

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

**Boulder, Colorado
25-26 September 2006**

Introduction

The Planetary Science Subcommittee (PSS) of the NASA Advisory Council (NAC) Science Committee met for the third time on 25-26 September 2006 at the Southwest Research Center, Boulder, Colorado. A total of 15 of the 17 subcommittee members participated in the meeting.

The agenda (attached) included a number of presentations and discussion topics. On the morning of the first day of the meeting, James Green, Acting Director of the Planetary Science Division (PSD), Science Mission Directorate (SMD), updated the subcommittee on division activities and responses to PSS recommendations from earlier meetings. Doug McCuiston, Director of the Mars Exploration Program, summarized recent activities in that program.

The remainder of the first day of the meeting was devoted to the Lunar Exploration Program and to planning for the NAC-sponsored Lunar Workshop scheduled for February 2007. Gordon Chin, Project Scientist for the Lunar Reconnaissance Orbiter (LRO), summarized the LRO mission as well as the Lunar CRater Observation and Sensing Satellite (LCROSS) mission of opportunity to be launched at the same time. A discussion of archiving of LRO data was led by Stan Scott, LRO Science Data Manager, and Ed Grayzeck, Planetary Data System (PDS) Program Manager. Tom Morgan summarized lunar science missions planned by other space agencies and NASA partnering arrangements with those projects. Steve Mackwell presented a summary of recent activities of the Lunar Exploration Analysis Group (LEAG) on behalf of Jeffrey Taylor, who recently stepped down as LEAG chair.

The National Research Council (NRC) Committee on the Scientific Context for Exploration of the Moon recently released an interim report on their ongoing study, and co-chairs Carle Pieters and George Paulikas gave a summary of that report to the subcommittee via teleconference. That presentation was followed by a discussion of planning for the Lunar Workshop led by NAC Science Committee member Mark Robinson on behalf of Brad Jolliff, who leads the workshop planning efforts.

The second meeting day began with an hour devoted to comments from the public. NAC chair Harrison Schmitt joined the PSS for half an hour to discuss the relationship between NAC and its science subcommittees as well as his expectations for the Lunar Workshop. Summaries of recent activities of the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM), the Mars Exploration Program Analysis Group (MEPAG), the Outer Planets Assessment Group (OPAG), and the Venus Exploration Analysis Group (VExAG) were presented by the respective assessment group chairs. James Green briefed the subcommittee on the science implications of the move of the Near Earth Object Observations (NEOO) Program from SMD to the Exploration Systems Mission Directorate (ESMD).

Two agenda items were not discussed at any length because of insufficient time. A discussion on modes of program prioritization in response to future budget changes was deferred to a later meeting of the subcommittee. A discussion of recently distributed comments by the Space Science Board and NASA Science Associates Group (NSAG) on the most recent draft of the NASA Science Plan was deferred so that PSS members could study the comments and e-mail their reactions to the rest of the subcommittee.

Leadership of the Planetary Science Division

At the last PSS meeting on 6-7 July, the subcommittee recommended that the SMD Associate Administrator should act as quickly as feasible to fill the soon-to-be-vacant and vacant positions of PSD Director and Deputy Director, respectively. The PSS was therefore pleased with the timely appointment of James Green as Acting PSD Director, effective 14 August 2006, and with the formal search for candidates to fill permanently the Director and Deputy Director positions. Dr. Green appears to appreciate all of the issues facing the division and has begun to address each of them in an energetic and creative fashion.

Research and Analysis Programs

At its May meeting, and reiterated at its July meeting, the PSS made the following recommendation with respect to Research and Analysis (R&A) programs within the PSD:

- *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.*

The primacy of that recommendation remains unchanged. James Green described plans to add two new opportunities to the existing R&A programs, a data analysis program for the New Horizons encounter with Jupiter next February and a Lunar Science Research Program. The addition of the these new opportunities is laudable and will broaden the community participation in the analysis of the first data from the New Horizons mission and with the preparation for the renewal of lunar exploration, beginning with the LRO mission. These initiatives notwithstanding, the restoration of healthy R&A programs across all of the disciplines within Planetary Science is critical to the ability of NASA to maintain expertise in solar system science, to recruit and retain students and young investigators, and to conceive, plan, and execute future missions of solar system exploration.

Planetary Data System Issues

On the basis of presentations made to the PSS, it is clear that the LRO project and the PDS are currently working together to ensure that PDS-compatible and scientifically useful data sets will be generated, validated, and transferred to the PDS on a pre-defined schedule. As of this time, however, no additional funds have been identified to support the PDS ingestion and validation of the raw and derived data sets from LRO observations or to support community access to these data sets.

- *The PSS requests that the augmentation to the PDS budget needed to support the archiving of raw and derived data from the LRO mission be determined, that sources for those funds be identified, and that the information so obtained be shared with the subcommittee.*

LRO will produce and deliver to the PDS Experiment Data Records (NASA Level 0) and selected Reduced Data Records (primarily Level 1 products, with samples of more highly derived products). The principal scientific payoff from LRO data sets, however, will largely be achieved through the generation and analysis of highly derived data sets (e.g., altimetry maps or images that have been radiometrically corrected and map projected).

- *The PSS recommends that derived data sets from LRO observations be produced and made available to the research community. The PSS requests that the cost of carrying out this recommendation be determined and that the needed mix of project funds and funds associated with a lunar data analysis program or programs be identified and reported to the subcommittee.*

The focus of the PDS on disciplinary nodes has provided great benefit in its exploitation of specific existing expertise in making NASA's planetary mission data sets widely available. By its nature, however, this practice does not lend itself to the exploitation of interdisciplinary data sets. Many instruments make observations either directly or indirectly relevant to the interpretation of measurements in other PDS nodes, but such observations are often in incompatible formats or in unlinked systems.

- *The PSS recommends that PDS explore how consideration can routinely be given to cross-disciplinary data sets.*

For example, when PDS is working with a new mission to formulate the data archive contents, a specific individual or subgroup could be assigned to the investigation of potential cross-disciplinary projects identified by either the project team or via a broader solicitation of community input. The additional data archive contents could then be defined on the basis of these findings and subject to the agreement of the instrument and data providers. Consideration could also be given to enhancing older data sets where a cross-disciplinary data product of particular value is identified.

Missions of Opportunity

Members of the planetary science community occasionally identify exceptional opportunities for NASA to participate in or to exploit missions and facilities toward the achievement of key planetary science and NASA programmatic goals. These include possibilities for providing instrumentation or other capabilities for a mission or mission-related facility involving non-NASA or foreign collaborations, as well as enhancements to a NASA mission. However, there is no regular vehicle in place for considering such opportunities outside of the relatively infrequent call for mission of opportunity (MOO) proposals as part of the Discovery Program and (for Mars) Scout Program NASA Research Announcements (NRAs)..

- *The PSS recommends that NASA consider opening opportunities for MOO proposals on a more frequent basis than that of Discovery and Scout Program NRA releases.*

One route to achieve this aim might be by modifying the Discovery and Scout Program NRAs to permit MOO proposals to be submitted at any time. Another might be through a separate and open call for MOO proposals. Either route would result in a more flexible mechanism for taking optimum advantage of opportunities as they arise. The usual standards of scientific peer and technical review would, of course, apply, and some revision to the current Discovery Program review process currently used for MOOs would probably be needed. The adjustment in procedures would seem well worthwhile as a step toward retaining NASA competitiveness in planetary science and mission activities, as well as taking maximum advantage of potential partnerships with other space agencies.

Outer Planet Flagship Missions

In its report from the July PSS meeting, the subcommittee stressed that flagship missions, in particular those to the outer solar system, cannot fit within the current budget cap for New Frontiers missions (\$750M in FY 2003 dollars at the time of the Juno selection). The PSS went on to recommend in July that

- *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 flagship Cassini mission has been spectacularly successful to date. The PSS is strongly supportive of maintaining Cassini operations as long as technically feasible and scientifically

warranted. A Cassini Data Analysis Program should be of sufficient duration to derive the maximum scientific understanding from the diverse data sets obtained by this mission.

NASA's Science Plan calls out Europa, Titan, and Enceladus as key targets for exploration of the outer solar system. To make progress on those elements of the Science Plan

- *The PSS recommends that in-depth studies to evaluate mission concepts and technologies for potential outer solar system missions should be completed as soon as feasible.*

The scientific goals for these missions have been defined in the NASA Science Plan and developed by the NRC, OPAG, and a variety of "focus groups." On the basis of current understanding of the highest-priority scientific goals, these missions would involve a Europa orbiter, a Titan aerial vehicle, and an Enceladus lander. The mission definition studies should involve broad scientific community involvement and multiple institutions. We envision mission concept studies for each of the three bodies to be funded at approximately \$1M per study to address specific science goals within the scope of the NASA Science Plan, namely a flagship-class (~\$2-3B) mission to be accomplished within a ~15-year time frame. The study results should be reviewed independently for their potential scientific return, technical feasibility, and cost. Moreover, NASA should work with OPAG and the science focus groups to develop an ongoing program of advanced mission concepts and technologies that will permit the full implementation of Science Plan objectives.

New Frontiers Mission Candidates

The list of candidate missions in the first open competition under the New Frontiers Program was taken from the decadal strategy for solar system exploration (*New Frontiers in the Solar System, An Integrated Exploration Strategy*, National Research Council, 2003). With the selection of Juno as the first mission competed under that program line, it is appropriate to begin consideration of additional mission candidates for future competitions. As one possibility, the 2006 Solar System Exploration Roadmap suggested that a Saturn Flyby with Probes mission be added to the New Frontiers menu. Other medium-class missions were identified in the decadal strategy as worthy of flight beyond the decade considered.

- *The PSS recommends that a process of regularly updating potential targets for New Frontier missions be put in place before the next New Frontiers Program competition.*

Provision of a Foreign Instrument to Juno

In his presentation to the PSS on the status of the PSD, Acting Division Director Green raised the following issue on which he sought guidance from the subcommittee. The Juno mission, now in Phase B under the New Frontiers Program, has been approached by a foreign space group that has offered to provide several spacecraft subsystems as well as an additional payload instrument. The provision of subsystems would offset some of the increase in mission cost associated with the NASA-directed decision to delay the launch, but the additional instrument was not part of the mission Concept Study Report that was the basis of competitive selection after scientific peer review. Initial analysis by the project indicates that the offered instrument can be accommodated within current margins for payload mass, power, and volume.

The PSS offers the following response:

- *A hallmark of Principal Investigator-led missions is that all decisions regarding mission development are informed by, and if possible enhance, the mission's scientific objectives. PIs leading spacecraft missions should nonetheless be discouraged from accepting an offer of an instrument to be added after the completion of competitive peer review and mission selection, particularly in view of the difficulties such an addition generally presents to the management of risk and cost.*

Notwithstanding the above guiding principle, situations may arise in which the offer of an additional instrument is coupled to the provision of other spacecraft components or subsystems

that, if accepted, would reduce mission risk or enable the full mission success criteria to be achieved by a cost-capped mission within the Discovery, Scout, or New Frontiers mission lines. In such a situation, whether to accept the coupled offer is a programmatic decision rather than primarily a scientific decision. A thorough review of scientific merit, technical accommodation, cost impact, and mission risk impact should be made prior to rendering such a programmatic decision.

Lunar Science Priorities and Workshop Planning

The PSS discussed at length the scientific priorities for continued exploration of the Moon. At the highest level, those priorities remain as listed in the report from the July subcommittee meeting:

It is the view of the PSS that 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 next step in the development of scientific priorities is to flesh out the detailed objectives for each of the above goals. The PSS has asked the LEAG, through a request to that group's executive secretary, to lead that task by developing a straw-man set of prioritized objectives and presenting them to the PSS for discussion and recommendations by the end of November.

As a result of the recent resignation of Jeffrey Taylor from PSS, the LEAG is currently without a chair. Given the important role that the LEAG will play in detailing the planetary science objectives for the future exploration of the Moon

- *The PSS recommends that a new chair be named for LEAG as quickly as feasible. The PSS is prepared to assist with the identification and recruitment of that chair.*

On the basis of the presentation of the current state of planning for the NAC-sponsored Lunar Workshop, the PSS judged that some important aspects of that planning were not as far along as might be expected given the imminence of the February meeting dates. In particular, the PSS had expected that speakers and discussion leaders would by now have been identified and the detailed workshop objectives and written products of the workshop would have been defined.

- *The PSS recommends that an expanded Scientific Organizing Committee for the Lunar Workshop be charged immediately with the detailed planning of workshop objectives and the recruitment of all key workshop participants.*

Several PSS members - including Lars Borg, Chip Shearer, and Larry Taylor – volunteered to serve on such a Scientific Organizing Committee, along with PSS member Ariel Anbar who was identified at the July meeting. All of these individuals are prepared to work on the development of these details over the very near term.

In subcommittee discussion MEPAG chair Ray Arvidson suggested that the MEPAG experience of mapping objectives to measurements, and from measurements to implementation, could provide an instructive guide to what the Lunar Workshop might achieve with lunar science objectives. Arvidson offered to work with the Scientific Organizing Committee to apply those lessons learned from the MEPAG efforts.

NEOO Program

A thorough presentation was made to the PSS by James Green of the status of the NEOO Program at the time of its transfer from SMD to ESMD. On the basis of that presentation

- *The PSS supports ongoing efforts to ensure that the scientific study of near-Earth objects and their provenance will not be impacted by the transfer of programmatic management between directorates.*

Planetary Science Subcommittee
October 2006

Planetary Science Subcommittee Meeting
September 25-26, 2006
Southwest Research Institute (SWRI)
1050 Walnut Street, Suite 400
Boulder, CO 80302

25 September (8:30 AM – 5:30 PM)

8:30	Welcome and administrative matters	Sean Solomon, Michael New
8:40	Planetary Science Division update	Jim Green
9:00	Mars Exploration Program update	Doug McCuistion
9:45	Lunar Reconnaissance Orbiter science update including LCROSS	Gordon Chin, Tony Colaprete
10:30	Discussion of LRO data archiving	Stan Scott, Ed Grayzeck
11:00	Discussion of international lunar science plans and partnerships	Tom Morgan
11:15	Lunar science objectives	Stephen Mackwell
12:30	Lunchtime science talk about Enceladus	John Spencer
1:30	Interim report of NRC study “The Scientific Context for the Exploration of the Moon”	Carlé Pieters, George Paulikas
3:15	Lunar Workshop planning	Mark Robinson
5:00	Discussion of mode of program prioritization for future budget changes	All
5:30	Adjourn	

26 September (8:30 AM – 12:30 PM)

8:30	Public comment period	
9:30	Discussion with NAC Chair on relationship of PSS with the NAC	Harrison Schmitt
10:00	Comments from CAPTEM, MEPAG, OPAG, and VExAG	Chip Shearer, Ray Arvidson, Fran Bagenal, Janet Luhmann
10:45	Science implications of move of NEOO Program to ESMD	Jim Green
11:15	SSB and NSAG comments on “Science Plan”	Michael New
11:45	Finalization of recommendations	Sean Solomon
12:30	End of meeting	