

REPORT
of the
Planetary Science Subcommittee
of the NASA Advisory Council Science Committee

NAC Science Subcommittee Meeting
Washington, D.C.
6-7 July 2006

Introduction and Charge

The Planetary Science Subcommittee (PSS) of the NASA Advisory Council (NAC) Science Committee met for the second time on 6-7 July 2006, along with the other four NAC science subcommittees. The PSS participated in plenary sessions during the morning of 6 July and during the morning and late afternoon on 7 July. Breakout sessions of the subcommittee were held during the remaining times on the two days. A total of 13 of the 17 subcommittee members participated in the meeting.

There were two principal charges to the subcommittee assigned by the NAC for this meeting. The first charge was to sharpen the objectives and discuss planning considerations for the Lunar Science Workshop to be organized by the NAC. The second charge was to review the latest version of the NASA Science Plan, currently in an advanced draft stage and slated for delivery to the U.S. Congress by the end of the calendar year. New recommendations made in response to these charges and other topics discussed by the PSS are given below in red italics.

The PSS also discussed two potentially serious issues that arose during the meeting. The first of these issues is the speed and fidelity of communication among the NAC, its subcommittees, and NASA. Because of that issue we reiterate here some of the key recommendations made by our subcommittee immediately following our first meeting in May; those recommendations are given in blue italics. The second issue is the timely continuity of leadership of the Planetary Science Division (PSD) of the Science Mission Directorate (SMD) following the departure from NASA Headquarters of the Division Director.

NAC Reporting of Subcommittee Recommendations

On the basis of comments made during and shortly after the meeting by the NASA Administrator and the NAC Chairman, the PSS wishes to raise several concerns regarding communication among the NAC, its science subcommittees, and NASA.

The PSS was surprised to learn, from an answer by the Administrator to a question posed during the opening plenary session, that as of the July meeting date none of the recommendations made by the NAC science subcommittees at their initial meeting in early May had yet been transmitted to NASA. This news raised the questions of why the transmittal process should take more than two months to complete and why the subcommittees had been asked to meet for a second time before the deliberations of the first meeting had been digested by the agency and an appropriate response prepared. We therefore offer the following recommendations:

- *The NAC should aim to transmit to NASA the recommendations of its science subcommittees within a time interval that is normally much less than two months. The NAC science subcommittees should not be asked to meet at intervals that are shorter than the typical time for transmittal of their recommendations to the agency.*

One week following the July meeting, the PSS was informed by the NAC chairman that at least some of the recommendations of the science subcommittees had been forwarded by the NAC Science Committee to the NAC and by the NAC to NASA. However, copies of those recommendations were not forwarded to the PSS by either the NAC chairman or the NAC

Science Committee chair at the time of their transmittal. We therefore offer the following additional recommendation:

- *As a move to enhance two-way communication between the NAC and its science subcommittees, the NAC Science Committee and the NAC should transmit in a timely manner copies of all of their communications to NASA that stem from recommendations that have originated with the subcommittees.*

Comments made by the NASA Administrator and the NAC chairman, particularly concerning subcommittee recommendations regarding programmatic mix and restoration of cuts made to Research and Analysis (R&A) programs in the President's fiscal year 2007 budget, suggest that the PSS recommendations made at and following the May meeting have not been studied in detail by the NAC leadership or NASA management. For that reason we repeat key recommendations here. In response to a request to assess the program balance proposed for 2007 within the PSD we made the following recommendations in May:

- *The R&A cuts in the President's 2007 budget for the SMD Planetary Science Division undercut NASA's return on investment in missions, threaten the viability of entire research fields, and jeopardize the continued recruitment of young space scientists and engineers....As soon as is feasible, the restoration of those cuts should be the top priority in the reallocation of funds within the PSD. **The maintenance of healthy and stable R&A programs beyond 2007 should be achieved even if doing so requires the delay of a future small, medium, or large mission.** [boldface added here]*

- *The cuts to the Astrobiology Program, apparently made in the absence of advice from the scientific community, are particularly damaging. First, even if a 50% cut to an R&A program were warranted on scientific grounds, because many awards are for multiple years, the implementation of such a reduction over 1 or even 2 years means that many of the research projects that will be terminated, sharply reduced, or simply not started will include some of those most highly rated by the peer review process. Moreover, the central scientific themes of astrobiology underpin strategic plans for the exploration of Mars and the outer solar system, inform plans for the renewed exploration of the Moon, and constitute the basis for elements of the plans of the Astrophysics Division to characterize the habitability of planets around other stars. Targeting the Astrobiology Program for anomalously large cuts is sufficiently inconsistent with the rationale enunciated for a broad sweep of SMD programs that budgetary restoration for that program should receive immediate attention.*

- *The PSS endorses the principal findings and recommendations given in the NRC Space Studies Board report entitled "An Assessment of Balance in NASA's Science Programs," particularly those dealing with program balance, the R&A programs, the Astrobiology Program, small missions, technology investment, mission cost growth, and community involvement in the program planning process.*

Despite statements implying the contrary by both the NASA Administrator and the NAC chairman, the PSS endeavored in May to discuss specific flight missions whose delay might enable the partial or complete restoration of cuts to the R&A programs. Those discussions were stymied, however, by the interpretation of conflict-of-interest rules presented to us by NASA attorneys. In our May report we therefore wrote "Efforts by the PSS to discuss the trade-space of program mix within the PSD...were strongly limited by the interpretation of NASA attorneys of regulations on conflicts of interest among members of federal advisory committees. In particular, the interpretation that subcommittee members involved with recently submitted proposals to the Discovery Program, proposals now in preparation for the Scout Program, or R&A programs targeted for large reductions must recuse themselves from discussions affecting those programs resulted in our inability to grapple with most specific scenarios for rebalancing the budget within the PSD. Such discussions could be held, according to the opinions of attorneys present at our meeting, only if conflicted subcommittee members left the room, but the affected members were so numerous and so well informed about the issues in question that the

remainder of the subcommittee could not act effectively in their absence.” As a result we recommended in May, and we reiterate here:

- *A solution must be sought to the legal obstacles imposed by the interpretation by NASA attorneys of federal regulations on conflicts of interest in order to permit open discussion of programs and potential budgetary trades by the full subcommittee.*

Even given the restrictions imposed on full subcommittee discussion of specific cost trades within the PSD, the PSS made the following recommendations in May that are pertinent to potential cost savings that might be applied to restoration of cuts to R&A and other high-priority programs:

- *Given the history of cost growth for recent SMD missions, particularly large missions, it is important that sufficient resources be invested into concept and Phase A studies of missions under consideration. Such investment should be made as an essential step in establishing mission priorities.*

- *Once a flight or support program has been initiated, stability and predictability of program funding are important to ensure that the most effective use is made of those funds. The PSS endorses as a decision principle that delays in approved missions, beyond those driven by technical considerations, should be avoided if at all possible, on the grounds that the increase in overall project cost and the disruption to staffing more than outweigh any short-term savings implemented as a solution to budgetary problems in a particular fiscal year.*

- *Efforts should be made to reduce management overhead in all programs.*

- *To enable the accurate tracking of support for PSD science programs, cost increases associated with the transition to full-cost accounting at NASA centers, “corporate” charges, and capital outlays (e.g., for construction of buildings) should be itemized and should not be counted as contributors to growth in science budgets. Further information on such costs should be provided to the PSS at a future meeting.*

- *The appropriate level of cost caps on competed missions should be revisited in future announcements of opportunity in an effort to balance the potential for cost savings against the provision of sufficient opportunity for innovative mission concepts. In parallel, NASA should exert agency-wide pressure to stem or even reverse recent increases in the cost of launch vehicles.*

Of course, should Congress add funds to NASA’s SMD budget so as to restore some of the cuts that had been made in the President’s 2007 budget — as the House of Representatives and the Senate Appropriations Committee have voted to do — the recommendations made by the PSS in May should provide guidance to SMD management for those programs that are regarded by the planetary science community as highest in priority for additional funding.

Leadership of the Planetary Science Division

The two days of the science subcommittee meeting, 6-7 July, coincided with the last two days that Andrew Dantzler held the position of Division Director for PSD. (Dantzler is leaving NASA to take a position at The Johns Hopkins University Applied Physics Laboratory.) The PSS was concerned that there was no announcement at the meeting of plans to fill the position that Dantzler would be vacating, either on an interim basis or permanently. The silence on such planning was doubly surprising given that the Deputy Director position in the division had gone unfilled since the departure from Headquarters of Melissa McGrath at the end of March 2006. (On 18 July an individual was named to serve as acting Division Director for the subsequent two weeks.) This sequence of events leads the PSS to make two recommendations:

- *The SMD Associate Administrator should fill the Director and Deputy Director positions within the Planetary Science Division on a permanent basis as quickly as feasible.*

- *SMD should develop contingency plans to assure the timely continuity of leadership in all directorate divisions in the event of departure or loss of key managerial personnel.*

Lunar Science Workshop Planning

Within the PSS, several pertinent aspects of planning for the NAC-sponsored Lunar Science Workshop began during the subcommittee deliberations at the May meeting, and it is worth repeating the relevant sections of our report from that meeting.

In the area of lunar data analysis pertinent to the future exploration of the Moon, the PSS noted the large volumes of relevant data to be collected by the Lunar Reconnaissance Orbiter as well as ongoing and planned lunar missions by other space agencies. At the May meeting the PSS recommended the following:

- *A program should be planned for the scientific analysis of data to be obtained by ongoing and future lunar missions, including the Lunar Reconnaissance Orbiter and missions by international partners.*

In the area of strategic scientific planning, the PSS discussed at its May meeting the strengths and weaknesses of conducting independent planning efforts for the exploration of Mars, the Moon, and the rest of the solar system. In May the PSS made the following two recommendations:

- *Strategic planning for solar system exploration should integrate the currently distinct plans for Mars and the Moon with those for other solar system bodies. Maintaining separate planning efforts runs the risk that intellectual gaps will arise between plans for different solar system targets and that technological and programmatic efforts will be unnecessarily duplicative. Such a synthesis of planning efforts does not imply integration at the programmatic level.*

- *Strategic planning for the renewed scientific exploration of the Moon should incorporate the findings and recommendations of the NRC lunar strategy now being initiated, the products of the NAC-sponsored workshop on lunar exploration to be held this fall, and the announced plans for lunar exploration by other nations. At the agency level, formal mechanisms should be established to coordinate and integrate lunar exploration planning between SMD and the Exploration Systems Mission Directorate (ESMD). The PSS looks forward to participating in the development of these plans.*

The PSS benefited at the July meeting from presentations on lunar science planning made in plenary sessions by NAC Chairman Harrison Schmitt and NAC Science Committee member Brad Jolliff and a presentation on the ESMD global exploration strategy made by ESMD Deputy Associate Administrator Doug Cooke. In our first breakout session, PSD Director Andrew Dantzler summarized the status of division programs, and Lunar Exploration Analysis Group (LEAG) chair and PSS member Jeffrey Taylor summarized the activities of LEAG on behalf of planning efforts at EMSD and SMD.

At its May meeting, the PSS had recognized that assessment and analysis groups previously organized to provide community feedback to NASA for targeted aspects of solar system exploration constituted natural subgroups for the subcommittee. For the Moon, LEAG serves that role. Because LEAG has already invested considerable effort in developing scientific goals for the further exploration of the Moon, their work provides a natural starting point for the deliberations of the PSS in preparation for a Lunar Science Workshop.

On the basis of discussions within LEAG and within the subcommittee, the PSS makes the following recommendation:

The top four high-level scientific goals for continued exploration of the Moon in the area of planetary science are to understand:

- *The bombardment history of the inner solar system,*

- *The origin of the Moon and the history of interior and surface processes,*
- *The shadowed polar environments on the Moon; and*
- *The lunar regolith as a recorder of the history of the Sun.*

The PSS discussed the following approach that the subcommittee will take in its planning for the Lunar Science Workshop. Starting with each of the high-level goals above, the PSS through the LEAG will develop objectives for each goal. The Exploration Strategy document in preparation by ESMD and described at the meeting would be an important resource for this step. An important aim to be accomplished at the workshop itself is the mapping of these objectives to measurement and infrastructure requirements through a science traceability matrix. In developing that matrix, it will be important to distinguish those objectives that are best addressed through robotic measurements from those that are best addressed by humans with geological field expertise. A critical component of that exercise will be the development of realistic estimates of the cost to accomplish each objective.

Between now and the time of the Lunar Science Workshop, the PSS set several intermediate-term milestones. A review and assessment of the ESMD Lunar Exploration Strategy will be led by LEAG and completed by the end of September. A forward-looking special session on lunar science will be organized for the Fall Meeting of the American Geophysical Union in December: PSS member Ariel Anbar will be one of two co-conveners. A version of the current scientific goals for lunar exploration — written in a form paralleling the document for outer solar system exploration recently completed by the Outer Planets Assessment Group (OPAG) — will be completed by LEAG this fall. Further planning for the Lunar Science Workshop will be discussed at the subcommittee's September meeting; one agenda item identified for us by a representative of the NAC Earth Science Subcommittee is the scientific potential of near- to thermal-infrared observations of the Moon by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor on NASA's Terra satellite.

The PSS developed several guiding principles that should be applied henceforth to planning for the Lunar Science Workshop and the further exploration of the Moon. **We recommend that within SMD:**

- **Balance should be maintained between focused investigations of particular bodies (Moon and Mars) and the continued reconnaissance and exploration of the rest of the solar system.**
- **The highest-priority goals for lunar science should be those planetary science questions that either are best addressed at the Moon or for which the Moon provides a particularly strong example, the study of which will enhance general understanding.**
- **The development of new technologies and infrastructure should be carried out so as to optimize applications across all programs.**

Finally, the PSS discussed several potential venues for the Lunar Science Workshop. Criteria deemed important to the subcommittee — and potentially to the group of individuals we hope will find workshop attendance attractive — include easy access by air, a suitable conference facility, and the potential for pre- or post-conference field trips to geologically relevant areas and astronomical observatories in the immediate vicinity of the workshop. By those criteria, three candidate sites are Hawaii (Volcanoes National Park and the several large observatory facilities on Mauna Kea), Tucson (El Pinacate Biosphere Reserve in Sonora, Mexico, and Mount Graham International Observatory), and Albuquerque (Zuni-Bandera Volcanic Field and the Very Large Array radio astronomy observatory).

Continued Assessment of NASA Science Plan

Prior to the July meeting, PSS members were sent copies of the most recent draft of the NASA Science Plan for 2007-2016. The PSS chair was also sent an advance copy of revision 7-8 of the 2006 Solar System Exploration Roadmap, and copies of the latest roadmap were made

available to subcommittee members at the meeting. (PSS member Jonathan Lunine was one of the co-chairs of the roadmap committee.) The PSS also benefited from a plenary presentation on the development of the Science Plan made by Greg Williams.

In general, the PSS found the Science Plan to be an excellent draft, consistent with the recommendations of the solar system exploration decadal survey document (*New Frontiers in the Solar System, An Integrated Exploration Strategy*, National Research Council, 2003) as well as the 2006 Solar System Exploration Roadmap. The committee discussed several comparatively modest changes that should be made to the roadmap as well as a related topic stimulated by a remark made by the NASA Administrator in his plenary presentation on the first morning.

Because of foreseeable budget limitations through 2016, the Science Plan includes none of the flagship missions to the outer solar system deemed among the highest in priority by the decadal survey and the roadmap, e.g., Europa Explorer or Titan Explorer. In his prepared remarks, the NASA Administrator offered the opinion that such missions should be competed under the New Frontiers mission line. That comment stimulated considerable discussion during the PSS breakout sessions.

The PSS endorses the New Frontiers Program as it is currently formulated. The first two of the missions under that program, the New Horizons mission to fly by Pluto and one or more Kuiper Belt objects and the Juno mission to orbit Jupiter, address high-priority objectives in solar system exploration and can be accomplished within the budget cap set for New Frontiers missions. The National Research Council (NRC) decadal survey has identified other solar system missions that can be accomplished within a similar budget cap (comet surface sample return, Venus in-situ explorer, and South Pole-Aitken basin sample return), and it is to be expected that the mission list will be refreshed periodically by subsequent decadal surveys or equivalent NRC committees. The 2006 Solar System Exploration Roadmap suggested that a Saturn flyby with shallow probes of the Saturn atmosphere would be a logical candidate for such an expanded list of New Frontiers mission opportunities.

Flagship missions, in contrast to the mission candidates above, cannot fit within the current budget cap for New Frontiers missions (\$750M in FY 2003 dollars at the time of the Juno selection). In particular, orbiter missions to the outer solar system cannot be completed within such a cost constraint. Nor can long-lived missions to the Venus surface, which would require the development of electronic components that can survive the 470°C surface temperature. The PSS concludes the following:

- Flagship missions will be required to address many of the most fundamental scientific objectives of solar system exploration and must be accommodated within any long-range strategy for the Planetary Science Division. The New Frontiers Program, too, is critical to the accomplishment of solar system exploration objectives. The New Frontiers Program should therefore not be expanded in an attempt to accommodate the goals and objectives of flagship-class missions.

The PSS proposes that the portion of the Science Plan dealing with solar system exploration be changed in four areas. First, it did not make sense to the subcommittee that small missions of opportunity be listed in the tables of mission priorities along with medium and large missions. By that argument, the Moon Mineralogy Mapper, although an important instrument selected as a mission of opportunity to fly on the Chandrayan-1 lunar orbiter, should not be included in Table 2.2.b. The instrument nonetheless warrants mention within the text that accompanies the table.

Second, the PSS was struck by the fact that the discussion of R&A (Section 3.3) contains no mention of the harm to the agency programs that would be effected if the cuts to R&A programs in the President's 2007 budget were allowed to stand and that has already been felt by cuts to R&A programs in 2006. The subcommittee recommends adding a paragraph to the section that reads "Recent cuts to the R&A Program have adversely affected NASA's ability to analyze data and materials returned from missions and to lay the foundations for future missions."

Third, the PSS noted that there is a deep and pervasive astrobiological focus to much of the Science Plan, a situation apparently at variance with the fact that within NASA's R&A programs the Astrobiology Program, as noted above, was targeted for anomalously deep cuts in fiscal years 2006, 2007, and beyond. This incongruence warrants the addition of some explanatory words lest silence on such an inconsistency undercut the overall rationale for the plan.

Fourth, the PSS took issue with the sentence introducing the mission priorities for Planetary Science in Section 2 that read "Mars is the highest priority target within the Solar System, and the exploration of Mars is an essential part of the Planetary Science Division's strategy for achieving its goals because all of the Planetary Science Division's fundamental science questions may be partially addressed there, it presents frequent launch opportunities, and its surface is easily accessed." The PSS recommends that that sentence be replaced with the following:

"Within solar system exploration, Mars is currently the highest-priority target for detailed investigation: (1) The ability to address all five of PSD's scientific objectives at Mars, coupled with its accessibility, make Mars a unique scientific target in the solar system. (2) Mars exploration has progressed to the level where scientific investigations require multiple assets that form a temporally and spatially interrelated infrastructure on the surface and in orbit. (3) Mars is specifically called out as a high-priority target in the President's Vision for Space Exploration."

In parallel with the above change in wording, a statement should be added emphasizing the need for balance within solar system exploration between detailed investigations of individual bodies and broader-based exploration of multiple bodies throughout the solar system.

Planetary Science Subcommittee
19 July 2006