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Meeting Minutes

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Welcome

Dr. Ronald Greeley, Chair of the Planetary Science Subcommittee (PSS) opened the meeting. Members introduced themselves and agenda items were briefly reviewed. Dr. Greeley acknowledged members who would be cycling off the subcommittee by March 1, 2011; these were Drs. Cravens, Herzog, Johnson, and Slavin. Dr. James Green, Director of the Planetary Science Division (PSD) added his commentary, noting that this would be a critical meeting as Congress debates budget particulars that will undoubtedly impact the division. He added that he wished to ensure that PSD continue to perform top science tasks with guidance from PSS. The Planetary Decadal Survey is due to be released on 7 March, therefore the next PSS meeting in April will deal with the outcome. Dr. Stephen Squyres will be presenting the contents of the Survey at the Lunar and Planetary Science Conference (LPSC); PSD is currently negotiating to support a live stream broadcast of the announcement. Dr. Greeley instructed that the announcement be available on "PEN."

NAC Science Committee Review of Analysis Groups

Dr. Greeley led a discussion of a study assessing the Supporting Research and Technology (SR&T) program of the PSD, including Research and Analysis (R&A) but excluding technology. The study had been prompted by 2009 PSS recommendations, as well as the National Research Council (NRC) report, *An Enabling Foundation for NASA's Earth and Space Science Missions*. The study is also being guided by the new NASA Science Plan. Key recommendations of the review are to ensure mission-enabling activities are linked to the goals of the Agency; to develop and implement an approach for balancing PSD's portfolio of activities; and to ensure the appropriate quantity of science officers to carry out these activities.

Providing background, Dr. Greeley explained that an SR&T Working Group was formed from PSS membership, and has conducted studies through meetings, telecons, and has kept the community informed through PEN, Town Halls meetings, and the various PAGs. MEPAG was commended for providing a written report that applies across the board, scientifically. The PSS Working Group is formulating observations, findings, and recommendations, and has issued a draft report.

Dr. Greeley requested feedback on the WG draft report, particularly regarding Recommendation 1, which calls for linking activities to specific activities of the division. The draft report was distributed along with a document that specified assignments for each subcommittee member to examine content, substance, consistency and word choice.

NASA Launch Services (NLS) II Update

Dr. Jim Norman gave an update on launch services. The NLS II contract is now in place for serving launch needs as NASA goes forward; the contract is very similar to NLS I but with substantial increases in costs, especially for heavy lift launches. Available rockets are the Falcon 9 through Atlas V; or medium-class to intermediate lift capacity. Price ranges are from \$32M to \$114M for small rockets; med- \$102 to \$136M for medium-class, and \$102 to \$334M for intermediate-class vehicles. The Delta IV is not currently offered, but there will be an opportunity to bring on other launch vehicles when they become available, in the August 2011

period. Vehicles are typically procured at Launch Month minus 30 days. A standard work plan is in now place for rocket providers to guide milestone payments all the way to launch day.

Among challenges within the NLS II, there has been performance loss in offers by ULA for the Atlas V compared to NLS I. Weight has been added to address structural issues, leading to a loss of about 400-500 kg in performance. The difference can be made up by adding solids, and work can be done on performance needs within the specifics of particular mission.

Prices have also increased. Factors influencing price increases include the erosion of the business base by 50-75%, resulting in cost increases of 100-800%; prices had been based on 5 launches per year versus early assumptions of 10-12 launches per year; NLS I prices had been heavily discounted and did not take into account normal escalation rates. Prices will also be driven by Department of Defense (DOD) and Air Force (AF) planning. In response to a question, Dr. Norman noted that small rockets such as Taurus and Pegasus will be available through NLS II, and that the Minotaur IV would be purchased from the AF.

Effects on Planetary Science were exemplified. The Mars Atmosphere and Volatile Evolution (MAVEN) mission, for example, will bear a total launch cost of \$187M. The Falcon 9 vehicle is expected to be on board in Spring 2013, and its cost is expected to be 43% less than an Atlas V. The ELC cost risk is being addressed, and it is anticipated that NLS II will be updated as soon as the National Reconnaissance Organization, NRO/DOD work out their ELV needs. A cost risk of \$10-20M (extra crew costs) for additional enhanced launch capability continues to be worked; it is expected that this type of cost risk will be an exception rather than the rule.

Mars Exploration Program

Mr. Doug McCuiston gave an update on the Mars Exploration Program (MEP). Preparations are underway to plan for a joint European Space Agency (ESA)/NASA effort for Mars 2016/2018 missions that could serve as a precursor to Mars Sample Return (MSR). MEP has acquired a new Program Scientist, Mitch Schulte; and a Joint Program Documentation- Executive Program Plan will be ready for signature in mid-February. A memorandum of understanding (MOU) will be sent to the State Department by March for the recognition of the ESA/NASA joint program for Mars. The NASA Program Implementation review is ongoing.

MEP was represented at the National Air and Space Museum on January 13, the event was hosted by the Smithsonian Institution and provided 3 panels on Mars findings, status of current technology, and efforts to seek signs of life.

Ongoing missions include the progress of the Opportunity rover toward the Endeavor Crater; it will be another 6-9 months before it reaches its destination. The Spirit rover remains silent; as peak solar power will occur in March, communication efforts will continue. The Mars Science Laboratory (MSL) is fully assembled and will start environmental testing shortly. MAVEN is green across the board, and all its phase C/D contracts have been signed.

In terms of MSL development, its solar arrays, ChemCam, and Sample Analysis at Mars (SAM) are complete. Mobility issues have been resolved. Some anomalous sensors and some contamination in drill bit have hindered Sample Acquisition/Sample Processing and Handling (SA/SPaH) instrument development, and MEP is working on resolving these. Batteries are out being reworked and refurbished. All budget reserves were spent in FY10, with an approved augmentation in December 2010 with reserves partially held at Headquarters, following

guidelines put in place by PSS. Lessons Learned will commence after numerous Inspector General (IG) and General Accountability Office (GAO) audits have concluded. The augmentation was indeed confined to the Mars Program, via principles previously outlined by PSS. MSL's environmental test sequence begins on 14 February. There will be a last workshop for site selection in May 2011. The candidates remain as before: the Eberswalde, Gale, and Holden Craters, and Mawrth Vallis. MSL still has ample schedule margin built in; and is scheduled to ship in June for the November 2011 launch.

A Joint Mars Executive Board has been stood up to facilitate discussion between NASA and ESA; the Board meets every quarter. Mr. McCuiston and Dr. Elwood of ESA are co-chairs. Joint Engineering Working Group(s) will also be established for future mission concepts, as well as a Joint Mars Architecture Review. Dr. Ed Weiler, Associate Administrator of the NASA Science Mission Directorate, and his ESA counterpart Dr. Southwood discuss higher-level issues at their bi-lateral meetings. A 2016 mission project office has been established at the Jet Propulsion Laboratory (JPL), with the ESA orbiter mission having been placed under the ExoMars Program Office. Overall governance, documentation, review processes are maturing, and were presented to an Agency Program Management Council (PMC) in October 2010. An MSR working group was established in April 2010. A Science Definition Team (SDT) for the 2018 opportunity has not yet been established, but a Science Analysis Group for MEPAG will serve as fodder for the 2018 SDT, probably in the Fall of 2011.

For the 2016 ExoMars/Trace Gas Orbiter mission, the spacecraft bus will be provided by ESA while NASA provides instruments. The landing system will be much like that used in the Mars Exploration Rover (MER) mission: the final descent is powered, with a crushable material situated beneath the spacecraft. NASA will contribute aerobraking and science payload operations. The orbiter will carry X-band capability through 2022, and there will be substantial ESA/NASA collaboration on all aspects. The key decision point (KDP)-A is scheduled for March 2011. There will be no K_a-band on this bus. Radio science has not been discussed yet but remains a possibility; Dr. Sanjay Limaye urged evaluation of this idea.

The 2018 Mars dual rover mission will use the Atlas 531 capability. The leading concept for this mission is to build a pallet and place both rovers on it, and then use a Sky Crane to lower the pallet to the planet's surface. This is recognized as an engineering challenge. A second concept is to nest the rovers together and land them on the surface. The rovers could conceivably be launched separately and to separate latitudes. In pre-phase A, the US rover/instrument configuration will be more driven by Decadal Survey results. The NASA rover will likely be solar powered as it cannot be scaled down for a radioisotopic thermal generator (RTG). A Stirling generator may or may not be available. The maximum load for a power system is 300 kg. Dr. McKinnon asked whether the MAX-C concept could be used with air bags. Dr. McCuiston replied that if a caching system is included, this would increase the size and mass of the rover. The current plan is to start at MER dimensions and work upward. The upcoming three months will be very busy, with many reviews and documentations in planning for future 2016/18 missions. The Mars Organics Molecular Analyzers (MOMA) instrument is being breadboarded at Goddard Space Flight Center; MOMA is a mass spectrometer, with a laser desorption instrument and ion trap.

Status of Potential Europa/Jupiter Mission

Dr. Curt Niebur gave an update on the status of the mission. The Europa Jupiter System Mission (EJSM) concept has been in development for a decade on both the NASA and ESA

sides. A multi-step downselection/study process has taken place in a competitive atmosphere, while assessing the technical maturity of the mission. All mission studies went through independent cost, science and technical reviews. The concept has been designed as a flexible mission, with two spacecraft that can either jointly or independently explore Ganymede and Europa. Europa would be assessed for its habitability features and Ganymede would be characterized as a planetary object, as well as assessed for its habitability. Both spacecraft could explore the Jupiter system as a whole as an archetypal gas giant. Synergistic science can also be performed with two spacecraft, and careful advance planning will be required to maximize synergistic science.

Addressing primarily the Jupiter Europa Orbiter (JEO) concept, the NASA mission design is still in pre-phase A. While awaiting the outcome of the Planetary Science Decadal Survey, NASA has continued to fund efforts to reduce the cost risk for EJSM. Cost risk is a core part of the development team's philosophy. NASA continues to focus on cost risk, in part through the appointment of Joan Salute as new Program Executive at Headquarters, and of Tom Gavin as the pre-project manager at JPL. Dr. Gavin has already held an "internal" mission concept review to clarify and consolidate areas for the mission to address. External assessments continue, as well as Planetary Protection trade studies for a Viking-style planetary protection approach (terminal dry-heat microbial reduction). The pre-project is also considering a variety of ways to address complexity and risk.

Recent activities include preparing for an instrument-procurement strategy, including workshops. A Joint Jupiter SDT released its report to NASA in November 2010. An Announcement of Opportunity (AO) and associated library are being prepared as a result of these activities. Instrument acquisition strategy, and instrument development and instrument cost remain the two key areas of uncertainty. There will be a two-step AO to address the technical complexity of the mission. The Outer Planets Analysis Group (OPAG) has provided input on the draft AO; Dr. Green noted here that because of the Continuing Resolution (CR), the draft must be held for now. The AO will be released after the Decadal Survey and the community is well aware of what might be in that draft.

Planetary Science Division (PSD) Update

Dr. Green presented a status of the division. Several retirements were noted, while more full-time civil service staff have come on board.

Recent accomplishments include the transfer of the Lunar Reconnaissance Orbiter (LRO) from the Exploration Mission Directorate (ESMD) to PSD. LRO has had one instrument anomaly that had no influence on science objectives. The Wide-field Infrared Survey Explorer (WISE) mission has been extended to support the Near-Earth Object (NEO) survey through January 2011. The successful launch of O/OREOS (astrobiology experiment- space exposure of organics, biological material) was also noted. EPOXI is being considered for a possible extended-extended use; there is no decision at this time, and it will be tied to the budget. EPOXI has a number of Astrophysics uses, however, and could be regarded as a mission of opportunity (MoO). This year marks the 7th anniversary of Spirit and Opportunity. The Discovery-12 AO received 28 proposals, and evaluation is in progress. New Frontier Step 2 proposals are due 28 January: these are Moon Rise (lunar sample return), OSIRIS-Rex (asteroid sample return), and SAGE (Venus lander). Dr. Mini Wadwha remarked that NASA was due to receive as many as 1500 particles from Japan's Hayabusa mission; samples are to be transferred early this year.

NASA continues its support of ESA Cosmic Vision missions Laplace, LISA, and IXO. ESA will hold its "Yellow Book" presentations in February 2011. Dr. Green would be at the Laplace presentation. Medium-class missions, as well as a third potential mission in 2020/22, are undergoing an evaluation and are awaiting an ESA decision. There is a large selection of planetary missions in this category.

Budget climate

Civil servant salaries have been frozen for 2 years, and a restricted travel budget is in force at NASA. The freeze could be extended for 5 years under a new policy of Federal austerity. NASA is still under a CR until at least 4 March. FY11 possibilities are a full-year at FY10 levels, and Congress is also considering going back to FY08 budget levels. These scenarios could affect plans to re-start domestic Pu-238, enhancement of NEO surveillance, and R&A (\$20M). The FY12 budget is due to be released on 15 February. The CR also prohibits re-starts, and thus may affect EJSM instruments. Altogether, the budget climate could represent a total of \$115M deficit to PSD, and possibly more. There are budgetary pressures from other science disciplines. Despite these constraints, Planetary still has an impressive program. Dr. Green noted that Dr. Weiler has always been strict about keeping budget woes confined within each division, and he expected that philosophy to remain unchanged.

Status of R&A

Fiscal conservation will also be enforced in R&A, and will be managed by underselecting in each of the R&A calls, putting on notice which proposers are in the "selectable" range, such that they can proceed with their grants. PSD will also use active grants management, such as phase-funding to match needs with PI approval. As to the impact on New Frontiers and Discovery, Dr. Green would be able to make an educated decision after the budget is released. All "selectable" proposals will be revisited when a complete budget picture for NASA has been determined. It was anticipated that ROSES 11 will be issued in February, and that will set the stage for proposals that are funded by FY12 money. Funds going into ROSES are based only on a notional budget, thus PSD can't be held to the numbers. "Selectables" may or may not want to re-propose. Mr. Michael Meyer commented that it is unlikely that a proposal designated as selectable would be carried over to the next year. Thus, timely invoicing of work should be done.

Planetary mission status

MSL, Juno and Grail are all on their way to launch in 2011 and are doing well. Cash flow to these missions is also on track. Juno launches in August and is projected to stay within its external commitment. GRAIL is to launch in September and is also projected to stay within its external commitment. MSL is due to launch on an Atlas V and has no unencumbered reserves left. PSD must budget now to have the necessary reserves on schedule and costs. For MSL, it will be necessary to get a reserve back to plan for contingencies, such as accidents and outreach activities associated with a nuclear payload. That money needs to be identified and must be in the budget.

MSL will require a total of another \$82.1M, as reported to Congress. This amount represents a 3% increase over the prior LCC of \$2.4276B. MSL will need to find \$23.3M in 2011 and \$46.3M in 2012. To do this, the program will follow PSS guidelines, and the cost will be borne by JPL, followed by MEP, and any impacts to non-Mars programs would be sought through delays rather than cancellations. If Juno and GRAIL launch under their reserves, this will contribute some relief to the MSL needs. There is little flexibility to cut back operating missions. Dr. Green

did not feel any cancellations would be necessary, but offered no guarantees. The possibilities would be to cancel some missions in development such as LADEE, or New Frontiers and Discovery missions. It was noted that past MSL overruns resulted in Mars technology development being essentially eliminated, and the overall ability to execute a Mars mission in 2016 was considerably eroded.

Dr. Green addressed the ongoing issue of re-initiating Pu-238 production in the U.S. The AAAC was briefed on the matter in October 2010, at which time the chair of the AAAC wrote a letter to the Department of Energy (DOE) and NASA, expressing its concern about the effects of a delay in Pu production on both Planetary and Astrophysics science missions, and recommending timely re-start of domestic production. DOE responded on 20 January, highlighting its cost-sharing plan with NASA at the level of \$15M by each agency. The program is not yet funded and will have to await an approved budget.

Year of the Solar System

In 2011, NASA will be working with JAXA to recover data from its missing Venus orbiter (V Climate Orbiter). On 14 February the comet Tempel 1 encounter will take place. PSD will respond to the Decadal Survey in March. MESSENGER will undergo orbit insertion at Mercury and Dawn its orbit insertion at the asteroid Vesta. Juno is scheduled to launch to Jupiter followed by GRAIL's launch to the Moon and MSL's launch to Mars. In 2012, Dawn will leave Vesta to travel to Ceres. MSL will land on Mars in August, and Opportunity will reach the Endeavour Crater.

PSD Issues

Like the Astrophysics and Heliophysics divisions, PSD must review all extended missions in one Senior Review. There are 6 operating missions to review for extended status in 2012: Mars Odyssey, MERs, Mars Express, Mars Reconnaissance Orbiter (MRO), Cassini, and the Lunar Reconnaissance Orbiter (LRO). PSD is proposing to undertake this Senior Review in March 2012. In response to a question, Dr. Green stated that PSD did not plan to have a Stand Alone Mission of Opportunity (SALMON) call in this fiscal year, but anticipated that the Decadal Survey would support international opportunities, so that SALMON would have support in the future.

Dr. Green returned to the issue of Decadal Survey release. Dr. Greeley suggested holding two PSS teleconferences (February and in mid- to late March). Dr. Melissa McGrath informed the subcommittee that NASA is planning Town Hall rollouts during the month of March, and dates are being set for the DPS toward the end of March, trying to target the Planetary community.

MESSENGER: Options for an Extended Mission

Dr. Ed Grayzeck briefly presented options for an extended mission (EM) for MESSENGER. Option 1 (preferred) presumes a Senior Review in Summer 2011, as the craft has enough fuel for one year of EM, and does not distract the project during the crucial period of March 2011. Option 2 is to extend the primary mission by 6 months, which has the disadvantage of not giving the project the 6-month lead time to prepare for orbit insertion, etc. At this point, an EM would concentrate on new discoveries found in the primary mission. Option 1 also provides enough time for preliminary data to be evaluated. Dr. Grant asked if all EM money went into a common pot, might this still be used for MSL? Dr. Grayzeck responded that while the budget is set up so that missions are in lines, the main concern is to use money the best way possible, as a Senior

Review might recommend. Dr. Jim Bell commented that the most important factor should be to avoid distracting the team, in support of Option 1. Dr. Prockter also supported Option 1.

Question and Answer period with SMD AA Ed Weiler

Dr. Weiler, Associate Administrator of the Science Mission Directorate (SMD) addressed the absence of an FY11 budget and its impact on SMD, noting that the CR has been especially problematic for the Earth Sciences Division (ESD) and PSD, because each of these divisions may not receive their proposed increases (\$115M for PSD and \$400M for ESD). NASA is obliged to follow the Anti-Deficiency Act and is therefore required to take care in obligating monies. Congress may or may not pass a budget in March. For FY12 and beyond, one may be given to expect that the discretionary budget will be frozen at a constant level; this would represent a major impact to PSD, as it had been growing 4-5% in the outyears. The Decadal Survey, as a result, will probably over-estimate PSD's resources, therefore the division must hammer out a program that does not set false expectations.

Dr. Des Marais asked whether robotic missions to the Moon would proceed normally. Dr. Weiler replied that the robotic program is under the same pressure as the rest of NASA. Asked if SMD had a formal plan on how to address the Decadal Survey, Dr. Weiler noted that while possibilities have been discussed, SMD would be unable to execute the entire Survey portfolio unless the FY11 budget comes to fruition. He encouraged the community to work with NASA in this regard, and to involve international partners. Dr. Green added that if the New Frontier and Discovery programs are deemed by the Decadal Survey to be high-priority items, and if the budget is available, Discovery would be evaluated in May and New Frontiers would follow in summer. Discovery would likely have an April selection meeting. Dr. Prockter commented that the two EJSM orbiters seem to be out of sync thus far. Dr. Weiler replied that once things settle down in Europe, NASA should think about the possibility of a joint roadmapping/Decadal Survey exercise with ESA. Dr. Marcus Allen is already talking with his international counterparts on this issue. However, there is no way to fund Europa, a full Mars program, a full Discovery/New Frontiers program, and a full lunar program within a budget that is expected to run no more than \$1.5B/year. Regarding Lessons Learned on the James Webb Space Telescope (JWST) having been incorporated into the Astro2010, the entirety of SMD may be facing fundamental changes in the size and frequency of missions, and the community may have to change its philosophy to sharing "firsts." Dr. Weiler expressed great optimism about the outcome of the Planetary Decadal Survey, but he urged the community to rethink the balance of the Planetary program. Dr. Castillo-Rogez asked if NASA had extracted all the science possible from existing data sets, with new techniques. Dr. Weiler replied that a Senior Review would determine this issue, adding that the Stardust 2 encounter represented the equivalent of a \$300-400M mission for an actual cost of \$29M.

Dr. Jessica Sunshine expressed concern that R&A could not support researchers adequately if large missions are reduced in number. Dr. Weiler re-stated NASA's practice of having researchers justify their science grants based on their relevance to NASA data produced by NASA missions. If NASA merely collects and does not analyze data, it is wasting time and taxpayer dollars. Asked about site characterization for future missions, Dr. Green replied that in its charge to the National Academy of Sciences (NAS), PSD made it clear that the whole program must be assessed, thus he anticipate the Decadal Survey to reflect a balanced program among R&A, technology, and missions. The community will need to step up to the plan, regardless of the outcome. Dr. Sykes expressed concern that a Decadal Survey based on invalid assumptions regarding available budgets would not be not useful to science. Dr. Weiler

reiterated the need to look for innovative ways to do science and added that flexibility would be key to dealing with a reduced budget. Asked if there were any dialogue with Russia on the Phobos-Grunt mission to the Mars satellite, Dr. Weiler explained that there are currently there are no bilateral discussions with Russia. There are channels for beginning the discussion, but they are clearly struggling.

A meeting participant noted that in the Discovery AO, it is apparent that proposers must carry encumbered reserves for international partner collaborations. Dr. Green clarified that the AO contains guidance on the cost of participation of international partners that appear to limit ability to work with international partner. He felt this would be reviewed and possibly revised before the next AO.

CAPTEM

Dr. Mini Wadhwa gave an update on the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM), noting that subcommittee memberships have changed to include a group addressing the Hayabusa samples to be forthcoming from JAXA, in addition to lunar sample, Stardust, Genesis, and Cosmic Dust allocation subcommittees. CAPTEM held its last meeting in November 2010. Since the last PSS meeting, CAPTEM has overseen 366 lunar sample allocations; 32 in Stardust 32; 4 in Genesis, and 10 in Cosmic Dust. The allocations have been evenly split between U.S. and foreign researchers. Current activities surround the spin-up of Hayabusa activity, the release of a Stardust sample curation review and report, and the completion of a Lunar Simulant Working Group (WG) report. Other CAPTEM activities planned include a Timed Collection Workshop in CA in February 2011, and a Workshop on Solar System Sampling.

The Hayabusa allocation subcommittee has been established and is in the process of drafting a policy document. Dr. Michael Zelinski has been designated curator at the Johnson Space Center, and a dedicated glovebox identified. Planning is well under way. CAPTEM's report on Stardust, completed in November 2010, revealed the perception of some potentially serious problems; on a longer time scale improvements will be required. Outstanding issues include the fact that the basic characterization of Stardust samples requires instruments that are not routinely available at the Curatorial Facility. The Website also needs updating. Recommendation 1 states that implementation of allocations must not be single-string (2 people are now available for this task). Recommendation 2 is to simplify requests to PIs; an email is considered sufficient. Recommendation 3 holds that priorities must be set and resources allocated such that Web site upgrades are completed in 2010. The last item has made great progress.

In response to a PSS request to identify the types of lunar simulants required by various communities, and partly in order to preserve existing lunar samples, a joint Lunar Exploration Analysis Group (LEAG)-CAPTEM Simulant WG was formulated. The WG is addressing problems such as the lack of appreciation of the uniqueness of lunar samples. There are over 30 lunar simulants worldwide that have been generated individually, with some residing at JSC (JSC) and Marshall Space Flight Center. The WG has suggested that a Planetary Simulant Advisory Team (PSAT) be set up in the future. It was noted that Dr. Larry Taylor felt simulants would also be important for Mars and NEO planning, and that the Small Bodies Analysis Group (SBAG) has also discussed the need for simulants.

Simulants will be required for tests involved large-scale soil moving, oxygen production, etc., and the symbiosis between science and engineering will also need further characterization. Human health/toxicity/dust studies can also make use of lunar sample simulants. The Working Group also suggests centralizing PSAT at JSC, and that NASA set aside 10% of the project budget for simulant development, while coordinating with PSAT.

New CAPTEM initiatives include the finalization of Hayabusa sampling preparations, and updating the long-term curation and maintenance plan at JSC.

LEAG

Dr. Chip Shearer reported on the status of LEAG, which held its last annual meeting in September 2010 around the theme: *How Can the Moon be Used as a Target for Human Exploration, Science, Commerce, Education, and Technology Development*. LEAG will sponsor a workshop in Houston in June to study Wet vs. Dry Moon issues. CAPTEM and LEAG have conducted a series of activities together, including a Lunar Sample Acquisition and Curation Review (LSACR1). LEAG Town Hall meetings planned for 2011 include the 42nd Lunar and Planetary Science Conference in March), and a Lunar Exploration Roadmap update.

Summary of LSACR1

CAPTEM and LEAG were requested to jointly review lunar sample curation, particularly with respect to the impact of sample return on critical engineering requirements for a human return to the Moon. Some findings are relevant to all planetary surfaces in human exploration. The joint team was also asked to review protocols on other bodies and on Earth. Part 1 of the review examined surface activities for sample acquisition and curation, such as sample acquisition tools, instrumentation for sample selection, sample contamination control, power needs, crew training, etc. Lessons Learned from the Apollo program and advances since Apollo, as well as capabilities needed for sampling lunar surface (sortie and outpost) were also considered in a series of finding. Part 2 of the review included a tour of the facilities at JSC, and focused on future needs for handling large volumes of material from any planetary body. Part 1 contained 56 individual findings, addressing issues tied to environmentally sensitive samples, human selection of samples, and mass-volume issues. Part 2 contained 25 findings tied to curation on Earth. The review team concluded generally that curation should be involved at the beginning of designing sample return missions. The review also found that the lunar sample facility at JSC is unique, and capable of handling a significantly larger collection.

A Workshop on Lunar Volatile Reservoirs will be held 13-15 June 2011 at the LPI, which will explore the implications for the evolution of the Moon and future human and robotic lunar exploration, and examine the potential of unopened Apollo samples for shedding light on observations.

The LEAG has observed a significant amount of synergy among PSS, the Exploration Subcommittee, and the LEAG, and felt it beneficial to have the various chairs of the analysis groups discuss these synergies. Dr. Greeley suggested that Drs. Shearer and Wadhwa contact the appropriate chairs of the relevant AGs.

MEPAG (Mars Exploration Program Analysis Group)

Dr. David Des Marais gave an update on the Mars Exploration Program (MEPAG). A recent science highlight, from the CRISM instrument on MRO, involved the discovery of a hydrated sulfate feature (in the infrared) on the SE edge of Santa Maria crater, which is within reach of

the Opportunity rover. This feature will be further investigated in late January and early February.

Other highlights include the observation of carbonate-rich outcrops on Mars, sand dune modification by seasonal defrosting of carbon dioxide, and “bathtub” rings of acid sulfates and kaolinite clay, etc., the latter of which implies that groundwater has played a role in forming surface features on Mars, supporting a global hydrologic model.

In response to previous PSS action items re: the ESA/US Mars mission effort, there will be a Mars Exploration Program Analysis Group (MEPAG) meeting held in Lisbon in June 2011. An End-to-End international analysis group (E2EiSAG) has been formulated, and received a briefing from the Exploration Systems Mission Directorate (ESMD) in September 2010 to discuss the development of a humans-to-Mars roadmap. Highlights from that meeting included a Decadal Survey update, discussion of outreach activities and ESMD planning, and reports on MSL and future Mars mission landing site activities.

The Supporting Research and Technology (SR&T) SAG recently concluded that present technology programs are insufficiently funded, leaving Technology Readiness Level (TRL) gaps, and furthermore, that R&A programs must be bolstered to support MEP, and that the proposal review process should be shortened and streamlined. Concerns have also arisen in MEPAG about sustaining the joint ESA/NASA effort, meshing the budgets, reaching a technical solution to the 2018 rover mission, and sustaining the partnership through an MSR campaign. One of the objectives of the E2EiSAG will be to synthesize prior MEPAG SAG findings and to develop a perspective of what the overall campaign must achieve. SAG charter tasks will include proposing reference-level campaign science objectives and priorities, desired sample characteristics, *in situ* capabilities, etc. Draft science objectives thus far include themes of life, surface characteristics, planetary evolution and human exploration. Sample suites will also be considered. Asked if there had been any discussion of how NASA and ESA can combine forces to reduce costs, Dr. Des Marais responded that the E2EiSAG’s next phase would include discussion of site criteria and reference landing sites. The Planetary Protection Subcommittee (PPS) is also starting to move forward on requirements for the 2018 sample-caching mission.

MEPAG future planning hinges partly on the outcome of the Decadal Survey. MEPAG will continue to monitor developments in the ESA/NASA joint Mars program, and will host a Mars Habitability Conference/MEPAG in June 2011. Asked about preliminary plans for sample caching, Dr. Des Marais reported that the MEPAG has discussed a two-cache rover design, keeping one cache behind in case of a launch failure back to Earth.

OPAG

Dr. McKinnon reported on Outer Planets Analysis Group (OPAG) meeting outcomes to discuss structural requirements and aspects of an AO for the EJSM, primarily to prod instrument development. The AO could be released as early as Spring 2011. Recent findings from OPAG include strong support for the joint mission to Jupiter. OPAG also is grateful to the joint Science Definition Team (SDT) for their work. Jupiter has been well studied, but OPAG recognizes that the cost of the Europa mission would impact the launch of any new OP mission. Dr. Green suggested that OPAG also consider another scenario: one mission with two spacecraft, depending partly on ESA’s selection of Laplace; if Laplace is not selected, should NASA think about an entirely new mission?

OPAG has considered targets of opportunity such as asteroids encountered en route, and Jupiter ring science. Dr. Prockter commented that the SDT has also considered these targets. OPAG also notes that the only Outer Solar System mission beyond 2017 will be New Horizons (if the Kuiper Belt mission is approved) and that OSS missions typically require long lead times. OPAG also expressed its support for re-starting the Pu-238 program. Should funding appear for future OP missions, OPAG recommends putting effort into focused OP technology development, radiation models, a focused effort in astrodynamics, etc.

OPAG also discussed the importance of the SR&T study, and received anecdotal evidence that support is declining for funding scientific analysis. OPAG also supports Participating Scientist program with respect to long-duration missions to provide “heritable” ties to missions. OPAG supports the Planetary Science Technology Review Panel and looks forward to its report. OPAG also encourages an increased selection rate for OPR in the R&A program. OPAG supports responsible reevaluation of planetary protection requirements for Europa exploration. OPAG recommends that rapid public release of certain raw or unvalidated data points be encouraged, and that agreement to do so be a criterion of selection for proposals. OPAG was also briefed by Dr. Janet Vertesi on planet mission sociology and embraced some of her recommendations for ensuring long-term mission success. OPAG noted that International Space Station (ISS) science activities would likely incur substantial costs, so that they should be assessed and prioritized via Decadal Survey recommendations. Dr. Greeley commented that ISS is generally not felt to be useful for PSD from a science perspective.

OPAG science highlights included the detection of transient surface liquid in Titan’s polar region, in the form of lake shrinkage seen in image comparisons. A cryovolcano has also been postulated to exist on Titan, and Cassini has found its best candidate yet, a feature called Sotra Facula. Several findings about Enceladus regarding its “tiger stripe” fractures, and specular reflection data from Titan lake were also noted. OPAG also noted observations about the “Pac-Man” thermal anomaly at Mimas, similar to that at Tethys.

VExAG

Dr. Sanjay Limaye presented an update from the (Venus Exploration Analysis Group (VExAG). VExAG held a workshop in August 2010. Dr. Limaye noted that a special issue of *Icarus*, slated for late Summer, will present nearly 40 papers on Venus. NASA has selected 7 participating scientists for the Akatsuki spacecraft, as Japan attempts a re-insertion at Venus in five to six years. Dr. Green reported JAXA’s guarded optimism on this prospect, and that more would be known by late March to April.

ESA’s Venus Express will be extended through 2014, and is operating normally. VExAG has expressed concerns about the very low influx of young scientists into Venus research, and the paucity of successful proposals in Venus ROSES calls. Funding is too low to support graduate and post-doctoral students. VExAG anticipates a supportive Decadal Survey for Venus, in the area of greenhouse science. VExAG also hopes to involve students more directly at LPSC. The SAGE mission to explore Venus has signed off on its CSR. Two proposals on Venus have been submitted to ESA’s Cosmic Vision, and several Venus proposals were sent to Discovery. The Russian Venera-D mission will most likely be pushed out to 2018. Potential atmospheric balloon missions to observe Venus also present some promise of returning some new science data quickly.

Upcoming activities of VExAG include an initiation of efforts to attract graduate students. The 9th VExAG meeting and Science Conference on Earth-Based Venus Observations will be held in September 2011. A Town Hall meeting at LPSC will include a segment called “Students and the Exploration of Venus in the Coming Decade.” Dr. Green recommended emphasizing the tie-in with the Decadal Survey at this meeting.

Highlights of a 2010 Venus atmosphere science meeting at the University of Wisconsin were related. At the meeting entitled *Surface to Thermosphere*, 60 papers were presented, along with a co-located STEM workshop. Presentations and abstracts from this meeting may be found at venus.wisc.edu/workshop. Dr. Limaye added that this well-received gathering included “Bill Nye the Science Guy” and was taped by the Wisconsin public television network.

Science highlights from VExAG include data suggesting that volcanoes on Venus are responsible for warm anomalies, and the bright clouds occasionally seen in Venus Express VMC images. High NIR emissivity features tend to be co-located with hot spots. Images of Venus that were taken at the same time Jupiter was impacted by an object in July 2009, have also revealed bright feature visible in UV only; it is interesting to speculate whether this had feature is related to the same event. Venus Express is documenting the range of Venus atmospheric parameters and how they may be tied to superrotation. PSS briefly discussed the potential for Akatsuki grants; Dr. Green noted that these grants would not be completed but could be re-issued in 2015 under a new competition. Asked to comment on a balloon opportunity in January 2014 to view Venus, Dr. Green responded that in the current budget climate, PSD cannot start major new initiatives, but recommended that the community remain engaged.

Discussion

Dr. Greeley acknowledged the service of departing PSS Executive Secretary Michael New, and presented a plaque of appreciation *in absentia*. Dr. Greeley then set the tone of the discussion, beginning with the potential for facing drastic decisions in order to balance funds to accommodate support of students, technology development and missions by setting priorities and achieving a rational balance. Dr. Johnson commented that PSS should perhaps be blind to costs if its main task is to assess scientific priorities. On another subject, Dr. Slavin stressed that SR&T enhances and enables flight projects, and was not in the business of duplicating NSF.

NASA Chief Scientist Report

Dr. Waleed Abdalati presented an overview of his new role of Chief Scientist at NASA and described his background as an Earth scientist, his experience at Wallops Island and Goddard Space Flight Center, iSAT, and the cryospheric science program. He viewed his role as being that of a strong science voice in Administrator Bolden’s circle, and believed Mr. Bolden preferred a Chief Scientist in SMD with an independent view, who will be able to step back to take a broad view of the Agency and how it supports various areas of science. The Chief Scientist is also expected to provide high-level representation for all areas of science to senior management at NASA, foster productive interactions between directorates and centers, and between NASA and other Federal agencies and international agencies. He expected to work closely with Dr. Weiler and Division Directors, as well as to appoint a Deputy, probably in space or planetary science. He also planned to hire a senior policy advisor for interactions with OMB, etc., and another staff member to handle life and microgravity sciences.

Dr. Green raised the challenge of meeting the interface between science and exploration and their two very different cultures. Dr. Abdalati reported that he had met with ESMD and was committed to ensuring that science will be true to spirit of the Decadal Survey and integrated with exploration when possible. Dr. Green anticipated additional guidance from the NRC in this area.

Dr. Limaye addressed the close connection between Venus and Earth science, particularly in the area of the greenhouse effect, and welcomed Dr. Abdalati to attend an August workshop on the subject. Dr. Green noted that over the last few years, comparative planetology/climatology has become more prevalent, and that the Planetary Science Database contains global circulation models, of Mars and Venus that can be merged with Earth science data. Other related data points include the effects of solar wind, and ionospheres/thermospheres on the various planets. Asked to comment on NASA's relationship with the Office of Science and Technology Policy (OSTP) on issues like the Pu-238 re-start, Dr. Abdalati felt that to date, OSTP seems receptive to a science voice and he hoped to develop a good relationship with the office. He also expected to partner with Dr. Bobby Braun of OCT to represent a science and technology voice to Mr. Bolden. Dr. Abdalati's intent was to stay out of the execution side of the program and to devote time to identifying synergies, and making the whole better than the sum of the parts. Asked how he would promote NASA as a science agency, Dr. Abdalati took the view that NASA carries out science that both serves and enhances humankind, and that its science program should be on a par with human space flight; he also felt he could use his experience communicating Earth science to tout NASA's achievements, and to be a tireless champion for science. He invited feedback from the community. Dr. Green expressed delight at having him on board.

SBAG Update

Dr. Mark Sykes gave an update on the Small Bodies Assessment Group (SBAG), which had just completed a January meeting. SBAG held a very successful technology forum on small body (SB) scientific exploration, to discuss technologies needed for SB exploration with the engineering community. SBAG is also engaged in developing a roadmap for SB exploration, to be maintained as a living source document that would be updated frequently as new technologies and discoveries came along. The roadmap will address science issues, SB population identification and characterization, *in situ* studies, laboratory and theoretical studies, human exploration, technology capability and needs, and data archiving and access.

The fourth meeting of SBAG's (SBAG4) technology forum considered technologies that needed only minor improvement to be useful, and identified goals and synergies. The group is also working on making more of a connection with Tibor Kremik on technology issues; Dr. Greeley encouraged all the AGs to do this. Dr. Sykes noted that SBAG is planning to include two engineers to promote communication between science and engineering communities involved in small bodies exploration, and expected that roughly a year from now, SBAG will be sufficiently set up to provide adequate guidance.

SBAG3 recommended that fly-by opportunities should be taken advantage of when possible; held a discussion of WISE results and NEO populations which offered targets for human exploration; and called for a WISE-like IR survey space mission (\$500M) to identify the first logical robotic precursor mission. Dr. Shearer suggested bringing in an ESMD representative to PSS to discuss robotic precursors. Dr. Greeley agreed, and noted that the new Chief Scientist would be chairing a WG to look at the role of the AGs, especially in making the link between

SMD and ESMD. Dr. Greeley had previously requested data from each AG in determining where the overlaps occur.

SBAG3 also recommended that it would be helpful to get AOs released in a more timely manner, allowing for at least 12 months of a proposal-writing period, and is working on establishing a time and date for an international small body agency (IPEWG) meeting.

SBAG science highlights included the high anticipation associated with the Hayabusa sample return, which is expected to be more substantial than sample from the Stardust mission. Particles have been identified as asteroidal. The EPOXI fly-by of Hartley 2, a carbon-dioxide-driven comet with fluffy ice particles is also anticipated with great interest. Dr. Castillo-Rogez commented on the lack of archiving of experimental work and felt it should be mandatory to archive all results. Asked if there would be funding available for US investigators to study particles from Hayabusa, Dr. Max Bernstein noted there would be a ROSES solicitation, based on what is learned at the LPSC and the availability of samples. The samples may be available directly from Japan before CAPTEM acquires them.

SR&T Study

Dr. Mark Sykes presented an introduction to the results of a community R&A survey, soliciting thoughts on the R&A program, usefulness of reviews, fraction of time devoted to research programs, number of proposals written, etc.

The study involved 468 respondents, with the distribution of institutions aligned closely with people funded through the ROSES program. Dr. Greeley continued the discussion of results that led to a set of findings and recommendations. PSS discussed these findings to come to a consensus.

1. *The Planetary Community and Program Officers are stretched thin in the preparation and review of proposals.*

Recommendation: increase grant size duration up to 5 years if justified and applied uniformly in PSD.

PSS members discussed the pros and cons of the approach at some length, with concerns raised about effects on the load and effort of reviews, and a decrease in the acceptance percentage. Dr. Sykes recommended the establishment of clear, uniform, and published guidelines about the evaluation process. Dr. Green felt that longer grants are starting to work for researchers with projects that have longer horizons, and that NASA must work with the community to increase grant size; he would like to see no less than \$125-130K per grant. The recommendation could be addressed by having fewer calls, aggregating the money and going through the misery less often. Staggered calls are also an option. Dr. Bernstein noted that duration, frequency and amount of grant proposals are linked to selection rates. Dr. Sykes commented that in an informal poll of soft-money people on selection rates, a less than 1-in-5 selection rate is not considered worthwhile. PSS discussed the use of a tiered approach. Dr. Linda Sparke, speaking of NSF, noted that the tiered approach helps the reviewer but not the proposer. Dr. Shearer felt the tiered approach might work in a technology development program where the officer has a better understanding of what the technology means to the future of NASA. Dr. Green feared that a tiered approach would eliminate high-risk, high payoff proposals. Dr. Greeley suggested tabling comments on this issue and taking them back to the working group. The recommendation remained under assessment.

2. The proposal process needs to be more transparent especially on communicating status of process.

Recommendation: publish standards used and a table giving approximate dates for hearing results.

Dr. Prockter agreed to reword the recommendation to add specific suggestions for increasing timeliness of communications.

3. PIs should be able to cover 50% of their salary in a single proposal; some felt 100% if justified.

Dr. Grant agreed with this recommendation. Dr. Sykes felt that there is a perception that there is a cap to grants. Dr. Green offered to include as an option in the call a few large proposals that could accommodate a few full-time employees. There was no clear consensus on this matter.

4. The quality and usefulness of summary reviews to proposers are inconsistent across programs and from year to year in PSD.

Recommendation: establish a uniform review and summary review forms for all Division programs and publish annually.

PSS discussed approaches to proposal reviews and how clearer writing skills on the part of both proposer and reviewer, as well as specific criticisms describing why a proposal was rejected, can serve as potential solutions to the problem. It was also suggested that clear directions be published for the benefit of reviewers, to identify audiences, and to sharpen definitions for terms such as “cost reasonableness.” Dr. Rall noted that PSD has been working to come up with a unified charge to the panels.

5. Some proposers who propose for more than 3 years but are funded for less time are not told why.

Recommendation: a standard PSD summary form should include a section that explains the justification for the shorter duration of the funding.

Dr. Green noted that there are reasons for this practice as seen from both a program perspective and review panel perspective. PSS suggested that a letter from the Program Officer (PO) should express this view, rather than the form.

6. Identification of qualified panel members is difficult; some programs “socialize” new people into community by having grad students and post-docs serve on panels.

PSS considered the inclusion of graduate students as Executive Secretaries on proposal review panels. There was mixed sentiment for this idea. Dr. Green commented that finding qualified panel members will always be difficult, and that all researchers should write sufficiently well such that a (general) scientist can understand a proposal. Dr. Grant noted that there is also a

problem with the perception of conflicts that is totally unjustified. Dr. Greeley suggested that Dr. Bernstein bring these matters of perceived conflict to the attention of the NASA's legal office. PSS concluded that there should be a regular solicitation of panel members and reviewers through Dr. Green and PEN; community members were encouraged to do their duty and sit on review panels. There was general support for the use of post-doctoral students as aides in reviews.

7. Some programs should provide an honorarium to review panelists.

Recommendation: PSD should have a uniform policy and rate for having an honorarium. Dr. Green stated that this is already a PSD practice. Dr. Bell commented that a small honorarium might push the more reluctant reviewers into service. Dr. Grundy noted that he would prefer to be asked to serve, and not simply sent a form letter.

8. Unofficial notification from HQ of review results often too late to be useful.

Dr. Green noted that this finding was linked to others that were specifically referring to some of the Mars calls; he reported that he is attempting to straighten this out with the addition of a dedicated civil servant.

9. Most programs call for a Notice of Intent (NOI), which are helpful in planning reviews.

Recommendation: responding to NOIs should or should not be required.

Dr. Green commented that requiring an NOI can help with other findings; this is all about quality proposals. Some felt there would be people who respond to every NOI, and later write a terrible proposal, and wondered whether the NOI could be longer and function as a triage measure. Dr. Castillo-Rogez felt it important for the community to understand that an NOI is beneficial. Dr. Greeley understood the finding as a call for improving proposals and helping POs. Green- look at Kelly study on NOIs versus success of proposals. Greeley- table pending more comments. Sykes- nice if reviewers could be identified well in advance of meeting – a week's notice is too short.

10. Most R&A/SR&T activities have not been evaluated on a regular basis.

Recommendation: hold a Senior Review of the program across the board every 10 years, at an interval that would also coincide with Decadal Survey releases.

Draft Report Discussion

PSS identified the potential audience for the report as the NAC Science Committee, most of whom are not planetary scientists, as well as Dr. Green and Congressional staffers.

Introduction

Dr. Prockter commented that the Introduction would benefit from more discussion regarding motivation.

Section 2

Dr. Limaye suggested that comparative planetology be adequately reflected in programs. Workforce development and substantial spending in Education and Public Outreach EPO were

also issues flagged as not being reflected in the report. Dr. Greeley suggested adding EPO supplements to section 4. PSS discussed whether Guest Observer (GO) programs were relevant to this report, depending on which division funded the program, as well as specific mention of the Outer Planets. The instrument development program was also cited for inclusion. Dr. Johnson suggested programs that are still running (but cannot be proposed to) should be asterisked.

Section 4

It was suggested that the Antarctic search for meteorites be called out in this section, as NASA funds the curation of these samples.

Section 5

Dr. Grant commented that there has been a shift in funding in some of the Astrobiology, Outer Planets, Planetary Atmospheres, etc., putting more of a burden on R&A for funding graduate students; there has been apparent shrinkage of science team money on flight projects. PSS felt that a Senior Review every 10 years to evaluate R&A and SR&T could address this problem. Dr. Green suggested providing Mike Wargo a chance to look over this section, and mentioning the GO programs. He encouraged the use of SALMON as a mechanism to fund U.S. scientists to participate in foreign flight projects.

Section 3

This section was marked as having “traceability issues.” Dr. Cravens offered a version categorizing objective 1 around the strategic goal of making an inventory of Solar System objects and determining what processes are active among them, with the orthogonal variables in this area being objects and processes. A listing of 49 examples was constrained by the type of investigation such as the composition of planetary bodies (as associated with programs and other elements) or distribution mapping; models of the Solar System; cosmochemistry; rings; magnetic field drivers; interaction of bodies with solar wind, etc. Dr. Prockter suggested only 5 or 6 examples for each objective. Dr. Greeley felt it necessary to have division activities included as they related to the objectives of the PSD Science Plan.

Dr. Wadhwa presented a version of Objective 2 that collapsed some categories and added the motivation for each investigation. There was general approval of this approach. Drs. Grant and Des Marais presented edits for Objective 3 that contained 10 major groupings and condensed headings, noting that some astrobiology program efforts were added. Dr. Greeley suggested using the existing table for section 3, coupled with an appendix of some consistent number of examples for each objective. A paragraph might suffice for each of the 5 objectives, explaining how the objective is addressed. PSS members tasked with writing agreed to send a paragraph to Dr. Greeley by the following week. The report should be finalized by the Summer.

Technology Review Panel Update

Dr. Kremic presented an update on the progress of the Planetary Science Technology Review panel, explaining that the purpose of the panel is to assist PSD in utilizing its resources in a coordinated and integrated fashion to carry out its portfolio. The panel will suggest process and policy changes, and will rely on the Decadal Survey to identify which technologies the division should invest in. There are three phases to the charter: assess current content, formulate ideas and recommendations, report and communicate. The panel will also produce two high-level, notional roadmaps.

During the assessment phase, the panel looked for missing content, issues, barriers, what works well, and also looked outside the Agency for best practices. The panel also held briefings with NASA Headquarters Program Executives, representatives from technology programs, and other government, industry, and academic experts. The panel formulated major observations in strategic, process or structure; resources (funds and people); and culture/communication issues. Within the strategic area, the first recommendation is for the establishment of a comprehensive technology development strategy with a clear owner, and a clear path defined for technologies from TRL-0 thru 9. PSD should engage the Office of the Chief Technologist (OCT) and ESMD to ensure coordination and leverage of planning. Technologies that address integration and ease of use must also be considered. Universities and external organizations must be part of the strategy in developing technology.

With regard to process/structure, the panel found that there is inconsistency among decision-making and planning elements among programs; people are stretched thin. TRL assessment processes need to be more accurate and consistent; structure is needed to allow scientists to link to technologists.

With respect to resources, technology budgets are unstable and unpredictable; previous technology priorities have not been adequately funded; and technology investments in other programs must be better leveraged. Dr. Green agreed that NASA hardly leverages its \$100M SBIR program. Under the aspect of culture/communication, the panel found that technology investments do not always realize all the benefits possible (lack of documentation that can help avoid reinvention; there is no easy way to find available or developing technologies). Increased communication and exposure among all stakeholders (scientists, mission teams, centers, division, etc.) are needed for better technology development and infusion; projects are too risk-averse to new technologies; there is tenuous support from higher management; and technology heritage is lost during gaps in flight. Dr. Green concurred that technologists need to be tied to a follow-through person, ideally a full-time employee at Headquarters.

The panel is currently collecting recommendations through various means, including a web survey; with 10 major draft recommendations, 4 of which are considered critical and impactful. The panel awaits the release of the Decadal Survey before finalizing its report, and will hold its next face-to-face meeting 14-15 March.

Draft recommendations include:

- Establish a Technology Program Director who reports directly to PSD Director.
- Develop and implement a technology strategy, formulate budgets and planning.
- Establish a point of contact for external stakeholders.
- Integrate PSD efforts and goals into a plan.
- Act as PE for a supporting office.
- Oversee decision processes, and identify priorities and gates.
- Ensure proper documentation is carried out and maintained, and easily accessed.
- Oversee coordination with other organizations.
- Ensure technology is linked to science goals.
- Ensure responsibility for moving technologies along or terminating them.
- Establish a Planetary Technology Program Office to assist the TPD, assist in implementing strategy, developing and maintaining roadmaps, developing tools for communicating technology data. Like ESTO, this office should focus on information systems and instruments, and take them through to airborne testing.

- Develop a comprehensive overall technology strategy; the panel drafted a table design to match tools and systems with programs, with elements broken down by critical capabilities/facilities through increasing maturity level. Dr. Green commented that it is important that OCT is developing cross-cutting technologies such as laser communications and Entry, Descent and Landing (EDL) technologies. He added that there is a danger from a political perspective, as this effort should not appear duplicative with OCT.
- Develop a more consistent and accurate TRL assessment process, building rigor and standardization. In PSD, the variety of planetary environments poses a challenge, therefore PSD should provide a set of limiting requirements for each environment. The panel is still in discussion with ESTO to refine this recommendation; the end result will be an assessment tool.
- Under management recommendations, the panel proposes to consolidate responsibilities to a Technical Director (TD) as much as possible. Strategically, PSD should actively pursue leveraging from other NASA programs, academia, and external agencies and industries. PSD should also develop clear decision and review processes; and develop a more rigorous way to create interactions between technologists, scientists and missions. A documented communication plan should also be developed and maintained with periodic workshops, in an effort to foster a culture for advocating for and defending technology.

Asked about foreign collaboration, Dr. Kremic responded that he would not exclude the idea, but has not addressed the International Trafficking in Arms Regulation (ITAR) concerns. Dr. Green noted that this concern has been raised to OSTP and there has been some discussion in Congress for changing some of the laws, but the issue is far below the radar screen. Dr. McKinnon suggested bringing ITAR issues to the NRC. It was noted that Dr. Braun has asked NRC to produce a roadmap for technology efforts. Other draft roadmaps would also be circulated within PSS.

Discussion and wrap-up

Dr. Rall agreed to send out doodle polls for two planned teleconferences. He also took as an action the potential need to extend some members appointments through April to deal with Decadal Survey. PSS noted that planetary simulant coordination among CAPTEM, LEAG and SBAG has no clear answer at moment; to this end, Dr. Wadhwa offered to forward a report authored by Larry Taylor to the PSS to start the discussion. Dr. Greeley adjourned the meeting.

Appendix A Agenda

Appendix B Subcommittee Membership

Membership Roster

Planetary Science Subcommittee

Ronald Greeley, Chair
Arizona State University

James Bell III
Cornell University

Tom Cravens
University of Kansas

Caitlin Griffith
Department of Planetary Sciences
University of Arizona

William Grundy
Lowell Observatory

George Herzog
Rutgers University

Jeffrey R. Johnson
Johns Hopkins University Applied Physics Laboratory

Sanjay Limaye
Space and Science Engineering Center
University of Wisconsin

William B. McKinnon
Department of Earth and Planetary Sciences
Washington University

Anna-Louisa Reysenbach
Portland State University

Charles Shearer
Institute of Meteoritics
University of New Mexico

James Slavin
NASA Goddard Space Flight Center

Dawn Y. Sumner
Department of Geology
University of California

Mark Sykes
Planetary Science Institute

Meenakshi Wadhwa
Center for Meteorite Studies
Arizona State University

Jonathan Rall, Executive Secretary
Planetary Science Division
NASA Headquarters, Washington, D.C.

Subcommittee Administrative Support:
Ms. Marian R. Norris
Management Support Specialist
Science Mission Directorate
NASA Headquarters, Washington, D.C.

Appendix C Attendees

Subcommittee Members

Ronald Greeley, Chair PSS, Arizona State University
Julie Castillo-Rogez, JPL, Caltech
Thomas Cravens, University of Kansas
David Des Marais, NASA Ames Research Center
Will Grundy, Lowell
Jeffrey Johnson, Johns Hopkins University Applied Physics Laboratory
Sanjay Limaye, University of Wisconsin- Madison
William McKinnon, Washington University
Louise Prockter, JHU/APL
Charles Shearer, University of New Mexico
James Slavin, NASA GSFC
Paul Steffes, Georgia Institute of Technology
Mark Sykes, Lowell Observatory
Meenakshi Wadwha, Arizona State University
Jonathan Rall, Executive Secretary PSS, NASA HQ

NASA Attendees

Jim Adams, NASA HQ
Max Bernstein, NASA HQ, SMD
Philippe Crane, NASA HQ
Ed Grayzeck, NASA HQ
James Green, NASA SMD
Tibor Kremic, NASA GRC
Tim Lee, NASA Ames
Doug McCuiston, NASA
Melissa McGrath, NASA MSFC
Michael Meyer, NASA HQ
Sarah Noble, NASA HQ
Marian Norris, NASA HQ
Jonathan Rall, NASA HQ
Linda Sparke, NASA HQ
Joan Salute, NASA HQ
Gregg Vane, NASA JPL
Mary Voytek, NASA HQ
Michael Wargo, NASA HQ/ESMD

Other Attendees

Dom Conte, Orbital Sciences
Rick Dissly, Ball Aerospace
Teresa Segura, Northrop Grumman
Joan Zimmermann, Zantech Corporation

Webex Attendees

Colleen Wilson-Hodge, NASA MSFC
T. Jens Feeley, NASA HQ
Gordon Johnston, NASA
Heidi Hammel, AURA
Jaime Reyes, Lockheed Martin
Janice Buckner, NASA HQ
Jeffrey Grossman, NASA HQ
T. Jens Feeley, NASA HQ
Jih-Fen Lei, NASA
Jim Bell, ASU
John Grant
Ken Reh, NASA JPL
Malcolm Ko, NASA JPL
Nicholas White, NASA
Robert Fogel, NASA HQ
Robert Pappalardo, NASA JPL
Waleed Abdalati, NASA HQ

Appendix D
Presentations

- Discussion of NAC Science Committee Review of Analysis Groups; *Ronald Greeley*
- NLS II Update: Space Operations Mission Directorate; *James Norman*
- Mars Exploration Program Update; *Doug McCuiston*
- Status of Europa Jupiter System Mission; *Curt Niebur*
- Planetary Science Update; *James Green*
- MESSENGER: Options for Extended Mission Proposal; *Ed Grayzeck*
- CAPTEM Report to the Planetary Science Subcommittee; *Mini Wadwha*
- LEAG Report to the Planetary Science Subcommittee; *Chip Shearer*
- MEPAG Report to the Planetary Science Subcommittee; *David Des Marais*
- OPAG Report to the Planetary Science Subcommittee; *William McKinnon*
- VExAG Report to the Planetary Science Subcommittee; *Sanjay Limaye*
- Presentation by Dr. Waleed Abdalati, New Chief Scientist
- SBAG Report to the Planetary Science Subcommittee; *Mark Sykes*
- SR&T Study and R&A Survey Results: Observations and Findings; *Ronald Greeley*
- Planetary Science – Technology Panel Update: *Tibor Kremic*