by 2011 and two mini lander missions by 2014.

Astrophysics

The President's NASA FY 09 budget request includes $1.1625 billion to fund NASA's Astrophysics program. The FY 09 request represents a $175 million or 13 percent decrease relative to the FY 08 appropriation for astrophysics.

Astrophysics funds:

- Astrophysics research, including research and analysis grants and scientific activities on balloons and suborbital rockets;
- Cosmic Origins Program, including the James Webb Space Telescope, the Stratospheric Observatory for Infrared Astronomy (SOFIA), and the Hubble Space Telescope and Hubble Space Telescope Servicing Mission-4;
- Physics of the Cosmos program to explore the nature of dark energy, black holes and other phenomena;
- Exoplanet Exploration to study and identify planets near stars like the Sun; and
- Scientist-led, competitively selected Explorer missions.

Key Issues for Astrophysics

What are the implications of the lack of a budget wedge to support future "Decadal" priorities for astronomy and astrophysics? The FY 09 budget requests $315.6 million through FY 13 to advance recommendations of the next decadal survey in astronomy and astrophysics, according to internal NASA budget documents. However, the request represents cuts of $75.8 million from the FY 08 request for such missions, according to NASA internal budget documents. NASA officials told Committee staff that most of the budget request for future decadal survey missions would be held as reserves for the James Webb Space Telescope Mission, which requires increases in its reserves in order to manage the mission at a 70 percent confidence level. There is no room for future astrophysics observatories in the current FY 09 budget's five-year budget plan. What does this mean for the health of the astrophysics program and community?

What are the implications to reductions in the Physics of the Cosmos line? What is NASA's rationale for proposing a Joint Dark Energy Mission budget that is considerably lower than the cost estimated in a National Academies report, which used an independent cost estimating process? The FY 09 budget proposes $388.5 million for FY 09- FY 13 to develop a JDEM mission and to continue technology development for other future missions in the Physics of the Cosmos program (previously called the Beyond Einstein program). The JDEM new start responds to a National Academies study, which recommends that "*NASA and DOE should proceed immediately with a competition to select a Joint Dark Energy Mission for a 2009 new start*." NASA plans to issue an Announcement of Opportunity for the mission in FY 08, which is planned to be conducted in partnership with DOE. NASA estimates the mission cost at the level of $600

million, not including a potential contribution from the DOE, and anticipates a JDEM launch in 2015. The National Academies study, *Beyond Einstein: An Architecture for Implementation,* included an analysis that estimated JDEM mission lifecycle costs (as managed at a 70 percent confidence level) to be $1 billion - $1.3 billion. The National Academies study also found that "*LISA [Laser Interferometer Space Antenna] is an extraordinarily original and technically bold mission concept that will open up an entirely new way of observing the universe*" and recommended that NASA provide additional technology development funds for LISA. However, the FY 09 budget request cuts about $129 million from the amount requested for these missions FY 09 – FY 12 for future missions in the Physics of the Cosmos program, according to NASA internal budget documents.

- How will programmatic cuts affect the overall Physics of the Cosmos program and the technology investments required to continue such innovative missions as LISA?

Are NASA's plans for an exoplanet mission to explore planets near stars like the Sun consistent with the findings of the Astronomy and Astrophysics Advisory Committee's (a Congressionally-chartered committee) Exoplanet Task Force?
The FY 08 budget request reduced the Space Interferometry Mission (SIM) mission, which would conduct a census of planetary systems and to identify the location and masses of targets for potential further study, to the level of a technology development program. The consolidated appropriation for FY 08 added $60 million and included explanatory language directing NASA to start developing SIM. The FY 09 request does not present SIM as a mission development program and instead notes that "*A new medium-class Exoplanet mission, managed by the Jet Propulsion Laboratory, will begin formulation in 2010, for which a re-scoped version of Space Interferometry Mission (SIM) is being evaluated as a potential candidate*." The Astronomy and Astrophysics Advisory Committee, chartered by Congress, convened an ExoPlanet Task Force, which developed "*a 15 year strategy for the detection and characterization of extrasolar planets ("exoplanets") and planetary systems*."

- What are the advantages and disadvantages of NASA's decision not to pursue full development of SIM?
- Will the exosolar planet mission planned in the FY 09 budget be revisited as part of the decadal survey, and if so, what does that mean for advancing NASA's newly created Exoplanet Exploration program?

What are the objectives of the Hubble Space Telescope Servicing Mission-4?

A fourth and final Shuttle servicing mission (STS-125) is scheduled for August 2008 to install new science instruments that will improve the Hubble's observational capabilities and to replace batteries and gyroscopes that will allow the Hubble to continue operating through 2013.

Heliophysics

The President's FY 09 budget request for NASA includes $577.3 million in direct program dollars for the Heliophysics theme, which seeks to understand the Sun and its effect on the Earth and the rest of the solar system; the conditions in the space environment and their effects on astronauts; and to develop and demonstrate technologies to predict space weather. The FY 09 request represents a decrease of $267.6 million in direct dollars from the FY 08 appropriation, due in large part to the programmatic and budgetary transfer of Deep Space Network and ground network systems (approximately $250 million) to the Space Operations Mission Directorate.

The program funds:

- Heliophysics research, including research and analysis; space missions; sounding rockets and other scientific platforms; science data and computing technology;
- the Living with a Star program that investigates solar variability and its effects on Earth (space weather) and the rest of the solar system;
- the Solar Terrestrial Probes program, which studies the interrelationships among the Sun, the Earth, and planetary systems; and
- the small and medium-class competitively-selected missions (Explorer missions) that endeavor to provide frequent flight opportunities to investigate focused research.

Key Issues for Heliophysics

How are data collected by NASA research satellites used for operational space weather services? What is needed to ensure the optimal use of NASA-funded research to improve space weather prediction? The Heliophysics Living with a Star Program includes the study of space weather and seeks improve our ability to predict variability in our Sun and solar storms. Space weather events can interfere with both on-orbit spacecraft and terrestrial assets such as electric power grids and can pose hazards to astronauts, especially during space walks. As society becomes increasingly reliant on global positioning signals for ground-based applications,

communications satellites, and Earth observations systems, the potential implication of spacecraft losses or altered signals due to space weather intensifies. NASA funds space research missions to help understand the nature and behavior of space weather. NASA also funds research to develop models of space weather. NOAA is responsible for the operational Space Weather Prediction Center, which provides forecasts on and alerts of space weather events. The Air Force also has a space weather capability. This year, NASA will launch the first mission of its Living with a Star Program, the Solar Dynamics Observatory (SDO).

- What contribution will the research data from the SDO mission make to improving the prediction of space weather?
- Data from NASA's Advanced Composition Explorer (ACE) research mission have been integrated into operational space weather services. What is NASA's role in helping plan for the continuity of data that is currently provided by ACE?

Are NASA's plan and proposed budget for initiating a Solar Probe mission realistic? The Solar Probe mission, which is part of the Living With a Star Program, was the highest priority large mission ranked in the 2002 National Academies decadal survey for solar and space physics. The objectives for the mission are to travel close to the Sun to measure the "*heating and acceleration of the solar wind*." The FY 08 omnibus appropriation provided $17 million "*for the solar probe mission for continued technical risk reduction activities and related studies. NASA is expected to request a new start…in fiscal year 2009*." NASA's current plans are to fund a new start for what is referred to as "Solar Probe Plus," a scaled down version of Solar Probe. However, the FY 09 budget request does not include dedicated funding for a Solar Probe mission. The status of Solar Probe is at the stage of concept development for a potential medium-class mission at a NASA estimated level of $750 million. The FY 09 request does not propose any funding for Solar Probe in FY 09, and the proposed FY 10 allocation is only $3.4 million, although the scheduled launch date is 2015.

APPENDIX A **FY 09 NASA Budget Request**

(Budget authority, $ in millions)	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
SCIENCE	**4,706.20**	**4,441.50**	**4,482.00**	**4,534.90**	**4,643.40**	**4,761.60**
EARTH SCIENCE	**1,280.30**	**1,367.50**	**1,350.70**	**1,250.90**	**1,264.40**	**1,290.30**
Earth Science Research	375.8	380.6	388.2	390.6	400.7	409.3
Earth Systematic Missions	530.1	677.9	661.5	583.2	563.6	569.6
Earth System Science Pathfinder	113.8	88.6	58.8	37.4	50	54.9
Earth Science Multi-Mission Operations	167.8	140.5	159.1	157.9	166.5	170.9
Earth Science Technology	47.3	46.1	49.2	50.6	51.6	52.8
Applied Sciences	45.4	33.8	33.8	31.3	32.1	32.8
PLANETARY SCIENCE	**1,247.50**	**1,334.20**	**1,410.10**	**1,537.50**	**1,570.00**	**1,608.70**
Planetary Science Research	242.1	270.8	315.8	355.6	373.2	382.6
Discovery	153	247	258.3	256	326.1	140.5
New Frontiers	132.2	263.9	250.3	232.3	227.7	236.9
Mars Exploration	553.5	386.5	299.6	344.5	341.1	413.8
Outer Planets	81.9	101.1	216.7	279.4	230.6	362
Technology	84.8	64.9	69.3	69.6	71.3	73
ASTROPHYSICS	**1,337.50**	**1,162.50**	**1,122.40**	**1,057.10**	**1,067.70**	**1,116.00**
Astrophysics Research	102.2	152.3	170.4	181	203	198.9
Cosmic Origins	807.3	674.4	571.1	515.4	485.6	458.5
Physics of the Cosmos	159	157	219.8	249	271.1	326
Exoplanet Exploration	162.6	48.1	67.7	68.4	96.4	126.2
Astrophysics Explorer	106.4	130.6	93.3	43.3	11.7	6.4
HELIOPHYSICS	**840.9**	**577.3**	**598.9**	**689.4**	**741.2**	**746.6**
Heliophysics Research	181.2	184.8	180.3	175.3	179.8	187.5
Living With A Star	217.1	223.8	212	216.6	232.8	237.5
Solar Terrestrial Probes	105.9	123.1	137.5	171.4	172.6	161.5
Heliphysics Explorer Program	61	41.3	66.8	125.1	156	160.1
New Millenium	25.8	4.3	2.2	1.1		
Near Earth Networks	39.5					
Deep Space Mission Systems	210.5					
Year to Year Increase		**-5.62%**	**0.91%**	**1.18%**	**2.39%**	**2.55%**

* FY 2008 Appropriation rescinded $192.475 M in prior-year unboligated balances, effectively reducing FY 2008 authority. Not included in totals.

** FY 2008 budgets are the enacted levels per the FY 2008 Appropriation as shown in the Agency's FY 2009 Budget Estimates. Source: NASA

Appendix B
Missions Exceeding Congressional Cost and Schedule Thresholds

Mission	% Cost Growth (from Base Year)	Delay in Months (from Base Year)
NPOESS Preparatory Project	19	26
Glory	31	3
Aquarius	6	10
Orbiting Carbon Observatory	18	3
Kepler	25	8
GLAST	5	8
SOFIA	3	9
Herschel	13	14

Source: NASA Fiscal Year 2009 Budget, Management and Performance Section