SPACE STUDIES BOARD NEWS

JULY—SEPTEMBER 2006

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FROM THE CHAIR

There is consternation these days between the National Aeronautics and Space Administration (NASA) and its external science community. In August, three senior science advisors were dismissed from the NASA Advisory Council (NAC). In the aftermath, the Administrator of NASA, Mike Griffin, through correspondence with the NAC and its science subcommittees and through a major speech at the Goddard Space Flight Center, clarified how NASA will manage its science program, and the role of the science community.

Quoting from the Goddard speech, "members of the external scientific community are suppliers to NASA, not customers." The role of the science community is defined in this way to avoid what is perceived as an inherent conflict of interest that results when the scientific community is a purveyor of products to the government, while at the same time being the primary source of advice as to which products the government should purchase. Accordingly, the formal internal advisory structure for science in NASA has been abolished, except for the NAC, whose function is to advise the NASA Administrator. The Associate Administrator for science, and her division directors, no longer have an independent, internal advisory structure.

During the near 50-year history of NASA, two very distinct management cultures have evolved. The human space flight management culture is a pure engineering culture in which NASA sets requirements. The only external community is aerospace industry, and they are not empowered to do anything other than supply NASA with services as requested. The science management culture is very different. Here there is a dedicated external-to-NASA community of scientists who feel obligated to engage with NASA on the execution of the science program to ensure its success and quality.

In the current construct for managing science in NASA, the human space flight engineering culture is being imposed on the science program. The external science community is to have the same role in NASA as the aerospace industry. This is a radical departure from the past and, in fact, a departure from the way in which other quality science programs in the Federal government—with engaged, external communities—are managed.

Science is done by scientists, most of whom, in the case of space science, do not work directly for NASA. The scientists perform their tasks, as do other scientists, by devising observations and experiments, by analyzing and interpreting the resulting data, and through supporting theoretical studies and modeling. NASA provides the space hardware from which the observations and experimental measurements are made. This is an essential role, but by itself it is not science. To define it otherwise would be to conclude that the manufacturer of laboratory equipment is doing science, as opposed to the scientists who are making discoveries with the equipment.

Since it is NASA's role to provide the scientists with the equipment required to make their observations, in that real sense, the scientists are indeed the customers of NASA. It is thus quite reasonable for scientists to have a direct say in how they want NASA to perform on their behalf. It is backwards to argue that scientists are suppliers to NASA. It is NASA who is the supplier and the science community who is the customer.

In the current model for managing science in NASA, the external science community is to be involved directly only through the National Research Council (NRC), which has the responsibility to set long-range strategic plans. After that, NASA, and particularly senior NASA managers, take over. To carry the laboratory equipment analogy further, that is like a scientist deciding on a field of research to pursue and then turning further decisions over to the laboratory equipment manufacturer. In this model, quality science is unlikely.

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FROM THE CHAIR

(continued from page 1)

NASA is, of course, also the supplier of funds to scientists to perform their science, which is where a conflict of interest can arise. It could be argued equally well that NASA has a conflict of interest. The agency is both the supplier of funds to its customers—the scientists—and the supplier of the tools necessary for them to do their work. Thus, NASA could fund the science—or, in particular, the technical approach to science—that it, arguing only with itself, deems appropriate.

To manage the conflicts of interest, both for the science community and for NASA, a set of self-governance procedures has evolved over the decades. The NRC has set recommended science priorities; it has weighed the value of one mission candidate against another and one program against another, within general funding constraints provided by NASA. Then a series of internal advisory committees at all levels in the NASA science program provided advice on how best to implement various missions and programs. And then there of course has been the peer review process; research grants and space instruments are chosen with members of the external science community participating in the evaluation.

The participation of the science community in the management of NASA's programs and flight missions has been of great value. It has introduced a constructive tension that pushes the program to excel. This constructive tension was noted as a strength of the science program in the NRC Workshop on National Space Policy Science[1], held before the announcement of the Vision for Space Exploration in January 2004. In fact, it was recommended that the human space flight program, to the extent possible, emulate this strength of the science program.

Of course, NASA, acting for the President and with the consent or direction of Congress, has the final say in the initiation of a program or in any selection, as is required by law. The question, however, is to whom is NASA accountable. In the current model, science in NASA is accountable only to the Administrator and through him to the President and the Congress. In the previous, scientist-participation model, NASA also accepted accountability to the science community, to act on their behalf in a collective effort to ensure a science program of excellence.

Probably all, and certainly most, past NASA Associate Administrators for science were encouraged or permitted to manage the science program of NASA on behalf of the nation's science community defined in the broadest sense. They were required, on behalf of the President and Congress, to administer the funds correctly, and to ensure that the program was one of quality and substance that served the needs of the nation. The demonstrable success of NASA's science program is testimony to the wisdom of this approach.

During the interval I was Associate Administrator (1987-1993) the science budget of NASA initially increased dramatically, tracing the growth in the overall budget of NASA following the Challenger accident. However, in the early 1990s the rate of growth leveled off suddenly and somewhat unexpectedly. The situation then is similar to today, with the additional overlay that human spaceflight, with the Vision for Space Exploration, now has a clear claim on its fair share of the NASA budget. The change in funding expectation for science that occurred in the early 1990s was weathered with little difficulty in large part because the science program was a collective effort of NASA and its science community. The consternation that is prevalent in the science community today, over the changes imposed by NASA, is similarly the result of the science community's response to having been disenfranchised from participation in the management of space science.

By abolishing the comprehensive internal advisory structure for science, NASA apparently believes that the conflict of interest will be avoided. In fact, the opposite is more likely. Now scientists are free to act individually and use access to NASA managers to attempt to influence favorable decisions. When the advisory structure was in place, such attempts at influence occurred in the presence of other scientists, who may have articulated differing positions, with the result that the interests of the community as a whole were represented.

Supporters of the space program in Congress are complaining that members of the science community are lobbying them for their individual programs, at the expense of other agency programs or sometimes at the expense of other science programs. Such behavior is to be expected. NASA has indicated that it will take direction only from the President and Congress, and thus one of the main routes to influence the execution of the science program is through Congress. Indeed, with the internal science advisory structure eliminated, Congressional supporters should brace themselves for an onslaught of individual requests from scientists.

NASA is in the process of finding a successor for the current Associate Administrator for Science, Mary Cleave, who has announced her intention to retire from NASA in the spring. It is to be hoped that her replacement will be granted the tools and the authority required to succeed in managing one of the world's most successful science efforts. The current experiment in managing science in NASA should be brought to a close as soon as possible. If not, the long-term quality and productivity of science in NASA is at serious risk.

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[1]National Research Council, *Issues and Opportunities Regarding the U.S. Space Program: A Summary Report of a Workshop on National Space Policy*, The National Academies Press, Washington, D.C., 2004.

DIRECTOR'S CORNER

This quarter's column was written by Space Studies Board Senior Program Associate, Dwayne Day.

President Bush's New U.S. National Space Policy: A Comparison with the Clinton Policy

On Friday, October 6, 2006, the White House released its new National Space Policy. The development of a new space policy to replace the Clinton administration policy issued in 1996 had been initiated in 2002 with an order by President Bush to the National Security Council and the Office of Science and Technology Policy. The policy document's release had been publicly expected for over a year. The ten-page document was signed by President Bush on August 31.

Unilateralism vs. Multilateralism

The new document states that the United States will be guided by several principles in its space policy. It declares that: "The United States is committed to the exploration and use of outer space by all nations for peaceful purposes, and for the benefit of all humanity." It also states that: "The United States will seek to cooperate with other nations in the peaceful use of outer space to extend the benefits of space, enhance space exploration, and to protect and promote freedom around the world."

Most analysts who have compared the 2006 policy with the 1996 policy have focused upon the tone of the document, particularly its adoption of a more unilateralist approach to the subject of access to space, and the policy's rejection of new treaties or other limitations on American access to or utilization of space. They have also focused on the policy's greater emphasis on national security space issues, noting, for instance, that whereas the 1996 policy outlined five goals for the U.S. space program and mentioned national security for two of them, the new policy outlines six goals for the U.S. space program and mentions national security in four of them. However, despite earlier reports, the policy does not specifically endorse the deployment of weapons in space, but it does make clear that the administration is opposed to any actions that may limit such deployment.

The new space policy clearly reflects both the overall policies of the current administration as well as the decisions that the administration has made in the past several years. For example, the United States withdrew from the Anti-Ballistic Missile Treaty in June 2002 and the space policy reflects the fact that the United States is no longer constrained by treaty from testing and deploying anti-missile weapons in space. Similarly, the United States developed and adopted its Orbital Debris Mitigation Standard Practices in 1997, after the earlier policy was released, and they are therefore incorporated into the new policy.

The unilateralist tone of the new policy is immediately apparent. The policy states in its principles section that: "The United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space." Compare this to the language in the 1996 policy: "The United States will consider and, as appropriate, formulate policy positions on arms control and related measures governing activities in space, and will conclude agreements on such measures only if they are equitable, effectively verifiable, and enhance the security of the United States and our allies." Whereas the 1996 document emphasizes "considering" arms control policies, the new document makes clear that the administration is wary of arms control in general and views it as a possible threat to American space operations.

The new tone is also reflected in what is no longer included in the new policy. For example, the 1996 policy used the word "cooperation" in reference to international activities approximately a dozen times; the new policy does so only four times. The 1996 policy used the words "arms control" seven times (including reference to the Arms Control and Disarmament Agency), whereas the new policy uses the words twice, with no reference to the Arms Control and Disarmament Agency's role in space policy-related issues.

Although the document appears to place a greater overall emphasis on national security space issues, this may in some ways merely reflect the fact that the administration views national security space as more troubled, and therefore in greater need of attention, than civil space. The civil space sector received clear direction several years ago, and the primary issue now is implementation, not policy and planning. Another example of this is the issue of space launch, which received specific attention in 1996, a time when the United States was still awarding study contracts for the Evolved Expendable Launch Vehicle. Now that the Delta IV and Atlas 5 rockets have reached operational capability, policy guidance is less important and hence space launch is not given much attention in the new document.

Perhaps most notably, the policy includes several government guidelines that are undoubtedly a response to the problems experienced by the national security space sector in the past decade. These guidelines include developing "space professionals," improving systems development and procurement, increasing and strengthening interagency partnerships, and strengthening and maintaining the U.S.-based science, technology and industrial base. In summary, the 2006 policy addresses a different set of problems than faced the nation in 1996.

Civil Space and Earth Observation

From the civil space perspective the new space policy reflects the goals of the 2004 Vision for Space Exploration and NASA's new focus on exploration. However, it also makes clear that exploration is not the *sole* goal of the agency, stating that the NASA administrator shall: "execute a sustained and affordable human and robotic program of space exploration and develop, acquire, and use civil space systems to advance fundamental scientific knowledge of our Earth system, solar system, and universe."

In contrast, the 1996 policy was more expansive, stating that NASA: "will focus its research and development efforts in: space science to enhance knowledge of the solar system, the universe, and fundamental natural and physical sciences; Earth observation to better understand global change and the effect of natural and human influences on the environment; human space flight to conduct scientific, commercial, and exploration activities; and space technologies and applications to develop new technologies in support of U.S. Government needs and our economic competitiveness."

The new policy includes no mention of the International Space Station nor the Space Shuttle. Similarly, whereas the 1996 document outlined a considerable role for international cooperation in civil space policy, the new version lists only two civil areas for cooperation: exploration programs and Earth observation.

Another major change compared to 1996 is that the earlier policy devoted considerable attention to the subject of Earth science or Earth observation, mentioning it over 20 times, and devoting an entire section to the subject. In contrast, the new document mentions this subject only six times. To some extent this reflects the fact that the Earth Observing System was in full scale development in 1996 and it has now been deployed. The 1996 policy also reflected government interest in promoting the budding commercial remote sensing field, which has now matured. The new policy might also reflect the fact that NASA has been awaiting direction in Earth science from the National Research Council's forthcoming decadal survey. However, even all of these factors combined seem insufficient to explain the lack of discussion of this subject in the new policy. Whereas the 1996 policy mentioned the importance of studying global change, the new version does not. This diminished attention to Earth science and observation reflects the current administration's policy agenda, as well as the fact that Earth science no longer has a champion in the Vice President's office.

One unusual aspect of the new policy is the section on space nuclear power. The section in the new policy is considerably longer than in the 1996 version, despite the fact that the United States (specifically NASA) no longer has plans to develop space nuclear reactors in the near future. Much of this section is also devoted to "non-government spacecraft utilizing nuclear power sources." There are currently no known non-government spacecraft proposed that fit this description, and the operations and development costs of such a vehicle would be prohibitively expensive. Yet they are included in the policy.

Implementing American Space Policy

The role of senior space policy documents should not be overemphasized. This document was started in 2002 and yet was not issued until four years later, after a tempestuous process. During those four years, American space policy changed in important ways, yet the 1996 Clinton policy was still technically in effect For all intents and purposes, the 2006 National Space Policy will become moot at the end of the current administration in January 2009, as whoever enters the White House at that time will have a different set of policy objectives. However, the annual budget cycle, not to mention the interaction between Congress and the White House, play major roles in determining what space policies get implemented and how. Clearly the new space policy reflects both a different space environment and the priorities of a different administration compared to ten years ago. But this document does not automatically signal a change in direction for the current administration's plans for space.

The 2006 National Space Policy can be found in pdf form here:

http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf

The 1996 National Space Policy that it replaces can be found in pdf format here:

http://history.nasa.gov/appf2.pdf

BOARD AND COMMITTEE NEWS

THE BOARD AND ITS STANDING COMMITTEES

- The **Space Studies Board** (SSB) did not meet during the quarter; however, the SSB executive committee (XCOM) did meet on August 22-24, 2006 at the National Academies' J. Erik Jonsson Woods Hole Center in Woods Hole, MA, for its annual strategic planning session. The XCOM received a visit from Senator Barbara A. Mikulski. Senator Mikulski shared her thoughts on NASA's space science program, and gave her insights and perceptions about the range of issues facing NASA and the country. She continues to work on securing support for the Mikulski-Hutchinson amendment to add $1 billion in funding for NASA in FY2007, and the best possible future for our nation in space.

  In addition to the discussion with Senator Mikulski, the XCOM spoke with several congressional representatives from the Senate and House Appropriations committees, the House Science Committee, and NASA representatives on the outlook for future SSB/SMD interactions.

  The committee continued general discussion on the roles and operations of the Board and its standing committees, ad-hoc committees, the NRC Report Review process, potential new study projects, and planning for the November SSB meeting and Decadal Workshop.

  The full Board will meet next at the Arnold and Mabel Beckman Center in Irvine, CA the morning of November 14, 2006, followed by the SSB Decadal Workshop, which will take place November 14-16, 2006.
- The **Committee on Astronomy and Astrophysics** (CAA) did not meet this quarter. CAA is in the planning stages for a Town Hall meeting it will hold at the January meeting of the American Astronomical Society, in order to gather community

input on the upcoming decadal survey for astronomy and astrophysics. CAA will meet next on November 28-29, 2006, at the National Academies' Arnold and Mabel Beckman Center in Irvine, CA.

- The **Committee on Earth Studies (CES)** continues to stand down as work continues on the decadal study.
- The **Committee on the Origins and Evolution of Life** met at the University of Colorado's Laboratory for Atmospheric and Space Physics on September 13, 2006, in Boulder, CO. The committee continued deliberation on the status of NASA's astrobiology programs, and, in particular, the current and future activities of the NASA Astrobiology Institute. In addition, the committee heard a presentation on the status of the exploration of Enceladus by the Cassini spacecraft. The committee will meet next on February 21-23, 2007, at the National Academies' Keck Center in Washington, D.C.
- The **Committee on Planetary and Lunar Exploration** did not meet this quarter. The committee is scheduled to meet on December 4-6, 2006, at the National Academies' Arnold and Mabel Beckman Center in Irvine, CA.
- The **Committee on Solar and Space Physics** did not meet during this quarter. Approximately half the committee members were engaged in the drafting and response to external review of a workshop report that summarized the proceedings from an October 16-20, 2005, conference, "Solar and Space Physics and the Vision for Space Exploration." Publication of this report is anticipated in early October 2006. The committee is now developing detailed plans for its next study which will examine the impacts (especially economic) and potential for mitigation of severe space weather events. The next meeting of the committee is October 11-13, 2006, in Washington, D.C.

AD HOC STUDY COMMITTEES

- The **ad hoc Committee on the Astrobiology Strategy for the Exploration of Mars** met at the University of Colorado's Laboratory for Atmospheric and Space Physics on September 13-15, 2006, in Boulder, CO. In addition to a briefing on the status of NASA's Mars exploration plans, the committee heard presentations on morphological biomarkers and on the scientific goals and status of the Mars Science Laboratory and, in particular, its astrobiologically relevant payload. In addition, the committee spent a considerable amount of time refining the outline of its report, assigning responsibility for the drafting of different sections to committee members and drafting a schedule for the completion of its task. The committee will hold its final scheduled meeting at the National Academies' J. Erik Jonsson Woods Hole Center on November 8-10, 2006 in Woods Hole, MA.
- The **ad hoc Committee on Astronomy Science Centers** did not meet during the third quarter. The committee completed work on its draft report, and the report is now in external review. We anticipate the report to be released in the first quarter of 2007.
- NRO and NASA terminated the **ad hoc Committee on Large Optical Systems in Space (LOIS)** study. NASA deobligated its funds, but NRO provided a no cost extension in order to allow the use of the funds for a future study to be determined.
- The **ad hoc Committee on the Limits of Organic Life in Planetary Systems** did not meet this quarter. The committee's draft report was sent to 10 reviewers in August and 9 reviews were received by late-September. The committee is currently engaged in revising the report in response to the comments provided by the reviewers. The report is scheduled to be released in the latter part of 2006.
- The **ad hoc Committee on Meeting the Workforce Needs for the National Vision for Space Exploration,** which operates under the joint auspices of the SSB and the Aeronautics and Space Engineering Board, held its fourth meeting at the Beckman Center in Irvine, CA, on September 27-29, 2006. The meeting was devoted to discussions of the committee's response to the study charge, NASA's response to its interim report, and to writing the committee's draft final report. The committee made substantial progress on the final report and plans to send it to external NRC review before the end of the calendar year.
- The **ad hoc Committee on NASA Astrophysics Performance Assessment** met at the Science Museum of Minnesota in St. Paul, MN on August 14-16, 2006. The committee heard about a number of projects which were recommended by the NRC reports *Astronomy and Astrophysics in the New Millennium* and *Connecting Quarks with the Cosmos*. The committee will meet next for a writing session on October 20-22, 2006, at the National Academies' Keck Center in Washington, D.C.
- The **ad hoc Committee to Review the NASA Science Mission Directorate Science Plan**, held its only meeting July 11-13, 2006, at the National Academies' Keck Center in Washington, D.C. The committee reviewed NASA's draft Science Plan and was briefed by NASA representatives and congressional staff. The committee held several teleconferences following the meeting to discuss its draft letter report. The letter report was submitted to NASA on September 15 and released to the public on September 25. The chair, Tom Young briefed NASA representatives and congressional staffers on October 5, 2006. NASA plans to produce a final version of the Science Plan by the end of 2006. The letter report, without references, is reprinted later in this newsletter.
- The **ad hoc Committee on the Scientific Context for the Exploration of the Moon** met August 2-4, 2006, at the National Academies' Beckman Center in Irvine, CA. The committee was briefed on a wide variety of lunar science and related issues which will assist in the formulation of the draft that the committee is currently writing. Also during this quarter, the committee held a telecon to make final revisions for the draft report's submission to NRC review. The committee's interim report, was delivered to NASA on September 15, 2006. The executive summary is reprinted later in this newsletter. The committee will meet next on October 25-27, 2006, in Santa Fe, NM, to assess the response to the interim report and continue work on its final report, which is scheduled for release in the second quarter of 2007. The committee also discussed outreach activities designed to engage the lunar science community; which began with a presentation at the meeting of the International Lunar Exploration Working Group in Beijing, China, in July 2006. Additional outreach activities will take place at a variety of meetings including the American Astronomical Society Division for Planetary Sciences meeting in Pasadena, CA, in October 2006 and the American Geophysical Union meeting in San Francisco, CA, in December 2006.

- The **ad hoc Committee on the Solar System Radiation Environment and NASA's Vision for Space Exploration: A Workshop** produced a report *The Solar System Radiation Environment and NASA's Vision for Space Exploration: A Workshop*, which is awaiting approval by the NRC as the quarter ends. The final report will be released in October 2006.
- The **Task Group on Organic Environments in the Solar System** did not meet this quarter. The committee is waiting for final approval of the report by the NRC. Release of the committee's report is tentatively scheduled for late Fall 2006.
- The SSB decadal survey, "**Earth Science and Applications from Space (ESAS): A Community Assessment and Strategy for the Future**" (http://qp.nas.edu/decadalsurvey), will generate consensus recommendations from the Earth science community regarding a systems approach to the space-based and ancillary observations that encompass the research programs of NASA and the related operational programs of NOAA and the USGS. An interim report was published in April 2005 (available at the above website); a final report, which will include prioritized recommendations directed at NASA, NOAA, and the USGS, is anticipated by the end of calendar year 2006.

The ESAS study is led by an 18-member steering (executive) committee and 7 thematically organized study panels. During the quarter, the ESAS Steering Committee met August 22-24 and September 28-October 1, 2006.

As the quarter ended, the committee was preparing a draft of its final report for submission to external review. It is anticipated that the report will enter review in mid-October and that final NRC approval of the report will occur in early December 2006.

The committee also received a request from NASA to perform additional tasks in a subsequent report stemming from recent decisions regarding changes to the NPOESS program.

- A **Meeting of Experts** in microgravity and life sciences was held on July 28, 2006, at The National Academies' Keck Center in Washington, D.C. The meeting was organized and convened by the SSB at the request of NASA's Exploration Systems Mission Directorate (ESMD). The 12 invited experts, most of whom had served on previous advisory committees to NASA's life and microgravity programs, met with ESMD officials to discuss the agency's strategic and tactical approach to implementing the non-exploration based basic and applied research as stated in NASA Authorization Act of 2005. As required for meetings of this type, no report or meeting minutes will be produced by the NRC.
- An **ad hoc Committee on Research Enabled by the Lunar Environment,** is being created to organize a workshop to gather community input on the key scientific and technological questions that can be addressed on or from the Moon. The study will focus on science related to exploration systems and technologies as opposed to planetary science, which is the topic of another study that is currently underway. The committee will review input from the workshop, past reports, and relevant NASA workshops. This activity is intended to be a precursor to further studies to assess the key issues identified. Membership selection for this activity will begin in October and, pending the schedule for related NASA workshops, the committee's workshop will be held in early or late spring of 2007.
- The **36th COSPAR Scientific Assembly** and **affiliated Space Science Exhibition** took place in Beijing, China, on July 16-23. The assembly was headquartered in the Friendship Palace of the Beijing Friendship Hotel and the scientific sessions took place on the adjacent campus of the Beijing Institute of Technology. In addition to a wide-range of presentations based on the latest findings from a variety of spacecraft missions, including Cassini, Mars Express and Deep Impact, the scientific program featured solicited contributions based on two recent SSB studies: an oral presentation of "The 2005 National Research Council report on Preventing the Forward Contamination of Mars" by C. Chyba, S. Clifford, A. Delamere, M. Favero, J. Niehoff, D. Paige, J. Priscu and M. Race (presented by D. Paige); and a poster paper "Reassessment of Planetary Protection Requirements for Venus Missions" by J.W. Szostak, R.L. Riemer, D.H. Smith and J.D. Rummel (presented by D.H. Smith).
- The **COSPAR Council** met on July 16 and 23 and the **COSPAR Bureau** met on July 22. The highlight of the first council meeting was the selection of Bremen, Germany, as the host of COSPAR's 2010 scientific assembly. Runner-up, Mysore, India, will host the scientific assembly in 2012. The 2008 assembly has already been awarded to Montreal, Canada. Other highlights included elections for the next four year term for COSPAR offices. Prof. R-M. Bonnet was reelected as President of COSPAR and Prof. Ed Stone and Dr. Wim Hermsen were reelected as Vice Presidents. The Bureau members elected were M-H Jiang (China); T. Kosugi (Japan); M.E. Machado (Argentina); G.G. Shepherd (Canada); R. Sridharan (India); L. Zelenyi (Russia). COSPAR also presented the 2006 awards and medals in Beijing. The recipients were: Ebherd Gruen and Asuhiro Nishida (COSPAR Award - for outstanding contributions to space science); Raymond Greenwald (International Cooperation Medal); John P. Burrows (William Nordberg Medal - "for distinguished contribution to the application of space science in a field covered by COSPAR"); Charles Elachi (Massey Award - "for outstanding contributions to the development of space research…in which a leadership role is of particular importance"); and Marcos Machado (Vikram Sarabhai Medal - "for outstanding contributions to space research in developing countries"). Zeldovich Medals, awarded to young scientists in each COSPAR scientific commission who are recognized for their excellence and achievements, were awarded to Olga Kalashikova (Commission A—Space Studies of the Earth's Surface, Meteorology and Climate); Tristan Guillot (Commission B - Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System); Marina Galand and Viviane Pierrard (Commission C - Space Studies of the Upper Atmospheres of the Earth and Planets Including Reference Atmospheres); Vladislav Izmodenov (Commission D - Space Plasmas in the Solar System, Including Planetary Magnetospheres); Mikhail Revnivtsev (Commission E - Research in Astrophysics from Space); Natalie Baecker (Commission F - Life Sciences as Related to Space); Ichiro Ueno (Commission G - Materials Sciences in Space); and Diana Shaul (Commission H - Fundamental Physics in Space).

NEW RELEASES FROM THE SSB

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

The Scientific Context for Exploration of the Moon—Interim Report

This report by the ad hoc Committee on the Scientific Context for Exploration of the Moon is available online at http://newton.nap.edu/catalog/11747.html. The study was staffed by Robert L. Riemer, study director, David H. Smith, senior staff officer, Catherine A. Gruber, assistant editor, Rodney N. Howard, senior project assistant, and Stephanie Bednarek, research assistant. The following is adapted from the report.

Executive Summary

We know more about many aspects of the Moon than any world beyond our own, and yet we have barely begun to solve its countless mysteries. The Moon is, above all, a witness to 4.5 billion years of solar system history, and it has recorded that history more completely and more clearly than any other planetary body. Nowhere else can we see back with such clarity to the time when Earth and the other terrestrial planets were formed.

Planetary scientists have long understood the Moon's unique place in the evolution of rocky worlds. Many of the processes that have modified the terrestrial planets have been absent on the Moon. The lunar interior retains a record of the initial stages of planetary evolution. Its crust has never been altered by plate tectonics, which continually recycle Earth's crust, or planetwide volcanism, which resurfaced Venus only half a billion years ago, or by the action of wind and water, which have transformed the surfaces of both Earth and Mars. The Moon today presents a record of geologic processes of early planetary evolution in the purest form.

For these reasons, the Moon is priceless to planetary scientists: It remains a cornerstone for deciphering the histories of those more complex worlds. But because of the limitations of current data, researchers cannot be sure that they have translated the message correctly. Now, thanks to the legacy of the Apollo program, and looking forward to the Vision for Space Exploration, it is possible to pose sophisticated questions that are more relevant and focused than those that could be asked over three decades ago. Only by returning to the Moon to carry out new scientific explorations can we hope to close the gaps in understanding and learn the secrets that the Moon alone has kept for eons.

NASA asked the National Research Council (NRC) to provide guidance on the scientific challenges and opportunities enabled by a sustained program of robotic and human exploration of the Moon during the period 2008-2023+ as the Vision for Space Exploration evolves. This interim report was prepared by the Committee on the Scientific Context for Exploration of the Moon. The committee will present additional material and more details in its full report, to be released in mid-2007.

PRIORITIES, FINDINGS, AND RECOMMENDATIONS

Within a balanced science program the committee provides the following prioritization of lunar science goals that can be accomplished by lunar measurements and analyses during the early phases of the Vision for Space Exploration. It has used the prioritization criteria adopted by the decadal survey *New Frontiers in the Solar System: An Integrated Exploration Strategy* (NRC, 2003) as a guideline: scientific merit, opportunity, and technological readiness. Each of these priorities has related orbital, in situ, returned sample, and human-tended measurement goals.

1. Fundamental Solar System Science
   - Characterize and date the impact flux (early and recent) of the inner solar system.
   - Determine the internal structure and composition of a differentiated planetary body.
   - Determine the compositional diversity (lateral and vertical) of the ancient crust formed by a differentiated planetary body.
   - Characterize the volatile compounds of polar regions on an airless body and determine their importance for the history of volatiles in the solar system.
2. Planetary Processes
   - Determine the time scales and compositional and physical diversity of volcanic processes.
   - Characterize the cratering process on a scale relevant to planets.
   - Constrain processes involved in regolith evolution and decipher ancient environments from regolith samples.
   - Understand processes involved with the atmosphere (exosphere) of airless bodies in the inner solar system.
3. Other Opportunities (additional information is required for these)
   - Utilize data from the Moon to characterize Earth's early history.
   - Determine the utility of the Moon for astrophysics observations.
   - Determine the utility of the Moon as a platform for observations of Earth.
   - Determine the utility of the Moon as a platform for observations of solar-terrestrial processes.

FINDINGS AND RECOMMENDATIONS

Lunar science has much broader implications than simply studying the Moon. There are strong linkages between the science goals recommended for the lunar exploration program and diverse scientific and applied concerns.

Principal Finding: Lunar activities apply to broad scientific and exploration concerns.

Finding 1: Enabling activities are critical in the near term.
In order to take advantage of the information expected to be returned from missions flown before 2010 by the United States and other nations, the committee finds that enabling, preparatory activities will be critical in the near term.

Recommendation 1: The committee urges NASA to make a strategic commitment to stimulate lunar research and engage the broad scientific community by establishing two enabling programs, one for fundamental lunar research and one for lunar data analysis. Information from these two efforts, the Lunar Fundamental Research Program and the Lunar Data Analysis Program, will speed and revolutionize understanding of the Moon as the Vision for Space Exploration proceeds.

Finding 2: Explore the South Pole-Aitken basin.

As the oldest and largest basin in the solar system, the South Pole-Aitken Basin on the Moon is a unique location.

Recommendation 2: NASA should develop plans and options to accomplish the scientific goals set out in the *New Frontiers in the Solar System: An Integrated Exploration Strategy*'s high-priority recommendation, through single or multiple missions that increase understanding of the South Pole-Aitken basin and by extension all of the terrestrial planets in our solar system (including the timing and character of the early heavy bombardment).

Finding 3: Determine the composition and structure of the lunar interior.

Determination of the interior structure and composition of the Moon are high-priority scientific goals.

Recommendation 3: Because a globally distributed network of many geophysical stations is critical for these investigations, an international effort should be pursued to coordinate the development of a standard, small set of key instruments (e.g., seismometer, thermal profiler, retro-reflector, etc.) and to cooperate in providing for its wide deployment across the Moon.

Finding 4: Maximize the diversity of lunar samples.

The Moon is a complex, heterogeneous body. Samples of the Moon from diverse sites are necessary to reach science goals.

Recommendation 4: Landing sites should be selected that can fill in the gaps in diversity of lunar samples. To improve the probability of finding new, ejecta-derived diversity, every landed mission that will return to Earth should retrieve at a minimum two special samples: (a) a bulk undisturbed soil sample (200 g minimum) and (b) at least 1 kg of rock fragments 2 to 6 mm in diameter sieved from bulk soil. These samples would be in addition to those collected at specific high-priority sampling targets within the landing site.

Finding 5: Proceed with lunar surface mission development and the site selection process.

Plans to return to the Moon will involve the selection of surface exploration sites. Many of the science goals the committee set out depend critically on site selection.

Recommendation 5: Development of a comprehensive process for lunar landing site selection that addresses the science goals of Table 1 should be started by a science definition team. The choice of specific sites should be permitted to evolve as understanding of lunar science progresses through the refinement of science goals and the analysis of existing and newly acquired data. Final selection should be done with full input of the science community in order to optimize science return while meeting engineering and safety constraints.

Finding 6: Understand the lunar polar deposits and environment.

Almost nothing is known about the sources of volatiles at the lunar poles and the processes operating on these volatiles. Lunar polar deposits and the lunar polar environment are probably fragile.

Recommendation 6: NASA should carry out activities to understand the inventory, lateral distribution, composition (chemical, isotopic, mineralogic), physical state, and stratigraphy of the lunar polar deposits. This understanding will be gained through analyses of orbital data and in situ data from landed missions in the permanently shaded regions. In situ studies should occur early enough in the lunar program to prevent substantial change in the polar environment due to robotic and human activities.

Finding 7: Understand and characterize the lunar atmosphere.

The lunar atmosphere is tenuous and therefore fragile. Its pristine state is vulnerable to alteration from robotic and human activities.

Recommendation 7: To document the lunar atmosphere in its pristine state, early observational studies of the lunar atmosphere should be made, along with studies of the sources of the atmosphere and the processes responsible for its loss. These include a full compositional survey of all major and trace components of the lunar atmosphere down to a 1 percent mixing ratio, determination of the volatile transport to the poles, documentation of sunrise/sunset dynamics, determination of the variability of indigenous and exogenous sources, and determination of atmospheric loss rates by various processes.

Finding 8: Evaluate the Moon's potential as an observation platform.

The Moon may be a suitable site for various scientific observations of Earth, Sun-Earth connections, astronomy, and astrophysics.

Recommendation 8: The committee recommends that a thorough study be done by NASA to evaluate the suitability of the Moon as an observational site for studies of Earth, Sun-Earth connections, astronomy, and astrophysics.

Finding 9: Establish strong ties with international programs. The participation of other nations in lunar exploration is a fact. Coordinated and cooperative international activities would benefit all participants.

> **Recommendation 9:** NASA is encouraged to explicitly plan and carry out activities with the international community for scientific exploration of the Moon in a coordinated and cooperative manner. The committee endorses the concept of international activities as exemplified by the recent "Beijing Declaration" of the 8th International Conference on Exploration and Utilization of the Moon.

The committee also presents several related findings and recommendations intended to facilitate a balanced program to reach the scientific goals:

Finding 1R: Optimize the partnership between NASA's Exploration Systems Mission and Science Mission Directorates.

> **Recommendation 1R:** Prior Space Studies Board reports examined management approaches to the integration of human exploration and space science. They found that an optimum approach consisted of establishing a science management office within (today) the Exploration Systems Mission Directorate, reporting jointly to the Science Mission and Exploration Systems Mission Directorates. Such an office should be established as soon as possible to ensure the productive involvement of science planning and implementation ab initio.

Finding 2R: Identify and develop lunar-specific advanced technology and instrumentation.

> **Recommendation 2R:** NASA should create an advanced technology program to develop lunar-specific capabilities that are critical to successful implementation of the lunar science strategy outlined in Table 1. This program should tap the creativity of the engineering and science communities to address development of robotic and instrumentation capability to meet needs that at present are unmet.

Finding 3R: Plan curatorial and principal investigator facilities for new lunar samples.

> **Recommendation 3R:** NASA should evaluate the future needs of curatorial facilities for the collection of new lunar samples. The state and availability of instrumentation for both curation and analyses should be assessed. Such a study should include representatives of the science community in detailed planning of an appropriate strategy.

Finding 4R: Optimize astronaut lunar field investigations—an integrated human/robotic approach.

> **Recommendation 4R:** NASA should provide astronauts with the best possible technical systems for conducting science traverses and emplacing instruments. An integrated human/robotic program should be developed using robotic assistants and independent autonomous/teleoperated robotic systems. The capabilities of these systems should be designed in cooperation with the science community and operations planning teams that will design lunar surface operations. Extensive training and simulation should be initiated early to help devise optimum exploration strategies.

A Review of NASA'S 2006 Draft Science Plan

On September 15, 2006, A. Thomas Young, chair of the ad hoc Committee on Review of NASA Science Mission Directorate Science Plan sent a letter report to Dr. Mary Cleave, NASA's Associate Administrator for the Science Mission Directorate. The letter report is available online at http://newton.nap.edu/catalog/11751.html. The study was staffed by Dwayne A. Day, study director, Joseph Alexander, senior staff officer, and Carmela Chamberlain, senior program assistant. The following is adapted from the transmittal letter to Dr. Cleave.

In your letter of April 12, 2006, to Space Studies Board (SSB) Chair Lennard Fisk, you requested that the Space Studies Board conduct a review of the Science Mission Directorate's (SMD's) draft Science Plan and provide its assessment and recommendations for how the draft might be improved. You asked for comments in the following areas:

- Responsiveness to National Research Council (NRC) recommendations in recent reports;
- Attention to interdisciplinary aspects and overall scientific balance;
- Utility to stakeholders in the scientific community; and
- General readability and clarity of presentation.

In response to your request, the ad hoc Committee on Review of NASA Science Mission Directorate Science Plan was established and met July 11-13, 2006, in Washington, D.C., to review the draft Science Plan. This report discusses the committee's findings and offers related recommendations.

The committee found the draft Science Plan to be an informative document demonstrating that a major NASA objective is to conduct scientific research to advance the fundamental understanding of Earth, the solar system, and the universe beyond. Some portions of the plan, such as that concerning astrophysics, do a truly excellent job of outlining why NASA carries out its science missions.

The committee also found that the draft plan outlines a defensible set of rules for prioritizing missions within each of SMD's discipline divisions, and it believes that SMD has made a serious effort to base its plans on the mission priorities established by the scientific communities that undertake and benefit from the missions that NASA conducts. Many of these priorities were established in NRC reports such as the decadal surveys, NASA's responsiveness to which the committee evaluates in the attached report. Historically, NASA has benefited from the advice provided by its several scientific advisory structures, and their health is vital to the agency's success in implementing its mission.

Although NASA was asked by Congress to develop a single prioritized list for missions across all four science disciplines (astrophysics, Earth science, heliophysics, and planetary science), for various reasons outlined in the report the committee does not believe that NASA should or could produce a prioritized list across disciplines at this time.

However, the committee does have some concerns about the draft plan. The committee found that the lack of a comparison of the current plan to plans produced in 2003 obscured the fact that NASA's space science plans have been significantly scaled back due to budget changes, and it recommends that NASA include a comparison between the current plan and those produced in 2003 for the Earth and space sciences.

The committee further notes that the NRC's recent report *An Assessment of Balance in NASA's Science Program* is largely neglected in the draft Science Plan. Although the NRC report was released shortly before the completion of the draft Science Plan, NASA representatives informed the committee that they had sufficient time to consider it. The committee acknowledges that the draft plan is based on the assumptions contained in the FY 2007 budget request and that the *Balance* report was critical of the adequacy of the budget to accomplish the total NASA plan. Nevertheless, the committee believes that the *Balance* report's recommendations are worthy of consideration and, where appropriate, incorporation in the NASA Science Plan.

The committee found that the current plan overemphasizes mission-specific work at the expense of strategies and steps for achieving goals in mission-enabling areas such as research and analysis, maintaining the Deep Space Network, and technology development. In addition, the committee noted that the draft plan often declares an intention to implement a program or identifies a goal or mission as a top priority, but then does not indicate what steps NASA will take to achieve the goals or what strategies it will pursue to accomplish its priorities.

The committee is concerned about the problem of mission cost growth and believes that if it is not successfully addressed, NASA will face the possibility of having to abandon either flagship missions or the ability to execute a balanced program. Mission cost growth and other factors identified in the attached report threaten the execution of the NASA Science Plan. The committee believes that addressing the issue of executability is a prerequisite for confidently defining a robust Science Plan, and it offers several recommendations on this subject.

The committee recognizes that NASA is awaiting the forthcoming NRC decadal survey on Earth sciences. However, the committee wishes to express its concerns about recent developments in Earth science, particularly recent decisions concerning the National Polar Orbiting Environmental Satellite System (NPOESS) program, whereby climate science instruments were deleted from the satellites. Many of these instruments are crucial to understanding the changing Earth system, and a strategy is needed to deal with their deletion from NPOESS.

By design, the draft plan addresses only those science programs that are conducted by SMD. The committee notes that an appreciation of the full extent of NASA's science activity requires a look at a number of programs outside SMD, in particular, the lunar precursor and robotic program, and the life and microgravity science activities within the Exploration Systems Mission Directorate (ESMD). The committee understands that Congress directed NASA to produce a Science Plan only for SMD. The committee concludes that the document would be improved if the introduction made clear the boundaries of the Science Plan's scope and also acknowledged that science is performed elsewhere within NASA as well, and the extent to which these other science programs are sensibly complementary to those within SMD.

Some of the committee's recommendations are broad and apply to all four of SMD's science disciplines, but the difficulties underlying the committee's concerns are more acute in some disciplines than in others. For example, the problems associated with controlling mission cost growth and preserving proper balance between large and small missions are now particularly pressing in astrophysics and, prospectively, in planetary science. The need to develop strategies for meeting future computing and modeling capabilities is particularly noticeable for Earth science and heliophysics. In addition, although the committee makes discipline-specific recommendations for the planetary and Earth sciences, it stresses that the astrophysics and heliophysics sections of the draft plan are also addressed in the more general recommendations and require equal attention.

The committee's recommendations on the implementation and viability of the draft NASA Science Plan follow:

1. The NASA Science Plan should compare the key aspects of its 2003 Earth and space science plans with the 2006 plan in a list or table that shows how the current plan differs from the previous ones. This comparison would also provide some indication of the starting point for the new Science Plan, and the changes that have occurred since 2003.

2. NASA/SMD should provide some indication of the strategy it will use to determine how critically needed technologies will be developed for future missions and their proposed timescales. The committee recommends that NASA outline a strategic technology plan, providing an indication of the resources needed and the schedule that must be met to enable the ambitious goals of the plan. But NASA should also seek to protect general Research and Analysis (R&A) funding from encroachment by technology R&A.

3. The NASA Science Plan should explicitly address realistic strategies for achieving the objectives of the mission-enabling elements of the overall program. The committee recommends that NASA:

   a. Undertake appropriate studies through its advisory structure in order to develop a strategic approach to all of its R&A programs (this strategy should include metrics for evaluating the proper level of R&A funding relative to the total program, the value of stability of funding levels in the various areas, and metrics for evaluating the success of these programs); and

   b. Develop a strategic plan to address computing and modeling needs, including data stewardship and information systems, which anticipates emergent developments in computational sciences and technology, and displays inherent agility.

4. NASA should improve mechanisms for managing and controlling mission cost growth so that if and when it occurs it does not threaten the remainder of the program, and should consider cost-capping flagship missions. Although NASA already does seek to manage and control mission cost growth, these efforts have been inadequate and the agency needs to evaluate them, determine their failings, and improve their performance. NASA should undertake independent, systematic, and comprehensive evaluations of the cost-to-complete of each of its space and Earth science missions that are under development, for the purpose of determining the adequacy of budget and schedule.

5. NASA/SMD should move immediately to correct the problems caused by reductions in the base of research and analysis programs, small missions, and initial technology work on future missions before the essential pipeline of human capital and technology is irrevocably disrupted.

6. For planetary science, the committee recommends as follows:

   a. NASA/SMD should incorporate into its Science Plan relevant recommendations from the NRC interim report on lunar science, when they are available, in such a way as to maintain the overall science priorities advocated by previous NRC studies, while recognizing that science advice will change as scientific understanding and technology improve.
   b. Although Mars should remain the prime target for sustained science exploration, the NASA Science Plan should acknowledge that missions to other targets in the solar system should not be neglected.
   c. Where the question of habitability (i.e., the ability of a planet to support life) is determined to be the main focus for exploration, a proper hierarchy of scientific goals and objectives should be developed, stronger pathways between the concept of habitability and proposed missions should be articulated and maintained, and basic discovery science should not be ignored.
   d. Life detection techniques should be clearly identified as an astrobiology strategic technology development area.

7. For Earth science, the committee recommends as follows:

   a. NASA/SMD should incorporate into its Science Plan the recommendations of the NRC Earth science decadal survey interim report, and should incorporate the recommendations of the Earth science decadal survey final report when it is completed.
   b. NASA/SMD should develop a science strategy for obtaining long-term, continuous, stable observations of the Earth system that are distinct from observations to meet requirements by NOAA in support of numerical weather prediction.
   c. NASA/SMD should present an explicit strategy, based on objective science criteria for Earth science observations, for balancing the complementary objectives of (i) new sensors for technological innovation, (ii) new observations for emerging science needs, and (iii) long-term sustainable science-grade environmental observations.

The committee elaborates on its findings and recommendations in the letter report attachment.

SPACE STUDIES BOARD NEWS

From Our SSB Summer Interns

***Ms. Stephanie Bednarek** completed an assignment in August as the SSB summer undergraduate intern. She came to the NRC after completing her third year at the University of Virginia, and she returned to UVA this Fall to complete her B.S. degree in Aerospace Engineering. Here are reflections on her experience with the SSB.*

Working with the Space Studies Board this summer allowed me to learn a great deal about the daily operations of space policy. I was continuously engaged in assignments that combined aspects from my current technical studies and my interests in public policy. My primary responsibilities focused around the Committee on Science Goals and Priorities for Lunar Exploration. I had the opportunity to assist in two committee meetings and aid in drafting the interim report. This, in addition to working on the reviews for several other reports, taught me a great deal about the process of issuing an NRC report. I was also fortunate to attend several congressional hearings this summer, which gave me a first hand account of the formation of science policy and appropriations. The entire SSB was incredibly generous with their time in introducing me to not only NRC operations, but also to the current issues in space studies and exploration. This hands-on experience with the Space Studies Board has encouraged me to continue my education and pursue a masters degree in science and technology policy as well as a career in space policy.

***Mr. Brendan McFarland** completed an assignment in August as the SSB summer intern. He came to the NRC after completing his second year at Johns Hopkins University of Maryland, and he returned to UHU this Fall to complete his B.S. degree in Physics and Astronomy. Here are reflections on his experience with the SSB.*

Each day at the Space Studies Board provided me with a new experience, whether it was shaking hands with an astronaut, chatting with a Nobel Prize winner, or working directly with the SSB staff on one of the many reports they are constantly busy with. During my internship with the SSB I attended multiple House and Senate hearings, NASA Advisory Committee meetings, and various SSB committee meetings. The highlight of these meetings was my trip to St. Paul, where the second meeting of the NASA Astrophysics Performance assessment was held. The meeting was particularly interesting to me because I am majoring in physics with a concentration in astronomy.

I learned more about space policy in this short period of time than I ever would have expected. Attending congressional hearings and writing up reports on appropriations language granted me insight into the congressional side of space policy. Attending the NAC Science subcommittee meeting gave me a view of NASA's own internal advisory processes. Working with the SSB staff on myriad reports at different stages of completion provided me with an understanding of the SSB report process, and the amount of hard work required at every stage.

My time at the SSB was extremely rewarding. The SSB staff was friendly and enthusiastic about making sure I got the most out of my time at the NRC. The knowledge and experience

I gained during this internship will prove exceedingly useful as I enter the second half of my college education.

Office changes…

In an effort to consolidate all of the National Academies' staff in the two Academy buildings—the main building on Constitution Avenue, and the Keck Center on 5th Street—some SSB staff were relocated to the 9th floor of the Keck Center, (*Barbara Akinwole, Joseph Alexander, Cathy Gruber, Dwayne Day, Sandra Graham, Tanja Pilzak, and Chris Shipman),* the remaining SSB staff *(Marcia Smith, Claudette Baylor-Fleming, Carmela Chamberlain, Art Charo, Theresa Fisher, Rod Howard, Celeste Naylor, David Smith, and Pam Whitney)* still reside on the 10th floor.

The 200 or so Academy staff left in the Georgetown Green Facilities, are scheduled to move to the Keck Center by the end of 2006. To accommodate this move, all major units were asked to occupy all unused office space.

While we all are not physically located on the same floor, all of our contact information remains the same, including the main phone number to contact the SSB staff (202) 334-3477.

Please visit the SSB website, for staff biographical and contact information.

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2004- 2006

___ A Review of NASA's 2006 Draft Science Plan: Letter Report

___ The Scientific Context for Exploration of the Moon: Interim Report

___ Space Studies Board Annual Report 2005

___ Review of the Next Decade Mars Architecture: Letter Report

___ An Assessment of Balance in NASA's Science Programs

___ Issues Affecting the Future of the U.S. Space Science and Engineering Workforce: Interim Report

___ Distributed Arrays of Small Instruments for Solar Terrestrial Research Report of a Workshop

___ Assessment of Planetary Protection Requirements for Venus Mission: Letter Report

___ Principal-Investigator-Led Missions in the Space Sciences

___ Review of NASA Plans for the International Space Station

___ Extending the Effective Lifetimes of Earth Observing Research Mission **(Limited Quantity)**

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

___ Review of Goals and Plans for NASA's Space and Earth Sciences

___ Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation

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

___ Utilization of Operational Environmental Satellite Data

___ Understanding the Sun and Solar System Plasmas—a 40-page full color booklet based on the report The Sun to Earth—and Beyond: A Decadal Research Strategy in Solar and Space Physics

___ Exploration of the Outer Heliosphere and the Local Interstellar Medium—A Workshop Report **(Limited Quantity)**

___ Solar and Space Physics and Its Role in Space Exploration

___ Plasma Physics in the Local Cosmos **(Limited Quantity)**

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___ New Frontiers in Solar System Exploration – a 32-page full color booklet based on the SSB report New Frontiers in the Solar System: An Integrated Exploration Strategy. **(Limited Quantity)**

___ 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

___ 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

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

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

___ The Quarantine and Certification of Martian Samples

___ Issues in the Integration of Research and Operational Satellites for Climate Research: I. Science and Design

___ Issues in the Integration of Research and Operational Satellite Systems for Climate Research II. Implementation

___ Microgravity Research in Support of Technologies for the Human Exploration and Development of Space and Planetary Bodies

___ Review of NASA's Biomedical Research Program

___ Institutional Arrangements for Space Station Research

___ Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies: Framework for Decision Making **(Limited Quantity)**

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

___ Supporting Research and Data Analysis in NASA's Science Programs: Engines for Innovation and Synthesis

___ U.S. –European Collaboration in Space Science

The Honorable Senator Barbara A. Mikulski with the SSB past and present board chairs (Richard Goody, Lou Lanzerotti, Lennard Fisk) and past and present vice chairs (George Paulikas and Tom Young), at the SSB Executive Committee meeting, August 22, 2006, at the J. Erik Jonsson Woods Hole Center, in Woods Hole, MA.

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