# COMMITTEE ON SCIENCE
# U.S. HOUSE OF REPRESENTATIVES

## *NASA Science Priorities*

### Hearing Charter

**Thursday, May 9, 2002 2:00 – 4:00 pm**
**2318 Rayburn House Office Building**

## 1. Purpose of Hearing

On Thursday, May 9, 2002, at 2:00 p.m. in room 2318 Rayburn, the Subcommittee on Space and Aeronautics will hold a hearing on NASA Science Priorities. The hearing will examine NASA's programs in Space Science, Earth Science, and Biological and Physical Research and strategies used to prioritize the missions and science goals within each of these enterprises.

Specifically, the hearing will review NASA's science program, including new initiatives for FY03, and the processes used to make decisions regarding mission selection, science focus, and timing. In addition, the hearing will examine the extent to which the science community is effectively used as a resource for prioritizing science goals. Major topics to be addressed include science goals for the International Space Station, strategies for Solar System exploration, and applications for Earth Science data.

## 2. Major Issues

**NASA's Outer Planets Strategy.**[1] Due to significant cost growth, NASA has proposed to terminate the "Outer Planets Program," canceling the Europa Orbiter mission and the Pluto-Kuiper Belt mission. In its place, NASA has proposed a new initiative for Solar System exploration called the "New Frontiers Program." New Frontiers will be cost-capped at $650 million per mission. Program goals will be based on the science priorities resulting from a National Academy of Sciences study ("New Frontiers in the Solar System: An Integrated Exploration Strategy") to be completed by early July 2002. Issues to be explored in the hearing include: Can the Pluto mission be funded under the New Frontiers Program? Will the program call for mission-specific proposals, or will proposals for all destinations be allowed? Are missions more costly than the New Frontiers program limit, such as a mission to Europa, possible under the proposed budget structure for solar system exploration?

**Nuclear Systems Initiative.** In its FY03 budget submission, NASA proposed to conduct research on three potential nuclear power energy sources for deep space probes: Nuclear Fission Electric Propulsion Research; Nuclear Fission Power Research; and a new design of Radioisotope Thermal Generators (RTG's) for Mars '09 and subsequent planetary exploration. These technologies could enable deep space missions without the need to rely on gravity-assisted trajectories using nearby planets, an option that can only be exploited when the planets are in the proper alignment. They would also enable probes to enter orbit around distant bodies and remain there for extended data collection time. This initiative spawns many questions. Will there be active coordination between NASA and

[1] Outer planets are the planets beyond Mars.

the Department of Energy and the Navy in the development of nuclear technology? What are the cost estimates for the development of these technologies? How likely is it that any of these technologies will be ready soon enough and at a cost that can support multiple missions under the New Frontiers program? Will the RTG's be available in time for the Mars exploration mission in '09? How will the newly designed devices be safety tested?

**United States Global Change Research Program and the Climate Change Research Initiative (Earth Science).** NASA's Earth Science Enterprise is the largest single component—about 70 percent—of the U.S. Global Change Research Program (USGCRP), providing satellites and data that serve as the backbone for the program. The USGCRP is currently under review by the Administration to determine the best government-wide approach for global climate change studies. No new follow-on missions to the Earth Observing System (EOS) are being proposed by NASA until the Administration has completed this review. Further issues to be covered during the hearing include the following: How will changes in the USGCRP and the related Climate Change Research Initiative (CCRI) impact NASA's Earth Science Enterprise? What assumptions can be made in the budget over the next five years given the current review of climate change programs and the freeze on development of follow-on earth science satellites?

**International Space Station Research.** The space station research program was cut by nearly $1 billion last year as a result of the projected cost overruns of the Space Station. The International Space Station (ISS) Management and Cost Evaluation (IMCE) Task Force, which last year evaluated the budget and management challenges facing the program, concluded that NASA needed to have clearer priorities for space station research. As a result, NASA created the Research Maximization and Prioritization (REMAP) Task Force to perform an independent review and assessment of research productivity and priorities for the entire scientific, technological and commercial portfolio of NASA's biological and physical research. A report from the review is due in June 2002. What is the status of REMAP? How is REMAP different than previous studies on science priorities? Can REMAP adequately address and prioritize all the varied disciplines of scientific research proposed for the ISS? How will research directed toward long-term space flight be compared to other scientific research proposed for the ISS?

**Prioritization Guidance from the National Science Community**. The various science enterprises within NASA engage the outside scientific community to various degrees when formulating science and mission plans. In some disciplines, representatives of the scientific community outside of NASA are providing formal science prioritization recommendations, such as the National Research Council's decadal reviews in astronomy and astrophysics, solar system exploration, and solar and space physics. The current REMAP (Research Maximization and Prioritization) Task Force is evaluating NASA's Biological and Physical Research program including International Space Station research priorities. Are these engagement strategies effective for prioritizing national goals for science in space? To what extent does NASA incorporate the recommendations of the outside scientific community? Can dialogue with the outside community be improved?

## 3. Background

### Space Science

NASA's Space Science Enterprise is responsible for all of NASA's programs relating to astronomy, the solar system, and the sun and its interaction with Earth. According to NASA, its mission is to seek the

answers to the following fundamental questions: "How did the Universe begin and evolve?" "How did we get here?" "Where are we going?" "Are we alone?" Space Science Enterprise programs are developed and prioritized under the following science themes: Structure and Evolution of the Universe, Solar System Exploration, Astronomical Search for Origins, and the Sun-Earth Connection. Missions can be individually funded, especially large, high priority flights (e.g., Hubble Space Telescope and the Mars Explorers), or funded through the "Discovery," "Explorer," or the proposed "New Frontiers" programs. The FY03 budget request for the Space Science Enterprise is $3,414.3 million, a 19 percent increase over the FY02 operating plan (see Appendix); this increase includes $191 million for Deep Space Network operations which are transferred from the Human Space Flight account. The budget request features two very significant changes from the previous baseline program, including "New Frontiers" as a reformulated planetary program, and a Nuclear Systems Initiative (discussed below).

Astronomy and astrophysics programs at NASA and the National Science Foundation (NSF) are examined in the National Academy of Sciences decadal survey report entitled "Astronomy and Astrophysics in the New Millennium," which prioritizes astronomy missions for both ground-based and space-based research. The highest priority major mission in the report's recommendation is the Next Generation Space Telescope currently under development by NASA. The report also recommends active interagency cooperation between NASA and the National Science Foundation for planning and coordinating programs in astronomy and astrophysics. Other programs like planetary science within NASA's Space Science Enterprise have not generally had the benefit of such external guidance from a cohesive national scientific community, but now there are two new decadal surveys underway by the National Research Council, one for Solar System Exploration and one for Solar and Space Physics. The reports from these studies are due in July and should be a guide to NASA in setting science and mission priorities.

**The New Frontiers Program**

A major revamping of the solar system exploration program—known as the New Frontiers Program--was proposed in the President's FY03 budget request. In contrast with usual past practice for outer solar system programs, missions in this program will be selected through an open and competitive process similar to that of the successful Discovery program and will be subject to rigorous reviews of cost, schedule, and risk. A cost limit of $650 million would apply to each mission. Nuclear power and propulsion technologies developed through the Nuclear Systems Initiative are envisioned as a key element of New Frontiers missions, enabling missions that can reach their targets faster than current missions and that will enable missions to remain at their target for longer periods of time before moving on to other targets.

Some researchers have suggested that the "New Horizons" Pluto-Kuiper mission, canceled in the FY'03 budget, should be funded as the first New Frontiers mission to ensure that Pluto is reached before its atmosphere freezes out (roughly predicted to take effect around 2020). A 2006 launch is required to take advantage of a gravity-assist by Jupiter. According to NASA, however, consideration of the Pluto-Kuiper mission for inclusion in the new program would require $122 million to be appropriated in FY03 and very strong community support (including a top ranking for the mission in the Solar System Exploration decadal review scheduled for release in July). Only $15 million is budgeted for the New Frontiers Program within the current FY03 NASA budget proposal.

NASA believes that even if a Pluto-Kuiper Belt mission ranks high in priority it would benefit by waiting for technologies developed in the In-Space Propulsion Program and the Nuclear Systems

Initiative. This technology would allow more comprehensive study of the outer planets and the Kuiper Belt. NASA believes that a mission utilizing the new propulsion technologies can still reach Pluto before its atmosphere freezes out.

**Nuclear Systems Initiative**

The Nuclear Systems Initiative builds on ongoing NASA investments in advanced electric propulsion and electronics miniaturization and invests in nuclear power and nuclear-electric propulsion technologies that will enable faster, more productive missions to outer planets. These power and propulsion technologies will allow greater science return because of greater power capacity and the ability to allow deep space probes more time to study their targets and even move from target to target. The three components of this technology development include research in nuclear electric propulsion, nuclear power, and radioisotope thermal generators (RTG's) for the Mars exploration mission in 2009 and for subsequent planetary exploration. NASA maintains that safety is the absolute highest priority for the program. Of possible concern is the uncertainty in the cost of these new technologies and the time needed for development.

**Europa**

The Europa Orbiter Mission to a moon (of the same name) orbiting the planet Jupiter was recently canceled by NASA due to cost growth. It was originally estimated to cost $500 million but this had grown to over $1 billion. Many scientists were particularly eager to see this mission succeed because there is strong evidence of water on Europa that may offer the real promise of finding the first forms of life outside our atmosphere. Europa could be considered under the "New Frontiers" program, but given the cost cap, and the need to fly at least one – if not two – radioisotope thermal generators (which are currently in short supply), some consider it highly unlikely this mission will launch. It is unclear if missions beyond the cost scope of New Frontiers are still possible in the current proposed NASA program structure.

## Earth Science

The Earth Science Enterprise (ESE) goals fall under the triad of "science, applications, and technology". Missions and programs are designed to observe and model the Earth system, to realize useful societal applications for the data, and to develop technologies to enable mission success. According to NASA, the purpose of the Earth Science Enterprise is to answer the fundamental question: "How is Earth changing, and what are the consequences for life on Earth?" The proposed FY03 budget for the Earth Science Enterprise is $1,628.4 million, only $4 million (0.17 percent) above the operating plan for FY02 (see Appendix). Pending a current review by the Administration on the national strategy for studies of global change, no new follow-on missions to the Earth Observation System (EOS) are proposed in the FY03 budget. The budget does include funds for missions currently active or in development. These missions include a series of Earth Observation System (EOS) and Earth Explorer missions, some with international partners, including Jason (in collaboration with France), Sage III (atmospheric studies, with Russia), Aqua (clouds and humidity studies, with Japan and Brazil), Grace (to study Earth's gravity field, with Germany), Aura (atmospheric chemistry), and several other missions to study surface ice, winds, and clouds on Earth. Also included are funds for the National Polar-Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP) and formulation funds for an ocean topography mission to follow the Jason mission launched in 2001. This mission will be implemented as a partnership between NASA, NOAA, and their European counterparts and will serve as a bridge project for research and operational mission agencies. The

Enterprise also supports programs for Advanced Technology and for Applications, Education, and Outreach.

The Earth Science Enterprise does not have as strong a dialogue with the national scientific community outside of NASA as does the Space Science Enterprise, although ESE does consult the outside community extensively when developing criteria for research priorities. The most recent Earth Science decadal review by the National Academy of Sciences ("Review of NASA's Earth Science Enterprise Research Strategy for 2000-2010") was a useful outside study of NASA's own Earth Science research plan, but it was not a prioritization effort and plan generated from the external scientific community to the same degree as are the decadal surveys for Space Science. There is a study underway by the National Academy of Sciences to recommend steps to facilitate University based, Principal Investigator-led Earth Science missions, as is encouraged in the Space Science enterprise. This would increase university involvement in NASA's Earth Science programs, though not at the level of guiding prioritization.

**United States Global Change Research Program**

A primary goal of the Earth Science Enterprise is to study global climate change, whether natural or human-induced. NASA is a major component of the interagency U.S. Global Change Research Program (USGCRP), contributing about 70 percent of the program by providing satellites and foundational data. The USGCRP is currently under review by the Administration to determine the best government-wide approach for global climate change studies. NASA will not to pursue any new Earth Science missions until the Administration has completed this review. Development will continue on previously started projects like the Landsat Data Continuity Mission. NASA's $3 million allocation from the Climate Change Research Initiative is being used for NPP (NPOESS Preparatory Project) algorithm development and aircraft observations of black carbon.

**Commercial Data Purchase for the Landsat Data Continuity Mission**

The Landsat Data Continuity Mission (LDCM) is a joint program with the U.S. Geological Survey to continue to provide Landsat-type data to researchers through a commercial remote sensing data purchase program. The LDCM program is unique in that it endeavors to balance the needs of geographic information systems scientists and researchers, while ensuring commercial viability for commercial remote sensing industry providers who can sell their satellite data to other users, such as farmers, commercial users, and other government agencies. The benefit to the government is that NASA would not bear the full cost and risks of the program. The LDCM program is currently under the formulation study phase, with a contract award expected in FY03.

## Biological and Physical Research

The purpose of NASA's Biological and Physical Research is to answer fundamental questions about the effects of the space environment on the fundamental principles of physics, chemistry, and biology as well as to conduct research to enable safe and productive human habitation of space for long-duration human space flight. This research is primarily focused on the International Space Station, but other research platforms such as aircraft and Space Shuttle flights are used to conduct microgravity research. The NASA FY03 budget request for biological and physical research is $842.4 million, a 2.7 percent increase from the FY02 operating plan. New FY03 initiatives include biological research over

multiple generations for a species in a variety of Earth orbits and research into the means to protect humans from radiation damage in Low Earth Orbit.

**Research Maximization and Prioritization Task Force (REMAP)**

NASA has chartered an independent task force under the NASA Advisory Council to provide recommendations regarding the research priorities for the agency's biological and physical research. The Research Maximization and Prioritization (REMAP) Task Force will serve as follow-on to the International Space Station (ISS) Management and Cost Evaluation (IMCE) Task Force, which last year evaluated the budget and management challenges facing the International Space Station program. REMAP is chartered to perform an independent review and assessment of research productivity and priorities for the entire scientific, technological and commercial portfolio of NASA's biological and physical research and to provide recommendations on how best to achieve its research goals. One issue raised is whether the REMAP Task Force's recommendations for research priorities are solely based on scientific merit alone or if the priorities are constrained within the President's FY03 budget request. In formulating recommendations for ISS science, the REMAP Task Force faces a difficult task of balancing and comparing research focused on a goal of supporting long-term human space flight with research in a wide range of disciplines that is focused on other important goals. The REMAP Task Force plans to report their findings to the NASA Advisory Council in June 2002.

**Non-Government Organization Management of the International Space Station**

In P.L. 106-391, NASA was authorized to enter into an agreement with a Non-Government Organization (NGO) to conduct the research utilization and commercialization management activities of the International Space Station. The objectives for an NGO arrangement of Space Station research are to reduce the time associated with processing research activities and increase the research productivity by effectively integrating academic, government, and industry utilization of the Space Station. NASA's NGO concept development team is currently preparing for a future procurement.

**Space Shuttle Science: STS-107 Research Flight**

Most recent Space Shuttle flights have been dedicated to activities related to International Space Station construction, leaving little mission time for scientific research on the shuttle. A long-sought dedicated Space Shuttle mission (STS-107) for biological and physical research experiments is finally scheduled for launch in July 2002. After 26 months of delay from its original launch date of May 2000, the STS-107 flight using the SpaceHab Double Research Module will perform research for crew health and safety as well as complete combustion and bioreactor experiments from previous missions. Questions remain as to whether microgravity science will be conducted on future Shuttle flights.

## 4. Witnesses

**Dr. Edward Weiler, NASA Associate Administrator for Space Science,** has been asked to address the following questions: What science goals and new initiatives are proposed in the FY03 budget request for NASA's Space Science Enterprise? What barriers must be overcome to implement the Nuclear Systems Initiative? What actions are planned to coordinate and collaborate with the Department of Energy, the Department of the Navy, and other relevant government agencies on this initiative? How will NASA incorporate or respond to the recommendations of the national scientific community such as current decadal reviews? What is the strategy for the "New Frontiers" outer planets program, and could a mission to Pluto be considered within that program?

**Dr. Ghassem Asrar, NASA Associate Administrator for Earth Science,** has been asked to address the following questions: What science goals and new initiatives are proposed in the FY03 budget request for NASA's Earth Science Enterprise? What is NASA's role in the U.S. Global Change Research Program and the Climate Change Research Initiative? How might the results of the current review of these programs alter what or when follow-on Earth Observing System (EOS) missions are flown? How does NASA's Earth Science program incorporate expertise and recommendations from the national earth science research community outside of NASA when setting science priorities? How can involvement of the outside scientific community be increased? What are NASA's plans for enhancing applications and access for NASA Earth Science data?

**Ms. Mary Kicza, NASA Associate Administrator for Biological and Physical Research,** has been asked to address the following questions: What science goals and new initiatives are proposed in the FY03 budget request for NASA's Biological and Physical Research? What are the objectives for NASA's Biological and Physical Research Maximization and Prioritization (REMAP) Task Force? How will science aimed at long-term human space flight be compared to research with other goals in the science prioritization process for the International Space Station? What is the status of NASA's plans to implement a Non-Governmental Organization (NGO) for International Space Station research?

# Appendix: Funding Profiles

**Office of Space Science**
($=millions)

| | FY2001 Oplan | FY2002 Oplan | FY2003 Request | FY2004 Outyear | FY2005 Outyear | FY2006 Outyear | FY2007 Outyear |
|---|---|---|---|---|---|---|---|
| **Development Programs** | 395.4 | 446.9 | 396.4 | 311.3 | 167.0 | 86.6 | 33.1 |
| *Space Infrared Telescope Facility (SIRTF)* | *118.3* | *113.0* | *47.4* | *0.0* | *0.0* | *0.0* | 0.0 |
| *Hubble Space Telescope (HST)* | *179.5* | *172.0* | *138.9* | *73.3* | *30.8* | *31.6* | 33.1 |
| *Gravity Probe-B (GP-B)* | *41.2* | *46.1* | *19.7* | *0.0* | *0.0* | *0.0* | 0.0 |
| *Thermosphere, Ionosphere, Mesosphere... (TIMED)* | *13.3* | *4.2* | *0.0* | *0.0* | *0.0* | *0.0* | 0.0 |
| *Stratospheric Observatory for Infrared Astronomy (SOFIA)* | *43.1* | *38.0* | *46.9* | *41.3* | *0.0* | *0.0* | 0.0 |
| *Solar Terrestrial Relations Observatory (STEREO)* | *0.0* | *52.9* | *74.3* | *90.0* | *61.2* | *20.7* | 0.0 |
| *Gamma-ray Large Area Space Telescope (GLAST)* | *0.0* | *20.7* | *69.2* | *106.7* | *75.0* | *34.3* | 0.0 |
| **New Frontiers** | 0.0 | 0.0 | 15.0 | 155.0 | 240.0 | 245.0 | 265.0 |
| **Payload and Instrument Development** | 39.6 | 47.5 | 38.0 | 22.0 | 18.1 | 12.3 | 10.2 |
| **Explorers** | 141.3 | 125.2 | 135.1 | 164.1 | 248.2 | 267.1 | 278.6 |
| **Discovery** | 213.0 | 214.6 | 207.7 | 231.1 | 252.8 | 260.9 | 265.9 |
| **Mars Exploration Program (MEP)** | 429.5 | 415.9 | 453.6 | 405.9 | 499.1 | 488.1 | 599.7 |
| **Mission Operations** | 122.8 | 174.8 | 385.2 | 423.4 | 384.4 | 379.1 | 388.5 |
| **Technology Program** | 353.2 | 440.2 | 703.9 | 1,009.4 | 1,111.5 | 1,258.1 | 1,286.9 |
| *Nuclear Power Program* | *0.0* | *0.0* | *79.0* | *61.0* | *61.0* | *15.0* | *18.0* |
| *Nuclear Propulsion Program* | *0.0* | *0.0* | *46.5* | *153.5* | *141.5* | *138.5* | *91.5* |
| *In-Space Propulsion* | *0.0* | *19.6* | *62.5* | *66.7* | *66.7* | *66.7* | *66.7* |
| **Research Program** | 613.0 | 645.3 | 709.6 | 811.7 | 893.6 | 950.3 | 980.2 |
| **Investments** | 13.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Institutional Support** | 285.6 | 356.7 | 369.8 | 373.0 | 379.8 | 383.3 | 407.9 |
| **TOTAL** | **$2,606.6** | **$2,867.1** | **$3,414.3** | **$3,906.9** | **$4,194.5** | **$4,330.8** | **$4,516.0** |

**Office of Earth Science**
($=millions)

| | FY2001 Oplan | FY2002 Oplan | FY2003 Request | FY2004 Outyear | FY2005 Outyear | FY2006 Outyear | FY2007 Outyear |
|---|---|---|---|---|---|---|---|
| **Earth Observing System** | **$710.6** | **$678.4** | **$485.2** | **$438.8** | **$430.1** | **$386.9** | **$351.9** |
| *Terra Project* | *3.3* | *2.4* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* |
| *Aqua Project* | *68.5* | *45.1* | *4.7* | *4.6* | *0.1* | *0.1* | *0.0* |
| *Aura Project* | *99.5* | *70.4* | *85.3* | *0.1* | *0.0* | *0.0* | *0.0* |
| *Special Spacecraft Projects* | *113.4* | *71.0* | *21.0* | *16.0* | *14.7* | *13.9* | *16.1* |
| *EOS Follow-on Projects* | *55.0* | *109.6* | *238.5* | *284.6* | *293.6* | *252.6* | *218.5* |
| *EOSDIS Project* | *279.1* | *293.0* | *74.3* | *76.0* | *69.3* | *71.3* | *66.6* |
| *EOS Algorithm Develop. Proj.* | *89.3* | *83.4* | *59.7* | *55.6* | *52.4* | *49.0* | *50.7* |
| *Quikscat Project* | *1.1* | *1.8* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* |
| *Landsat Project* | *1.4* | *1.7* | *1.7* | *1.9* | *0.0* | *0.0* | *0.0* |
| **Earth Explorers** | **$141.6** | **$74.2** | **$71.2** | **$74.0** | **$90.0** | **$143.6** | **$160.9** |
| **Research and Technology** | **$564.2** | **$537.1** | **$506.3** | **$506.8** | **$507.9** | **$545.8** | **$574.6** |
| **Mission Operations** | **$57.8** | **$47.6** | **$247.8** | **$266.7** | **$250.9** | **$250.6** | **$258.7** |
| **Investments** | **$10.3** | **$0.0** | **$0.0** | **$0.0** | **$0.0** | **$0.0** | **$0.0** |
| **Institutional Support** | **$277.7** | **$288.4** | **$317.9** | **$334.2** | **$350.4** | **$354.6** | **$375.0** |
| **TOTAL** | **$1,762.2** | **$1,625.7** | **$1,628.4** | **$1,620.5** | **$1,629.3** | **$1,681.5** | **$1,721.1** |

**Biological and Physical Research Enterprise**
($=millions)

| | FY2001 Oplan | FY2002 Oplan | FY2003 Request | FY2004 Outyear | FY2005 Outyear | FY2006 Outyear | FY2007 Outyear |
|---|---|---|---|---|---|---|---|
| **Biological and Physical Research and Technology** | **312.9** | **273.9** | **317.9** | **359.6** | **387.9** | **418.5** | **428.3** |
| *Bioastronautics Research* | *101.0* | *95.5* | *113.0* | *116.6* | *122.0* | *122.2* | *125.6* |
| *Fundamental Space Biology* | *40.6* | *35.3* | *56.0* | *77.7* | *98.3* | *121.6* | *126.9* |
| *Physical Sciences Research* | *130.4* | *120.0* | *134.1* | *149.9* | *155.4* | *164.5* | *170.6* |
| *Space Product Development* | *29.2* | *17.0* | *14.8* | *15.4* | *12.2* | *10.2* | *5.2* |
| *Health Research* | *11.7* | *6.1* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* |
| **ISS Research Capability** (FY2001 number included for comparison purposes.) | **[457.4]** | **371.3** | **347.2** | **338.7** | **347.1** | **317.8** | **333.3** |
| **Agency Health and Medical** | | **3.9** | **3.9** | **4.1** | **4.1** | **4.1** | **4.1** |
| **Institutional Support** | **49.3** | **170.9** | **173.3** | **180.6** | **182.7** | **184.8** | **189.1** |
| **TOTAL** | **$362.2** | **$820.0** | **$842.3** | **$883.0** | **$921.8** | **$925.2** | **$954.8** |