SPACE STUDIES BOARD NEWS

JANUARY—MARCH 2008

INSIDE THIS ISSUE

SSB CALENDAR

Cmte on Solar and Space Physics (CSSP)—**Washington, DC**	*Apr. 1-2*
Cmte on Earth Studies (CES)—**Washington, DC**	*Apr. 7-8*
Heliophysics Performance Assessment Cmte—**Washington, DC**	*Apr. 22-24*
Cmte on the Origins and Evolution of Life (COEL)—**Washington, DC**	*May 13-15*
Experts Meeting on Organization of the Decadal Study in Microgravity Research—**Washington, DC**	*May 15-16*
The Societal and Economic Impact of Severe Space Weather: A Workshop—**Washington, DC**	*May 22-23*
Cmte on Science Opportunities Enabled by NASA's Constellation System—**Boulder, CO**	*June 9-11*
Space Studies Board Meeting—**Washington, DC**	*June 25*

FROM THE CHAIR

The only certainty in NASA these days is uncertainty.

Alan Stern, the NASA Associate Administrator for the Science Mission Directorate (SMD), resigned in the last week of March, having had the position for less than one year. Alan is a person of talent, energy, enthusiasm, and dedication to the success of Earth and space science. I wish him well in his career after NASA.

The Associate Administrator for Science at NASA is one of the most demanding management positions in the Federal government. The program is large, diverse, and technically challenging; the interfaces are many. As Associate Administrator, you need to be the equivalent of the CEO of a large subsidiary of a major corporation, and your constituents are as varied as those of the president of a major university. You need to empower a competent staff to manage all the different elements of the science program. You need to coordinate your activities with your management chain and your many external stakeholders so that you in fact have the power to make the right decisions. You need to anticipate that the costs and technical challenges of space hardware are rarely fully predictable in advance, and you have to manage in this uncertainty and deliver successful missions.

Ed Weiler, the current Director of the Goddard Space Flight Center and past Associate Administrator for SMD (1998-2004), has returned as interim Associate Administrator for Science. We should be very grateful for Ed's willingness to re-enter the cauldron of NASA Headquarters and confident of his ability to succeed. Ed has a proven record of having been a highly successful Associate Administrator.

We need, however, to brace ourselves for bad news. The program that Alan Stern put together—seven new starts, an increase in the Research & Analysis budget, all within a budget that only grows at 1% per year—is, in all likelihood, too good to be true, particularly with the pending need to fully fund the Mars Science Laboratory and the James Webb Space Telescope. Ed may find himself in the position of delivering the bad news of reality. As a science community, we need to work with Ed to tell him which of Alan's initiatives are the most important, since all priorities are not possible unless we can get more funding for science at NASA.

There are also some potential liens on the budget for the Science Mission Directorate (SMD), one of which is to fund the cost of flying the Alpha Magnetic Spectrometer (AMS). AMS is an extraordinary project. Many of the world's leading scientists in particle physics formed a consortium to develop a highly capable cosmic ray detector, funded by ~$1.6 billion in international contributions. They did so based on the commitment of NASA, made through the Department of Energy, to launch AMS on the Shuttle and attach it to the International Space Station (ISS). But then the Columbia accident happened, the Shuttle is to be retired, and its remaining use is to complete the construction and supply of the ISS. And so AMS, now in final calibration, has no ride. There is discussion of adding another Shuttle flight, or finding some other solution to launch AMS, but this discussion is often accompanied by the threat of charging the solution to SMD. That is quite unfair. The small portion of AMS that has been NASA's responsibility has always been funded through the physical science organization, which in its latest incarnation is housed within the Exploration Systems Mission Directorate. AMS as an experiment has never been prioritized or even considered by any of the governing NRC studies in astrophysics, and so prioritizing this science within SMD is simply not possible. It would, however, be most unfortunate if AMS remains unflown. It would be yet another example of the United States abrogating an international scientific commitment. It would also be yet another example of the folly of building the ISS but having no way to use it for science, which after all was one of the main arguments for its construction.

There is also uncertainty in Congress these days. In all likelihood, Congress will go home before the election without passing a budget for most agencies, including NASA. There are

strong disagreements between the Democratically-controlled Congress and President Bush on many domestic priorities, and the expectation is that Congress will not conclude the budget for FY2009 until there is a new Administration and a new Congress. That obviously places uncertainty on many of NASA's programs. It is likely that the House or the Senate or both will markup the NASA budget at the Appropriations Subcommittee level, even if the markups do not immediately result in a bill that is sent to the President. It is to be hoped that such markups aggressively fund NASA, since this would be an important signal to the next Administration as to what NASA actually requires to be able to execute the nation's priorities in space.

The most uncertainty results from wondering what the next President's policies will be with regard to NASA and civil space in general. Each of the leading candidates has made some statements about NASA, in varying degrees supportive. There are not many details, nor should we expect any. NASA is not a big issue with the voters who are deciding the highly contested primaries, nor should we expect it to be in the general election.

When the new Administration takes over there is an opportunity for a critical analysis of the Vision for Space Exploration and NASA's role in the national agenda. We are now four years into implementing the Vision. So far, with the exception of the initial FY2005 budget, the Administration has not requested the funds it said were required to execute the Vision. There were underestimates of the costs required to continue to fly the Shuttle and complete the International Space Station. Consequently, NASA has been forced to cannibalize much of the rest of its program to even begin to make progress on the Vision. And it is hard to say that the Vision of returning to the Moon has generated much excitement, or even understanding among the public, particularly among the young who are expected to benefit most from the future that the Vision promises.

As was discussed in previous Chair's columns, and was a subject covered in recent testimony before the House Science and Technology Committee, the new Administration should consider whether there was a flaw in the Vision for Space Exploration, which we did not recognize at the time. The Vision is all about the future – extending our civilization into space, with the long-term benefits that we expect to accrue for our country. There is, however, little in the Vision that is of immediate concern. So when near-term needs intervene, such as providing funds for the war in Iraq or for Hurricane Katrina, it is NASA that comes up short in funding.

It should be possible to provide NASA with a role that is not only about the future, but is important in the present. Perhaps it is a more important geopolitical role – cooperatively leading the nations of the world in the exploration of space, and by doing so improving the image of the United States. Perhaps it is a more important role in improving the competitive position of the United States. Or simply reemphasizing the programs that are of demonstrable immediate importance to the taxpayers – Earth science to provide the scientific basis for understanding global climate change, and aeronautics.

And it is to be hoped that with a more important role for NASA, the new President and his/her Administration will care that NASA succeeds and provide the resources and the opportunity for success.

The future is uncertain, but there is no reason to assume that it cannot be better.

Lennard A. Fisk
lafisk@umich.edu

DIRECTOR'S CORNER

As 2008 and a new budget season in Washington begin, the issues facing NASA seem clear – and familiar. Once again it is difficult to escape the reality that NASA is being asked to do too much with too little, that space science cannot thrive with budget allotments that do not keep pace with inflation and continued cost growth in existing programs, and that constant turnover in leadership depletes morale and imperils strategic planning. Add in the looming potential changes in direction for the agency as a whole stemming from whoever wins the White House in November, and the road ahead appears daunting.

Whatever good news one can find, such as the increase in requested funding for Earth science programs, is coupled with not-so-good news – the money came by robbing

Peter to pay Paul. The increase came at the expense, particularly, of the Mars program, but also astrophysics and heliophysics. Certainly priorities must be set, and there will be winners and losers in any such contest, but one cannot help but wonder when the last shoe will drop.

Lamenting the size of the NASA budget is not fruitful. NASA received $17.3 billion for FY2008, of which the Science Mission Directorate got $4.7 billion (expressed in the new "full cost simplification" budget structure where indirect costs are budgeted in "cross-agency support," and accounting for the shift of the Deep Space Network to a different mission directorate). That's a lot of money, as advocates of other causes will point out. The problem is not so much the size of the budget itself, but the level of resources NASA is being given compared to the tasks it has been assigned.

Congress criticizes the White House for not requesting sufficient funds to match the programs it has asked NASA to pursue. The White House retorts that if Congress found NASA's programs compelling, they would appropriate additional funds instead of abandoning the increases proposed or passed by the House and Senate, as happened during the final days of budget negotiations over the FY2008 budget at the end of last year. Under the Constitution, Congress does indeed have the power of the purse, but the President has the power of the veto, and in a Congress as divided as it is, overriding a veto is next to impossible. For this reason, many expect that Congress will not finalize the FY2009 budget before the elections and, if the Democrats retain Congress and gain the White House in November, final resolution of the FY2009 budget will be deferred until after the inauguration. NASA and most other government agencies then would be required to function under a continuing resolution that holds them at their FY2008 funding levels for about half of FY2009.

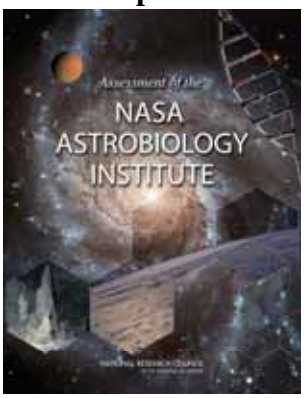
For NASA, the question then is whether its outlook will improve after the elections. That is a difficult question to answer, but it is a reasonable bet that whichever party is in charge will not provide NASA with the amount of funding many NASA advocates assert is needed to adequately fund all the programs NASA has on its plate – $2 billion more per year is an often-heard figure. The chances of Congress passing a $1 billion increase for a single year, as championed in the Mikulski-Hutchison-Shelby amendment in the Senate last year, may have a slightly greater chance of success, but is inadequate to solve the problem.

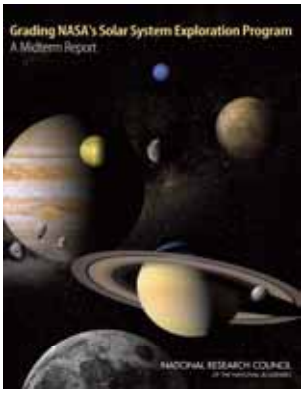
Problems, actually. There is not a single source of NASA's dilemma. Yes, NASA has too many programs on its plate for the likely available resources. And there are cost growth issues, too. Explanations are offered that programs are not experiencing cost "overruns," but that they were underfunded or undercosted from the beginning, and the cost growth was therefore inevitable and knowable. Whatever. The result is the same – existing programs are eating the seed corn. Others complain that NASA centers add to the cost of programs because the political goal of "10 healthy centers" is the driving force at the agency today, not scientific or engineering excellence, or cost effectiveness. Still another factor is lobbying by individuals or groups on behalf of specific projects that were not included in NASA's budget request and ultimately end up in congressional report language directing NASA to pursue them anyway, with no associated increase in resources – essentially unfunded mandates.

Wherever one looks, another seemingly insurmountable problem blocks the road to the future. It is time for a fresh look at all of NASA to devise a program that fits expected resources and has sufficient political buy-in, at least for the next two-year congressional term if not a four-year presidential term, to succeed. The National Academies is about to begin an internally-funded study entitled *Critical Issues in U.S. Civil Space Policy*. It will look not only at NASA, but all of civil space programs (government and commercial) and national security space programs, to the extent that they intersect with civil space. The future of NASA will certainly be a critical focus of the study, however. One cannot hope for magic solutions, but perhaps with a change in leadership at the White House, whether Republican or Democratic, and advice from the distinguished panel that we are now forming, an exciting and executable NASA program will emerge.

Marcia S. Smith
msmith@nas.edu

Recently Published Reports





Free PDFs available online at www.nap.edu

SSB STANDING COMMITTEE CHAIRS

COMMITTEE ON ASTRONOMY AND ASTROPHYSICS (CAA)*
Chair: Charles L. Bennett

COMMITTEE ON EARTH STUDIES (CES)
Chair: Berrien Moore III
Vice Chair: Ruth Defries

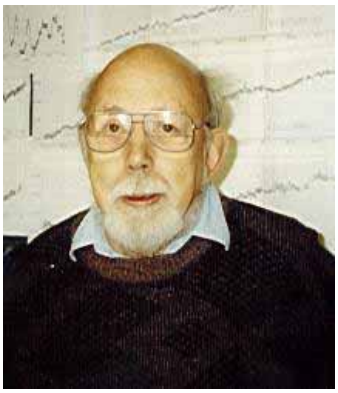
COMMITTEE ON THE ORIGINS AND EVOLUTION OF LIFE (COEL)**
Co-Chairs: Kenneth H. Nealson and Bruce M. Jakosky

COMMITTEE ON PLANETARY AND LUNAR EXPLORATION (COMPLEX)
Chair: Joseph F. Veverka

COMMITTEE ON SOLAR AND SPACE PHYSICS (CSSP)
Chair: Daniel N. Baker
Vice Chair: Thomas Zurbruken

*Joint with the Board on Physics and Astronomy
**Joint with the Board on Life Sciences

DR. FRANK B. MCDONALD RECEIVES THE SPACE STUDIES BOARD'S JAMES A. VAN ALLEN LECTURESHIP



The Space Studies Board is pleased to announce that Dr. Frank B. McDonald has been selected by the SSB's Executive Committee as the recipient of the SSB James A. Van Allen Lectureship for Space and Earth Science.

The award is named for Dr. James A. Van Allen, who was renowned for his role in establishing the International Geophysical Year and for his accomplishments in space science. It was at Dr. Van Allen's home in 1950 that he, Lloyd V. Berkner, and others first conceived of the International Geophysical Year—an 18-month global effort involving scientists from around the world making coordinated observations of various geophysical phenomena. Dr. Van Allen became an original member of the Space Science Board when it was formed in 1958.

Although Dr. Van Allen had a long and distinguished career in space science, he is undoubtedly best known for his participation in Explorer 1, the first successful U.S. satellite. He was responsible for the inclusion of a Geiger counter on Explorers 1 and 3, which led to the confirmation of the existence of the Van Allen Radiation Belts, energetic charged particles that surround the Earth. This discovery created an entirely new field of physics: magnetospheric physics. Over the next four decades, he was involved in more than two dozen other space missions including the Pioneer and Mariner missions and the Orbiting Geophysical Observatory series.

It is fitting, then, that the recipient of the Space Studies Board's James A. Van Allen Lectureship is Dr. McDonald, who began his career as an integral member of Dr. Van Allen's research group at the University of Iowa in the 1950s after completing his graduate studies at the University of Minnesota. From early in his career, Dr. McDonald, who was elected to the National Academy of Sciences in 1986, established himself as a pioneer of space physics and cosmic-ray astrophysics.

Dr. McDonald has made many important discoveries in space physics using instruments for which he has been the Principal Investigator, the quiet time fluxes of 3-12 MeV electrons; the important role of radially propagating merged interaction regions with modulating cosmic rays; and a particle population he named "anomalous cosmic rays," which are a component of low-energy cosmic rays with a highly unusual elemental composition. He is one of the members of the scientific team for the Voyager missions, and he continues to study data from the Voyager spacecraft to determine characteristics of the heliosheath, the region of subsonic flow of solar plasma beyond the termination shock at our solar system's edge.

Dr. McDonald built a world-class laboratory for high-energy astrophysics at NASA's Goddard Space Flight Center, which developed important instruments for studying x-rays, gamma-rays, and cosmic rays. Dr. McDonald served as NASA Chief Scientist and, later, as Associate Director/Chief Scientist at Goddard. He also worked for a brief period at the Office of Science and Technology Policy. Upon retiring from NASA, he became a Senior Research Scientist in 1989 at the Institute for Physical Sciences and Technology at the University of Maryland, where he continues to produce important science.

We are pleased to recognize Dr. McDonald's contributions to the field of space science. Dr. McDonald will present his lecture, entitled *Explorer 1: Gateway to the Never Ending Wonders of Space Science*, at an invitation-only event at the National Air and Space Museum on June 26 as part of the SSB's celebration of 50 years of space science and the SSB's 50th birthday. The full text of his remarks will be included in the fall edition of this newsletter.

Victoria Swisher
vswisher@nas.edu

The Lloyd V. Berkner Space Policy Internship

The deadline to apply for the autumn Lloyd V. Berkner Space Policy Internship is **June 16, 2008**. For information about applying, please visit our website <http://www7.nationalacademies.org/ssb/Berkner_Space_Policy_Internships.html>.

The Lloyd V. Berkner Space Policy Internships are offered twice annually. The summer program is restricted to undergraduates and the autumn program is open to both undergraduate and graduate students. Individuals seeking a Lloyd V. Berkner Space Policy Internship must have the following qualifications:

- Be a registered student at a U.S. university or college;
- Have completed his/her junior year, majoring in physics, astronomy, chemistry, biology, or geology (other areas considered on a case-by-case basis);
- Have long-term career goals in space science research, applications, or policy;
- Possess good written and verbal communications skills and a good knowledge of his/her particular area of study;
- Be capable of responding to general guidance and working independently;
- Be familiar with the internet, world-wide web and basic research techniques; and
- Be familiar with Microsoft Word and HTML (highly desirable, but not essential).

IMPACTS OF THE FY2009 NASA BUDGET REQUEST

Charles L. Bennett is a professor of physics and astronomy at Johns Hopkins University

NASA's astrophysics program has had a record of great success, and continues to address some of the most pressing scientific questions facing us today. But, it is a time of transition for the program.

Budget levels for astrophysics in FY2008, as in FY2007, are flat, and the proposed FY2009 budget shows a decrease in real terms before flattening in the out-years through FY2013. While the Science Mission Directorate's (SMD) budget outlook is similar, the astrophysics program actually declines as a percentage of SMD, in part to support the important new initiatives in the Earth Sciences Division.

Despite the diminishing budget, NASA was able to respond effectively to the NRC's NASA Astrophysics Program Assessment report, which recommended that NASA ensure a diversified portfolio of small and large missions.

NASA reinstated the Nuclear Spectroscopic Telescope Array (NuSTAR), and issued an announcement of opportunity for a new Small Explorer-class mission. Similarly, following the Beyond Einstein Program Assessment Committee's advice, NASA will proceed with the Joint Dark Energy Mission (JDEM) as the first of the Beyond Einstein (BE) missions to move forward. NASA deserves credit for rebalancing the program within the available resources.

While the last decadal survey's number one priority mission, the James Webb Space Telescope (JWST), is expected to have reached its peak funding level in FY2008, there remains the potential for more contingency funds to be added. Other large potential liens threaten the new balance in the astrophysics program.

In the FY2008 Consolidated Appropriations Bill, Congress directed NASA to study the delivery of the Alpha Magnetic Spectrometer (AMS) to the International Space Station (ISS). Since there are no available shuttle missions on which AMS can be launched before the Shuttle retirement date, either Congress would need to require and fund an additional Shuttle flight, or AMS would need to be placed in orbit by other means. Estimates of this alternative approach are on the order of $400 million to build a spacecraft and purchase a launch. AMS remains a potential lien on the astrophysics budget. The Space Interferometry Mission (SIM) received Congressional direction to continue development, at a level of $60 million, or $38.4 million over the request. A Congressional mandate for a SIM new start, without additional new funding, would place an enormous squeeze on the already over-constrained program. The current large mission development expenditures in the astrophysics program fund JWST, JDEM, and the Stratospheric Observatory for Infrared Astronomy. The new liens threaten to eliminate technology development for future missions, such as those in the BE line, eliminate small missions, substantially reduce the operating missions, and cut back support for research and analysis grants.

The FY2009 budget then poses some difficult questions for the upcoming Astronomy and Astrophysics Decadal Survey. The previous decadal survey's number one priority mission, JWST, will reach its peak funding level within this decade. But as the FY2008 appropriations and FY2009 request play out, will the astrophysics budget be able to support a new flagship? Is SMD's programmatic rebalancing from larger to smaller missions stable, or will the lack of available funds skew the program increasingly towards only smaller missions?

There are many exciting potential missions to consider, but the declining budget and large unknowns will make prioritization a challenge. The next survey will be difficult, but the community looks forward to planning how best to address the most compelling questions in astronomy and astrophysics, using realistic mission cost estimates within a realistic overall budget.

Joseph F. Veverka is a professor of astronomy and chair of the Astronomy Department at Cornell University.

A major task for COMPLEX during the remainder of 2008 will be to help set up a committee which will start work in early 2009 on the next Decadal Study for planetary exploration. The last Decadal, New Frontiers in the Solar System: An Integrated Exploration Strategy, was published in 2003. During the past year a group chaired by Wes Huntress and Norine Noonan (Committee on Assessing the Solar System Exploration Program) was tasked with assessing the progress made by NASA in achieving the goals established in the last Decadal. With a few significant exceptions, the committee found that NASA is making reasonable progress in achieving the goals established, but also concluded that progress was unlikely to continue at the current rate due to a number of factors including escalating mission and launch vehicle costs. The report deplored the fact that NASA had so far failed to implement either a Europa mission or a Mars Sample Return mission, both given the highest priority in the last Decadal.

Most recently COMPLEX has been assessing the implications of the FY 2008 and proposed FY 2009 budgets for planetary science. Some good things are happening, but there are also concerns. Plans to increase the funding for R&A programs and to re-invigorate astrobiology research have been announced. Work is being initiated on planning the next major flagship mission to the outer solar system to continue the exploration tradition of Voyager, Galileo and Cassini.

Sadly, at the same time the continuity and stability of the highly successful Mars Program is threatened by proposed restructuring accompanied by significant reductions in funding. Ironically one of the reasons given for the restructuring is to put more emphasis on a future Mars Sample Return (MSR) mission thereby being more in line with the recommendations of the last Decadal Study. Another reason appears to be that funds are being redistributed to other efforts. While generally strong community support for an MSR mission exists, there is vigorous skepticism that NASA will be able to devote the resources necessary to carry out an MSR mission on the schedule proposed.

The community is anxiously awaiting the release of the next New Frontiers AO. However, there are already concerns about the likely cost cap. The last New Frontiers AO, which led to the selection of JUNO, had a cost cap of $750M. Although several studies during the past year have concluded that a reasonable cost cap would be about $950M, there are rumors that the actual cost cap will be significantly less. Such a situation will lead to predictable problems in the future. Is NASA ready to select less challenging and less ambitious missions, or will it buy into a future in which cost overruns are a certainty? Cost overruns have had and will continue to have severe consequences on a system that is not structured to maintain adequate reserves and margins.

IMPACTS OF THE FY2009 NASA BUDGET REQUEST (CONTINUED)

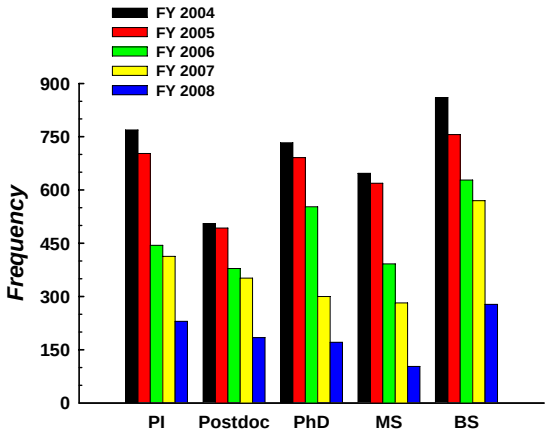
James Pawelczyk is an associate professor of physiology, kinesiology, and medicine at the Pennsylvania State University

At a glance, NASA funding for life and microgravity sciences in FY 2009 appears similar to previous years. But the details count. While the overall bottom line changes little, a subtle, yet significant renewal may be underway.

Life and microgravity sciences remain in the Advanced Capabilities Division of the Exploration Systems Mission Directorate. In FY 2008 the budget request for this Division was $671 million direct costs; in FY 2009 the request is $452 million. The largest reduction in the Division's budget results from changes in the Lunar Precursor Robotic Program as the Lunar Reconnaissance Orbiter enters its integration and testing phases. Funding for life and microgravity sciences appears to have stabilized; the largest portion remains the Human Research Program, whose allocation of $152 million is increased slightly from a FY 2008 level of $147 million.

Good news? It depends on your perspective. To fully appreciate the FY 2009 budget request one needs to place it in the context of the changes in funding that have occurred over the past 5 years. With the dissolution of the Office of Biological and Physical Research the life and microgravity sciences research portfolio was rebalanced to reduce fundamental research while preserving those elements considered essential to near-term exploration goals. This pragmatic approach led to unprecedented cuts in funding for life and microgravity sciences, cuts that were borne disproportionately by the external science community.

An analysis of the NASA Task book (peer1.nasaprs.com), the official reporting database for external life and microgravity sciences research, tells the story more clearly. Five-year data are summarized in the following figure:



In FY 2004, 769 investigators were funded, supporting 505 postdoctoral fellows, 733 PhD students, and 860 undergraduate students. In FY 2008 just 230 principal investigators are funded, supporting 184 post docs, 171 PhD students, and 278 undergraduate students. Consistent with near-term exploration priorities, the loss of investigators in the human research program (36%) is less than that observed in fundamental space biology (70%) and the physical sciences (90%). Overall, the 5-year impact has been considerable.

FY 2009 sustains these cuts with some improvements. Two solicitations in human research were funded in the FY2008, the first such offerings in three years. Radiation biology has received similar attention, with new requests for proposals in FY 2007 and FY 2008. Complete funding statistics are not yet available, but one can expect from these solicitations that a total of approximately 20 newly funded proposals will be chosen from more than 400 applications; an overall funding rate of less than 5%. Although this rate is shockingly low (composite NIH funding rates are at more than 20%, for example), the fact that so many applications were received suggests that there remains strong interest in NASA from the life sciences community.

The next 18 months will be equally important to the physical sciences community. New research racks and modules arriving at the International Space Station in March, May and September 2008 will enable new combustion and fluid sciences research. Work performed with these facilities is characterized as "non-exploration research" as part of the NASA Authorization Act of 2005 that designated the ISS as a National Laboratory and required that 15% of ISS research funding be directed toward non-exploration research. In addition, the FY 2008 budget includes a much welcomed Congressionally-directed budget augmentation of $13.5 million which has led to restoration of funding for several previously cancelled projects in the physical sciences. Unfortunately this augmentation is not reflected in FY 2009 or subsequent years of NASA's budget request, so the future status of these projects, and the future of space life and microgravity sciences as whole, remains uncertain.

It is precisely this uncertainty which has prompted a key new component in the FY 2008 authorization language, directing the NASA Administrator, "to enter into an arrangement with the National Research Council to conduct a 'decadal survey' of life and physical sciences research in microgravity and partial gravity to establish priorities for research for the 2010-2020 decade." This will be a new task for the Space Studies Board that could have great consequence for fundamental research in these areas.

In summary, in FY 2009 life and microgravity sciences are retained in limited form as directed technology programs that support development of the Orion spacecraft and lunar exploration. Some "keep alive" measures are helping to sustain interest from the external science communities, at least in the short term, and non-exploration research is experiencing some growth. The challenge before these groups will be to communicate, through the upcoming decadal planning process, their strategic and long-term value to the Vision for Space Exploration.

Berrien Moore III is Executive Director, Climate Central, Inc .

Dr. Moore's views on the impacts of the FY2009 budget can be found in his testimony to the House Committee on Science and Technology Subcommittee on Space and Aeronautics which is reprinted on pg. 15 of this newsletter.

IMPACTS OF THE FY2009 NASA BUDGET REQUEST (CONTINUED)

Daniel N. Baker is professor and director at the Laboratory for Atmospheric and Space Physics at the University of Colorado

Introduction

The Heliophysics Division (HPD) of NASA's Science Mission Directorate (SMD) is concerned with understanding the Sun and its effects on the Earth and the broader solar system. HPD works in concert with other parts of NASA and with other federal agencies to pursue both basic, fundamental physical research as well as to understand and mitigate the effects of the space environment ("space weather") on space-based and ground-based technologies. In this sense, heliophysics pursues both programs in local astrophysics as well as programs of applied science.

Prior to the Fiscal Year (FY) 2004 federal budget cycle, HPD (and its predecessor solar and space physics managerial entities) had established a vigorous, balanced, and highly effective set of programs built around four major lines of funding. The longest-established line was the Explorer program, which is shared with the Astrophysics Division. This Explorer program is managed by HPD for all of NASA. In FY04, the Explorer line was funded at today's equivalent of ~$300M. The Explorer line includes medium-class (MIDEX) and small-class (SMEX) missions.

Other HPD program lines included the Solar Terrestrial Probe (STP) program that is intended to carry out community-consensus missions of high priority interest for solar and space physics. The STP line of spacecraft was envisioned as costing ~$350-400M per mission and was planned to have a launch every 18-24 months.

The third, and newest, HPD line of missions is called the Living with a Star, or LWS, program. This component of HPD was viewed as supporting the "applied", or space weather, part of the heliophysics program. The funding for this LWS program was envisioned as being in the $300M range (in present-day dollars) and was again viewed as supporting a wide range of community-consensus missions at a cadence of one new launch every 18-24 months.

Rounding out the HPD flight program is the suborbital (sounding rocket and balloon) program. This part of the HPD portfolio has long been viewed as a key arena in which to fly and test new instrumentation, to train students, and to validate new technologies. The suborbital program had historically been funded at a level equivalent to perhaps $100M per year (in FY08 dollars), but over time, this funding had fallen (by ~FY07) to ~$30M per year.

These HPD flight programs, along with Research and Analysis (R&A) and Mission Operations and Data Analysis (MO&DA) funds have constituted the NASA solar and space physics portfolio.

FY 2009 Heliophysics Program Division Budget Request

The President's budget request for Heliophysics amounts to $577.3M. This number would have totaled $833.3M, but in the FY09 budget, $256M was transferred out of HPD to another NASA mission directorate. This funding had, in prior years, been managed by HPD to cover the Deep Space Network and other space operations needs. Table 1 shows the FY09 budget request plus the 5-year runout.

Table 1: Heliophysics Budget for FY 2009

Fiscal Year	Budget Authority ($M)
FY 2009	$577.3M
FY 2010	$598.9M
FY 2011	$689.4M
FY 2012	$741.2M
FY 2013	$746.6M

Comparison to Solar and Space Physics Decadal Plan

The first-ever decadal program plan for Solar and Space Physics was published by the National Research Council in 2003. This plan, called *The Sun to the Earth – and Beyond*, laid out a clear and compelling plan for attaining the top NASA priorities across the heliophysics discipline. Table 2 shows the decadal plan elements in various program categories. The right hand column shows what the FY09 budget contains pertinent to each program category.

As can be seen, in the large (or "flagship") category, the FY09 budget calls for starting a major (~$750M) mission called "Solar Probe Plus". This will accomplish some, but not all, of the objectives describe for the decadal Solar Probe program. In the "moderate" category of missions (STP and LWS), only two missions have been started in the HPD program plan. The number one STP program, Magnetospheric Multiscale (MMS) has now entered the detailed design (Phase B) stage, but the launch is deferred several years beyond the decadal plan. The MMS launch date is now planned for 2014 and the cost is ~$980M, over twice the original budget. Other STP missions of high priority in the decadal survey, the Global Electrodynamics Constellation (GEC) and the Magnetospheric Constellation (MagCon), do not appear in the FY09 budget at all.

Table 2: Top NASA Recommendations From *The Sun to the Earth -- and Beyond* (NRC, 2003)

Decadal Survey		FY 2009
Category	Recommendation	Budget Status
Large	Solar Probe	Solar Probe Plus
Moderate	1) Magnetospheric Multiscale	Launch deferred to 2014
	2) LWS Geospace	RBSP launch in 2012
		ISTP Missing
	3) Jupiter Polar Mission	June launch in 2011
Vitality	NASA SR&T	R&A back to pre-cut levels

In the LWS moderate-mission category, the Radiation Belt Storm Probe (RBSP) mission has also entered Phase B and is on target for a 2012 launch. However, the companion geospace mission, Ionosphere-Thermosphere Storm Probes (ISTP), does not appear at all in the FY09 budget request.

The final, high-priority moderate mission for heliophysics that appeared in the decadal plan was a Jupiter Polar Mission. A different, but rather comparable, mission was selected by NASA's Planetary Division under the New Frontiers banner. This mission (Juno) will launch in 2011.

Lastly, the 2003 Decadal Review gave a high priority to revitalizing the Supporting Research and Technology (SR&T) part of the HPD budget. It was regarded as key in the decadal plan to rebuild the sounding rocket program and to bolster Research and Analysis funds. To NASA's credit, the suborbital program was increased from ~$30M (in FY08) to ~$45M (in FY09). Also, the R&A program of HPD has begun a small, gradual increase.

IMPACTS OF THE FY2009 NASA BUDGET (CONTINUED)

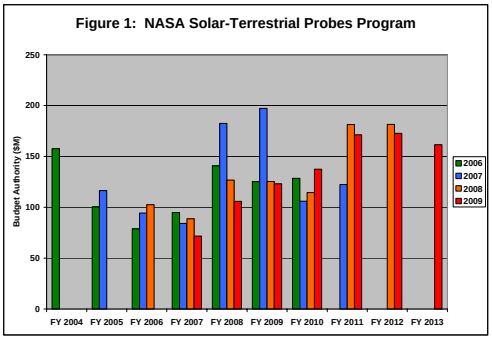
Major Issues

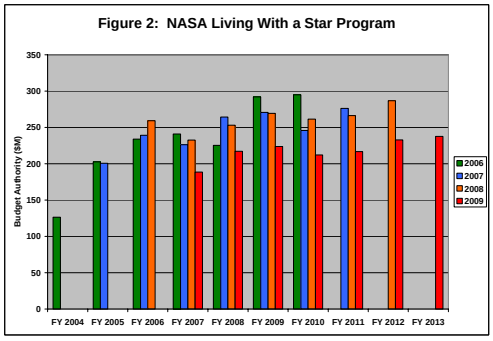
To begin with good news, the last year or two in HPD has seen some very positive accomplishments. The Solar-B mission (now called "Hinode") was launched successfully in September 2006 and is returning excellent solar physics data and images. The two-spacecraft STEREO mission was launched successfully in October 2006 and is producing outstanding solar wind and solar imaging data. The five-spacecraft MIDEX mission, THEMIS, was launched in 2007 and is operating very well in pursuit of magnetospheric substorm studies. Similarly, the Aeronomy of Ice in the Mesosphere (AIM) Small Explorer mission was launched in April 2007 and has already returned spectacular new images of polar mesospheric (or 'noctilucent') clouds. All of these are truly outstanding achievements in heliophysical science.

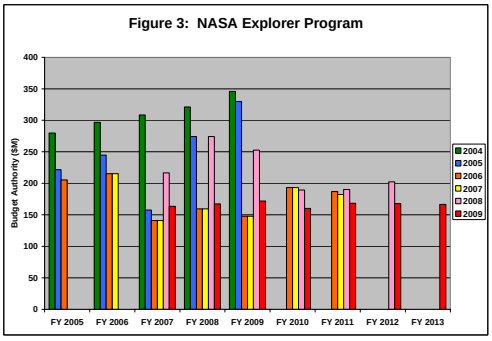
However, despite these remarkable successes and achievements, there are severe stresses in the heliophysics program. Figure 1 shows the annual budgets for the Solar-Terrestrial Probes program from FY04 to FY13. The dark green shows the FY06 plan for STP while blue shows FY07, orange shows FY08, and red shows FY09. As was noted above, the decadal plan had anticipated $200-300M per year for STP funding. The current budgets are approximately one-third of this level. Perhaps by FY11 or FY12, we may see budgets reaching half of what they were in the FY03 budget plan. Over $1B of content has been removed from the STP program compared to what the decadal plan estimated.

What about Living With a Star? Figure 2 shows the same kind of request and five-year runout numbers for LWS as was shown for STP in Fig. 1. We see from Fig. 2 that LWS has remained healthier in general than STP. However, the FY09 budget removes $70-80M per year from the Living With a Star Program compared to what was planned even as recently as FY06.

Finally, the Explorer program is also not exempt from reductions. Figure 3 shows the budget and runout that had been planned for Explorers in the FY04 period. Expectations were that ~$350M per year would be available for both heliophysics and astrophysics Explorer missions. The FY09 budget request provides for half that amount of annual spending. As with the STP program, we can conservatively estimate that the Explorer program has lost $1.5 to 2.0B of funding authority since FY04, when the Vision for Space Exploration was announced.







Summary

In assessing the FY09 budget impacts, I would urge taking a longer view. Tremendous content in the heliophysics program was removed in the FY05, FY06, and FY07 budgets. This harm has continued in the enacted FY08 budget plan and would be further propagated by the FY09 budget request. A healthy, balanced budget existed for heliophysics in the recent past (~FY03-FY04), but this has been decimated in recent years.

I would urge strongly that NASA work aggressively to constrain cost growth in its major (community consensus) programs and missions. I believe that applying the lessons and techniques from PI-led missions could help constrain major mission costs.

Finally, I would urge immediate and full restitution of funding in the Explorer, R&A, and sounding rocket programs. These are not huge amounts of dollars, but they are key to workforce training, to instrument development, and future space research capability.

SSB ACTIVITIES

THE BOARD AND ITS STANDING COMMITTEES

The **Space Studies Board** (SSB) held its 155th meeting at the National Academies' Keck Center in Washington, DC, on March 10-12, 2008. The first day was devoted to briefings on relevant agency budgets for fiscal year 2008 and the requests for fiscal year 2009. Guest speakers included Alan Stern, NASA Science Mission Directorate; Jitendra Joshi, NASA Exploration Systems Mission Directorate; Mary Kicza, NOAA-NESDIS; Wayne van Citters and Richard Behnke, National Science Foundation; Dennis Kovar, DOE Office of Science-High Energy Physics; Paul Shawcross and Amy Kaminski, Office of Management and Budget; Damon Wells, John Henry Scott, and Jean Cotton-Allen, Office of Science and Technology Policy; and congressional staff, including Dick Obermann, House Science and Technology Subcommittee on Space and Aeronautics (Democratic Staff); Ed Feddeman, House Science and Technology Subcommittee on Space and Aeronautics (Republican Staff); and Chan Lieu, Senate Commerce Committee (Democratic Staff). The Board continued the discussion of the fiscal year 2009 budget request on the second day with reports on its impacts from the chairs of the SSB standing committees and a Board member from the microgravity life and physical sciences. The Board also met with the NASA Administrator, Mike Griffin.

The Board will meet next at the National Academies' Keck Center in Washington DC, on June 25, 2008.

The **Committee on Astronomy and Astrophysics (CAA)** is on hiatus until the completion of the upcoming Astronomy and Astrophysics Decadal Survey.

The **Committee on Earth Studies (CES)** resumed activities following a long hiatus while the decadal survey, "Earth Science and Applications from Space," was underway. The newly appointed members of the committee can be found at <http://www7.nationalacademies.org/ssb/ces1.html>. As the quarter ended, the committee was making final preparations for an April 7-8, 2008 meeting in Washington, DC. Guests at this meeting will include the Director of NASA's Earth Science Program, Michael Freilich, and the head of NOAA NESDIS, Mary Kicza. Following discussions with these officials and others, as well as the relevant NRC units, the committee will prepare draft statements of task for studies or workshops that would be carried out by ad hoc NRC committees.

The **Committee on the Origins and Evolution of Life (COEL)** held its first meeting of 2008 at the National Academies' Keck Center in Washington, DC, on February 13-15. In addition to briefings on the current status of NASA's astrobiology and related programs, the committee devoted a significant amount of time to presentations, discussions, and deliberations concerning NASA's planning for an outer solar system flagship mission. In response to a request from the Space Studies Board, committee members drafted an assessment of the current status of Astrobiology program in light of the agency's enacted budget for FY 2008 and proposed budget for FY 2009. Astrobiology studies in planning or being organized by COEL include: (1) a review of the planetary protection requirements for Mars sample-return missions—requested by NASA and to be undertaken by an ad hoc committee; (2) "An Astrobiology Strategy for the Exploration of the Outer Solar System"—proposed to NASA but not yet initiated; and (3) "The Origins and Evolution of Life: A Science Strategy for the 21st Century"—statement of task in development.

Future meetings of COEL will take place on the following dates: May 13-15, 2008, in Washington, DC; October 22-24, 2008, in Irvine, California; and February 18-20, 2009, in Washington, DC.

The **Committee on Planetary and Lunar Exploration (COMPLEX)** met on March 19-21, 2008, at the National Academies' Keck Center in Washington, DC. In addition to briefings on the status of NASA planetary sciences, the presentations and discussions of the committee were primarily focused in three areas: (1) understanding funding and development issues related to the Mars Science Laboratory mission; (2) potential commercial capabilities for launching small planetary science missions in the future; and (3) understanding NASA's needs for the upcoming NRC decadal survey in solar system exploration. Other presentations included briefings on NSF plans for the Arecibo Observatory, Stirling cycle technology for radioisotope-powered missions, and early results from the Messenger flyby of Mercury. The committee is currently organizing a meeting for August 20-22, 2008, in Woods Hole, that will focus on the planning needed for the decadal survey

The **Committee on Solar and Space Physics (CSSP)** did not meet this quarter, but its first meeting of 2008 will be held April 1-2 at the National Academies' Keck Center in Washington, DC. The committee will receive presentations on the current state of NASA and NSF heliophysics programs, NASA's research and analysis grant program, ground-based neutron monitors, an economic analysis of the impacts of space weather, and the committee will also discuss the congressionally-mandated NASA Heliophysics Performance Assessment. The committee will pursue several topics for potential future workshops or studies and plans to meet again in August.

STUDY COMMITTEES

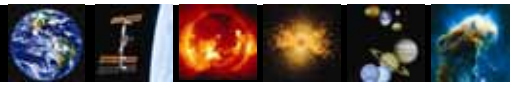
The ad hoc **Committee to Assess Solar System Exploration** released its final report, *Grading NASA's Solar System Exploration Program*, in November and briefed NASA officials in early January. The committee co-chairs and several members also briefed congressional staff of the House Science and Technology Committee and the House Appropriations Committee. In March the committee co-chairs and several members also briefed the NASA Advisory Council's Planetary Science Subcommittee on the results of the committee's study. Associate Administrator for Science Mission Directorate Alan Stern and NASA Administrator Mike Griffin both stated in congressional testimony for the FY2009 budget that NASA was pursuing an outer planets flagship mission because the NRC had given NASA a low grade for not starting the Europa mission recommended by the 2003 solar system decadal survey. They also stated that because the NRC had given the Mars Exploration Program an "A" grade, the agency could afford to make cutbacks in that program.

An ad-hoc **Committee on Critical Issues in U.S. Civil Space Policy** is being organized under the auspices of the SSB and the ASEB to prepare a report to advise the government on critical issues in U.S. space policy. The committee will, inter alia, analyze the rationale for U.S. efforts in space and the elements comprising leadership in this area; examine the balance and interfaces between fundamental scientific research in space, human space exploration, and applications of space technology and civil space systems for societal benefits; assess the role that commercial space companies can play in fulfilling national space goals and the proper role of the government in facilitating the emergence and success of commercial space companies; and recommend options for government attention to address and potentially resolve problems that the committee might identify.

The committee will identify issues that are critically important to the future vitality and progress of the U.S. civil space program and recommend options to address and resolve critical issues. The committee should complete its work in the first half of 2009.

The first meeting of the ad hoc **Heliophysics Performance Assessment Committee** is scheduled for April 22-24 at the National Academies' Keck Center in Washington, DC. The committee is tasked with studying the alignment of NASA's Heliophysics Science Division with previous NRC advice, primarily the relevant NRC solar and space physics decadal survey, *The Sun to the Earth-and Beyond*. This is the SSB's third mid-decade assessment of the activities of a NASA science division, and is preceded by two prior SSB reports: *A Performance Assessment of NASA's Astrophysics Program* and *Grading NASA's Solar System Exploration Program: A Midterm Report*. The committee will receive presentations from and conduct discussions with congressional staff, NASA staff, and former members of the committees that produced the solar and space physics decadal survey and the two prior mid-decade surveys in astrophysics and solar system exploration.

The ad hoc **Committee on NASA's Beyond Einstein Program** held a Town Hall meeting on January 9, 2008 during the AAS 211th meeting in Austin, TX, to discuss the report's findings and recommendations with the astronomy and astrophysics community.



The ad hoc **Committee on a Strategy to Mitigate the Impact of Sensor Descopes and De-manifests on the NPOESS and GOES-R Spacecraft** was formed shortly before the SSB held a workshop on *Options to Ensure the Climate Record from the NPOESS and GOES-R Spacecraft* (summary of the workshop proceedings is available at <http://books.nap.edu/catalog.php?record_id=12033>). NASA and NOAA requested that the NRC form this ad hoc committee to carry out a fast turn-around follow-on study that would: (1) prioritize capabilities, especially those related to climate research that were lost or placed at risk following recent changes to NPOESS and the GOES-R series of polar and geostationary environmental monitoring satellites; and (2) present strategies to recover these capabilities.

As the quarter ended, the committee's report was in external review. A pre-publication version of the report from the committee is expected by April 30, 2008.

The ad hoc **Committee to Review the NASA Astrobiology Institute** has completed all of its scheduled meetings and the published version of its report, *Assessment of the NASA Astrobiology Institute*, was delivered to NASA on March 21. Activities now focus on report dissemination.

The ad hoc **Committee to Review New Opportunities in Solar System Exploration** delivered its report, *Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity*, to NASA on March 4 and publicly released the report on March 12. On the day of its public release, Planetary Science Division director Jim Green announced that NASA had accepted all of the report's recommendations, which increase the number of mission options for the next New Frontiers announcement of opportunity, which will be released by NASA in the summer.

The ad hoc **Committee on Science Opportunities Enabled by NASA's Constellation System** was formed in January and held its first meeting February 20-22 at the Keck Center in Washington, DC. The committee is charged with evaluating new science opportunities that the Constellation program hardware might enable. During its first meeting, the committee was briefed on the Ares I and Ares V rockets and the results of eleven "Vision Mission" studies conducted for NASA from 2005-2006. The committee's second meeting was held March 17-19 at the Beckman Center in Irvine and was entirely devoted to writing the committee's interim report, which entered review on March 31 and is due for release in early May. The committee also issued a request for information to the scientific community and will hold two more meetings, in Boulder, June 9-11 and one in August on a date to be decided. The committee's final report is due in November.

The **Planning Committee on the Societal and Economic Impacts of Severe Space Weather Events Workshop** met on Feb. 19-21, 2008 at the National Academies' Keck Center in Washington, DC. The meeting was focused on data gathering and planning for the workshop, which is scheduled for May 22-23, 2008, in Washington, DC. Members of the committee, as well as a number of invited experts, provided briefings on space weather effects on various infrastructure systems including GPS, aviation, satellites; and the electrical power grid. Speakers from NASA and NOAA briefed the committee on their space weather programs and services, and the committee also heard briefings on economic approaches to evaluating space weather impacts. As arranged, most of the speakers and invited participants remained for a full day of discussion with the committee on the workshop goals, topics, and issues.

The final day of the meeting was held in closed session and the committee developed a preliminary agenda outline and potential list of speakers. Since then the committee has continued to meet via telecon and has been fully engaged in development activities for the workshop sessions and in identifying, soliciting and coordinating with speakers and other participants.

The summary report on the September 2007 **Workshop to Promote Dialog on Space Science Activities and International Traffic in Arms Regulations** was released on February 12, 2008.

A review draft of the report on the November 2007 SSB-ASEB **Workshop on U.S. Civil Space Policy** was completed and sent out for external review in mid-March. The report summarizes highlights of the workshop's invited talks, panel discussions, and general discussions to consider aspects of the question, What are the principal purposes, goals, and priorities of U.S. civil space? The report should be completed and released in the second quarter of 2008.

OTHER ACTIVITIES

The Committee on Space Research (COSPAR) of the International Council of Science conducted its annual business meetings—including meetings of the COSPAR Publications Committee, COSPAR Program Committee, COSPAR Scientific Advisory Committee and COSPAR Bureau—at CNES Headquarters in Paris, France, on March 25-28. Activities now focus on the final preparations for the biannual COSPAR Scientific Assembly, to be held in Montreal, Canada, on July 13-19, 2008.

On March 14, NASA held a **Meeting of Experts on balance in the solar system exploration program**, convened by the NRC. The meeting involved approximately a dozen experts in the field of solar system exploration offering candid off-the-record advice to Associate Administrator Alan Stern and several of his advisors on various issues concerning the future of solar system exploration. Under the rules of the meeting, the NRC does not take minutes or prepare any written materials for NASA. At the time of the meeting, three additional meetings on other space science topics were planned.

Forging the Future of Space Science—The Next 50 Years

In the first three months of this year, the Space Studies Board has continued with its series of events commemorating the 50th anniversary of the International Geophysical Year, with public seminars in Tallahassee Florida, Austin, Texas, and Paris, France. The Paris venue was selected to underscore the international character of space science and was organized in conjunction with COSPAR. Each seminar involved an afternoon panel session addressing the future of space science in various disciplines, followed by an evening lecture.

The featured lectures were delivered by Carl Walz, NASA Astronaut and Director, Advanced Capabilities, NASA Exploration Mission

Systems Directorate (*Leaving the Planet – Science & Technology Development Results on the International Space Station*); Christopher Chyba, Professor of Astrophysical Sciences and International Affairs, Woodrow Wilson School, Princeton University (*The Possibility of Life Elsewhere in the Universe*); and Christopher Rapley CBE, Director, Science Museum, London, England (*Understanding the Poles of the Earth, Moon and Mars*).

Two more seminars will be held in the month of April, and planning is underway for an all day public colloquium, in Washington, DC, on June 26, 2008, the 50th Anniversary of the SSB. The colloquium will be followed by an invitation-only reception at the National Air and Space Museum in the course of which the SSB will award its James A. Van Allen Lectureship to Dr. Frank B. McDonald (NAS). Dr. McDonald will lecture on *Explorer 1: Gateway to the Never Ending Wonders of Space Science.* (See highlight article on p. 4 of this newsletter.)

Details of upcoming events in the series, along with webcasts, podcasts, and presentation files from past events, can be found on the web at: <http://www7.nationalacademies.org/ssb/International_Public_Seminar_Series.html>.

FREE PUBLIC EVENTS

When Where	Lectures
Apr. 14, 2008 Boulder, CO	**Understanding the Sun: Voyager's Continuing Journey of Discovery** Edward C. Stone, California Institute of Technology Local co-host: University of Colorado at Boulder
Apr. 25, 2008 Fairmont, WV	**Future of Space and Earth Robotic Exploration: Scientific and Technological Challenges** Charles Elachi, Director, JPL Local co-host: West Virginia High Technology Consortium Foundation
Jun. 26, 2008 Washington, D.C.	All-day colloquium* Local co-host: The National Academies

** This event will include presentation of the Space Studies Board's first James A. Van Allen Award for career achievement in space and Earth science.*

Webcasts, Podcasts, and PDF files

of the Forging the Future of Space Science panel discussions, roundtables, and lectures are available at <http://www7.nationalacademies.org/ssb/IGY_SSB_2007_webcasts_and_presentations.html>

NEW RELEASES FROM THE SSB

Summaries are reproduced here without references, notes or attachments. Copies of reports are available from the SSB office at 202-334-3477 or online at <www.nap.edu/>.

Space Science and the International Traffic in Arms Regulations: Summary of a Workshop

This report by rapporteur Margaret G. Finarelli is available at <http://www.nap.edu/catalog.php?record_id=12093>. The study was chaired by Norman P. Neureiter and staffed by Joseph K. Alexander, Study Director, Carmela J. Chamberlain, Program Associate, Victoria Swisher, Research Associate, Sandra Wilson, Program Assistant, and Catherine A. Gruber, Assistant Editor.

ITAR, which controls defense trade, includes the U.S. Munitions List (USML) which specifies categories of defense articles and services covered by the regulations. In 2002 ITAR was amended to exclude U.S. universities from having to obtain ITAR licenses when performing fundamental research involving foreign countries and/or persons. Despite this provision, there remains considerable uncertainty among university researchers about whether the regulations apply to their research leading to a rather conservative interpretation of the regulations and the imposition of burdens that might not be necessary. To explore this concern, NASA asked the NRC to organize a workshop of all stakeholders on the implications of ITAR for space science. This book presents a summary of the workshop discussions including those on perspectives on recent developments and implementation of ITAR; overarching issues; problems arising from ITAR's implementation; and opportunities for near-term actions and improvements.

Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity

This report by the Committee on New Opportunities in Solar System Exploration: An Evaluation of the New Frontiers Announcement of Opportunity is available at <http://www.nap.edu/catalog.php?record_id=12175>. The study was chaired by Reta Beebe and Warren W. Buck and staffed by Dwayne A. Day, Study Director, Celeste Naylor, Senior Program Assistant, Victoria Swisher, Research Associate, and Catherine A. Gruber, Assistant Editor.

The New Frontiers Program was created by NASA in 2002 at the recommendation of the NRC's solar system exploration decadal survey . In order to optimize solar system research, the NRC recommended a series of principal-investigator-led missions that encourage innovation and accomplish the main scientific objectives presented in the survey. Two of the five recommended missions have been selected and, as was also recommended in the survey, the NRC was asked in 2007 to provide criteria and guiding principles to NASA for determining the list of candidate missions. This report presents a review of eight missions—the three remaining from the original list of five from the survey, plus five missions considered by the survey committee that were not recommended. Included in the review of each mission is a discussion of relevant science and technology developments since the survey and set of recommended science goals.

CONGRESSIONAL TESTIMONY

At the March 13 hearing before the House Committee on Science and Technology's Subcommittee on Space and Aeronautics, SSB Chair Lennard A. Fisk, and SSB member and chair of the SSB Committee on Earth Studies, Berrien Moore III, testified on their perspectives on the state of space science activities at NASA and the FY2009 budget. Their prepared statements are reprinted here (without references, notes, appendices, tables or figures). Dr. S. Alan Stern, Associate Administrator for Science, NASA, Dr. Steven W. Squyres, Professor of Astronomy, Cornell University, and Dr. Jack O. Burns, Professor, Center for Astrophysics and Space Astronomy, University of Colorado, also testified. Their prepared statements are available at <http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2119>.

NASA's Space Science Programs:
Review of Fiscal 2009 Budget Request And Issues

Before the House Committee on Science And Technology
Subcommittee on Space and Aeronautics
March 13, 2008

(From L-R): Dr. Stern, Dr. Fisk, Dr. Moore, Dr. Squyres, Dr. Burns.

Photo courtesy of the House Committee on Science and Technology

Lennard A. Fisk
NRC Space Studies Board

Mr. Chairman, members of the subcommittee, thank you for inviting me here to testify today. My name is Lennard Fisk, and I am the Thomas M. Donahue Distinguished University Professor of Space Science at the University of Michigan. I also served from 1987 to 1993 as the NASA Associate Administrator for Space Science and Applications. I am currently the Chair of the National Research Council's Space Studies Board, although the views I offer today are my own.

In your invitation letter asking me to testify before you today you asked a series of questions that I would like to address now in sequence.

The State of the Space Science Program

You asked me to comment on whether the space science program is moving in the right direction. I would like to expand this question to read is space science moving in the right direction and are the resources adequate to achieve success.

The budget for the Science Mission Directorate (SMD), and its projected runout, has many, very positive features. There are new starts for seven different missions. Each of the major disciplines—planetary, astrophysics, heliophysics and Earth science—has at least one major new start. Earth science in particular is able to begin making progress in pursuit of the science objectives of its recent NRC decadal survey. There are also increases in the Research & Analysis program, which is vital to the health and the future of space science. The space science community is buoyed by the opportunity to pursue important new science missions and relieved that the unwise decisions of the past have been reversed.

All of these positive features of the SMD program have been accomplished within a fixed budget envelope, which is currently, and for the next few years, growing at only 1% per year. This is a problem. Some of the new starts in the budget come at the expense of other programs that are displaced or deferred. The growth in Earth science is heartening given the importance that society places on deploying NASA's technical prowess to understand global climate change. The growth in Earth science, however, came by taking funds from other science disciplines, all to remain within the fixed budget envelope. Moreover, there is no flexibility in the SMD budget, no robustness. A single major setback in the cost of some mission under development would seriously stress the carefully woven plan of maintaining the vitality of all the different science disciplines.

It needs to be recognized also that NASA's response to the NRC Earth science decadal survey is inadequate if we are serious about understanding global climate change. That decadal survey report pointed out that the Earth science budget has decreased by about $500 million per year since 2000. Restoration of at least this amount of annual funding is required in order that the nation can have a satellite system that adequately provides the sound scientific underpinning for planning for the inevitable climate change that lies before us. However, in the runout of the SMD budget to FY2012 only a total of about $600 million, not $500 million per year, is provided. To be sure, the increased funds for Earth science are all that are available in an overall flat budget. The new funds come from the other science disciplines, and to take more would devastate those constrained, but otherwise healthy programs.

In many ways SMD is a graphic illustration of the dilemmas that face all of NASA—too few resources to accomplish the many tasks that the nation has placed on the agency. Whether it is human space exploration, the use of the Space Station, aeronautics, or science, the funding is not adequate. SMD is doing well with what it has, trying to maintain the vitality of the space and Earth science communities, and to move the program forward with new mission opportunities. However, there is so much more that needs to be done, whether it is a solid start on the Earth science decadal survey recommendations, a vigorous Mars program, a full Living-with-a-Star program, or a vigorous program to understand the astrophysical challenges of dark energy and dark matter. And the budget needs to be robust so that it is actually executable. The

funding constraints on all of NASA and on SMD in particular need to be lifted, and the required resources need to be provided so that the nation can have the space program that the nation needs and deserves.

The State of Heliophysics

You asked me to comment in particular on whether the Heliophysics program is moving in the right direction. Heliophysics is the study of the Sun, the heliosphere (i.e. the region of space created by the solar wind, the outward expansion of the solar atmosphere), the plasma environment of the planets, and the coupling and interactions among these various environments. Research in Heliophysics is essential for understanding the coupling between the Sun and Earth, and for predicting the space environment through which our space assets and eventually our astronauts will fly.

There is good news in this program. As in other disciplines in space science, there is an increase in the Research & Analysis program budget and a new start for the Solar Probe mission. This good news is tempered, as in other disciplines, by the reality that the increase in budget for these elements of the program came at the expense of other planned initiatives, which cannot now be pursued. The budget envelope for Heliophysics is fixed, and in fact has been used, in part, to provide Earth Science with needed funds to make a start on its decadal survey missions. In the case of Solar Probe, then, the required funds have come from the Living-with-a-Star program, which is now unable to pursue, in the near term, either the Sentinel program or missions to the ionosphere.

The new start for Solar Probe should be viewed, then, as a realignment of the scientific priorities. NASA has judged that it is more important to make direct measurements in the region of the solar atmosphere closest to the Sun, than are other priorities such as the study of the ionosphere. This logic is understandable. The inner region of the solar atmosphere is the source of the solar wind and solar energetic particles. It is a region where current instrumentation cannot observe the governing magnetic field and where direct in-situ observations are required to resolve the many mysteries that inhibit our ability to predict the space environment created by the Sun. The Solar Probe mission was endorsed by the 2003 NRC decadal survey for this field. It was considered to be an important, large mission for which funds beyond the planned budget envelope needed to be provided. This has not proven to be feasible, and the required funds have been taken from other planned missions. The science priority, however, of Solar Probe is not in question.

The planned Solar Probe mission is very clever, and solves a number of the concerns associated with previous concepts for Solar Probe. Solar Probe needs to make multiple passes through the solar atmosphere, which is a dynamic, ever changing environment. Only by multiple passes can we avoid confusion that arises from the fact that this is such a dynamic place. The required multiple passes are achievable because the planned Solar Probe mission does not penetrate as close to the Sun as some previous versions of Solar Probes were planned to do. However, the current Solar Probe concept is judged by the scientists who have studied the mission in detail to have a penetration distance that is adequately close to be able to resolve the fundamental processes resulting in the heating of the solar atmosphere and acceleration of energetic particles.

The other important feature of the planned Solar Probe mission is that it is to be undertaken in concert with the European Space Agency Solar Orbiter mission, for which NASA has agreed to provide part of the payload. Solar Orbiter is to be placed in an orbit around 30 solar radii from the Sun, and to achieve an orbit that is inclined to the solar equator. From this vantage point, a capable set of remote sensing instrumentation will make detailed observations of the solar surface and atmosphere, and a capable set of in-situ instruments will observe the solar outputs of plasma and energetic particles in detail.

It should be possible to have Solar Orbiter in place while Solar Probe is doing its penetrations deep into the solar atmosphere, and the combination will be an historic opportunity to once and for all develop a comprehensive, predictive understanding of the basic processes that control the solar atmosphere and its influence on the heliosphere, and on the Earth and other planets. There is, however, an obligation with this combined program that must be met. The instrumentation on both Solar Probe and Solar Orbiter must be comprehensive and complete. The investment in these missions will be large, and the scientific payloads need to be capable of realizing the scientific breakthroughs that this historic opportunity will allow.

The Status and Health of the Science and Engineering Workforce

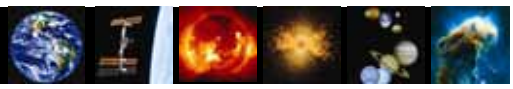
You asked for my perspectives on the status and health of the science and engineering workforce as it relates to NASA's space and Earth science plans. I would respond to this question from several different perspectives.

Let me comment first on the NASA workforce. The age distribution of the civil service workforce at the NASA centers is disturbing. It is strongly peaked at age 45-49, with only a small fraction of the workforce under 30, and almost an equal number over 60. There needs, in my judgment, to be a rejuvenation of the NASA workforce. Experience is important, but more current training, particularly in the engineering disciplines, and the enthusiasm, energy, and willingness to explore new concepts that inherently come with youth, are important as well. It will not be easy to rejuvenate the NASA workforce. Fixed budgets, the current age distribution, and the requirement mainly imposed by Congress for 10 healthy NASA centers places severe restrictions on NASA's ability to hire new scientists and engineers.

There is an unfortunate corollary to NASA's inability to rejuvenate its workforce. We want our best young scientists and engineers to aspire to participate in the nation's space program, yet it is widely known that the prospects for jobs at NASA, and thus a major leadership role in the exploration of space, are meager at best.

Next I would comment on the science and engineering workforce outside of NASA. The number of students available to participate in the space program is probably adequate for the simple reason that space requires only a small fraction of the nation's science and engineering workforce. The issue here is the quality of the students, their particular training, and their attitude when they enter the workforce.

There are many capable science and engineering students in this country. The question is why should the best and the brightest aspire to participate in the space program when there are so many other exciting technical challenges that lie before them. The students see a space program that is not a national priority sufficient to receive the funding and support that is necessary for its success. Under these circum-



stances, only those students who have always aspired to pursue a career in space are likely to enter the field, as opposed to those who have the talents and the capabilities to pursue many different technical disciplines. Thus workforce and priorities for space are linked. If space becomes a national priority, the nation's highly capable technical workforce will respond.

There is also a question of training. It is essential that engineers in particular receive hands-on training with real space projects or space-related hardware. The vast majority of the senior technical workforce currently executing the space and Earth science program had hands-on opportunities earlier in their careers, and they all would say that it was essential for their current success. We should expect no difference for the next generation. It is incumbent upon NASA to provide the universities with the opportunities to offer their students hands-on experience if we are to continue our technical success.

The previous two items are strongly coupled. The experience in most universities is that when students have hands-on research experiences in space engineering as undergraduates they invariably decide to pursue careers in space. If NASA provides universities with the opportunities to offer hands-on experience, not only does the required training occur, but the best and the brightest are recruited into space.

Finally, there is the issue of attitude, particularly among young scientists entering the fields of space and Earth science. Space science is 50 years old this year; Explorer 1, the first space science mission, was launched in 1958. In a science discipline at this age, which is dominated now by scientists who have practiced their disciplines for decades, inevitably there are well established points of view that have been developed, which are resistant to new ideas. It is important that the new scientists entering the field challenge these established points of view, for that is how progress is made in science. And it is incumbent upon NASA, through its Research & Analysis program, to encourage new approaches and new thoughts, so that progress is made and the true answers to the many mysteries of the universe are revealed. Consequently, I strongly support the proposed increase in funding for the Research and Analysis program.

The State of NASA's Space Weather Program

You asked what is the status of NASA's program to collect data and conduct research on space weather. There are two aspects of this issue that I would like to address: first, the monitoring of space weather that affects Earth, and second, our ability to learn how to predict space weather.

It is important to have a spacecraft at the Sun-Earth L1 point in front of Earth that can provide real-time warning of space weather events that will impact Earth, and also provide information on solar wind conditions for basic research on the response of the Earth's magnetosphere, ionosphere, and atmosphere to space weather events. At present this information is provided by the Advanced Composition Explorer (ACE), which was launched in 1997. It is unwise to rely entirely on ACE and its instrumentation, some of which is showing signs of age. It is possible to put up a relatively inexpensive spacecraft to perform the basic monitoring function. I would add that such a spacecraft may be more appropriately a NOAA rather than a NASA responsibility, since NOAA is to provide operational space weather predictions.

The second issue is our ability to develop a true predictive capability for space weather. It is not sufficient simply to monitor the immediate arrival of a space weather event, or to base predictions on general correlations between events on the Sun and the arrival of space weather disturbances at Earth. Rather, we need to have an adequate understanding of the basic physical processes that govern the acceleration of the solar wind, the release of Coronal Mass Ejections, and the acceleration of energetic particles. With this understanding, we will eventually be able to make detailed observations of the Sun, put that information into comprehensive numerical models, and make real-time predictions of the space weather that will impact the space environment of the entire solar system, and of the Earth in particular.

The pursuit of a detailed understanding of the basic physical processes that govern the solar atmosphere and its extension into space, the response of the space environment of Earth, and the development of comprehensive numerical models is the main purpose of the Heliophysics Division in SMD. It is important that these efforts be encouraged so that a true predictive capability is developed as soon as possible. Missions such as Radiation Belt Storm Probes, which are currently under development, are important for understanding the response of the Earth's magnetosphere to space weather events. Missions such as the upcoming Solar Dynamics Observatory and the proposed Solar Probe and Solar Orbiter, which I discussed earlier, are essential for developing an understanding of the basic mechanisms that heat the solar atmosphere and accelerate energetic particles.

It is also important to make maximum use of the space assets currently in place to study the Sun and the plasma environments that the Sun creates throughout the solar system. There is a flotilla of spacecraft in place known as the Heliophysics Great Observatory. These missions, from the recently launched STEREO missions that observe the Sun and its outputs in 3-dimensions to the venerable Voyager missions probing the distant heliosphere, all are essential to our understanding of the physics that governs the plasma processes in our solar system. It is important to use these missions in a coordinated way, to derive the maximum possible information from them, and in doing so to create the scientific foundation for the predictive models of space weather that we require.

Issues to Address in the Reauthorization of NASA

You asked for input on the important issues that should be addressed with respect to NASA's space science program as Congress considers its reauthorization of NASA. I would like to take the liberty of answering this question in the broader context of NASA as a whole since I do not believe that the NASA space science program can be considered separately from NASA's overall activities and goals.

We are now four years into implementing the Vision for Space Exploration that was announced by President Bush in January 2004, and it is worth a critical analysis of where we are. So far, with the exception of the initial FY2005 budget, the Administration has not requested the funds it said were required to execute the Vision. There were underestimates of the costs required to continue to fly the Shuttle and complete the International Space Station. Consequently, NASA has been forced to cannibalize much of the rest of its program to even begin to make progress on the Vision. And it is hard to say that the Vision of returning to the Moon has generated much excitement, or even understanding among the public, particularly among the young who are expected to benefit most from the future that the Vision promises.

We should ask ourselves whether there was a flaw in the Vision for Space Exploration, which we did not recognize at the time. The Vi-

sion is all about the future – extending our civilization into space, with the long-term benefits that we expect to accrue for our country. There is, however, little in the Vision that is of immediate concern. So when near-term needs intervene, such as providing funds for the war in Iraq or for Hurricane Katrina, it is NASA that comes up short in funding.

I would encourage you, then, as you consider the reauthorization of NASA, as I would encourage the next Administration, to provide NASA with a role that is not only about the future, but is important in the present. There are several ideas worth discussing:

NASA could use, and serve, a more important geopolitical role. The obvious one is to lead the world in the exploration of space, in a cooperative and facilitating way. NASA then becomes an instrument of our foreign policy through its ability to improve the image and impact of the United States around the world. If that is important to the next Administration then perhaps the resources necessary for NASA to play its proper role in leading the world will be provided.

NASA could use, and serve, a more important role in improving the competitive position of the United States, through the encouragement of technology development, entrepreneurialism, and technical education. This would be a new emphasis for NASA that would encompass more than just human space flight, which is an engineering challenge but which does not often emphasize new technologies. It is the science disciplines of NASA, with their needs for new sensors and electronics and robotic capability that are a better stimulus for technology.

And finally there are the programs in NASA that are of demonstrable immediate importance to the taxpayers – Earth science to provide the scientific basis for understanding global climate change, and aeronautics. In the current implementation of the Vision these programs have been allowed to decline and atrophy, and they deserve strong re-emphasis.

Berrien Moore III, Ph.D.
Executive Director, Climate Central, Inc
Co-Chair, Committee on Earth Studies, NRC Space Studies Board

Mr. Chairman, Ranking Minority Member, and members of the Committee: thank you for inviting me here to testify today. My name is Berrien Moore III. For the past 20 years, I was Director of the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire. Recently, I have assumed the position of Executive Director for a new nonprofit organization, Climate Central, to be located in Princeton NJ and Palo Alto, CA. I appear, today, largely in my capacity as the recent co-chair of the National Research Council (NRC)'s Committee on Earth Science and Applications from Space, which authored the first "decadal survey" for the Earth Sciences and as the current chair of the National Research Council (NRC)'s Committee on Earth Studies of the Space Studies Board. This said, the views expressed in today's testimony are my own, but I believe they reflect community concerns.

Mr. Chairman, the world faces significant and profound environmental challenges: shortages of clean and accessible freshwater, degradation of terrestrial and aquatic ecosystems, increases in soil erosion, changes in the chemistry of the atmosphere, declines in fisheries, and above all the rapid pace of substantial changes in climate. These changes are not isolated; they interact with each other and with natural variability in complex ways that cascade through the environment across local, regional, and global scales. Information from NASA and NOAA environmental satellites is critical in addressing these problems, but as a result of significant cuts over several past budget cycles, growth in the cost of accessing space and in development of instruments, and inflation, we find ourselves with a growing mismatch between needs and resources. The fiscal year 2009 budget for NASA begins to redress some of this imbalance, but much more will be needed for many budget cycles to come.

I will now turn to the specific questions included in the letter of 28 February 2008 that I received from the Committee:

Do you believe NASA's space science program, and especially the Earth science program, is moving in the right direction? What, if any, changes would improve the program, and why? Please elaborate on your perspectives.

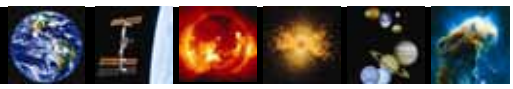
Last June, this subcommittee held a hearing, "NASA's Earth Science and Applications Programs: Fiscal Year 2008 Budget Request and Issues." In opening statements, the chair of the subcommittee (Udall) and its now ranking minority member (Feeney) stated that:

> "I called today's hearing for the purpose of examining how well NASA's plans and programs compare to the priorities of the decadal survey, and the extent to which NASA intends to support those priorities in the FY 08 budget and beyond. As numerous witnesses before this Committee have testified, the situation facing NASA's Earth Science program is not good...to quote the Decadal Survey, the nation's system of environmental satellites is 'at risk of collapse'" –Rep. Mark Udall (D-CO)
>
> "NASA's Earth Sciences program has produced stunning scientific results, often demonstrating, for the first time, measurements and capabilities that have never before been accomplished. I want that record of achievement to continue, and it's also my desire that we build upon the program's success to enable the goals established in the Decadal Survey." –Rep. Tom Feeney (R-FL)

The subcommittee hearing focused on NASA Earth science programs in general and the recommendations of the recently completed National Research Council decadal survey, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond" in particular. The decadal survey outlined near-term actions meant to stem the tide of capability deterioration and continue critical data records, as well as forward-looking recommendations to establish a balanced Earth observation program designed to directly address the most urgent societal challenges facing our nation and the world.

Testifying on behalf of the Decadal Survey steering committee, in which I served as co-chair, Dr. Richard Anthes, President of the University Corporation for Atmospheric Research, outlined the key elements of the recommended program:

- Restoration of certain measurement capabilities to the NPP, NPOESS, and GOESR spacecraft in order to ensure continuity of critical



data sets.

- Completion of the existing planned program that was used as a baseline assumption for this survey. This includes (but is not limited to) launch of GPM in or before 2012 and securing a replacement to Landsat 7 data before 2012.
- A prioritized set of 17 missions to be carried out by NOAA and NASA over the next decade. This set of missions provides a sound foundation for Earth science and its associated societal benefits well beyond 2020.
- A technology development program at NASA with funding comparable to and in addition to its basic technology program to make sure the necessary technologies are ready when needed to support mission starts over the coming decade.
- A new "Venture" class of low-cost research and application missions that can establish entirely new research avenues or demonstrate key application-oriented measurements, helping with the development of innovative ideas and technologies. Priority would be given to cost-effective, innovative missions rather than ones with excessive scientific and technological requirements.
- A robust NASA Research and Analysis program, which is necessary to maximize scientific return on NASA investments in Earth science. Because the R&A programs are carried out largely through the Nation's research universities, such programs are also of great importance in supporting and training the next generation of Earth science researchers.
- Suborbital and land-based measurements and socio-demographic studies in order to supplement and complement satellite data.
- A comprehensive information system to meet the challenge of production, distribution, and stewardship of observational data and climate records. To ensure the recommended observations will benefit society, the mission program must be accompanied by efforts to translate raw observational data into useful information through modeling, data assimilation, and research and analysis.

In order to lay the foundation for implementing the full set of recommendations during the next decade, we further recommended these very near-term actions:

> First, NASA should commit to and begin to implement its recommended Decadal Missions. Although, the NASA budget for Earth Sciences is not now adequate to implement the survey recommendations (see next question), a useful start can be made with modest resources. The survey's initial seven missions (2010-2013) should begin in 2008; the first four (CLARREO, SMAP, ICESat-II, and DESDynI) should begin intensive Phase A activities and the next three (for the time period 2013-2016 -- HyspIRI, ASCENDS, and SWOT) should begin pre-Phase A studies. Increment needed beyond President's Request in FY08: $90 million.
>
> Second, NASA should increase its suborbital capabilities. NASA's airborne programs have suffered substantial diminution and should be restored. In addition, NASA should lead in exploiting unmanned aerial vehicles (UAV/ technology). Both conventional and UAV aircraft are needed for instrument development, and hence risk reduction and technology advancement, and for their direct contribution to Earth observations. Increment needed beyond President's Request in FY08: $10 million.
>
> Third, NASA should increase support of its Research and Analysis (R&A) program and in Earth System modeling. Improved information about potential future changes in climate, weather, and other environmental conditions is essential for the benefit and protection of society. This improvement will come from: a) better observations (the recommended missions and enhanced suborbital capabilities); b) more capable models of the Earth System; and c) a vigorous research program to use the observations in models and interpret the results. The R&A program has suffered significant cuts in recent years and these should be reversed. R&A investments are among the most cost-effective as they directly exploit on-going missions, advance knowledge to better define what is needed in the future, and sustain and develop the requisite scientific and engineering workforce. Increment needed beyond President's Request in FY08: $20 million.

The President's fiscal year 2009 budget for NASA includes a major new initiative in Earth science and applications, including a plan to provide $910 million over five years (FY2009-2013) that addresses to varying degrees the items above and begins implementation of the decadal survey's nearest-term recommendations. In addition, the budget provides funding to restore the OMPS-L sensor to the NPOESS Preparatory Project (NPP) spacecraft, which is now scheduled for launch in 2010, integrate a spare CERES instrument on NPP, and support instrument development and analyses to identify a suitable satellite platform for hosting the total solar irradiance sensor (TSIS). All of this is very welcome news, but I have several concerns:

- **The Initiative's funding comes at the expense of other NASA science programs:** Approximately two-thirds of the additional $910 million over five years are obtained by drawing from each of the three other science areas in the science mission directorate (SMD). In the planetary portfolio, some $200 million came from the Mars program as a result of delay in a Scout mission procurement. The contribution from the Heliophysics division included changes such as a stretching out in the development of the Solar Probe mission. The Astrophysics division contributions were largely obtained by reducing funding in the out-years of the five-year plan, (2011-2013).
- Earth science requires an ongoing commitment of funding at a higher level than is provided in the FY09 budget run-out and redistribution of resources simply is not a long-term solution to the problem. As noted by members of this committee, NASA has been asked to accomplish too much with too little; what is needed is an increase in the overall top-line budget for NASA, which in turn will allow an increase in NASA's science budget. Absent such an increase, it will not be possible to restore Earth science funding to the needed FY2000 levels (as recommended in the decadal survey) without inflicting great damage to the other science portfolio areas.
- **As illustrated below, the Initiative still falls very short of what is required to implement the Decadal Survey**. Below is an updated version of a graphic that we prepared for the Decadal Survey; it now includes budget profiles from the FY08 and FY09 Presidential budgets (FY08 and FY09). As before, we present the data in FY06 dollars to remove the effects of inflation. It is evident that after an

initial rise, funding for Earth science at NASA actually begins to decrease again.

- **The climate record from NPOESS is still very much in danger**. As this committee knows too well, cost and schedule problems triggered a Nunn-McCurdy review of the NPOESS program. Many of the specific capabilities related to better understand, predict, and eventually mitigate the effects of global climate change were lost in the restructured program. The changes to NPP and the decision to find a platform for a new TSIS are welcome news, but, as detailed in a forthcoming NRC report, far from what is needed. Finally, NOAA must have adequate resources to support the development and stewardship of Climate Data Records. This was addressed in both the Interim and Final reports of the decadal survey, and I call it again to the attention of the Committee.

In summary, I am encouraged by the renewed emphasis on Earth science at NASA; however, without additional resources, there is a limit to what management's best intentions can accomplish. The NASA Earth science program is doing what it can with the resources it has been given; it simply has not been given enough to accomplish all that is expected of it, and, more importantly, all that the Nation needs. I address explicitly what further needs to be done in my answer to Question Two below.

What, if any, challenges do you foresee for the future of the NASA Earth science program as presented in the FY 2009 budget request? What are your suggestions for addressing those challenges?

As I noted in my response to question #1, the FY09 NASA Earth science program request is very good news, but I am concerned about whether the initiative can be sustained and whether it is advisable to fund Earth science at the expense of other NASA science programs. The planned addition of $910 million over five years to the Earth science budget also still leaves a very large shortfall in what is needed to execute the recommendations of the decadal survey (see again the figure above).

The 17 missions recommended by the decadal survey are organized into sets in order to take most advantage of concurrent observations to advance our understanding of Earth as a system—four missions are recommended for launch in the 2010-2013 timeframe. In contrast, the FY09 budget plans for one to launch in 2012 and a second in 2015. A third is slated for 2017. This makes the concurrent observations between missions very difficult. The overall program recommended by the decadal survey is simply not being adequately implemented.

I would like to suggest two challenging and important actions: First, both the Science Mission Directorate and the Earth Sciences Division need a budget plus above the President's request. Congress did this last year, and the result was particularly positive since it served to not only achieve the direct benefits one might expect, but it also encouraged industry to begin to invest anew in technologies relevant to the missions recommended by the decadal survey. For the Earth sciences, the target for this Congressional increase should be a) more rapid implementation of the first four missions and b) a greater technology investment in the missions in the 2013-2016 timeframe— particularly the first two or three missions in the 2013-2016 timeframe. Second, Congress should address the inadequacies in the out-year budget; this could be particularly important as the executive branch of government goes through a transition.

As NASA begins to plan missions recommended in the National Academies Earth science Decadal Survey, what actions do the Decadal Survey and other community input recommend to further the applied use of the data for societal benefits and the transition of research data into operational service? What, if any impediments exist that could constrain progress in this area, and how can they be overcome?

In the decadal survey report, the steering committee expressed a particular concern with the lack of clear agency responsibility for sustained research programs and the transitioning of proof-of-concept measurements into sustained measurement systems. To address societal and research needs, both the quality and the continuity of the measurement record must be assured through the transition of short-term, exploratory capabilities, into sustained observing systems. The elimination of the requirements for climate research-related measurements on NPOESS is only the most recent example of the nation's failure to sustain critical measurements. Therefore, our committee recommended that, *"The Office of Science and Technology Policy (OSTP), in collaboration with the relevant agencies, and in consultation with the scientific community, develop and implement a plan for achieving and sustaining global Earth observations.*" In addition, we recommended that the plan recognize the complexity of differing agency roles, responsibilities, and capabilities as well as the lessons from implementation of the Landsat, EOS, and NPOESS programs.

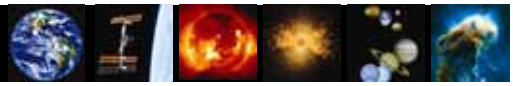
I am pleased to note that this recommendation is being taken very seriously by the OSTP. It is my understanding that they are developing an overall strategy for Earth observations policy, which will include interagency issues of the kind raised in the decadal survey as well as issues related to the U.S. contribution to a global observing system and GEO.

The issue of an overall national strategy and plan for Earth observation is of central importance, and I return to it below in my answer to the Committee's final question.

Another area that requires attention is the NASA applied sciences program. Last year, the NRC completed a review of this program; at the end of my testimony, I attach a copy the recommendations from that report. These recommendations are entirely consistent with those in the decadal survey; we also noted that the key to meeting societal needs for Earth observation data is to have the potential "users" of these data represented in a substantive way from the earliest stages of mission development, determining priorities, designing products, and evaluating benefits. As noted in my response to question #1, renewed support for the NASA Research and Analysis program is also critical to the success of the applied sciences program.

The Committee on Science and Technology plans to reauthorize NASA this year and in so doing will communicate policy direction to NASA as well as to the next Presidential Administration. What, in your view, are the most important issues with respect to NASA's Earth science programs that Congress should consider in its reauthorization of NASA?

NASA should consider how to best leverage its Earth science program resources to accomplish both the intended science and societal outcomes as described in the decadal survey. An integrated programmatic approach is required to align efforts towards these common goals.



This means coordination of, for example, NASA's technology development investments to ensure needed technologies are ready to support recommended missions. It also will require additional support to applications end users' involvement in mission formulation, and targeted R&A investments to begin work on laying the scientific foundation needed to maximize the value of mission observations. In other words, we need to eliminate the traditional "stove pipe" approach, which often decouples funding priorities between program elements; sustained programmatic attention is required to implement the needed missions in a reasonable timeframe. Yet, as we stressed in the decadal survey, the program must also provide opportunities for entirely new measurements and approaches and so programmatic flexibility must be retained to both accommodate and enable new discoveries.

A key to making more efficient use of scare budget resources is to develop a comprehensive approach to Earth observations from space. As stated above in my response to question 3, the decadal survey committee expressed great concern that the nation's civil space institutions (including NASA, NOAA, and USGS) are not adequately prepared to meet society's rapidly evolving Earth information needs. These institutions have responsibilities that are in many cases mismatched with their authorities and resources: institutional mandates are inconsistent with agency charters, budgets are not well matched to emerging needs, and shared responsibilities are supported inconsistently by mechanisms for cooperation. Further, these are issues whose solutions will require action at high levels of the federal government. It was for these reasons that we recommended development and implementation of a comprehensive plan for achieving and sustaining global Earth observations.

Returning to my opening comments, we know that the planet's environment is changing on all spatial scales including global, and change is rapid, perhaps more rapid than at any time in human history. Further, we know that many of these changes are occurring as a result of human activities. These human-induced changes are over and above the stresses imposed by the natural variability of a dynamic planet and are intersecting with the effects of past and existing patterns of conflict, poverty, disease, and malnutrition.

As I noted, the changes cascade through the Earth's environment in ways that are difficult to understand and often impossible to predict. Therefore, at the least, these human-driven changes in the global environment will require that societies develop a multitude of creative responses, including strategies for mitigation and adaptation. Earth observations are a critical part of developing these responses.

The linked challenges of confronting and coping with global environmental changes, and addressing and securing a sustainable future, are daunting and immediate, but they are not insurmountable. These challenges can be met, but only with a new and even more vigorous approach to observe and understanding our changing planet and with a concomitant commitment by all to alter our actions.

SUMMARIES OF CONGRESSIONAL HEARINGS OF INTEREST

Attended and summarized by
Victoria Swisher, SSB Research Associate

House Committee on Science and Technology Hearing
NASA FY09 Budget Hearing
February 13, 2008

Witness: NASA Administrator Michael Griffin.

Representatives: Bart Gordon (D-TN), Mark Udall (D-CO), David Wu (D-OR), Brad Miller (D-NC), Nick Lampson (D-TX), Charlie Melancon (D-LA), Ralph Hall (R-TX), Dana Rohrabacher (R-CA), and Tom Feeney (R-FL).

Congressman Gordon and Congressman Udall noted that the Administration has failed to provide the resources NASA needs to carry out the Vision for Space Exploration. They noted that NASA is addressing the NRC's Earth Science decadal survey by investing more money in Earth Science; however, they were also concerned about other unfunded and underfunded programs in the FY09 request. Committee members were also concerned about the several-year gap between the shuttle retirement and the availability of the new Constellation system, and how that gap will affect NASA's workforce. They discussed with Administrator Griffin options for shortening the gap or otherwise enabling the United States to be able to launch U.S. astronauts during that time period (2010-2015). Administrator Griffin talked about the possibility of purchasing transportation from the nascent U.S. commercial sector, the current status of the Constellation program, and the challenges of narrowing the gap. He indicated that the United States will need to rely on Russia to launch astronauts and therefore new contractual agreements are needed with Russia to use the Soyuz vehicles after the shuttle is retired. That in turn will require Congress to grant another waiver for NASA from the terms of the Iran, Syria and North Korea Nonproliferation Act, which limits what NASA can purchase from Russia in connection with the International Space Station (ISS). Administrator Griffin emphasized the need for Congress to act this year. The current waiver is good through 2011, but time is needed to negotiate a new contract.

Administrator Griffin also discussed the fact that right now using all available cargo space on the space shuttle to complete construction of the ISS has a higher priority than flying the Alpha Magnetic Spectrometer (AMS) to the ISS as a science experiment. If Congress wants NASA to fly AMS to the ISS, an additional shuttle flight will be needed and NASA does not have sufficient funds for it, so Congress would have to appropriate those additional funds. In response to a question about why NASA wants to return to the Moon before sending astronauts to Mars, Administrator Griffin stated that going to the Moon allows the agency to demonstrate technology before going to farther destinations like an asteroid or Mars.

House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies
National Aeronautics and Space Administration
March 5-6, 2008

Witnesses: NASA Administrator Michael Griffin, Associate Administrator for Science Alan Stern, Associate Administrator for Aeronautics Jaiwon Shin, Associate Administrator for Space Operations Bill Gerstenmeier, and Deputy Associate Administrator for Exploration Doug Cooke.

Representatives: Alan Mollohan (D-WV), C.A. Ruppersberger (D-MD), Adam Schiff (D-CA), Michael Honda (D-CA), Rodney Frelinghuysen (R-NJ), John Culberson (R-TX), Robert Aderholt (R-AL), and Tom Latham (R-IA).

The Members in attendance expressed concern over the mismatch between NASA's responsibilities and the President's budget request, and whether it is still possible to maintain a balanced program that supports all aspects of NASA's portfolio. When discussing issues related to the budget, Administrator Griffin asserted that NASA has been allotted enough money by the President to accomplish its goals. The Members discussed with Administrator Griffin international partnership issues arising from the several-year gap between shuttle retirement and the availability of the Constellation system, particularly with regard to U.S. reliance on Russian Soyuz vehicles.

With regard to space science missions, Representative Schiff expressed concern about whether NASA was committed to the Space Interferometry Mission (SIM) to detect exoplanets, and about recently reported changes to the Mars program. Administrator Griffin and Alan Stern asserted that the Mars program was not being significantly changed, except that a Mars Sample Return mission was being added for launch in 2020. At the same time, a new "flagship" missions was being added for other planetary science destinations (e.g., Europa, Titan). Members also expressed concern over whether current investments in university research were attracting the talent needed for NASA's future workforce, and Administrator Griffin replied that while undergraduate and graduate projects are important, an increase in their funding would require that funds be taken from another program at NASA. Members inquired as to the progress in detecting Near-Earth Objects (NEO) and whether Arecibo would be relevant to protecting against NEOs. Administrator Griffin replied that Arecibo is an NSF facility and that NASA should not be expected to be responsible for funding it now that NSF has decided terminate its funding. Alan Stern added that NASA is currently doing a Congressionally-mandated study to identify NEOs that might hit the Earth and that this particular study relies on optical telescopes, not radar telescopes like Arecibo. He added that in general, detecting NEOs relies on a variety of detection methods, not just the radar-based method utilized by Arecibo.

Members also asked how NASA was trying to fly the Alpha Magnetic Spectrometer (AMS) to the International Space Station, to which Administrator Griffin responded that completing the ISS was NASA's priority and it was not currently authorized to fly an extra shuttle mission to accommodate AMS. Administrator Griffin also emphasized the need for the U.S. to bring production capabilities for Plutonium 238 online soon to fuel future NASA science missions that require radioisotope power sources. In response to Members' questions regarding technology development in the Science Mission Directorate and the recent reduction of the New Millennium program, Alan Stern replied that a NASA review found that technology development within individual missions was more effective than having a general technology development program like New Millennium.

Administrator Griffin also discussed with Members the possible scientific value of sending humans to the Moon and the possibility of visiting a Near Earth Object using the Constellation system. Members expressed concern that NASA does not have enough money to accomplish its goals and tried to determine which programs at NASA were suffering as a result. They focused on asking the witnesses about how increases in the Earth Science budget were accomplished and expressed the concern that NASA was reducing the funding for a successful program like the Mars program and pitting different science disciplines and centers against one another for funding. Alan Stern replied that each portfolio in the Science Mission Directorate contributed money to create the boost in funds for the Earth Science budget. Administrator Griffin added that it was not the intent of NASA to pit centers against one another, but that at any budget level each discipline would compete for a larger share. The committee closed the hearing by stating it would be looking for ways to provide NASA with more resources.

SSB STAFF

MARCIA S. SMITH
Director
BRANT SPONBERG
Associate Director and Senior Program Officer
JOSEPH K. ALEXANDER
Senior Program Officer
ARTHUR A. CHARO
Senior Program Officer
SANDRA J. GRAHAM
Senior Program Officer
ROBERT L. RIEMER
Senior Program Officer*
DAVID H. SMITH
Senior Program Officer
DWAYNE A. DAY
Program Officer
BRIAN D. DEWHURST
Program Officer*
VICTORIA SWISHER
Research Associate
BARBARA S. AKINWOLE
Information Management Associate
TANJA E. PILZAK
Administrative Coordinator
CHRISTINA O. SHIPMAN
Financial Associate
CATHERINE A. GRUBER
Assistant Editor
CARMELA J. CHAMBERLAIN
Program Associate
THERESA M. FISHER
Program Associate
RODNEY N. HOWARD
Senior Program Assistant
CELESTE A. NAYLOR
Senior Program Assistant
LINDA WALKER
Senior Program Assistant

*Staff of other NRC Boards who are shared with the SSB

SPACE STUDIES BOARD STAFF NEWS

Celebrations

In January, three members of the SSB staff were honored at the 2007 Division on Engineering and Physical Sciences staff awards. Barbara Akinwole and Victoria Swisher were honored with the Communication Award for their efforts in promoting the Space Studies Board through our website, conferences, and promotional products. Carmela Chamberlain was honored with the Mentorship Award for her years of working with new staff as a mentor, both officially and unofficially.

Congratulations to Barbara, Victoria, and Carmela!!

New Faces

Brant L. Sponberg has joined the SSB as Associate Director and Senior Program Officer.

Before joining the SSB, Mr. Sponberg was a program analyst with the Department of Energy (2007-2008), managed commercial launch and innovative technology development programs at NASA Headquarters (2004-2006), staffed the development of the Vision for Space Exploration under the NASA Comptroller (2003-2004), and covered NASA programs for the White House Office of Management and Budget (1997-2003). Mr. Sponberg received his M.A. in science, technology, and public policy from George Washington University (1997) and his A.B. in astrophysics and history from Harvard University (1995).

Kayleigh Ayn Bohemier and Laura M. Delgado will be joining the SSB this summer as the 2008 Lloyd V. Berkner Space Policy Interns.

Ms Bohemier attends Smith College, where she majors in English and minors in Astronomy, and will be entering her senior year this fall. While at school, she works with the Astronomy Department as a teaching assistant for introductory lab classes. This semester, she is studying abroad at Royal Holloway University of London. Kayleigh discovered her interest in space policy when she read *Venus in Transit*, a work that exposed her to the extensive political drive behind astronomical research and development, shortly after a grassroots work experience. In addition to space policy, her interests include writing, open source software, and cooking. She plans on pursuing a masters degree in Science and Technology Studies or Science Policy.

Ms Delgado will be a senior at the University of Puerto Rico this fall, where she majors in Political Science. Laura became passionate about space policy after stumbling upon an article on space debris and from then on researching about the political role of space exploration. Her internship experience at the Office of Congressman Luis Fortuño during Fall 2007 allowed her to learn more about this complex area and encouraged her to consider it as a career goal for the future. She currently works as a research assistant on a project titled "Corruption, Information and Electoral Accountability" and also as an Intern for Development at the Arecibo Observatory, hoping to ensure that scientific facilities such as this one remain in operation to the advancement of science. Apart from this, she is also a writer, a calligrapher and a certified artisan in pyrography. After completing her Bachelors degree in May 2009, Laura intends to pursue a joint JD and M.A. in International Science Policy, in hopes of one day working as a space policy advisor.


Barbara Akinwole


Victoria Swisher


Carmela Chamberlain


Brant Sponberg

SELECTED REPORTS AVAILABLE FROM THE SPACE STUDIES BOARD

For a complete list of titles visit our website at <www7.nationalacademies.org/ssb/SSB_reports_by_year.html>

Free PDF versions of all SSB reports are available online at <www.nap.edu>.
(Search for available titles then click the blue "Sign in" button to download a free PDF version of the report.)

Hardcopy versions of all reports are available free of charge from the SSB while supplies last.
To request a hardcopy of a report please send an email to ssb@nas.edu, include your name, mailing address, and affiliation.
Remember to include the name and quantity of each report that you are requesting.

2006-2008

___ Space Science and the International Traffic in Arms Regulations: Summary of a Workshop

___ Assessment of the NASA Astrobiology Institute

___ Grading NASA's Solar System Exploration Program: A Midterm Review

___ Options to Ensure the Climate Record from the NPOESS and GOES-R Spacecraft: A Workshop Report

___ NASA's Beyond Einstein Program: An Architecture for Implementation (Request CD__ or Paper__)

___ The Limits of Organic Life in Planetary Systems

___ Portals to the Universe: The NASA Astronomy Science Centers

___ The Scientific Context for Exploration of the Moon: Final Report (Request CD __ or Paper (limited) __))

___ An Astrobiology Strategy for the Exploration of Mars (CD only)

___ Decadal Science Strategy Surveys: Report of a Workshop

___ Building a Better NASA Workforce: Meeting the Workforce Needs for the National Vision for Space Exploration

___ Exploring Organic Environments in the Solar System

___ A Performance Assessment of NASA's Astrophysics Program

___ Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond

___ Space Radiation Hazards and the Vision for Space Exploration: Report of a Workshop (CD only)

___ An Assessment of Balance in NASA's Science Programs

1998-2005

___ Review of NASA Plans for the International Space Station

___ Priorities in Space Science Enabled by Nuclear Power and Propulsion (CD Only)

___ Assessment of Options for Extending the Life of the Hubble Space Telescope (CD only)

___ Utilization of Operational Environmental Satellite Data: Ensuring Readiness for 2010 and Beyond

___ The Sun to the Earth—and Beyond: Panel Reports

___ Satellite Observations of the Earth's Environment: Accelerating the Transition of Research to Operations

___ Using Remote Sensing in State and Local Government: Information for Management and Decision Making (Limited Quantity)

___ Assessment of Directions in Microgravity and Physical Sciences Research at NASA

___ Toward New Partnerships in Remote Sensing: Government, the Private Sector, and Earth Science Research (Limited Quantity)

___ New Frontiers in the Solar System: An Integrated Exploration Strategy

___ The Sun to the Earth—and Beyond: A Decadal Research Strategy in Solar and Space Physics

___ A Strategy for Research in Space Biology and Medicine in the New Century

If you are unable to email your request, please send a copy of this form to the address or fax number below. Remember to enter the number of reports you wish to receive in the space to the left of each report.

Space Studies Board
The National Academies
500 Fifth Street, NW
Washington, DC 20001
or fax a copy to: 202-334-3701

Name _____ Affiliation _____

Address _____ City/State/Zip _____

Email _____