

Planetary Science Subcommittee Meeting, October 5-6, 2015

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Meeting Minutes

Jonathan Rall, Executive Secretary

Janet Luhmann, Chairman

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Welcome and Administrative Matters

Dr. Jonathan Rall, Executive Secretary of the Planetary Science Subcommittee (PSS), opened the meeting and made administrative announcements. Dr. Janet Luhmann, PSS Chair, called the meeting to order and welcomed members. Introductions were made around the table.

PSD Status and Findings Update

Dr. James Green, Director of the Planetary Science Division (PSD), provided a status of the division. Europa is now officially part of the mission roster. Major events of 2015 include Dawn's images from its continually lowering orbit at Ceres; the end of the Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) mission; the selection of instruments for the new Europa mission; New Horizons flyby of Pluto and future plans for a Kuiper Belt object flyby; and the announcement of five selections in Step 1 of the Discovery program competition. NASA plans to support the Japanese mission Akatsuki in another attempt at orbit insertion around Venus on 7 December. Both NASA's Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) and the European Space Agency's ExoMars missions are to be launched to Mars in March 2016, while Juno will arrive at Jupiter on 4 July 2016. In addition in 2016, PSD will make the final down-selection in the Discovery program, and Cassini will begin its end-of-mission proximal orbit, ending in Saturn's cloud tops.

The MESSENGER mission yielded 300K images and 10TB of data over the course of more than 4000 orbits around Mercury. The spacecraft made many low-altitude passes before termination; the data indicate that the impact occurred at 54.4 latitude, 210.1 East longitude. The ESA BepiColombo spacecraft will be able to view the impact site eventually. The mission found evidence of a dynamic magnetosphere and rapid reconnection, and has contributed to a better understanding of the planet's dipole, polar deposits, and rich volatile content.

Dawn arrived at the asteroid Ceres on 6 March of this year and was captured into orbit, using ion engines to achieve a circular orbit, and started surveying the body on 23 April at an altitude of 4000 km. Dawn is currently descending to its low-altitude mapping orbit (LAMO; 404 orbits). There is no plan to pull out of orbit and go elsewhere. The spacecraft lost a reaction wheel and will end its life in LAMO. The mission has yielded spectacular images and a topographical map of Ceres. The crater hosting the famed large bright spot has been named Occator; it is being studied quite closely; recent papers indicate the presence of salts and vapor associated with the bright spots, consistent with Herschel's proposed observations of active water regions. An interesting finding is the lack of central peaks in craters. Instead, images indicate unique central holes, of unknown origin. These may be the result of salts upwelling from below.

New Horizons completed its successful fly-through of the Pluto-Charon system, and imaged two occultations of Pluto, a body 2/3 the size of Earth's Moon, bearing methane, nitrogen, and carbon monoxide snows which sublime in the sunlight. Darker regions are thought to be composed of tholins. The atmosphere was seen to be primarily nitrogen, with traces of methane and tholins (complex carbon chain molecules, red-colored) in the haze. Tholins are likely formed by ionization and dissociation occurring in the atmosphere. The images of Pluto's majestic icy mountains and frozen plains received enormous media coverage all over the world, including on large displays in Times Square, and in a Google doodle, the latter of which was observed by 3.5

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billion people in one day.

Discovery and New Frontiers status

The Discovery call in February 2015 resulted in 28 proposals, cost-capped at \$450M through phase D, and excluding the launch vehicle (LV) and phase E. New Frontiers, cost-capped at \$850M excluding LV and phase E, will release an Announcement of Opportunity (AO) this fiscal year. PSD is progressing well to the launch of the Discovery mission, InSight (launch window opens on 4 March). Five Discovery 2014 selections were announced on 30 September, with the current budget supporting a 3-year launch cadence. Step-1 selectees, teamed with the Science and Technology Mission Directorate (STMD) were: Psyche, a journey to an asteroid that will utilize deep-space optical communications; VERITAS, a Venus radar mission also featuring deep-space optical communications testing; NEOCam, a camera for imaging Near-Earth objects; Lucy, a tour of five Trojan bodies at Jupiter's Lagrange Point; and DAVINCI, an exploration of Venus's atmosphere. In late Fall 2016, the plan is to select one or two missions at Step 2 depending on executability reviews and budget. If two are selected, PSD will slip the 2017 Discovery call. Dr. Clive Neal commented that the cadence slipped as per the Decadal Survey recommendation of 24 months. Dr. Green noted that the program planning is a work in progress, and that the cadence is still far better than 54 months, as had been the previous case. Dr. Nancy Chabot commented that she was pleased with the current progress, given the budgetary challenges. Dr. Luhmann asked if there was a foreign contribution limit requirement for the calls. Dr. Green responded that this didn't need to be taken into consideration in any of the selections. The call benefited greatly from mature instrument availability, and the STMD contribution of optical communications capabilities and solar arrays; the latter helped to leverage the limited budget.

The New Frontiers missions include New Horizons's current exploration of Pluto and the Kuiper Belt, Juno, and Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx; in development). Hubble has identified two Kuiper Belt objects (KBOs) for New Horizons to visit, and PSD has decided to allow the project to target one of the KBOs, a 26-30 km object named KBO 2014 MU69, a Pluto-like building block. The decision doesn't signify an extended mission (EM); it just gives the spacecraft an opportunity to fly by that object. The New Horizons team has been asked to consider possible Astrophysics projects, given New Horizons' unique position in the Solar System. If included in a Senior Review for such a project, the Astrophysics Division (APD) would bring its money, or a *quid pro quo* offer to use APD assets for Solar System observations.

Juno is well on its way to Jupiter for arrival in July 2016. The OSIRIS-REx launch window opens in September 2016; the mission will launch from the Kennedy Space Center and traverse to the asteroid Bennu, returning samples in 2023. PSD has just completed a Research Opportunities in Space and Earth Sciences (ROSES) selection for the new entity called the Homesteader Program. Roughly \$8M of instruments were selected under this program. Its goal is to mature technologies and retire risk. The call received 134 step-1 and 84 step-2 proposals. There were 8 selections for which charts will be posted.

The current plan for the New Frontiers #4 call follows the recommendations of the Decadal Survey, including Comet Surface Sample Return and Saturn Probe missions. New Frontiers #5 will add a Lunar Geophysical Network and an Io Observer, getting PSD back on the Decadal Survey schedule as much as possible. These New Frontiers selections will require radioisotope

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power. For New Frontiers 4, PSD has budgeted for three Multimission Radioisotope Thermal Generators (MMRTGs), or two enhanced MMRTGs (higher efficiency). The Mars 2020 rover will use an MMRTG. The Europa mission will use solar power. In terms of radioisotope power systems and technology investments, the total budget runs at \$100M per year thru 2016. This budget also funds the Department of Energy (DOE) infrastructure for producing plutonium.

The Europa mission is progressing well in phase A. Mission objectives are to explore Europa's ice shell geology, composition, and carry out reconnaissance orbits. The 9 selected instrument proposals include a magnetometer, dust analyzer, and ultraviolet spectrograph. The baseline goal is to make 45 low-altitude fly-bys while maintaining an orbit at Jupiter, much like the Cassini/Titan exploration, to mitigate problems caused by the high-radiation environment at Europa. Dr. Candice Hansen commented that the Outer Planets community is thrilled with the progress toward the Europa mission.

Dr. Green reported on a Small Innovative Missions for Planetary Exploration (SIMPLEx-2014) call, which provided new awards in FY15 for cubesats. The first PSD cubesat was launched in 2008, studying the exposure of organics to the space environment. Increasingly, the Earth Science Division (ESD) and STMD have been funding small instruments to go on cubesats. Getting them into orbit is difficult; as the larger missions are developed there will be opportunities to bring smaller payloads along. A lunar polar hydrogen mapper cubesat will ride on EM-1; the mission is still struggling with mother-daughter communication, and power. A plutonium-module might be useful in this case and is being considered. Another selection is an Earth orbiter called Q-Pace, as well as cubesat studies for a Mars micro-orbiter, a Hydrogen Albedo Lunar Orbiter, and DAVID, an asteroid visitor that uses an ion drive. PSD also hopes to hold a 2016 cubesat call, and is looking for potential rides. Dr. Nancy Chanover asked if PSD had an overall vision for Outer Planets exploration in this call. Dr. Green responded that for PI-led missions, he might consider augmenting program for a ride share opportunity. InSight has two cubesats riding with it; these are limited, short-life fly-by satellites, a good use of cubesats. Dr. Michael New clarified that a PI-led mission can indeed include cubesats, but that alternatively, if PSD has a mission with some extra launch mass, the cubesat does not have to be attached to the main spacecraft. This is a "drop-off" concept. Dr. Luhmann noted that potential opportunities had already been identified for the two cubesats selected for flight, but not for the ones under study. She encouraged the community to leverage Human Exploration and Operations Mission Directorate (HEOMD) opportunities as well (Lunar Flashlight, e.g.).

PSD has also been using Astrophysics assets for various tasks. In New Horizons alone, SOFIA was used to observe an occultation of Pluto for 90 seconds, very successfully, probing the lower atmosphere. There will be a PSD Astrophysics Assets workshop at the Division for Planetary Sciences (DPS) of the American Astronomical Society on Tuesday, 10 November. On the agenda are K2, the Spitzer and Keck telescopes, the Infrared Telescope Facility (IRTF), the Hubble Space Telescope (HST) and the James Webb Space Telescope (JWST). Dr. Hansen observed that APD has been asking the Juno mission to consider possible ways of detecting zodiacal light, as an example that the communication is bidirectional.

Research and Analysis

PSD has asked the National Academies to review the PSD Research and Analysis (R&A) restructuring experiment. The committee will address linkages and structure of R&A program

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elements to determine whether the changes have benefited the overall program. Dr. Luhmann asked how current mission Phase E commitments figured into R&A sufficiency assessment. Dr. Green replied that Phase E costs must be estimated in the proposals, but not as part of the cost cap, rather as separate funding. The New Frontiers and Discovery research lines are separate from the R&A program. Dr. Rall pointed out that Participating Scientists are solicited in ROSES, but they are paid for in the mission lines. The Homesteader Program came out of New Frontiers future lines, for example, not the research line. Asked about the timescale for the NRC study, Dr. Green hoped to have results in time to feed into the midterm review, which will begin in late 2016. Dr. Larry Nittler noted the existence of community concern with the reorganization, particularly with regard to the balance of resources across the program, and the current low selection rate. Dr. Green assured the subcommittee that all these issues were to be included in the scope of the evaluation. Dr. Rall added that PSD is just trying to make sure it hasn't broken anything and continues to make progress against Government Performance and Results Act - Modernization Act (GPRAMA) goals. It will take some time for the results of the restructuring to surface for future GPRAMAs. The NRC committee will also examine resources and budgets for R&A, and how the program was executed.

PSD has also initiated an ice giant mission study at the Jet Propulsion Laboratory (JPL) to identify potential mission concepts, and to assess capabilities afforded by the Space Launch System (SLS) for rapid access to the Outer Solar System, in preparation for input into the next Decadal Survey. The Europa mission is designing for both an Atlas launch and for SLS. There will also be an ice giant workshop at DPS on the Thursday of the meeting period. Study ground rules include addressing both Uranus and Neptune Orbiters, identifying clean interfaces with foreign partners, and establishing a Science Definition Team.

New Communications Policy at NASA

The role of science missions in NASA communications has evolved. Education and Public Outreach (EPO) funding was removed as a budget line in 2014, and Education was consequently placed under a new cooperative agreement. Communications is now defined as a comprehensive set of activities to convey an understanding of and inspiration about NASA's work to target audiences (public and other stakeholders), and NASA employees. The critical takeaway message is that science missions must now use the Communications office of a NASA center or JPL to manage the Communications plans and activities. These Communications offices will be responsible for leading and executing mission Communications activities in coordination with the mission PI. These activities are not within the PI's cost cap; they are funded from the project budget. The Communications plan is developed with the project and PI during Phase B of the mission. Dr. Lori Glaze asked how Communications was being handled with the OSIRIS-REx mission. Mr. David Schurr interjected that NASA is currently working a transition plan with Goddard Space Flight Center's Communications office. Dr. Lisa Pratt commented that there is a lot of confusion in the ROSES calls as to how the new policy affects PIs on smaller proposals. Dr. Rall noted that clarifications would be forthcoming. Mr. Schurr added that the new Communications policy was a mission policy, not a research policy. Dr. Chris House asked about the distinction between Communications and Education. Dr. Green replied that Communications covers such areas as social media, press releases, news services, etc. Education is completely different, an ongoing activity that is not driven by mission events. The PI no longer has to plan for the Communications portion of a mission. Dr. Green asked to be informed of community talks and forums, in order to disseminate the information to help coordinate community efforts in

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communicating results and science items of note. He noted that Juno is also being transitioned for Communications, which will be handled at JPL. Dr. Luhmann commented that following the Education Cooperative Agreement Notice (CAN) announcement, there was much concern about carrying forward activities; this may be worth a discussion at DPS. Dr. Green agreed to bring his charts to DPS. He added that GSFC is handling Communications for the Lunar Reconnaissance Orbiter (LRO).

PSS March 2015 findings

Responding to a PSS finding on the need for an Agency-level NEO mission, Dr. Green could not comment, as a current competition was in progress.

PSD agreed with a PSS finding on Sample Use Policy, as well as a finding encouraging international collaborations. Dr. Green reported that PSD had just had bilateral talks with its ESA counterpart, where members discussed a mutual interest in Europa, future studies, and the Indian Space Research Organisation's (ISRO) future Mars plans.

Addressing other topics of interest and concern, Dr. Green noted that PSD was following on PSS findings on pursuing interconnections with HEOMD. PSD is considering Extended Mission funding for LRO and the Mars Opportunity rover; the Continuing Resolution (CR) covers these two missions. Budget details have yet to be worked out. PSD continues its investment in radioisotope power sources and Stirling engines. Dr. Green reported that he was still working on keeping the Analysis Groups intact, despite having been excluded from the NAC infrastructure in a recent policy change. PSD continues to try to improve launch cadence and has succeeded in the case of the Discovery program. PSD is also actively coordinating investment with STMD. Mr. Schurr added that recent proposals for Discovery reflect that the STMD collaboration with PSD is working well. Dr. Green noted that the recent Comparative Climates of Terrestrial Planets II workshop was well attended, and that an official NASA Conference Proceeding will be the product. The next workshop will be held in 2017.

PSD R&A Findings

Dr. Michael New provided an update on PSD's restructured R&A program. At present, the program has received step-1 proposals for everything but Habitable Worlds. PSD is almost through with this year's ROSES call. There will be an InSight Participating Scientist call, most likely in 2016. In the Solar System Workings (SSW) category, there is now a single step-1 deadline, and two step-2 deadlines. After the issuance of an encourage/discourage letter, a proposal is assigned to one of the two deadlines. There's been a lot of conversation about how people were assigned to the two deadlines. The program staff tried hard to de-conflict panels, as panels in a multi-disciplinary program must vary widely depending on proposals.

There has been a change in proposal numbers; in general, the number of step-2s has decreased from 2014 to 2015, but Exobiology proposal numbers have increased greatly. The Discovery Data Analysis Program (DDAP) had a big increase in step-1s, largely because of the end of the MESSENGER mission. Dr. Luhmann asked if people were crossing over disciplines to propose in Exobiology. Dr. Christina Richey responded that this was the case, but that the numbers overall have stayed relatively stable. Dr. Rall pointed out that the first step-2 was lighter than anticipated, because SSW's deadline was being changed to avoid overworking staff. Dr. New reported seeing

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about a 25% drop from step-1 to step-2 proposals, just as in the previous year. In Emerging Worlds, for example, where only 5 out of roughly 160 proposals were discouraged, there was still a 20% drop.

Selection metrics

The overall selection rate in the restructured program is 21%. Scores of 1561 proposals from 2014 were presented graphically in what Dr. New termed a “Max-o-gram” (eponymous for Dr. Max Bernstein), a construct that was well-received by some subcommittee members. Dr. Rall noted that the intent is to continue to document results in this way.

In essence, the charts showed that Excellent proposals had a very high probability of being funded. For scores Very Good, chances dropped to about 50%. The analysis of the overall R&A program is unfortunately hampered by a lack of analytical tools. Dr. Luhmann asked about the type of feedback provided to proposers. Dr. New explained that if a proposer was declined for programmatic reasons, this was stated; i.e. a letter would state that a proposal is meritorious but declined. Dr. New encouraged proposers to call for more specific feedback. Dr. Pratt strongly encouraged PSD to capture more basic metrics on proposals, to get a sense of how reviewers review; when money gets tight, reviewers tend to downgrade proposals because of the competition.

Dr. Luhmann asked how the normalization of panels through subgroups has worked out. Dr. New replied that most groups looked at the subpanel ranking, not just the absolute score. He couldn't say that a Very Good would be the same in two different panels, but overall a Very Good has about a 37% probability of being funded. The analysis is still subjective, but the program is trying to eliminate panel-to-panel variation. The 21% success rate for all proposals varies by perhaps +/- 2%. The plan for next year's selections is a work in progress. There is a guarantee for a floor budget; however if Congress increases appropriations, the R&A program will make a subsidiary selection. Mr. Schurr added that the floor will be set until there is an appropriation in March 2016. The plan is to use both proposal pressure and a set budget to guide selections.

In terms of programmatic balance, Dr. New reported that while PSD has made a first-cut analysis, it has not yet been vetted by the whole division. An assignment of tasks has been made to address the five strategic goals. Dr. Luhmann asked if the Program Managers (PMs) and the community felt that this restructure is going in the right direction. Dr. New responded that on the PM side, it's easier to tell people what R&A is doing and how it's funding things. Additionally, because the staff works in caucuses of 3-6, there is more than one person to handle a problem. There has been positive feedback from the panels in this regard. The reorganization also helps in experimenting with process. Emerging Worlds experimented with proposal selection by having a discussion, followed by one person writing an evaluation, then by a panel vote. The result has been greater consistency and good feedback from reviewers. In terms of community response, it has been hard to tell whether there is broad consensus, or a small vocal minority voicing its opinion on certain matters. Dr. New thought the community was still adjusting to the changes. Dr. Chabot commented that the Small Bodies Analysis Group (SBAG) has heard a lot of anxiety about whether the whole science community is in a healthy place related to declining selection rates. Dr. New felt that the conversation is starting and that it needs to happen. Dr. Hansen noted that the Outer Planets community was concerned about the size and not the structure of SSW. As Outer Planets Analysis Group (OPAG) chair, she reported being asked whether the dollar

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amounts for OP research proposals are roughly equivalent to what had been funded previously. Dr. Rall reported that he hired a summer intern to put key words into the database to help analyze such questions, and Dr. New reported having just hired someone to do statistical analyses, in the manner of the National Science Foundation (NSF); in the interim, NASA has been running homegrown statistics. Generally, no increase in multiple proposals from the same PI has been seen, but there has been an increase in award size. Laboratory programs and field campaigns tend to be more expensive. Dr. Neal noted that a letter from the sample analysis community has indicated concern with lack of funding. Dr. New replied that the matter is being discussed. Dr. Neal felt that the situation argued for more feedback from the Program Manager. Dr. New noted that if a proposal score is reasonably high, the PI should call NASA staff to determine what new features would help a re-submission. Dr. House seconded the existence of community angst, and appreciated his colleague's concerns in SSW about ultimately going to one deadline. Responding to concerns, Dr. New commented that regardless of how big the program is, there will always be a limited number of planetary scientists. Dr. Rall felt that the large SSW panel had been a great success, and that reviewing a huge number of proposals was not stupendously hard. Dr. New added that there is also a process for formal review of a decision, which can be used if necessary.

Facilities Future Plans

PSD is planning to review NASA-funded, science-enabling research facilities (e.g., Ames Vertical Gun Range, AVRG) in order to gauge interest in the community via requests for information (RFIs), Lessons Learned studies, and identifying needs at a Lunar and Planetary Science Conference (LPSC) session. Dr. Doris Daou will be running Lessons Learned activities at the AVRG, the Planetary Aeolian Laboratory (PAL) and Reflectance Experiment Laboratory (RELAB). This is not a Senior Review, rather it is a Lessons Learned activity that involves no funding. The exercise is merely asking: what are you doing, who is using it? Dr. Pratt asked whether outside facilities heavily used by the NASA community would also be evaluated. Dr. New replied that the LPSC and a future Cooperative Agreement Notice (CAN) are what will help NASA determine this and who should apply. The current effort is meant to rationalize NASA support for current and future facilities. Asked if there were plans to share this with APD (e.g. for detectors), Dr. New did not know the answer. However, he mentioned that the Regional Planetary Imaging Facilities will also be part of the current review. Dr. New also referred to new procedures for US Geological Service (USGS)-releasable maps, asking that interested parties contact Jim Skinner, Map Coordinator. USGS now has a form letter that lists specifications for mapping, which does not constitute an endorsement; it is just a statement of technical support. Applications for USGS maps must include tactical specifications.

FY15 research budget line

Dr. New reported that the FY15 research budget line total is \$155M. Mars R&A constitutes \$9.9M; Outer Planets, \$8.5M; Discovery research (excluding Participating Scientists), \$8M; Joint Robotics Program for Exploration (JRPE), \$7.8M, and Near Earth Object Observations (NEOO), \$15M. The Homesteader program is outside this budget line and will appear in 2017. A mid-term call for the Solar System Exploration Research Virtual Institute (SSERVI) will be released as soon as possible in FY16, which will also leverage APD and HEOMD funding. The President's Budget Request for FY16 is nearly identical to FY15 for R&A. NEOO is proposed to grow to

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\$50M in FY16. There is also a portion of FY16 funding for Spitzer. NEOO will solicit competed research in FY16 under Solar System Observations (SSO). A Planetary Data System cooperative agreement has been evaluated and six teams selected; the structure is similar to the previous agreement. Overall, the award process takes up to 3 months; about 50% of awards are sent within 45 days. Dr. New closed by reminding proposers to include their Data Management Plans in proposal cover pages.

Big Data

Dr. Erin Smith provided an update on the Ad Hoc Task Force on Big Data, which will include representation from both science and industry, and which will report to the Science Committee and to the NAC. Big data encompasses many meanings; for astronomers, big data means TB of data. For Earth science, it's interoperability. For yet other disciplines, it's storage and management, databases, and usability. It is recognized that communities must start communicating more openly on the issue. The Task Force is also responding to the needs of the National Oceanic and Atmospheric Administration (NOAA), climate change stakeholders, and areas of ecological concern. Advances in the use of big data will enable new science and new avenues of research, and yield more questions than answers. Data will also be used for new purposes, as well as enable more real-time decision-making in areas such as space weather (CMEs). The Task Force will have 10 members; eight have been signed on thus far: two from Earth Science; two from Heliophysics; one each from Planetary and Astrophysics; and two from industry (Amazon, Verizon) for expertise on data analysis and machine learning.

Dr. Smith had already received Science Committee feedback on the process, and has presented to the Heliophysics Subcommittee (HPS). She requested an analogous statement from PSS, encompassing goals, objectives, tasks, and deliverables that pertain to specific planetary domains. Task Force products could be a white paper cataloging what NASA does in each discipline, in addition to findings and recommendations to be brought to the NAC. Dr. Gaddis offered to distribute an online link regarding Future Needs for Planetary Science, authored by Dan Crichton.

Lunch Talk

Dr. Amy Mainzer presented recent NEOWISE results for the benefit of members.

SMD Education CAN Selection

Ms. Kristen Erickson, Director of Science Engagement and Partnerships at SMD, presented details of the newly established Education Cooperative Agreement Notice (CAN), and a discussion of restructuring strategy and new selections. Ms. Erickson reports to Marc Allen, the Deputy Associate Administrator for Research at SMD. There is a current announcement to fill a vacancy for Science Education Manager within SMD. Definitions for Education and Communications at NASA changed in 2012, and are codified in NASA policy documents. Education is distinct from Communications. The educational core collectively known as Science, Engineering, Technology and Mathematics (STEM), is common to them both. NASA acknowledges the fundamental desire to enhance STEM education in the U.S. In establishing the

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new restructured approach, SMD used the Decadal Survey recommendations in all four subdisciplines of SMD to inform restructuring efforts. In February 2015, released an official CAN after a lengthy process of engagement with the community. Education goals are to: enable STEM education; improve U.S. scientific literacy; advance national educational goals; and leverage efforts through partnerships. The FY15 budget provides \$42M for NASA science education; and selections from the CAN were announced Sept 25, 2015. A broad panel of experts, including practitioners, participated in the selection process to evaluate proposals. A total of 27 of 73 compliant proposals were selected for awards. Fifteen are from Legacy institutions, but 44% of proposers are “new players.”

Three selections support the 2017 Total Solar Eclipse, allowing for a full year of academic preparation, partly in response to the successful engagement of the Transit of Venus, and also in response to declining scientific literacy. Only one-third of the U.S. population understands the fundamentals of the scientific method.

Awards are to be completed by the end of the calendar year 2015. PIs are located across the US, but there is huge gap in representation in the middle of the US (ND, SD, OK, KS, NE, IA, WI) and in the Southern states.

Sixteen out of 27 selections are in planetary science. Awards will be evaluated and managed on the basis of a number of criteria, including requirements for needs assessments, logic models, baselining, reporting and evaluation. After baselines are established, more extensive SMD agreements will include internal evaluation functions. All agreements will be evaluated by external independent evaluators. An annual review by internal and external experts will occur in November of each year to assess performance, set priorities for the upcoming year, and to identify efforts that do not meet evaluation criteria, which can then be transitioned out before the end of the performance period. Funding can be provided to subject matter experts (SMEs) to cover travel and time when working with selectees. Dr. Green added that he was going to start asking PSD missions to identify SMEs. Dr. Neal observed that Education efforts could be a time drain on SMEs. Dr. Green noted that the intent is to negotiate once the breadth of interaction is identified. Ms. Erickson added that the different learning environments must be identified; historically, Education has incentivized the mission first. The education environment has changed, and now the intent is to send SMEs into the environment. Dr. Luhmann recommended that Ms. Erickson communicate, especially with the unsuccessful Education proposers, the opportunities that are available through the CAN. Ms. Erickson noted as well that SMEs can be funded through Communications for speaking at educational institutions.

All existing Education efforts will be transitioned into the cooperative agreements that result from this solicitation, which is advertised as a 5-year agreement, but it is expected that there will be another targeted call in 3-5 years to address identified gaps, especially in underserved communities, and in the formal education environment.

NEOO Program and ARM Updates

Mr. Lindley Johnson gave an update on the Near Earth Object Observations (NEOO) program.

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The 17-year-old program detects and tracks natural objects that approach within 28 million miles of Earth, and has provided 98% of new detections of NEOs since 1998. The NASA Authorization Act of 2005 increased the scope of NASA's objectives, to find objects of 140m or greater that may threaten the Earth. As of September 2015, 13,035 asteroids have been detected and tracked,, including 1623 potentially hazardous asteroids. The current status of the goal of identifying one-kilometer-plus objects is at least 90% complete with respect to the original objective. In meeting the newer objectives, NEOO estimates that the program is 75-76% incomplete in finding the 140m + population. Assets supporting the program include NEOWISE, LINEAR/SST, Pan-STARRS, and the Catalina Sky Survey, as well as the Minor Planet Center, which is an international observation database, and the Center for NEO Studies at JPL. As more capable telescopes come on line, discoveries will include more >140m objects.

Physical characterization efforts include radar and infrared observations, light curve photometry, and long-arc high-precision astrometry. NEO funds some key assets such as the Goldstone and Arecibo radar facilities, warm-phase Spitzer operations, and the NASA Infrared Telescope Facility. Funding for the NEOO program in FY15 was \$40M, including data analysis, and the Antarctic search for meteorites. The program is working to get data to the science community for detecting bolides or "fireballs" that enter the Earth's atmosphere. Chelyabinsk was just one of the larger of the 550 events that were observed from 1994-2013. Enhanced bolide data release and timeliness will help to inform all nations that these are natural events, and not a nuclear detonation, and will also support trajectory analysis for recovery of meteorites ("free sample return").

In summary, the program is growing, and has better formalized program management and program scientist assignments. There is also manpower devoted to interagency liaisons with the Federal Emergency Management Agency (FEMA) and others, and mitigation research.

ARM

Dr. Michelle Gates, a detailee from HEOMD to the Associate Administrator's office, presented a briefing on the Asteroid Redirect Mission (ARM). ARM is a solar electric propulsion (SEP) technology capabilities demonstration that seeks to identify, redirect and explore a near-Earth asteroid material in cis-lunar space. The endeavor provides an early step to the ability to transport multi-ton objects with advanced SEP; and advanced deep-space astronaut capabilities, in the journey of humans to Mars. The mission will demonstrate high-efficiency large solar arrays, SEP, exploration of extravehicular activity (EVA) capabilities, and deep-space rendezvous sensors and docking capabilities, at about 70,000 km from the surface of the Moon. The mission's five objectives are to conduct a human mission providing a stepping stone to Mars exploration; demonstrate advanced SEP; enhance detection of NEOs; demonstrate planetary defense techniques; and support commercial, interagency and international partnerships. A Formulation Assessment and Support Team (FAST) has been chartered, and will participate in formulation efforts by providing input for investigation in science, planetary defense, in-situ resource utilization and technology demonstration.

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ARM has had interactions with the SBAG, including with a June 2015 meeting of SBAG that resulted in a discussion of the reference target asteroid 2008 EV5, as well as support for the mission based on input that it would enhance science and resources benefit. The ARM is intended to robotically acquire a boulder from an asteroid surface, and to deflect the trajectory of the asteroid as a planetary defense demonstration, as well as to perform deep space EVAs with the acquired boulder. Draft Level 1 requirements have been drafted and approved for entry into phase A.

There are 4 valid candidate targets, including Bennu. The asteroid 2008 EV5 has been selected as a reference target, associated with a December 2025 reference crewed mission design. Dr. Chabot commented that as SBAG Chair, she appreciated the interaction, and was impressed at how quickly the FAST announcement came out.

Mars Exploration Program (MEP)

Dr. Jim Watzin presented a status of the Mars Exploration Program (MEP). MEP is healthy, the current budget supports the current work, and Mars 2020 is proceeding well toward an Preliminary Design Review (PDR) in February 2016. Fabrication of the Mars Organic Molecule Analyzer (MOMA) is under way for the ESA ExoMars mission, which is a mass spectrometer being contributed by the US. Planning for the future is a pressing priority, as the 2022 opportunity is only 5 years from the next budget-planning horizon. Aging infrastructure at Mars must be replaced, while responding to the recommendations of the Decadal Survey. MEP is making progress on its Journey to Mars, with many studies on orbiters and landers as an integral part of the architecture. Much energy has been expended over the last six months in collaboration with HEOMD and STMD. In the orbital environment and operations, MEP needs to learn how to return a flight from Mars to Earth, and develop autonomous rendezvous and docking capability, utilize SEP, and develop ascent capability from the Mars surface. HEOMD and STMD are very interested in determining in-situ resource utilization (ISRU) feasibility.

Mars Odyssey and the Mars Reconnaissance Orbiter (MRO) are a decade old or older, and must be replaced or augmented. Sample return will require reconnaissance, communications, mobility on surface, and flexibility in arrival and departure capabilities, all of which point to SEP for orbit. A Human Science Objectives AG (HSO-SAG) has been set up, as well as a Human Landing Site Study (HLS²), and an ISRU and Civil Engineering (ICE) Working Group. Along with the Decadal Survey, these groups are providing insight for the NEX-SAG (Next Orbiter options). A notional sample-return mission set in the 2020s starts with the Mars 2020 rover, followed by a Mars Orbiter 2022 Resource Survey to find water close to the surface, a round-trip surface-to-surface excursion to explore such areas as dust toxicity and surface navigation; and finally, exploration precursors for exploring ISRU production, and increased Entry, Descent and Landing (EDL) and mass precision. A Mars 2022 orbiter is envisioned as using SEP and carrying advanced telecommunications capabilities in a 5-year mission. SEP can enable more payload mass and power. A multi-functional orbiter would include remote sensing, high-rate optically based telecommunications, and sample capture capabilities. Conceptual payload approaches could take advantage of technologies that are already relatively mature. MEP is seeking order-of

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magnitude improvements for direct-to-Earth (DTE) communications using deep space optical communications, and is seeking also to increase data rates for the proximity link.

The next step is sample retrieval; key enablers will include both higher-precision and higher mass EDL, terrain-relative navigation (TRN) sensors and control, and the ability to carry 25% more EDL fuel. Sample return will require 1.5mT (50% improvement) in landed mass, and perhaps a hybrid fuel Mars Ascent Vehicle (MAV). There are currently 45 candidate human landing site proposals, to be discussed at the first Human Landing Site Workshop, 27-30 October at LPI near JSC. Planetary protection requirements are an integral part of systems engineering, while the program is starting to approach the transition to human exploration. The dialogue is just starting on planetary protection in human exploration. Dr. McSween commented that MEP seemed to be finally concentrating on MSR, and felt that the approach was sounding more realistic. Dr. Chabot noted that the notional 2022 orbiter has no budget and is not part of the Decadal Survey. Dr. Watzin responded that there are precursor activities that can link multiple directorates and support an orbiter; Decadal Survey recommendations are interpreted as science goals, not specific missions. To enable sample return, reconnaissance and telecommunications will be necessary. In terms of budget, there is interest in both HEOMD and STMD in such an orbiter. Dr. Pratt noted that the Decadal Survey makes it clear that if there is an extraordinary discovery, plans can change. Dr. House asked if an SEP tank carries enough fuel to get back to Earth. Dr. Watzin replied that the tradeoff on SEP is time, but it gives flexibility on departure times from Earth and Mars. The round trip would be about two years.

Mars 2020 Update

Dr. Ken Farley, a geochemist and Project Scientist for the Mars 2020 mission, briefed PSS on the Mars 2020 mission. Mars 2020 fits into several decades of Mars exploration that has sought habitable regions and water. Mars 2020 will directly address the search for life on Mars, as well as support future sample return. The rover will seek regions that might preserve a definitive biosignature, and evidence of past habitable environments. To make a definitive judgment, the samples need to come back to Earth for analysis. Sample parameters include chemical characteristics (organic molecules); elemental abundances (distribution, redox pairs) and isotopes; macro- (stromatolites) and microscopic (microfossils, microtubules) structures; and mineralogy. Mars 2020 mission objectives include geologic context and history; *in-situ* astrobiology; and collection and preparation of samples for future return. In addition, Mars 2020 will enable future human exploration by filling strategic knowledge gaps (SKGs) and furthering relevant enabling technologies. Launch is planned for 2020, arriving at Mars in February 2021. The mission will use Sky Crane EDL and embark on a two-year surface mission, with a roughly 20-km roving capability. To the maximum extent possible, the rover will use heritage technology, but will carry additional sensors and cameras. There are seven instruments; a camera similar to MastCam on Curiosity, with a zoom lens; SuperCam (Raman and fluorescence spectroscopy); Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC); Planetary Instrument for X-Ray Lithochemistry (PIXL); Radar Imager for Mars' Subsurface Experiment (RIMFAX), a ground-penetrating radar device; Mars Environmental Dynamics Analyzer (MEDA), to study weather and atmospheric dust; and the Mars OXYgen In situ resource utilization Experiment (MOXIE) for conversion of CO₂ to O₂. A camera called WATSON will be

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included to image both the rover and rocks on the surface. EDL and parachute up-look cameras have also been added to the mission suite. The sampling and caching system continues to be a challenge. The approach is to rotary-percuss a sample into a sealed tube; there are 42 sample tubes. The requirement is to acquire roughly 30 sealed tubes. The system may need to heat the tubes to drive off volatiles; including this capability is to be determined. Dr. Neal commented that the system seemed a too low-TRL system with many potential single-point failures.

Adaptive caching is the baseline approach for Mars 2020. At some point after collection and continued roving, samples will be deposited in one location. There is no cache container that holds the samples; the tubes and seals are designed to withstand >10 years on Mars. This configuration allows for continued sampling and caching after the prime mission. Offloading the samples reduces mission risk, and risk-averse behavior. Samples could be down-selected individually for Earth return long after the end of the Mars 2020 mission. Currently, the mission is planning to coat sample tubes with aluminum oxide to create a high emissivity surface to reduce the internal temperature of the tube.

Mars 2020 is entering the preliminary design review (PDR) phase, moving to key decision point (KDP-C) in the first quarter of 2016. Asked how cache retrieval will be carried out, Dr. Farley replied that a future rover would follow visible tracks, to a location tightly known. The plan is to choose a site that has a very low probability of dust deposition. The Mars 2020 rover can only eject, and not retrieve, a sample tube. The mission is following an extraordinarily stringent set of requirements for allowable contamination; tubes are to be baked and never exposed to the carbon that falls from Earth's atmosphere, and must have an extremely low probability of harboring just one microbe. Each tube will carry 15 g, and is 8 or 9 cm long and 1.5 cm wide. The interior of the tubes will be coated, and likely made with either titanium alloy or stainless steel. Asked if there were any plan to expose the tubes to simulated Mars atmosphere, Dr. Farley replied in the affirmative.

Mars 2020 Landing Site Selection

Dr. Michael Meyer presented a briefing on landing site selection for the Mars 2020 mission. Guiding principles for site selection is that the site must be critical to all aspects of 2020. The process is open to all and must be informed by the broad expertise of the science community. The site must meet all engineering requirements, and must be located in an astrobiologically relevant environment, and contain preserved information concerning the geological record and potential biosignatures. The sample cache must include igneous rocks. Participants in the Mars 2020 landing site selection include the science community, Steering Committee, Mars characterization investigators, 2020 Science Team and project members, Headquarters and other *ex officios*. All landing site selection activities will be documented at the URL: marsnext.jpl.nasa.gov/announcements/index/cfm.

There have been four to five workshops over 4-5 years; eight top landing sites were identified by the second Landing Site Workshop in June 2015. A final planned workshop will be held in June 2018, with a potential for another in July 2019, in advance of mission launch in July 2020. The HiRise camera has collected 127 complete images, and requires just one more image that

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represents one-half of a stereoscopic image. The second Landing Site Workshop considered 21 sites, one of which was new: the S. Nili Trough. The community used five scientific selection criteria, as well as engineering constraints, to winnow down to eight sites, and developed a rubric to focus a discussion of site attributes. Scientific criteria included geologic setting and the ability to understand the history of the site; evidence of ancient habitable environments; the presence of rocks with high potential for preserving biosignatures; and abundance, diversity and quality of samples for addressing both astrobiology and planetary evolution. The eight landing sites are Jezero, Columbia Hills/Gusev crater, NE Syrtis, Eberswalde, SW Melas Chasma, Nili Fossae Trough, Mawrth, and Holden Crater (an original MSL candidate site). Nili Fossae Carbonate was “demoted” due to its higher elevation, but is not entirely ruled out. Two sites for additional science investigation being considered are Hypanis and McLaughlin. The Mars 2020 Returned Sample Science (RSS) board, still to be convened, will represent the interests of future sample analysis scientists, in order to provide guidance; the board will also contribute to landing site selections. NASA Headquarters is sponsoring the board member selection process, which will include community members, *ex officio* members, Mars program and planetary protection representation. Dr. Luhmann asked if there would be another layer of decision-making once the rover was on-site. Dr. Meyer replied that the RSS board would be operational until the time of launch. Once operations commence, the program envisions an open competition for choosing which samples to cache. The chair and co-chair of that board would be part of the Project Science Group.

COSPAR

Dr. Gregg Vane presented a briefing on the Committee on Outer Space Research (COSPAR) and its relevance to the PSS. The COSPAR Assembly is coming to Pasadena in 2018, and Dr. Vane encouraged the community to attend. COSPAR, founded in 1958, was established by the International Council for Science in response to Sputnik, and as an outgrowth of the International Geophysical Year. COSPAR holds biennial scientific assemblies, interspersed with small symposia. Its goal is to promote international research in space. The COSPAR Council is the governing body, comprised of the NRC from US, IAU, etc. There are 44 national members and about a dozen scientific unions. The current president is Len Fisk, and there are two vice presidents. The COSPAR Bureau is advised by a COSPAR Scientific Advisory Committee. The Space Studies Board (SSB) comprises the official US National Committee for COSPAR. The NRC appoints a US representative to COSPAR based on SSB nominations. Charles Kennel is the current US representative. The last COSPAR assembly received 4000 abstracts, in all space-science disciplines. COSPAR proceedings are published in *Advances in Space Research*. It is important to note that COSPAR develops, maintains and promulgates the world’s planetary protection policy. Of relevance to the PSS are Scientific Commissions (SC) B and F, and a special-purpose panel devoted to planetary protection (PP).

Aside from importance of PP, COSPAR also provides extensive international scientific engagement for the US scientific community, opening possibilities for collaboration in missions and projects. The Planetary Protection Panel is currently chaired by Gerhard Kminek, the Planetary Protection Officer (PPO) for ESA. NASA PPO Cassie Conley, Victoria Hipkin (Canadian Space Agency), and Hajime Yano (Japanese space agency JAXA) are vice chairs. All

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four current leader terms will expire in 2018.

The current PP policy was adopted in 2011, following a final update in 2009. In 2016 in Istanbul, there will be proposed updates to this policy, a decision that is carried out by the COSPAR Bureau. The Pasadena Assembly in 2018 will offer opportunities for further updates to this policy, therefore the community should start thinking about this now. Dr. John Rummel commented that the 2002 policy was just a coalescence of a policy from 1963. The updates since 2002 include an addition of human space exploration requirements, and some minor technical changes with respect to Mars special regions in 2011. The fundamental idea of the policy is to serve science and protect Earth by avoiding backward and forward contamination in space endeavors.

To engage in an effective way, community members should plan to attend and participate in the 2016 assembly (www.cospar-assembly.org) and business meetings of the PPP and SCs B and F. These are where issues related to PP policy are raised and debated, and if necessary, updated. Dr. Vane suggested that PSS members engage actively with COSPAR's Planetary Protection Panel. Dr. McSween asked if there were any changes the community might want to see in PP. Dr. Vane responded that one area of changing policy would be how to achieve PP policy goals, given the abundance of new discoveries [recurring slope lineae (RSLs) at Mars, ocean research, new technologies] that should be incorporated into future policy updates. Dr. Luhmann asked how the community might provide input to policy development as events rapidly occur. Dr. Rummel felt that the PP policy was already in front of events, particularly through a strong relationship with ESA's PPO and ongoing workshops. Science Mission Directorate Associate Administrator John Grunsfeld has pointed out that new plans related to planetary protection will be needed if a Mars mission were to visit RSLs.

Discussion

Dr. Luhmann and the subcommittee raised several issues for potential findings:

Evaluation of the R&A re-organization as it relates to programmatic coverage.

Education; PSS felt the effort should be given encouragement for engaging underserved communities, but voiced a concern that the cooperative agreement may be missing key components in Planetary; selected teams are also not very geographically diverse. Dr. Pratt noted the enormous gap of representation in regions where there is a fight to represent science and evolution in school curricula. Dr. Chabot suggested bringing back Ms. Erickson on the following day for further discussion.

Big Data response. The subcommittee contemplated a comment on the distribution of expertise on the Ad Hoc task force

Sample Return Mission plan. Dr. Neal felt the current plan was well thought out and may invite comment.

No issues were identified for consideration by the full Science NAC Committee. Dr. Chanover suggested a possible affirmation for a Mars 2022 orbiter. Dr. Pratt noted that there needed to be

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funding flowing in from HEOMD and other parts of NASA that have a big stake in a new orbiter. Dr. Mainzer recommended that PSS make a statement of encouragement for Discovery selections and the program's return to a more frequent cadence.

October 6, 2015

Dr. Luhmann opened the meeting and reviewed the day's agenda. Dr. Green made some comments, clarifying some potential miscommunications. He referenced a statement from the Space News website, which contained the headline: "Two Discovery missions now means fewer later." He stated that there is absolutely no intention to select fewer Discovery missions in the future; rather PSD will continue to maintain a 32-34 month cadence rather than the previous 54-month cadence. The plan in fact is to select more Discovery missions. The headline should read "fewer AOs" and not fewer missions. In addition, Dr. Green reiterated that the latest Discovery cost cap is \$450M, excluding the launch vehicle and phase E, as it worked well in the latest selections. Lastly, he made it clear that the Homesteader program grants are going to individuals that are investing in instruments for the New Frontiers program, to make proposals more competitive and buy down risk; the purpose of the program is to pave the way for hopefuls. Dr. Green also addressed Space News comments that described making proposals "easier to judge." He stressed that PSD efforts have nothing to do with the evaluation process; the intent is to just help the community to get competitive and win. Dr. Chabot noted that there wouldn't be a Discovery AO in 2017 because of the two recent mission selections, and that this remains a concern in the community. Dr. Green replied that the Discovery cost cap doesn't require that every proposer should attempt to spend \$450M. He reminded everyone that both GRAIL and InSight were well below their cost caps. Dr. Vane observed that a JPL study on the value of cost caps found that average cost of phase E was around \$500M, and that PSD had in fact responded effectively to the Decadal Survey exhortation to keep up with inflation by excluding phase E and the launch vehicle in the Discovery program.

A NASA Exoplanet Research Coordination Network; Nexus for Exoplanet System Science (NExSS)

Dr. Rall gave a briefing on a new cross-divisional research activity with APD and HPD, in which NASA is employing an NSF-like "meta-program" called Nexus for Exoplanet System Science (NExSS), a coordination network that is loosely managed by a confederation of scientists. As PSD had received many meritorious proposals for exoplanets, it formed NExSS as an opportunity to try something new with some existing grants. Because exoplanet research cuts across SMD, the idea is to leverage existing programs in SMD to advance the field. The goal is to break down stovepipes through a virtual structure that supports research, providing an opportunity to foster collaborations, and to use novel networking strategies. Dr. Mary Voytek has already successfully instituted virtual collaborations through the establishment of the NASA Astrobiology Institute (NAI), albeit with a more specifically required and funded collaboration mandate.

Implementation of NExSS is carried out through existing programs in SMD. Out of PIs from all divisions, 11 members have been selected for complementary research topics. Dr. Rall emphasized that there are practically no new funds, and no new funding calls in this case, only

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\$10K in additional support per PI for extra expenses related to the (originally not proposed) interaction. Dr. Green commented that he fully supported the opportunity to have a connected set of science, particularly since astronomers need to interact with planetary scientists in exoplanet research areas. The whole idea is to have these groups talk to one another in virtual meetings and through a shared website, supported by just a few coordinating dollars. PSD will probably look for other ways to branch out in the future. A renegotiation of budget helped to support this effort, in addition to the many excellent NAI proposals for exoplanets. Dr. Verbiscer asked why the community was not given the opportunity to propose to NExSS. Dr. Green explained that the community did have the opportunity, simply in the form of the original proposals. If NExSS works, it may end up a named program as part of a future competition.

An APD representative confirmed that the funding is not intended to fulfill the scientific goals of the individual proposers; they have been selected to get together to talk over scientific strategy, such as how to find candidate planets for JWST. He stressed that NExSS is not providing “special money” for researchers. Dr. Green expected the program to evolve over time, and planned to seek PSS input on its progress. Dr. Luhmann commented that other researchers would want to add their voice to the discussion and asked how one should get involved. Dr. Green noted that on a periodic basis, these researchers get together and give open presentations via Webcasting. The main goal of NExSS is not to produce papers, but to get people working together. The next workshop will be advertised in the next few weeks. Dr. McSween applauded NExSS as a clever way to increase communication between disparate research lines, but felt concerned that it is a road to another virtual institute. Dr. Christina Richey made the point that the participants are already being funded through their individual grants; there are five planetary PIs, six Astrophysics, and one Heliophysics participant. They’ve been together for less than a year, and there is no intent to form a new NAI or a new SSERVI.

Analysis Groups

Venus Exploration Analysis Group (VEXAG)

VEXAG Chair Dr. Lori Glaze gave a brief summary of recent activities. The VEXAG is in transition, with Pat Beecham stepping down in October, and with a new deputy, Bob Grimm, stepping in. It is not clear what the process is under the new structure, a problem common to all the AGs at this juncture. Dr. Green commented that he continues to deal with the changes, but emphasized that the AGs should feel free to bring in the right people in the interim. Clearly, PSD wants the input to come in, even though the AGs are no longer officially connected to the PSS; perhaps input can be given for the time being through public comments. Dr. Green welcomed the AG chairs to remain on PSS, even if they step down from the AGs. Dr. Rall encouraged AG members to continue to self-nominate individuals for representation on the subcommittees.

Dr. Glaze reported changes on the VEXAG’s Executive Committee membership as well, with three members rolling off and three new ones rolling on. The Venus community is ecstatic that two Venus missions have been selected for phase A studies, and is planning science presentations on the two missions. A Venus Science Priorities Workshop was held recently, and numerous other community activities reflect the new work in progress. The Glenn Extreme Environments Chamber is now operational, ideal for testing Venus atmospheric chemistry at near surface

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temperatures and pressures. The publication of the Venus III Book is impending. The next VEXAG meeting will be held in late October. The Japanese Akatsuki spacecraft will be once again attempting an orbit insertion on 7 December; NASA has selected 6 Participating Scientists for this mission. The International Venus Conference will be held in Oxford, England in April 2016. Dr. Glaze presented notable science nuggets, including data providing evidence for active volcanism on Venus; emissivity anomalies associated with tesserae on Venus; and HST observations of sulfur in Venus's upper atmosphere, suggesting that sulfur concentrations are connected to the solar cycle. The findings from VEXAG's April meeting were predominantly Venus-centered; no findings were carried forward to PSS.

Outer Planets Analysis Group (OPAG)

Dr. Hansen, Chair of the OPAG, reported on the AG's August meeting; the next meeting will be held in February in San Antonio. Major objectives at the August meeting were to celebrate the present, given the successes of New Horizons at Pluto, Cassini at Saturn, Juno approaching Jupiter, and a new start for a Europa mission, but address the looming 10-year gap in outer solar system exploration. While Outer Solar System exploration now has a future, the community has focused its concern on the ten-year gap in major missions from 2020-2030, as well as the selection of the next targets of interest, such as ice giants and ocean worlds. OPAG findings of note include applause and support for expediting the Europa mission, while OPAG also encourages NASA to provide on-ramps for Europa scientists by judiciously adding participating and interdisciplinary scientists early in the mission. Science return will be enhanced by formation of a committee to coordinate collaborative investigations with the ESA JUICE mission. OPAG also notes that the US House Appropriations Committee has proposed support for an Ocean World exploration program. OPAG strongly endorses the creation of an Ocean Worlds Exploration program at NASA.

Cassini is entering the last year of its mission, thus OPAG would like to see a continuation of the Cassini Data Analysis Program (CDAP) for parsing the final data. OPAG also supports continuing NASA work in evolving radioisotopic power sources, and suggests that the lists for New Frontiers 4 and 5 missions be combined. In advance of the next Decadal Survey, a Science Definition Team will be convened for proposing Uranus and Neptune ice giant mission studies. OPAG also suggests a query to the community to solicit feedback on the Decadal Survey's treatment of the Outer Planets (panel structure). OPAG supports Earth-based observations of the Outer Solar System. OPAG supports augmentation for the R&A program and urges the NRC to look at the program restructuring in terms of Outer Planets science in the decade-long gap in missions. The AG also discussed stepping up efforts in communicating results through science nugget/metrics on science return, agreeing that it is the researcher's responsibility to produce and disseminate such metrics. Recent science items include the discovery of an active lava lake on Io, the application of Cassini data to learn about Jupiter, and libration measurements that suggest the existence of a global ocean located inside Enceladus.

Mars Exploration Program Analysis Group (MEPAG)

MEPAG Chair, Dr. Lisa Pratt, reported on the most exciting recent science on Mars, namely the data confirming the nature of RSLs on Mars, which got tremendous coverage in the media, and was published in Nature Geoscience. Other findings support the existence of carbon sequestration

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on Mars, consistent with the alteration of crust in the presence of a carbon dioxide atmosphere; either water once flowed in a thin atmosphere, or there was a thicker atmosphere that was subsequently lost to space. Another high-visibility paper was released, regarding the high methane content of Mars meteorites from Antarctic, and its implications for microbial habitability on Mars. MRO detected a subsurface layer of mostly water ice, based on focused imaging of terraced craters in an Arcadia Planitia, an area the size of CA and TX. MEPAG continues to reach out to HEOMD, and in particular is still seeking to replace the HEO liaison, the late Mike Wargo. Upcoming activities include meeting of the NEX-SAG, HSO-SAG, a Landing Site Workshop (LSW) for human missions on Mars, a second 2020 LWS, and the creation of a Returned Sample Science Board for Mars 2020.

Lunar Exploration Analysis Group (LEAG)

Dr. Clive Neal, LEAG Chair, reporting on LEAG activities. The Executive Community has been reconstituted, and has reached out to younger scientists and engineers. LEAG has also added a Commercial Advisory Board (CAB) to explore potential synergies between scientific and commercial exploration. The first CAB meeting will take place at the next LEAG session in the next few weeks. LEAG activities in 2015 included a New Views of the Moon II (NVMII) conference; the creation of a Geological Astronaut Training Specific Action Team (SAT); and a Global Exploration Roadmap revision activity. The roadmap's final version is due at end of October. The LEAG has received an ESA Topical Team response to LEAG's Volatile SAT report. Dr. Neal will be briefing the SSB on human exploration in the near future. Other future activities include a workshop on the Nature of the Lunar Mantle, an International Lunar Workshop that will be wrapped into NVMII, and a LEAG town hall meeting. Science nuggets include LRO data that indicate global thrust faulting on Moon, thought to be the source of shallow moon quakes. LRO/GRAIL data have also provided data on the presence of volcanic glasses in the structure of certain lunar mascons. Asked for an update on what was once known as the cartography research AG (CRAG), incoming PSS member Dr. Sam Lawrence noted that he had held a successful meeting on data and idea-sharing, and was trying to adopt CRAG as an annual meeting. He reported his group was drafting a Strategic Plan for cartography in time for the midterm review. Dr. Nittler asked Dr. Neal about efforts to increase the diversity of representation in the LEAG. Dr. Neal reported that the LEAG is aware of the need.

Small Bodies Analysis Group (SBAG)

Dr. Chabot, SBAG chair, reported results of the latest meeting. The next meetings will be held in January in Pasadena, and in June in Washington, DC. SBAG issued findings on the ARM, stating that it appreciates the ongoing engagement with HEOMD, which has provided valuable dialogue through regular meetings. The SBAG feels that ARM has identified a scientifically compelling target. SBAG reiterates the importance of returning to a 24-month launch cadence in the Discovery program, which is important to the small body community. There is continuing community angst about low selection rates in the R&A program, and SBAG endorses SSB efforts to analyze the re-organization. There is particular concern about small, PI-led laboratories. A healthy community must be maintained for decades, not just on a mission-to-mission basis, and there must be an overall strategy to deal with budget and programmatic fluctuations.

SBAG urges NASA to fast-track selections for the Hayabusa-2 Participating Scientist program,

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and furthermore strongly endorses a return of the AGs to their previous classification, to benefit from the value of open community forums. SBAG is currently producing a Goals Document, to be finalized in March 2016. SBAG has formed committees on planetary defense, science, and human exploration and recently filled three open positions on its Steering Committee. Dr. Tim Swindle will take over as SBAG Chair, and plans to be on PSS by August 2016.

Curation, Analysis and Planning Team for Extraterrestrial Materials (CAPTEM)

Dr. McSween, CAPTEM chair, reported that there would be many changes in membership over the next year or so. CAPTEM has accepted the new task of curating and allocating space-exposed hardware at Johnson Space Center (JSC), including parts from the Long Duration Exposure Facility (LDEF) and HST. CAPTEM sponsored a successful Stardust workshop in summer 2015, and its Meteorite Working Group and the Lunar Subcommittee met to consider sample allocation requests. The next virtual CAPTEM meeting will occur at the end of October. Science highlights include findings on the presence of fine-grained materials in returned comet samples, which are both difficult to work with and to characterize; they have been seen to be much more complex than coarse-grained material. The utility of meteorites for bolstering spacecraft data has also been demonstrated; observations such as those made by Dawn at Vesta can markedly improve neutron and gamma ray measurements. The Genesis mission team, cleaned up some remaining collectors and recovered science, in the process creating Kr and Xe gold standards for the solar wind baseline. Asked about the lack of gender diversity at CAPTEM, Dr. McSween replied that the team was definitely trying to rectify the matter. Mars sample-return handling discussions have started at JSC, but the community is more focused on OSIRIS-REx at the moment.

Discussion

Dr. Luhmann asked Dr. Green to comment on R&A and midterm planning issues. Dr. Green noted that he has been protecting R&A throughout many rounds of budget cuts, and that low selection rates across SMD will likely continue, because supporting funds have not increased. PSD will continue, however, to find ways to support the community with programs like Homesteader and by leveraging efforts across NASA. PSD is still preparing on the midterm charge, and will not give the charge to the academy until the end of 2016. He noted the importance of completing the SSB study on R&A before NASA formulates the midterm charge. The dialogue has started, however. Asked for assistance in community generation of polished science nuggets for PSD, Dr. Green suggested contacting the appropriate program officers. Dr. Luhmann encouraged Dr. Hansen to share OPAG's lessons in creating these. Dr. Green took an action to post the contents of a file containing his collection of science nuggets, and get them posted on the Planetary website.

Dr. Luhmann requested an update on Fran Bagenal's briefing on community health (2009/10). Dr. Green noted that he had tasked Jeff Grossman with an analysis of the community makeup and status

Government Performance and Results Act - Modernization Act (GPRMA)

The PSS discussed and scored the strategic goals and science objectives in 2015, as measured against those contained in the 2014 SMD Science Plan.

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Strategic Goal 1, **Objective 1.5.1: Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.**

Dr. Gaddis moved to vote Green, to unanimous concurrence. Objective 1.5.1 was deemed Green.

Objective 1.5.2 Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolved.

Dr. House moved to vote Green, to unanimous concurrence. Objective 1.5.2 was deemed Green.

Objective 1.5.3: Demonstrate progress in exploring and finding locations where life could have existed or could exist today.

Dr. Nittler moved to vote Green, to unanimous concurrence. Objective 1.5.3 was deemed Green.

Objective 1.5.4: Demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.

Dr. Neal moved to vote Green, to unanimous concurrence. Objective 1.5.4 was deemed Green.

Objective 1.5.5 Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

Dr. Neal moved to vote Green, to unanimous concurrence. Objective 1.5.5 was deemed Green.

Education Re-visit

Ms. Erickson returned to PSS to clarify some issues with Education, addressing concerns about peer review for awarded contracts, and providing assurance that the competition was rigorous. In addition, she stressed that Education is trying to serve learners in a different context, and trying to understand what the needs are. The selections were just announced, and NASA is still going through the negotiations with the awardees. The abstracts of the 27 selectees will be posted on NSPIRES. Science education is no longer mission-focused, thus NASA is now trying to focus on science thematics and on themes in the K-12 curriculum. Missions are not taught in the classroom. Scientific literacy is at the core of the effort. While subject matter experts (SMEs) are funded through the missions, the awardees are not funding SMEs (unless this is condition was part of the proposal). Mission funding for SMEs still comes from the Director. Dr. Glaze asked how researchers funded by R&A can become SMEs in order to interact with Education. Ms. Erickson reported that there were some selectees with planetary science themes, and that reaching out to SMEs beyond these selectees is in future work. Much of what was selected was in the out-of-school learning environment, involving online, self-directed modules. She named PSS member Dr. Ariel Anbar as a preeminent thought leader in this area; he is working on a grant from the Bill and Melinda Gates Foundation (<http://achievingthedream.org/resource/14379/the-inspark-science-network>). R&A SMEs can intersect in such areas. Ms. Erickson challenged the community to think about how to get science content into the education growth areas.

To make the connections, SMD is working with PSD to identify a point of contact, and will have

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representatives that will be the broker back into planetary science. Like nodes in PDS, there will be people that the SMEs can reach out to and work with. This is also a work in progress. Dr. Green encouraged PSS to wait for the negotiations to occur, identify the gaps, and then facilitate connections. He welcomed community members to act as leaders on these issues. Dr. Neal asked what the SMD plan would be for either supporting or dismantling the partnerships that have been built over time. Dr. Green commented that these partnerships are reorganizing. Ms. Erickson reiterated that many selectees are from legacy participants, and exhorted the community to learn to be better partners, and focus on the issue at hand, which is to address science education. Dr. McCoy noted that the weakness in the system is still underserved communities, and preferred to think that raising the floor rather than lowering the bar is the issue. Education needs to meet the kids where they are. He suggested that the 27 selectees reach out to the underserved. Dr. Pratt reiterated that there's really a problem with the geographical gaps and hoped that Education could find a way to fill them in. She noted that NASA must reach rural kids, who frequently have practical skills that are valuable in the lab. Ms. Erickson observed that there are many co-investigators associated with selectees that reflect a better reach of the CAN. The current gaps reflect the lack of proposals from these areas. SMD's solicitation did receive proposals from National Space Grant groups and indeed two are included in the selections. Dr. Glaze asked about the risk of cutting out planetary components as negotiations go forward. Ms. Erickson replied that there is very little risk; the planetary cadence of launches and celestial activities guarantees this. After the 2017 solar eclipse, there will be another targeted call. In addressing the geographical gaps in representation, Ms. Erickson said the SMD would continue to inform the community about opportunities through the NAC subcommittees, but was also relying on individual community members to spread the word. SMD cannot continue an insular approach; it will require a considerable volunteer effort that is funded out of the scope of the CAN.

Ethics Briefing

The subcommittee received its annual ethics training.

Findings and Recommendations

The subcommittee reviewed findings on the pending PSD R&A evaluation, and agreed on formulating a response to rather than a finding on the Big Data Task Force, summarizing the sorts of programs and projects that have relevance to planetary science, archiving, and database access. Also deferred was a finding on MEP's sample return plan, as the subcommittee expected to receive future briefings about the budget wedge and management plan regarding the path of humans to Mars. PSS prepared a statement on the Discovery/New Frontiers cadence, offering positive recognition and encouragement.

In light of a planned joint session with the Planetary Protection Subcommittee (PPS) in June 2016, PSS agreed to include an agenda item on beginning a serious discussion about planetary protection requirements as they relate to scientific exploration.

With respect to the AGs, PSS considered a finding regarding Headquarters support of AGs in

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general, and continued representation on PSS.

PSS discussed the midterm evaluation and preparation for the next Decadal Survey. The committee heard that Director Green has started a dialogue. Dr. Green anticipated that PSD would not get a glowing report from the midterm, which would then focus the discussion on carrying forward, or re-evaluating, goals that had not been met in the previous decade. Dr. Hansen felt that the New Frontiers program should be reevaluated. Dr. Mackwell observed that in the Survey of Surveys, AGs were identified as the places where the discussion starts early in the process when planning for the next Decadal Survey. It also explicitly suggests how to make a clean, clear statement of task, and how to address the things that fall between the cracks. Dr. Luhmann asked that an action be taken to have the AGs start a discussion on how to provide inputs to the next Decadal Survey, as well as to have a PSS briefing on the Survey of Surveys.

Astronomy and Astrophysics Advisory Committee (AAAC) Proposal Pressures Study Group

With Dr. Luhmann's early departure, Dr. Chabot acted as temporary PSS Chair.

Dr. Keivan Stassun presented an interim report summary on an AAAC study group on proposal pressure. The Study Group was formed to seek an optimal response to the falling success rates across the Astronomy and Astrophysics programs at both NSF and NASA. The conclusions of the study generally applied across the board to both NSF and NASA. In NSF Astronomy and Astrophysics grants, success rates have suffered a linear decline since 2001, with selection rates dropping from 30% to slightly more than 15%. This figure is expected to drop to 10% if there is no facility divestment within a few years. Divesting facilities will not totally solve the problem; it is estimated that rates will still remain at 15%. In NASA Astrophysics research program, selection rates are at 18%, and in planetary the rate is about 20%. Part of the decline is attributed to the fact that the number of unique PIs is rising; there has not been an increase in multiple proposals from PIs. About 85% of PIs submit one proposal, with the remainder submitting two, and a small percentage submitting three or four. There is no "postdoc" problem with competition; there has been in fact a slight increase in senior investigators (15+ years from PhD.). There is also no shotgun approach problem; the number of Excellent proposals has not decreased. The greatest loss has been seen in the Very Good category, where there has been a steady decrease in success rates (dropping from 25% to 7%). Unsuccessful proposals are, however, being resubmitted. Ever more unique PIs reapplying in consecutive years would accelerate the rise in proposal numbers and falling selection rate.

Regarding the impacts of more proposals in the condition of a declining success rate, a model based on empirical data suggests that a 20% average success rate means that a PI who tries three times will get funded 50% of the time. The "Matthew effect" suggests that new/unfunded researchers will suffer decreased success rates at an average success rate; meaning about a 50% chance for recently funded proposers and a 10% probability for recently unfunded proposers. At a 35% rate, the problem of funding at three tries translates to a 27% chance that a Very Good proposal will go unfunded. The report concludes that the 20% rate means the time cost of writing a successful proposal is greater than the time it takes to write two papers. The bottom line suggests that success rates of 15% are not sustainable; anecdotally, people are leaving the field, panels are more risk-averse, and new researchers are not entering the field. Success rates greater

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than 30% are considered healthy. Potential solutions to the problem include more funding, rebalancing the program (facilities vs. people), changing grants sizes or opportunities, or decreasing the size of the US astronomy community.

Future plans include a possible survey of AAS and APS, while the group continues to refine data from the agencies. The Study Group will issue a final report by the end of 2015 or early 2016. The draft report is online now at AAAC website: Google "NSF AAAC," and click on the link for the upcoming November meeting. Dr. McSween asked if other disciplines were looking at this problem. Dr. Stassun didn't know specifics, but pointed out that the von Hippel paper, alluded to in the briefing, had used astronomy and psychology as two exemplar fields for their model. Dr. Green commented that selection rates are declining across disciplines, and that, relative to knobs that one can turn, there is a trend in increasing grant size. Decreasing size and funding more grants might make things equally difficult. Dr. Stassun noted that while average grant sizes in general have increased in absolute dollars, they have declined in inflationary terms. Dr. New observed that, in his studies, in inflation-adjusted terms, he had seen flat or slightly increased values. Dr. McSween felt that think NASA has made a good faith effort in countering the Matthew effect by removing progress reports. Dr. McCoy suggested that holding the selection rate at 35% could increase the probability of a Very Good proposal being funded after three tries. Dr. Green was willing to try this tactic. Dr. Richey commented that PSD has been doing this in some form for a couple of years, or doing descopes and pilots for young investigators; PSD recognizes the implicit biases and is trying to counteract them. She noted that proposers did do better the next year if they were given some help.

Dr. Green observed that NASA is 50 years old; the field of planetary science is maturing and it is becoming tougher to compete. Dr. Stassun commented that the community seemed to be suffering the effects of a flat budget, more people, and a negative feedback loop. Dr. Green urged that the conversation continue, but to be very clear about the purpose. The goal is to concentrate on the best science and to fund as many worthy proposals as possible.

Dr. Rall addressed some specifics that must be taken into account if R&A substantially changes. If a PSD budget line is cut by more than 20%, it will require a new statement of work. At an average grant size of \$125k, for every four grants, one could allow another selection. Dr. New added that one must also take into account the idea of cost realism. Longer grant periods make the problem worse, and cycles of three- and four-year grants would beat against each other to deleterious effect. Dr. Green suggested the AGs discuss the situation and present their conclusions at the next PSS meeting.

Dr. Chabot adjourned the meeting at 4:15 pm.

Mars 2022 Orbiter

Preliminary information from a MEPAG science analysis group that studied functions for a Mars 2022 orbiter to be inserted into the overall plans for Mars exploration indicates a large and complex mission set merging goals of human exploration, technology demonstration, and planetary science. Coordination across multiple NASA Directorates will be necessary for funding the proposed mission architecture without placing an undue burden on other Planetary Science missions. At the next meeting of the PSS, we would like to hear details about the anticipated funding wedge and management plan for the currently envisioned set of highly collaborative missions on the path to humans at Mars.

Discovery and New Frontiers

We applaud PSD's issuance of a Discovery AO in 2014 and the timely completion of the Step 1 review process by the end of Fiscal Year 2015. The PSS is excited by the selection of five missions for Phase A study, leaving open the possibility that 2 missions may be selected for flight and making significant progress toward returning to the 24 month cadence for Discovery recommended by the Planetary Decadal Survey. We also applaud the commitment from the PSD to release New Frontiers Announcements of Opportunity #4 and #5 during this decadal cycle, as recommended by the Planetary Decadal Survey for medium missions. We encourage the continued support of the lines of PI-led cost-capped missions that deliver world-class science and encourage innovative approaches.

Assessment of Reorganized R&A

The PSS has requested, across the full range of R&A programs within PSD, selection statistics, open access to titles and abstracts of funded proposals, total funding levels by program, selection rates by panel score for new program elements, and statistics on time required for determining selectable and selected proposals following proposal submission or review. This information would allow us to compare these data for the year before the R&A program restructuring to subsequent years in order to address community concerns over the reorganization.

We understand it is currently difficult to assemble this information due to the lack of tools. We therefore request that the resources be allocated to the program managers to set up a database with the relevant information from all PSD research programs and the necessary software for regularly mining information from this database. The goal of such an investment is to allow both improved PSD tracking of R&A activities and communication of information to the proposing community. Such communication is particularly necessary in this era of low selection rates and the associated stress. We

encourage continuing a regular dialog with the planetary science community about the R&A program through venues such as townhalls at LPSC, DPS and AGU.

AG Status

The PSS recognizes the value of community dialog with PSD managers and greatly appreciates the sustained support by PSD for all of the Assessment/Analysis Groups (AGs). These groups provide an effective conduit for communication between PSD and the scientific communities represented by the individual AGs. In addition, their summaries provided to PSS allow further discussion of concerns and topics of broad interest, as well as overviews of progress in specific areas of planetary science endeavor. PSS encourages continued opportunities for the AGs to present reports to the Planetary Science Division leadership, and to participate in PSS meetings.

Other reports:-----

Response to Request for SMD Big Data Task Force Input:

The planetary science community is on track to manage and work with more than a petabyte (1,000 terabytes or 1,000,000 gigabytes) of science and engineering data (representing the holdings of the NASA Planetary Data System) in the next year. Along with this large volume of data come the challenges of processing, managing and analyzing data using tools and capabilities that may not have kept pace with the rapid growth of planetary data. There is a strong need within the planetary science community for improvements in the following areas:

- interdisciplinary standards for formatting, documenting and serving data to enable and foster increased collaborations across the Science Divisions,
- availability of high fidelity data products from missions, instruments and other data sources, for those investigators whose science investigations can be achieved using higher order data products as a starting point rather than the calibrated archived data,
- access to high-density storage and efficient transfer of data across widely varying bandwidths, to enable quick and easy data access and efficient archiving from all regions of the United States,
- the ability to quickly find, download and analyze data from many science disciplines regardless of their location (i.e., improved search and retrieval functions),
- access to on-demand analytical tools and services that enable users to identify and extract meaningful information from large volumes of data (e.g., automated, intelligent algorithms to search for features such as Mars' recurring slope lineae in an image; detailed examinations of features of Saturn's icy moons in Cassini images),
- visualization and data synthesis capabilities to support rapid and sophisticated science discovery, i.e., data fusion techniques to optimize the science return of disparate but related data sets (e.g., using both atmospheric density profiles and

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- high resolution images to study dust devils on Mars; merging information from both remote sensing (e.g. IRTF, Hubble) and mission measurements to exploit Saturn auroral campaigns), and
- training of data providers and users in new data science methods and capabilities (e.g., modern search and retrieval tools, analysis programming languages, etc.).

Additional Agenda items for next meeting (22-23 Feb. 2016):

1. Information on CAPS Decadal Survey plan and on NRC 'Survey of Surveys' Report
2. Update on Planetary Protection Subcommittee activities and plan for June 2016 joint session
3. Update on Education CAN activities and plans
4. Update on NExSS activities and plans
5. Update on PSD cubesats plans

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Appendix A
Attendees

Subcommittee Members

Janet Luhmann, **Chair, Planetary Science Subcommittee**

Ariel Anbar, Arizona State University

Nancy Chabot, Applied Physics Laboratory

Nancy Chanover, New Mexico State University

Lisa Gaddis, US Geological Survey

Lori Glaze, NASA Goddard Space Flight Center

Candice Hansen PSI

Mihayi Horanyi, University of Colorado (via Webex)

Christopher House, Pennsylvania State University

Amy Mainzer, Jet Propulsion Laboratory

Harry McSween, University of Tennessee (via Webex)

Tim McCoy, Smithsonian Institution

Clive R. Neal, University of Notre Dame

Larry Nittler, Carnegie Institute

Lisa M. Pratt, Indiana University

Anne Verbiscer, University of Virginia

Jonathan Rall, Executive Secretary PSS, NASA HQ

NASA Attendees

Gabriel Adler, NASA HQ

Diane Brown, NASA HQ

Dwayne Brown, NASA HQ

Doris Daou, NASA HQ/SSSERVI

Elaine Denning, NASA HQ

Kristen Erickson, NASA HQ

Ken Farley, NASA JPL

Kelly Fast, NASA HQ

Michelle Gates, NASA HQ

James Green, PSD, NASA HQ

Jeff Grossman, NASA HQ

Jennifer Kearns, NASA HQ

Michael Meyer, NASA HQ

Mamta Nagaraja, NASA HQ

Michael New, NASA HQ

Sarah Noble, NASA HQ

Arik Posner, NASA HQ

Christina Richey, NASA HQ

Christy Rivera, NASA HQ

Mitch Schulte, NASA HQ

David Schurr, NASA HQ

Erin Smith, NASA ARC

Tom Statler, NASA HQ

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George Tahu, NASA HQ
Elsayed Talaat, NASA HQ
Gregg Vane, NASA JPL
James Watzin, NASA HQ
Alice Wessen, NASA HQ/JPL
Dan West, NASA HQ
Richard Zurek, NASA JPL

Other Attendees

Linda Billings, NIH
Orlando Figueroa, OLELLC
Brad Keelor, British Embassy
Steve Mackwell, USRA LPI
Amy Reis, Ingenicomm
Joan Zimmermann, Ingenicomm

Webex Attendees

B. Archinal
Fran Bagenal
Patricia Beauchamp
Scott Black
Stephen Clark
William Cook
Richard Davis
Monty DiBiasi
James Dean
John Dyster
Christian Gangitano
Bob Grimm
Jeffrey Hollingsworth
Mihaly Horanyi
Mike Kelley
Samuel Lawrence
Dan Leone
Alfred McEwen
Hap McSween
Suparna Mukherjee
Betsy Pugel
Erin Preston
John Rummel
Kurt Retherford
Marcia Smith
Kevin Stassun
Robert Sullivan
Tommy Thompson
Richard Warwick

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Appendix B
Membership Roster
Planetary Science Subcommittee

Janet Luhmann, Chair
University of California, Berkeley

Ariel D. Anbar
Arizona State University

Nancy Chabot
The John Hopkins University
Applied Physics Laboratory

Nancy Chanover
New Mexico State University
Astronomy Department

Lisa Gaddis
U.S. Geological Survey
Astrogeology Science Center

Lori Glaze
NASA Goddard Space Flight Center

Candice Hansen-Koharcheck
Planetary Science Institute

Mihaly Horanyi
University of Colorado
Laboratory for Atmospheric and Space Physics

Christopher House
Pennsylvania State University
Department of Geosciences

Amanda Mainzer
Jet Propulsion Laboratory

Timothy J. McCoy
Smithsonian National Museum of Natural History

Harry McSween

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University of Tennessee
Department of Earth and Planetary Sciences

Clive Neal
University of Notre Dame

Larry Nittler
Carnegie Institution of Washington

Lisa M. Pratt
Indiana University

Anne Verbiscer
University of Virginia

Jonathan Rall
Executive Secretary
NASA Headquarters
Science Mission Directorate: Planetary Science Division

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Appendix C
List of Presentation Materials

1. Planetary Science Division Status and Findings Update; *James Green*
2. Planetary Science Division Research and Analysis Findings and Update; *Michael New*
3. Ad Hoc Big Data Task Force; *Erin Smith*
4. Nexus for Exoplanet System Science (NExSS); *Jonathan Rall*
5. Science Mission Directorate Education Cooperative Agreement Notice Selection; *Kristen Erickson*
6. Near Earth Object Observations Program Update; *Lindley Johnson*
7. Asteroid Redirect Mission Update; *Michelle Gates*
8. Mars Exploration Program; *James Watzin*
9. Mars 2020 Project Update; *Kenneth Farley*
10. Mars 2020 Landing Site Selection and Returned Sample Science; *Michael Meyer*
11. Committee on Outer Space Research; *Gregg Vane*
12. Curation, Analysis and Planning Team for Extraterrestrial Materials (CAPTEM); *Harry McSween*
13. Lunar Exploration Analysis Group; *Clive Neal*
14. Outer Planets Analysis Group; *Candice Hansen*
15. Mars Exploration Analysis Group; *Lisa Pratt*
16. Small Bodies Analysis Group; *Nancy Chabot*
17. Venus Exploration Analysis Group; *Lori Glaze*
18. Astronomy and Astrophysics Advisory Committee (AAAC) Report on Proposal Success Rates; *Keivan Stassun*

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Appendix D

Agenda

Planetary Science Subcommittee Meeting

October 5 and 6 2015

NASA Headquarters

Washington D.C.

Monday, October 5, 8:30 a.m. – 5:00 p.m. (3H42)

8:30 Welcome, Agenda, Announcements (J. Luhmann, J. Green, J. Rall)
8:45 PSD Status & Findings Update (J. Green)
10:00 break
10:15 PSD R&A & Findings Update(J. Rall)
10:55 Big Data (E. Smith)
11:15 NExSS (J. Rall)
11:45 Lunch -- CLOSED
1:00 SMD Education CAN Selection (K. Erickson)
1:30 NEOO Program and ARM Updates (L. Johnson)
2:00 Mars Exploration Program(J. Watzin)
2:30 Mars 2020 Project Update(K. Farley)
3:00 Mars 2020 Landing Site Selection and Returned Sample Science (M. Meyer)
3:30 Break
3:45 COSPAR (G. Vane)
4:15 Draft Findings (All)
5:00 Adjourn

Tuesday, October 6, 8:30 a.m. - 5:00 p.m. (3H42)

8:30 Agenda Updates & Announcements (J. Luhmann, J. Rall)
9:00 Analysis Group Quick Update and Discussion (All)
10:30 Break
10:45 GPRA-MA (All)
12:15 Lunch -- CLOSED
1:30 Q&A Session with the Committee (All)
2:00 Findings and Recommendations Discussions (All)
3:00 AAAC Report On Proposal Success Rates (K. Stassun)
3:30 Break
3:45 Findings and Recommendations Discussions (All)
5:00 Adjourn (All)