

Planetary Sciences Subcommittee (PSS)
NASA Advisory Council Science Committee

NASA Headquarters

April 18 & 19, 2011

Meeting Report

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Remarks and Announcements

The Planetary Science Subcommittee (PSS) of the NASA Advisory Council (NAC) Science Committee met two days at NASA Headquarters, April 18-19, 2011. The meeting opened with welcome remarks by Dr. Ron Greeley (PSS Chair).

Annual Ethics Briefing

The Subcommittee received its annual ethics briefing by Mr. Jim Reistrup. The ethics rules and criminal laws governing financial conflicts, imputed interests, representational conflicts, post employment restrictions, standards of conduct, and impartiality were reviewed with the Subcommittee. Questions or concerns should be directed to the NASA Ethics team at 202-358-2465 or ethicsteam@hq.nasa.gov.

National Research Council (NRC) Decadal Survey (DS) Overview

Dr. Larry Soderblom reviewed the NRC DS. The DS is congressionally mandated and receives its task statements from NASA and the National Science Foundation (NSF). The DS puts strong emphasis on evaluation of mission technologies, readiness, and the reality of conducting missions. Its goal is to seek out and build consensus around community views via town hall meetings and community-submitted white papers. Based on the science identified via white papers, which are the main input to the DS, as well as other community inputs, three crosscutting themes were developed for Planetary Science: *Building New Worlds, Planetary Habitats, and Workings of Solar Systems*; key scientific questions were identified for each theme.

A couple of different study classes were conducted. For multiple options, mission architecture was done to determine the spectrum of approaches and address the scientific questions to identify the highest *science-per-dollar* options. Five panels evaluated the missions; each mission had one or more science advocates working with a study team. The panels made judgments in terms of scientific depth and breadth and ranked the missions; a steering committee seated above the five panels made similar evaluations. From this cross-panel prioritization, missions were selected in parallel to go from research and analysis (R&A) to full mission study. Roughly 25 mission candidates emerged for detailed study by teams that included at least one science representative from the appropriate panel. Detailed Cost and Technical Evaluations (CATE) were performed on high priority mission candidates. The CATE estimates are based on multiple methodologies, including actual costs of analogous past missions; all costs are in FY15 dollars. Studies for missions not recommended are kept intact and archived for later reference and/or reconsideration. The study reports are available on the web and are included in the DS report.

Dr. Soderblom reviewed the key DS recommendations. For ongoing and approved missions, “PSD should continue missions in development and missions in flight subject to senior review including Discovery, New Frontiers (NF) and other missions.” For R&A, “the NASA planetary R&A budget should increase by 5 percent above the total approved FY11 expenditures in the first year, and then by 1.5 percent above inflation each successive year.” For Technology & Development, “a planetary exploration technology development program should be established and carefully protected from incursions on its resources and funded at 6-8 percent of the total NASA Planetary Science Division budget.” The Discovery Program “should continue at its current funding level, adjusted for inflation, with a cost cap per mission also adjusted for inflation (i.e., to \$500 million FY15). A regular, predictable, and rapid (<24-month) cadence of Discovery Announcements of Opportunity (AOs) and selections should be assured.” The Mars Trace Gas Orbiter (TGO) “should be joint with the European Space Agency (ESA) with NASA providing most of the science payload and launch; the mission to be carried out as long as the division of responsibilities with ESA is preserved.” The “NF cost cap should be changed to \$1.0 billion FY15, excluding launch vehicle costs; NF4 and NF5 missions should be selected in the decade 2013-2022.” The un-prioritized list of NF4 candidate missions includes: “Comet Surface Sample Return, Lunar South Pole-Aitken Basin Sample Return, Saturn Probe, Trojan Tour and Rendezvous, and Venus in

Situ Explorer.” NF5 includes “the remaining candidates from NF4, Io Observe, and Lunar Geophysical Network.”

Flagship recommendations, in priority order, include the following:

- Mars science: Begin a NASA/ESA Mars Sample Return campaign with a *descoped* Mars Astrobiology Explorer-Cacher (MAX-C)/ExoMars staying within \$2.5 billion. The partnership between NASA and ESA must be equitable and must be preserved; this is the only alternative for Mars exploration.
- Jupiter Europa Orbiter (JEO): NASA should fly JEO only if changes to both the mission and the planetary budget make it affordable without eliminating other recommended missions. NASA should immediately find a way to reduce the cost of JEO, incorporating necessary technologies and science re-scope for investigation of a probable ocean in the outer solar system.
- Uranus Orbiter and Probe: Uranus is preferred over Neptune for 2013-2022 for practical reasons involving available trajectories, flight times, and cost.
- Technology & Development: The high priority missions recommended for future study and development are: Titan Saturn System Mission, Neptune Orbiter and Probe, and Mars Sample Return Lander and Orbiter. If *less funding is available*: the flagship missions should be de-scoped or delayed; Discovery missions should be delayed only if adjustments to flagships cannot solve the problem; and preserving the technology components of R&A should be a very high priority.

Recommended steps for reducing launch vehicle costs include the use of dual manifesting (two missions on a single launch), block buys across NASA or with other agencies, and development of technologies that reduce flight system mass for smaller launch vehicles. With regard to Plutonium (PU-238), NASA currently relies on existing domestic and Russian PU-238 inventories, which are insufficient to sustain long-term deep space explorations that include Discovery, NF, and large missions. Without a restart of PU-238 production, NASA will not be able to carry out important planetary missions, particularly in the outer solar system. Some solar system bodies are likely targets of future human exploration, e.g. the Moon, asteroids, and Mars and its moons. “It is vital to maintain the science focus of peer-reviewed NASA missions to these bodies.”

Additional DS recommendations for supporting NASA activities cover data distribution and archiving, education and outreach, telescope facilities, the deep space network, and sample curation and laboratory facilities.

Planetary Science Division (PSD) – Bilateral Response/Results

Dr. Jim Green reviewed events associated with the DS. Discussions with the Office of Management and Budget (OMB) and the Office of Science & Technology Policy (OSTP) are ongoing; the FY11 budget passed, and NASA is under Continuing Resolution (CR) until October 1, which means a PU-238 restart will not occur this budget year. The FY12 budget is in Congress and development of the PSD FY13 budget has begun in preparation for the final President’s budget in February. The PSD FY11 funding level is \$1.4 billion, well above FY10. PSD is reviewing the current funding status of missions to provide realistic budget targets for upcoming R&A selections, hoping to award as many previous “selectable” proposals as funding allows. In response to a question from Dr. McKinnon, Dr. Green replied that final numbers are just now coming in. With respect to reconsideration of the Near Earth Objects non-selection, Dr. Green explained that the proposals are too old to reconsider so the new proposals will be used going forward.

Missions in formulation include Discovery and NF--both on schedule. For Discovery, 28 proposals have been received that offer a wide diversity of science targets, goals, and approaches. The evaluations and NF site visits are ongoing and on schedule; announcements and contracts can proceed with the current funding. The PU-238 start-up plan completed jointly with DOE went to Congress in 2010. The plan

states that NASA and DOE equally share the costs, estimated to be \$75-\$90 million over six years. The Authorization Act of 2010 authorizes NASA to provide funds to DOE to start production under a reimbursable agreement; however, new projects, e.g. PU-238, cannot proceed during a full year CR.

A joint NASA-DOE response, delivered to OMB in February 2011, is currently under review. This document becomes public once approved by Congress. PSD must be prepared if Congressional approval does not happen. If NASA has to carry the load, the approach in terms of projects, deliverables, requirements, and management would be different. In response to another question, Dr. Green noted that substantial funding is not required up front.

The NASA/ESA bi-lateral meeting on March 29 was timely given the current and future budget constraint projections, including the large dip in planetary funding. It was also a key opportunity to review where PSD is with respect to Decadal requirements to descopce both JEO and Mars 2018. ExoMars/TGO is going into Phase B for 2016. For the 2018 Dual Rover, ESA's cost proposal and NASA's FY12 President's budget required a new approach. Also, the mission's technical complexity, in terms of accommodating both the ExoMars and MAX-C rovers, created unacceptable cost and technical risk. The agencies agreed to de-scope to single rover architecture, merging rover design to leverage both partners' strengths. NASA's focus will be on the DS and sample caching; ESA's focused will be on mobility and drilling. A joint executive board will provide guidelines and define roles and responsibilities. A joint engineering working group began April 6 to create the best technical solution under the constraints. A joint science team is being organized to set up mutual science objectives and level-one requirements. A question about instrument schedule acceleration led to an explanation that instruments would need to be delivered in 2013 for a 2016 launch; PSD will accelerate that as much as possible.

In terms of who will build the rover, Dr. Green noted that an engineering working group will come up with the best technical solution. The only item pre-determined as a U.S. element is the descent stage; on the ESA side, it is the drill. NASA is currently the mission lead for Mars 2018. In response to a question from the Subcommittee, Dr. Green noted that the interface requirements and control documents will have to be followed by ESA; this will be a new rover.

The joint science team will establish common objectives; studies have been done during the last two years to come up with what the NASA Rover looks like in dual rover mode. The instrument suite will be driven by joint science team work and goals, capabilities, and asset discussions. There will be a definition team when an AO for instrument selection goes out. The joint engineering group is working on what the rover will look like.

A key decision gate for ESA is its May 26-27 Program Board for Human Exploration, when discretionary programs for the budgets are submitted by each participating member state. This "Go/No Go" decision for 2018 is about the basic architecture concepts and ESA/NASA responsibilities. The Joint Mars Sample Return Working Group continues its activities and will ramp up (as the 2018 joint rover takes shape) to identify the next series of steps to return samples. NASA has budgeted about \$1.2 billion.

The second major topic at the March 29 bi-lateral was ESA's Cosmic Visions program. Prior to the meeting, ESA had directed its three Cosmic Vision class missions to reformulate their studies. The three missions were: Laplace, and two astrophysics programs—Exo, an X-ray imager; and the Laser Interferometer Space Antenna (LISA), a gravitational wave detection system. ESA invited NASA to have an observer present during its deliberations and study for the Laplace re-look, and NASA invited ESA to participate in its deliberations and study. ESA wants to have a report to its program board by February 2012. This is the non-discretionary part of the program and a competition that NASA wants to honor.

PSD's strategy going forward will occur over several fiscal years, starting with analysis and planning in FY11, selection of up to three Discovery 12 Phase-A missions, a NF3 down-select, and a start for re-planning the Mars 2018 mission with ESA. In FY12, the Europa study will ramp down and a Mission of

Opportunity (MoO) will be initiated with ESA on Laplace; the MoO for the Joint Mars Program with ESA will also be finalized. Implementation of Decadal priorities should begin in FY13 and FY14.

The Planetary program architecture includes laying in current commitments, accommodating the Decadal recommendations with a healthy R&A program, Discovery every two years, NF, and Mars 2018 as currently being re-planned. PSD also has direction from OMB to set aside \$10 million for cooperative activities with human exploration beyond low-earth orbit. Because the full Decadal recommendations greatly exceed the President's 2011 budget, PSD is using Decadal decision-making rules to develop a balanced budget and move forward with a balanced program that includes small, medium, and large missions. Dr. Green repeatedly stressed how critical a partnership with ESA is in maintaining the balanced program. The opportunity right now is with ESA, which, if missed, means NASA would have to pick up all Flagships on its own.

PSD's approach to develop a new notional budget is to cap R&A at \$200 million per year. The next Discovery AO is on a 36-month cadence; Discovery 13 will be approximately 36 months from Discovery 12. NF3 will be selected with NF4 and NF5 within the decade with no slip to the NF schedule. The extended mission budgets for operating missions will go through the senior review process to determine which missions to extend. If the senior review says everything should continue, they will be prioritized. The dedicated Lunar R&A wedge will be transferred into R&A, and JEO would be de-scoped to studies funded in FY11 and FY12, meaning no JEO instrument AO, albeit some budget for radiation technology efforts. The budget is running at about \$200 million and the technology program represents about six percent of that.

Dr. Green characterized the "notional" budget as a mapping based on the Decadal decision rules going forward. The real budget will be presented when the President releases actual figures for a five-year run-out in February. How to execute the mission has not been decided; there is a set number of dollars for which everyone must compete and missions must be ranked. Launch vehicle costs are carried in the line as well. Dr. Green explained that using the 70 percent confidence level has been successful over the last few years, so PSD will continue this approach. As new capabilities arrive during this next decade, competition should increase, driving prices down and making funding available for other elements.

In response to a question, Dr. Green explained that PSD has been working with ESA on Mars sample return strategies since about 2007. ESA is interested and has been investing in certain technologies for sample return for a couple of years. ESA also has a set of industry studies out that are competitive and well-funded for a sample return orbiter. The Statement of Intent signed in November 2009 states that the ESA partnership is for sample return. With respect to ESA's timeline for completion of its Human Exploration Program study, Dr. Green suggested there may be more details after the European council meeting toward the year's end. The big milestone for the Europeans is somewhere in calendar year 2012, when they confirm and commit money to go forward at their ad ministerial council, which occurs every three years.

NRC Decadal Survey Discussion

There was a general discussion by the Subcommittee about DS recommendations with respect to the Mars program. Sample return was discussed at length. Dr. Soderblom explained that the Mars panel looked at several aspects, one being whether or not to proceed to search for evidence of life; there is strong consensus outside and within the community to proceed. The DS team concluded that bringing samples back to a sophisticated lab environment is the practical approach. There are no NF missions for Mars; however, there may be smaller opportunities at the Discovery level that would be competitive, albeit likely result in a different Mars program. The DS sets a course to not only begin the process of sample return during this decade, but also to develop technologies for future decades. White papers from the DS are accessible on www.solarsystem.nasa.gov. These, along with R&A preliminary studies and mission study reports, will be archived for reference and/or reconsideration, if necessary. With respect to DS lessons learned, a focused NASA-led study is ongoing to survey Decadal people to evaluate how well the

NASA mission concept studies worked. In anticipation of this study and the next DS, there will be lessons learned. Dr. Soderblum explained the *science-per-dollar* mission ranking and evaluation processes that were used in the DS. Dr. Green noted that in the DS, the primary focus is on ESA collaborations; however, there is tremendous support for MoOs. ExoMars TGO is an example of a successful ESA collaboration.

The Subcommittee briefly discussed NF with regard to DS recommendations for NF4 and NF5 selections and budget. In response to a question, Dr. Green said he will provide an update on the call for the Lunar Science Institute at the next PSS meeting. There was a brief discussion about funding holdback for civil servant salaries. During the current FY, funds were removed and then reinstated into the budget halfway through the year. During the next FY, civil servant salaries will again be removed from the budget in the hope that as the 2012 budget is passed, there will be Congressional support for the approach. The total budget line is \$200 million; if funding must go to civil servant salaries, the budget will be reduced accordingly and a new line will be created. The budget assumes full cost accounting; going into 2012, the planetary budget will adjust accordingly.

The NRC DS discussion ended, and Dr. Greeley made a few administrative announcements concerning the three afternoon breakout sessions. Dr. Des Marais chaired the Mars session, Dr. McKinnon chaired the Outer Planets session, and Dr. Sykes chaired the Supporting Research and Technology (SRT) session. Each group was tasked with developing recommendations with respect to the following: schedule, decision points, decision process, AO process, minimum science issues, and the costing process for implementing DS recommendations. The breakout session objectives included: (1) develop ideas from the science perspective on implementation; (2) provide general impressions of DS recommendations; (3) provide a summary of DS recommendations in telegraphic form; and (4) review the flagship de-scope process. With regard to their flagship missions review, the Subcommittee members were reminded about the international collaborations requirement for flagships and the attendant increased costs associated with the collaborations. Dr. Greeley noted that the breakout sessions are a FACA activity and anyone can participate through the Chairs.

Mr. Jonathan Rall posed three fundamental questions to the SRT/RA group for their consideration: (1) What is the specific goal(s) of the study? (2) What approaches would PSS recommend to accomplish this goal(s) if the grant size, grant duration, and success rate could not be increased? and (3) given the President's FY12 budget proposal, should PSD alter its goal of encouraging early career researchers or alter any of its programs? The Subcommittee members adjourned to their respective break-out rooms for the remainder of the day.

Tuesday, April 19, 2011

Planetary Science Division Update

Dr. Green reviewed the recent and ongoing PSD mission events and upcoming activities. Upcoming activities include Dawn insertion at asteroid Vesta in July with a press conference in early August, the Mars Opportunity Rover arrival at the Endeavor Crater sometime in 2012, Dawn departure from Vesta, and Mars Science Laboratory (MSL) landing on Mars in August. The July 25 teleconference to discuss follow-up plans for the DS response will be rescheduled to sometime in June. Dr. Ron Greeley advised he will poll the Subcommittee members to find a new date. Once the date is set, 30 days is needed for the Federal Register notice. With regard to the working relationship between Earth Science (ES) and the Science Mission Directorate (SMD), PSD has started a dialogue with ES and also reached out to Heliophysics; both groups are interested, but have not yet made any commitments.

Dr. Waleed Abdalati, NASA Chief Scientist, told the Subcommittee that he is very interested in the PSS view of the DS. He sees the DS as an essential needs statement from the community and paths forward and believes the Planetary Decadal is outstanding and actionable with its realistic cost estimates and

decision rules. While the DS looks at one dimension of a multi-dimensional space, the advisory committees have the responsibility and opportunity to speak to “where the rubber meets the road.” They also set the priorities to stay true to the Decadal and the community and provide advice to NASA. Dr. Abdalati’s focus is on creating balance between the DS recommendations, advisory committee input, and OMB to create science programs to serve the community’s needs. He is also establishing cross-centered/cross-directorate activities to maximize the Agency’s science return.

In response to a question, Dr. Abdalati stated that he thinks a Science and Exploration Working Group is the right thing to do; how to populate the group needs to be worked out. He is also a strong advocate for promoting cross-divisional cooperation, believing there is tremendous value to applying expertise from one division to another. In closing, Dr. Abdalati noted that the perception of NASA as a science agency is one of his biggest challenges; his vision and success metric will be the extent to which science immediately jumps into everyone’s mind when they think of NASA. Dr. Abdalati invited the Subcommittee members to share their constructive viewpoints and ideas with his office.

Breakout Session Reports

The Chairs presented their sessions’ results. During the presentations, Subcommittee members offered editorial comments and/or suggestions to the following wording and content.

Europa/Outer Planet Breakout Report

Dr. William McKinnon presented his group’s report noting the inclusion of findings from the Outer Planet Analysis Group’s (OPAG’s) March meeting immediately following release of the DS. Details of the March findings are available on the OPAG website.

General Impression of Decadal Recommendations: DS is not a blueprint for a 20-30 year program. However laudable a goal, Mars Sample Return (MSR) is a focus for PSD (“first among equals”); it cannot be a sole focus for PSD over 20-30 years. This is not scientifically defensible, and it is not what the Decadal calls for. The Decadal is notable for its cost realism. MSR is notable for its ability to proceed in discrete stages. The Decadal calls for only the first element of MSR to be launched in 2013-2022, which allows for the necessary technology development to return the samples to Earth in the following decade. The Decadal is explicit in its prioritization of a descoped Outer Planets flagship to start later in the decade 2013-2022. This is the “ideal solution.” If the budget beyond the present 5-year horizon allows, the Mars 2018 mission will be followed by a de-scoped Europa mission.

Specific recommendations--New Frontiers (NF): The present five-year budget does not allow for an Outer Planets Flagship. Given the realities of Outer Planets exploration, the focus must necessarily fall to the NF mission class (and perhaps Discovery).

Specific Recommendations--Availability of Plutonium-238: Dr. McKinnon referred to OPAG’s March findings on this issue which are available on the OPAG website.

Specific DS Recommendations – Technology Investments: PSS supports the PSD plan to incorporate technology activities into a single, supported line. OPAG concludes that technology and study investments should be guided by this reassessment and made in the coming decade to enable Titan exploration.

Specific DS Recommendations – International Collaboration: The breakout group added a reference to the Stand ALone Missions of Opportunity Notice (SALMON) process to its March DS findings as noted below in bold print: OPAG strongly endorses the V&V recommendation that NASA vigorously pursue international cooperation in planning and executing planetary missions in the Outer Solar System. OPAG fully endorses the ESA Jupiter Ganymede Orbiter (JGO) mission concept. OPAG fully endorses the ESA JGO mission concept and PSD’s commitment to contribute instruments **through the SALMON process**. OPAG encourages continued collaboration between NASA and ESA as well as the U.S. and European scientific communities during the extended study phase for JGO.

Flagship Descope Process--Uranus Orbiter with Probe (UOP) mission: A logical time to initiate UOP mission studies would be FY 2013, after the situations with regard to “Joint-Lander-C”, Europa flagship, and Ganymede (Laplace) are further clarified.

Flagship Descope Process – Schedule: FY11--“New Europa” Science Definition Team (SDT) study to look at options for a descope mission; Oct 2011--study report at OPAG; FY12--Detailed Europa mission study if there is a recommendation or obvious path forward from OPAG; Feb 2012--ESA L-class “Decision” on how to proceed; April/May 2012--FY13 planning; Aug 2012--MSL Arrival--milestone for PSD to ensure the entry/descent/landing (EDL) system works; FY13--continued Europa mission study and technology development.

In response to a question, Dr. McKinnon agreed there should be a plan to use dollars wisely for missions not mentioned in the DS. OPAG supports the DS recommendation to move NF class to \$1 billion and remove the launch vehicles. In the absence of a flagship, the selection could fall to NF or Discovery, depending on how the AO is structured. With regard to Outer Planets, Dr. McKinnon noted that the most recent Discovery call at least opens the possibility for an Outer Planet mission; the call was constructed to try to move the Discovery program outside the solar system and into the near horizon of the outer solar system

Mars Breakout Report

General Impressions of the DS Recommendations: (1) positive overall opinion of DS report and recommendations; (2) regarding prioritization during budget challenges, endorse prioritization of SR&T, Discovery, NF, and Flagships; (3) strongly endorse efforts at international collaboration; (4) Mars 2018 designated Flagship Number 1 is excellent--MSR is NOT the culmination of the Mars program, but rather, the NEXT KEY STEP in an ongoing, highly productive program that has much more to accomplish; (5) some Mars community concern about MSR potentially dominating the 2020-2030 decade and that Mars is not included in New Frontiers queues; (6) applaud retaining Mars within scope of an augmented Discovery program; and (7) strong support for stabilizing/augmenting the SR&T budget.

Specific Recommendations: (1) the *Caching system* is the key NASA stake in the 2018 rover; (2) the NASA caching system and the ESA subsurface drill are both essential to address highest priority science objectives for both agencies; (3) strongly endorse TGO mission; (4) endorse early planning to ensure adequate funding for extended missions that are critical for planning future missions (e.g., Odyssey, MRO) and that continue to provide great science value for the cost; and (5) endorse focused technology development programs.

Flagship Descope Process – Part 1: (1) the Mars Exploration Program Analysis Group (MEPAG) Science Analysis Groups (SAGs) help guide prioritization of mission goals and objectives de-scopes; (2) in any de-scoped mission, the systems required for NASA caching science and the ESA subsurface drill science are essential to address highest priority objectives for both agencies; (3) endorse Joint Science Working group effort to define Level 1, etc., requirements for meeting key mission goals and objectives; (4) descope by slipping launch from 2018 to 2020 is technically feasible, but must be done early to minimize costs of postponement; (5) costing process--“Decadal Survey Process” (external costing exercise--should be employed to cost the 2018 rover mission after its Level 1 requirements are defined (September 2011) but before April 2012 when the FY14 budget process begins; the costing process should continue to be applied to all solar system missions; (6) endorse initiatives for ^{238}Pu , required for 2018 rover radioisotope heater units (RHUs); (7) should issue a draft AO for arm and mast instruments; (8) instrument AO should be released simultaneously in U.S. and in Europe; and (9) irrespective of whether or not the 2018 mission is viable, technology development for sample return is of critical importance and should continue.

Flagship Descope Process Schedule: May 2011--ESA Program Board (PB-HME); June 2011--MEPAG meeting, Lisbon; Fall 2011--2018 rover defined; Fall 2011--begin 2018 costing study and Pre-Ministerial meeting; Feb. 2012--FY13 budget announced; Mar. 2012--MEPAG meeting; April 2012--costing 2018 rover finished; April 2012--FY14 budget work begins; 2013--ESA Ministerial 2018 decision.

In response to a question, Dr. Green explained that every five years ESA has a major Ministerial that charts the course of its program for the long term; the next one is in 2013. ESA's Program Board adjudicates these things between the Ministerial; the Program Board is meeting at the end of this year. With regards to reliance on CATE studies, Dr. Green explained that independent cost analyses of technical challenges, projected costs, etc., are constantly provided; CATE is one of a series of approaches that is used. Identifying trip wires and not-to-exceed costs is part of the independent cost analyses.

SRT/RA Breakout Report

Rall'S Program Officer Issues

(1) Goal or goals of any revamping of the R&A program: The goal is to reduce the pressure to write proposals to R&A programs on scientists, improve the efficiency of proposal reviews, and to make it more efficient for program officers to manage their respective programs; (2)

What approaches would PSS recommend to accomplish this goal (or these goals) if grant size, grant duration and success rate could not be increased?

Independent of these possibilities, NASA should hire program staff whose job is to support program officers. NASA should increase the number of program officers, which have been found by a recent NRC study (An Enabling Foundation for NASA's Space and Earth Science Missions, 2010) to be critically understaffed. Program officers are tasked with managing both missions and R&A programs, which can be very difficult, with the result in some cases that R&A programs preferentially suffer. This should be monitored by the PSD R&A Lead, and when an R&A program is not being well managed in this situation, the program officer should be assigned to either missions or R&A programs, but not both. In addition, internal controls of program funds should be improved to prohibit modification of program budgets without prior approval by, or knowledge of, program officers or the division director. There also needs to be improved IT support for program officers by NSPIRES and NRESS regarding corporate memory of their programs, including access to records of past reviews, panel members, and external reviewers through a database that can be accessed and queried by program officers. Program consolidation could also advance this goal by reducing subject-matter duplications across programs, but only if undertaken in a funding-neutral way.

; (3) given that the President's FY12 budget proposal included a decreasing PSD budget, should PSD alter its goal of encouraging early career researchers (through NESSF, ECF, etc.) or alter any of its programs? No. Early career programs generate a small number of new scientists and should be strengthened by lifting restrictions on proposer qualifications, including extending the maximum number of years since PhD and removing the requirement barring a proposer from being in a tenure-track or other permanent position.

Specific DS Recommendations:

(1) Increase the R&A budget for planetary science by five percent—the declining PSD budget does not allow for the strict implementation of the Decadal recommendation of the five percent increase. However, implementation of the decadal language supporting increased funding for these programs would, at a minimum, call for a FY11 budget level no less than the FY10 level, with no cuts to the R&A programs going forward. It is not clear that the proposed flat budget of \$200 million for R&A programs going forward meet this criterion. Additional information should be provided to PSS that demonstrates this to be the case, or the funding should be increased to a level that meets this condition. In determining the FY10 funding level for R&A programs, funds re-phased to FY11 should be included. The specific Decadal recommendation for increased funding for R&A by percent with subsequent years increasing with inflation plus 1.5 percent should be revisited from year to year in the context of updated budget prospects for PSD with the intent of implementing that recommendation when the budget environment

improves. Funding for the R&A program should not be diluted by the inclusion of significant new responsibilities. Such new responsibilities added to the R&A program should be accompanied by the additional funds needed to support it.

(2) Increase average grant sizes and reduce the number of proposals--This recommendation should not be implemented without modeling the effects of such changes, including their potential impact on the workforce. Additional information on individual proposers (e.g., percent funded by grants) would be of value for these models and should be included in NSPIRES. A report on such modeling should be made to the PSS for its assessment. Any consolidation of programs (e.g., to reduce subject overlap) should be done in a way that preserves net funding to the programs. This should not be an exercise to find “cost savings” in research programs – reallocation of resources across programs is a separate issue to be dealt with in the context of a senior review.

(3) A funding line to promote further use of these suborbital observing platforms--Suborbital observing platforms are not user facilities to which non-instrument developers can bring science projects (as they do to IRTF or Ames Vertical Gun). To promote utilization of and support for suborbital observing platforms, with the desire that new user facilities be developed, funding for suborbital observing platforms should be sought within the Technology Development Program.

Integrating Recommendations into the PSS Report on Mission Enabling Activities ***Specific Recommendations -Technology Development***

Finding: PSD has a variety of technology-related activities to support near-term and long-term flight projects, including specific instrument-development programs. It has been recognized that support for development has been sporadic and is often inadequate to reach the Technology Readiness Level (TRL) sufficient for proposing an instrument for flight.

Recommendation: The PSD should establish its own balanced mission-enabling technology program and make available substantial, stable funding through the competed process to develop technology and scientific instruments for flight qualification (TRL ~6). To stimulate technology proposals, the PSD should expand its program of future mission studies to identify early technology drivers for high priority science and common needs for future missions.

Recommendation Implementation of the Survey’s recommended technology development program requires that a significant fraction of this program be dedicated to the development of technology that enables and enhances science return from the frequent Discovery class missions.

Recommendation (draft): PSD needs to consider the establishment of a well-coordinated and integrated program for development of the next generation of laboratory instruments to be used in sample characterization and analysis. In addition, the NASA’s advisory group for returned samples (CAPTEM) should be involved in the early planning phases of sample return missions to plan for appropriate collection, characterization (including containment and hazard assessment, if required), curation, handling and allocation of returned materials.

Recommendation (Personal, MVS): “Technology development” should also include information technology. In particular, given the large data volumes returned from missions (e.g., MRO) and planned, making use of improving communication systems, investments need to be made that will enable new means of processing and extracting information from these large volumes. The “eye-brain” combination is no longer sufficient.

Specific Recommendations - SMD mission-enabling activities are linked

PSS Response (draft): There are undoubtedly activities not currently supported by the PSD through the research and analysis programs and supporting activities that are needed to meet the objectives of the Division (e.g., systematic ongoing synoptic monitoring of planetary atmospheres, systematic physical

characterization of main belt asteroids, laboratory measurements of reflectance and emission properties of planetary materials and ices over sub millimeter wavelengths). These unsupported activities will change and expand with time as new questions arise from new knowledge achieved in the pursuit of these objectives. An open-ended means needs to be developed by which these unsupported activities can be identified and integrated into the portfolio of PSD supported activities.

Venus Exploration Analysis Group (VEXAG) Response to DS

1. VEXAG supports the recommendations of the Decadal Survey for an exciting and balanced exploration of the solar system. VEXAG endorses the recommendations for frequent, regular New Frontiers and Discovery missions, with somewhat higher cost caps, as well as supporting strongly the Supporting Research and Technology Development Programs.
2. VEXAG is pleased to see the Venus Climate Mission recommended as one of the large missions to be conducted within the decade based on the 2013 Decadal Survey priority list.
3. VEXAG will pursue creation of an International Focus Group for the Venus Climate mission recommended by the Decadal Survey.
4. VEXAG urges NASA to embark on the Venus Climate Mission Science Definition Working Team towards realizable mission architecture within the decade with international participation, coordination, and collaboration at a reduced cost to NASA.
5. VEXAG fully supports the VISE New Frontiers Mission as fundamental science. VEXAG notes that other key science objectives might also be accomplished within the NF4 and NF5 opportunities.
6. VEXAG emphasizes that technologies such as high temperature electronics and materials require significant and immediate investment to enable or extend the capability of future Venus missions to explore the lower atmosphere and surface. VEXAG notes that the publication of the 2013-2022 Planetary Survey marks two full decades since Magellan arrived at Venus. The enormous success of this mission led to many important questions about Venus and highlighted its significance for a better understanding of our home planet. However, a lack of new missions by the U.S. has led to a much diminished active Venus community, supported by only about three percent of the R&A budget. The size of the community may be now below a critical mass, making it difficult for research panels to include knowledgeable scientists.
7. NASA's support of the Participating Scientist program for Venus Express (and also for the curtailed Akatsuki/Venus Climate Orbiter mission from JAXA) has been laudable and consistent with the Decadal Survey recommendation regarding international collaborations, and VEXAG encourages expanding support for future Participating Scientist programs with Venus Express and any other future missions.
8. In the next decade, in absence of orbiting spacecraft around Venus, the sub-orbital program element under Research Opportunities in Space and Earth Sciences (ROSES) may become the major means of Venus observations from a long-lived Earth based balloon-borne stratospheric telescope. VEXAG urges NASA to fund the sub-orbital program adequately to enable such flights that may provide up to several months long balloon missions as also recommended by the Decadal Survey. International collaboration is possible and likely

Small Bodies Analysis Group (SBAG) Response to DS

General Impressions of the DS Recommendations: (1) the Survey should have a very positive impact on the future of small body science; (2) it recognizes the fundamental importance of planetary research programs and the Discovery program where much of the small bodies research is currently undertaken; (3) two of its five recommended New Frontiers missions involve small bodies (Comet Surface Sample Return, Trojan Tour and Rendezvous); (4) survey recommendations for investment in technology

development has the potential of increasing opportunities and science return from missions to small bodies across all mission classes; (5) survey support for ground-based observations highlights an essential activity required to characterize the diversity of asteroids, comets and other objects comprising the different populations of small bodies.

Note on DS Recommendation: The Decadal Survey made its recommendations in the context of positive budget projections for NASA that deviate substantially from current expectations. The Survey did recognize the potential for this and fortunately provided some guidance for understanding how its recommendations might be implemented. However, such guidance is limited, so when detailed implementation of language would contradict the goals and objectives identified by the Survey for that language, an implementation that advances the goals and objectives should be followed.

Finding #1: Current budget expectations for PSD are such that plans for future Flagship missions are not possible. Pursuit of Flagship missions in this budget environment jeopardizes the implementation of Decadal recommendations for smaller missions, research and analysis programs, and technology.

Finding #2: Future Flagship missions should be funded by Congress as new starts in the NASA PSD budget. This allows for the possibility of high science return missions identified within the Survey as meritorious, but outside the budget range considered practical. This would require revisiting Flagship recommendations in an open and transparent process.

Finding #3: The importance given by the Survey to the R&A programs argues for an implementation of the Survey recommendation on R&A funding that would not allow these programs to fall below their FY10 funding levels.

Finding #4: To “maintain the original goals of the Discovery program” and provide a “regular, predictable, and preferably short (< 24 month) cadence for Discovery Announcement of Opportunity (AO) releases and mission selections,” NASA needs to have calls on 18-24 month timescales, selection of two missions per call, and accept higher mission risk. This would ultimately translate into an average of one Discovery mission launch per year.

Finding #5: The recommendation that the Discovery program call allow space-based telescopes to be proposed should include both survey facilities (analogous to WISE) and user facilities (analogous to HST and Spitzer).

Finding #6: The New Frontiers mission line provides important opportunities for the Small Bodies community to pursue scientific objectives whose feasibility is beyond the scope of Discovery class missions. Savings by forgoing Flagship missions should support the recommended selection of two New Frontiers class missions in the coming decade, in addition to supporting the recommendations for the Discovery program.

Finding #7: Implementation of the Survey’s recommended technology development program requires that a significant fraction of this program be dedicated to the development of technology that enables and enhances science return from the frequent Discovery class missions. The balance should be invested in potential technologies that enable and substantially reduce the expense of high-value New Frontiers and Flagship missions.

Finding #8: Within NASA investments in potential technologies that enable and substantially reduce the expense of high-value New Frontiers and Flagship missions in this decade and beyond, priority should be given to developing technologies required for a future Comet Cryogenic Sample Return Mission. These include: 1) collection of cryogenic samples from depths up to three meters below the nucleus surface, preferably intact core tubes; 2) containment of samples at cryogenic temperatures, ~ 125 K, during return to Earth and through re-entry and recovery; and 3) analysis techniques for handling and studying cryogenic samples in the laboratory.

Finding #9: The Survey recommended that mission instrument teams be required to generate high-level derived data products as well as low-level products before the completion of the project. This cannot be implemented without the segregation of funding for data product generation and archiving in a manner that protects these activities from mission cost overruns.

Finding #10a: Recommendations for continued NASA support of large ground-based facilities (NASA IRTF, Keck, Goldstone, Arecibo, and VLBA) should be implemented with a corresponding share of time for solar system observations. In addition, NASA should work with NSF to ensure that appropriate time is provided for planetary studies on NSF facilities. Such time allocations are required to aide research of the numerous small bodies within the solar system and help support spacecraft missions to these objects. These allocations are important for the general study of solar system objects, but are more so for observing targets of opportunity and transient events (e.g., impacts on Jupiter, asteroid collisions, close NEO approaches, comet outbursts, etc.).

Finding #10b: The Decadal Survey recognizes the importance of the Large Synoptic Survey Telescope (LSST) for solar system studies and encourages the timely completion of this facility. NASA should ensure that an appropriate amount of LSST time be allocated by NSF for the detection and characterization of solar system objects that is commensurate with the level of funding contributed for NASA's share of the observations.

Finding #11: In times of fiscal limitations, NASA does best to focus on those recommendations that promote and solidify infrastructure supporting planetary science.

Finding #12: Decadal Survey support of NASA engaging in international partnerships, when appropriate, to enable missions unlikely to be pursued by single countries or single space agencies, should be implemented in part via participation by NASA in standing planning groups such as the International Primitive Bodies Exploration Working Group (IPEWG). In addition, the process required for NASA participation in international missions needs to be streamlined, so that the Agency can respond to potential missions of opportunity more effectively.

Finding #13: The Science Mission Directorate (SMD) and the Human Exploration and Operations Mission Directorate (HEOMD) should evaluate and cooperate on future NASA robotic precursor missions and human expeditions to Near-Earth Objects (NEOs) with respect to synergies for science, exploration, resource utilization, and planetary defense. This requires a standing committee tasked to bridge these Directorates to provide awareness and input on these synergies. The SBAG is the appropriate committee to undertake this role.

Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) Response to DS

Specific DS Recommendations: *Flagship Missions*--CAPTEM strongly supports NASA/ESA Mars Sample Return campaign: Descoped Mars Astrobiology Explorer-Cacher (MAX-C); *New Frontiers*--CAPTEM highly supports Comet Surface Sample Return and Lunar South Pole-Aitken Basin Sample Return; *Technology Development*--CAPTEM particularly supports Mars Sample Return Lander and Orbiter; *Supporting NASA Activities*--For sample curation and analysis: establish a single advisory group to provide input on collection, containment, characterization and hazard assessment, and allocation of samples; consider the full costs to NASA of receiving and curating samples when planning sample return missions; before samples return, establish a program to develop instruments and facilities for sample analysis; *National Science Foundation*--NSF's Office of Polar Program supports important meteorite collection and planetary analog studies in Antarctica. This support should continue. NSF also funds laboratory research that is important to planetary science. Expanded NSF funding of laboratory research in planetary science is recommended.

CAPTEM Response

1. Assist with planning and implementation of a long-term curation plan (looking toward a five-year horizon) to include: planning for Mars Sample Return that meets planetary protection requirements (Flagship), planning for additional lunar and cometary samples (NF), and planning for samples from asteroidal bodies (NF/Discovery).
2. Looking toward the next decade through technology development in support of collection and curation (e.g., development of cold curation capabilities).
3. Encourage sample science community (through forums such as workshops etc.), to develop unique, shared laboratory facilities for analysis of planetary materials and seek avenues of funding from NSF for laboratory studies of planetary materials.

Lunar Exploration Analysis Group (LEAG) Response to DS

General Impressions of DS Recommendations: (1) overwhelming support of the Decadal; (2) supports NF and Discovery cost cap increases; (3) support for R&A recommendations; (4) strong support for SMD/Exploration Systems Mission Directorate (ESMD) (HEO-MD) joint missions; and (5) strong support for SALMON/MOO calls for U.S. participation in international/potential Highly Elliptical Orbit (HEO) lunar missions.

LEAG Recommendations: (1) strongly encourages international collaboration and cooperation in lunar missions and science; (2) strongly encourages the PSD to examine synergies with ESMD (HEO) that could facilitate joint missions; (3) recommends that the PSD, with broad community input, develop an enabling technology development plan for future planetary missions; and (4) suggest if South Pole-Aitken Basin (SPA) Sample Return is the selection for NF3, then LGN should be included in NF4.

Preliminary PSS Recommendations to the Science Committee

Dr. Greeley reviewed the draft PSS recommendations for the upcoming Science Committee meeting, soliciting editorial comments and/or suggestions from committee members. The strategy for briefing the Science Committee was also discussed. Emphasis on the cross-mission directorate, PU-238, and capitalizing on European-developed technologies were three additional topics suggested to Dr. Greeley for inclusion in his Science Committee presentation

Meeting Deliverables

1. Reschedule teleconference to last two weeks of June between hours of 11 a.m. and 4 p.m., EDT. Dr. Greeley will survey Subcommittee members to come up with the date.
2. Subcommittee members should review the minutes from previous PSS meetings and send corrections to Dr. Rall by the end of April.
3. Watch for the draft of the PSS report in response to the National Research Council (NRC) assessment of mission enabling activities.
4. Determine the method for archiving and preserving DS white pages. Dr. Green will review this and make sure white papers and all relevant reports are loaded on the server so they will be available.
5. Jonathan Rall will initiate paperwork to extend the appointments of those scheduled for rotation off the PSS on May 31 so they can participate in the June telecon.

Review and Wrap-up

Presentations will be posted on the website. The October PSS meeting may have to be postponed to avoid NASA bi-lateral meetings.

The meeting was adjourned.

PLANETARY SCIENCE SUBCOMMITTEE**NASA Headquarters April 18-19, 2011****April 18 Monday - Room MIC 3 (3H46)**

8:30	Welcome, meeting overview	Greeley, Green
8:45	Annual ethics briefing	Reistrup, OGC HQ
9:45	NRC Decadal Survey overview	Soderblom
10:15	Break	
10:30	Planetary Science Division response and results of the bilateral discussions	Green
11:30	Lunch	(on own)
12:45	NRC Decadal Survey discussion	Soderblom and all
2:45	Break	
3:00	Working group breakouts (Mars, Europa/outer planets, SRT/R&A)	
5:00	Adjourn	

April 19 Tuesday – Room MIC 5 (5H45)

8:30	Planetary Science Division update	Green
9:30	Europa/outer planet breakout report	McKinnon
10:30	Break	
10:45	Mars breakout report	DesMarais
11:45	Lunch	(on own)
12:45	SRT/RA breakout report	Sykes
1:45	VEXAG response to DS	Limaye
2:00	SBAG response to DS	Sykes
2:15	CAPTEM response to DS	Wadhwa
2:30	LEAG response to DS	Neal for Shearer
2:45	Break	
3:00	PSS recommendations (preliminary) on DS	all
5:00	Adjourn	

Breakout rooms:

Conference Room: 3U38 & 2V76

Date and Time: 04/18/2011, 03:00 PM-05:00 PM

USA toll free conference call number 800-779-7680, pass code PSS, to participate in this meeting by telephone.

Appendix A – Agenda

Planetary Sciences Subcommittee (PSS)
NASA Advisory Council Science Committee
Membership List

Ronald Greeley Regents' Professor	School of Earth & Space Exploration Arizona State University
Jonathan A. R. Rall Executive Secretary	Planetary Science Division Science Mission Directorate
James F. Bell Professor	Department of Astronomy Cornell University
Julile Castillo-Rogez	Jet Propulsion Laboratory Pasadena CA
Tom Cravens	University of Kansas Lawrence KS
David Des Maires	NASA Ames Research Center Moffett Field CA
John Grant	National Air & Space Museum Washington DC
William M. Grundy	Lowell University Flagstaff AZ
Gregory Herzog	Dept. of Chemistry & Chemical Biology Rutgers University
Jeffrey R. Johnson	Johns Hopkins University Applied Physics Laurel MD
Sanjay Limaye	Space Science & Engineering Center University of Wisconsin
William B. McKinnon	Dept. of Earth & Planetary Science Washington University

Appendix B – Membership

Louise Prockter	Dept. of Space Physics John Hopkins University
Anna-Louise Reysenbach	Dept. of Biology Portland State University
Charles Shearer	Institute of Meteoritics University of New Mexico
James Slavin	NASA Goddard Space Flight Center Greenbelt MD
Paul Steffes	School of Electrical & Computer Engineering Georgia Institute of Technology
Dawn Y. Sumner	Dept. of Geology University of California, Davis
Jessica Sunshine	Dept. of Astronomy University of Maryland
Mark V. Sykes CEO & Director	Planetary Science Institute Tucson AZ
Meenakshi Wadhwa Director	Center for Meteorite Studies Arizona State University

Planetary Sciences Subcommittee (PSS)
 NASA Advisory Council Science Committee
 April 18-19, 2011

Participants

Subcommittee Members

Ronald Greeley, Chair	Arizona State University
Jonathan R. Rall, Executive Secretary	NASA Headquarters/Science Mission Directorate
James F. Bell	Cornell University
Julie Castillo-Rogez	Jet Propulsion Laboratory
David Des Maires	NASA Ames Research Center
John Grant	National Air & Space Museum
William M. Grundy	Lowell Observatory
Gregory Herzog	Rutgers University
Jeffrey R. Johnson	Johns Hopkins University
Sanjay Limaye	University of Wisconsin
William B. McKinnon	Washington University
Louise Proctor	Johns Hopkins University
James Slavin	NASA Goddard Space Flight Center
Paul Steffes	Georgia Institute of Technology
Dawn Y Sumner	University of California, Davis
Mark Sykes	Planetary Science Institute
Meenakshi Wadhwa	Arizona State University

NASA

Jim Green	NASA HQ
Sarah Noble	NASA HQ
Janice Buckner	NASA HQ
Marian Norris	NASA HQ
Ralph Beaty	NASA HQ
Jim Reistrup	NASA HQ
Amy Kaminski	NASA HQ
Curt Niebar	NASA HQ
Jeff Grossman	NASA HQ
Philip Crou	NASA HQ
Mary Vortek	NASA HQ
Michael Meyer	NASA HQ
Adriana Ocampo	NASA HQ
Mike Reddy	NASA HQ
Chris Johnson	NASA HQ

Other Attendees

Kurt Lindstrom
Carolyn Cook
Scott Hovarter
Clive Neal
Cheryl Reed
Richard Zurok
Jeff Johnson
Larry Soderblum
Jeff Hayden
Brook Lakew
Linda Givvings
Scott Hovarter

APL
Zantach

Notre Dame
APL
JPL
APL
USGS
N. Science Corp
GSFC, NASA
GWI
Lockheed Martin

Planetary Sciences Subcommittee (PSS)
NASA Advisory Council Science Committee
April 18-19, 2011

Presentations

Annual ethics briefing	Reistrup, OGC HQ
NRC Decadal Survey overview	Soderblom
Planetary Science Division response and results of the bilateral discussions	Green
Planetary Science Division Update	Green
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Mars breakout report	DesMarais
SRT/RA breakout report	Sykes
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SBAG response to DS	Sykes
CAPTEM response to DS	Waxhaw
LEAG response to DS	Neal for Shearer

Appendix D - Presentations