NASA ADVISORY COUNCIL

Planetary Sciences Subcommittee

July 19, 2013

Teleconference

MEETING MINUTES

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Janet Luhmann, Chair

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Jonathan Rall, Executive Secretary

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Prepared by Elizabeth Sheley
Zantech IT

Friday, July 19, 2013

Introductory Remarks

The Planetary Science Subcommittee (PSS) of the NASA Advisory Committee (NAC) met via teleconference on July 19, 2013. Dr. Jonathan Rall, Executive Secretary of PSS, asked participants to identify themselves. Dr. Janet Luhmann, PSS Chair, explained that this was a very abbreviated meeting.

Planetary Science Division (PSD) Status Update

Dr. Jim Green, Planetary Science Division (PSD) Director, began his Division update by noting that he would discuss upcoming planetary events, mission status, campaign science, the asteroid initiative, the astrobiology Cooperative Agreement Notice (CAN) cycle 7, and radioisotope power systems and the Department of Energy (DOE).

Mission Status

After a quick review of upcoming planetary events, Dr. Green told the PSS that the Lunar Atmosphere and Dust Environment Explorer (LADEE) was soon to launch from the Wallops Flight Facility. The mission includes three science instruments and a laser communications demonstration. The Mars Atmosphere and Volatile EvolutioN (MAVEN) mission is scheduled to launch in November, with Mars orbit insertion expected in September 2014. MAVEN's core mission is to examine the upper atmosphere and ionosphere of Mars and the loss processes that must be occurring with the solar wind interaction.

The Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) has been confirmed, recently and therefore has entered Phase C. It is scheduled to launch in September 2016. This mission will encounter an asteroid, named Bennu, in October 2019. OSIRIS-REx will bring back samples of at least 60 grams on its return in 2023. Samples will be managed out of our Curation Facility at the Johnson Space Center (JSC).

The launch of Interior Structure from Seismic Investigations, Geodesy and Heat Transport (InSight) is planned for launch in March 2016, landing on Mars about 9 months later. The project is now in Phase B, with the key decision point for confirmation to occur in November. The prime mission will spend one Mars year (669 Earth days) on the surface. This mission has a lot of international participation.

The 2020 Mars Rover science definition team (SDT) has completed its report and it is available at http://mars.jpl.nasa.gov/m2020. Since the report came out, there have been many meetings with the Administration, which have all been very positive. There has been similar enthusiasm in Congress. The team did a great job, and Dr. Green expects that this mission will help keep the enhanced wedge on the budget at the end of the decade.

Campaign Science

Campaign science maximizes science output by using multiple coordinated observations. The first example of this is the plan for multiple observations of Comet ISON around the time when it passes 0.07 au from Mars on October 1, 2013. There will be many Mars assets looking at the comet, including Curiosity. In the days following the comet's perihelion (0.0125 au) on Thanksgiving (Nov. 28), whether intact or in pieces, it should become an easy naked-eye object in the pre-dawn or dawn sky for observers in mid-northern latitudes. The community has offered many proposals for study, some of which have been accepted. The Spitzer mission already made observations earlier in the summer, and there have been some good views from large ground-based telescopes. More information is available at http://solarsystem.nasa.gov/ison. ISON may not be the "comet of the century," but it should be interesting. An effort is being made to talk about it with the public. Comet Siding Spring, also from the Oort Cloud, will be flying within about 0.0008 au of that planet on October 19, 2014, allowing use of some of the same observing tools for comparison.

Through several international missions, the science community is coming together on space-based observations of the Jovian system. Ground-based observatories will also make coordinated observations. The idea is to measure the upstream solar wind and how it interacts with the Jovian system, detect Io's variable, and learn how it interacts with the Jovian atmosphere and magnetosphere. It is important to promote these activities in order to leverage existing assets. Io is particularly important, as it was called out in the Decadal Survey (DS). The observations will enable better proposals.

Asteroid Initiative
NASA has begun an asteroid initiative, in which the idea is to capture and redirect a 7-meter diameter, 500-1,000 ton near-Earth asteroid and bring it into cis-lunar space. Astronauts could visit this body as early as 2021. The Small Bodies Assessment Group (SBAG) reviewed some of the studies that were done and discussed variations. One idea was to visit a larger rubble pile asteroid and bring back a sizable surface boulder. SBAG also discussed how to use ion engines to move a large rubble pile to carry out an asteroid deflection technology test. The heart of this mission is in demonstrating advanced ion propulsion technology that can be used and leveraged in the future.

PSD's primary involvement will be in the asteroid identification segment. The funding for this effort will expand ground-based and general observation capabilities, and will enable PSD to find more Near-Earth Objects (NEOs). Dr. Green believes that this augmented observation program will help the science community in the future. Currently, NASA identifies about 1,000 each year and has found more than 90 percent of those larger than 1 km. The current goal is to detect 90 percent of the NEOs larger than 140 meters by 2020. This funding will help in that effort.

Astrobiology CAN Cycle 7
A draft CAN has been released to the community for comments, with the final version to be released later this year. PSD is hoping for six or seven teams that will complement the teams continuing on from earlier cycles.

Radioisotope Power Systems/DOE
In the President's Fiscal Year 2014 (FY14) budget, NASA is the prime customer for Pu-238. DOE will be able to provide about 1.5 kg of this plutonium per year. NASA will now fully fund the DOE infrastructure for this effort. Because NASA does not know the cost of the DOE infrastructure, Dr. Green formed a zero-base review committee to review the needed DOE facilities and capabilities. This report will be available by October 1.

Discussion
Dr. Luhmann pointed out that there was no discussion of the budget. Dr. Green said that there has been no change since the last meeting. PSD has an approved budget from Congress but it must be reduced to take into account the Congressional sequester and rescission. The final operating budget is currently being worked out between Congress and the Administration. When it is approved, he will move forward based on their direction.

Dr. Horanyi thought the amount of Pu-238 being produced was low, given what is actually used. Dr. Green explained that NASA has more than enough plutonium in its inventory to last through this decade. However, it is old, and none has been created since 1988. With an 88-year half-life, it is losing effectiveness. The new Pu-238 will be mixed in with the old plutonium to provide more viable power. In that scenario, 1.5 kg is a great amount to start generating, and it will take PSD's missions well into the next decade. The intent is to keep this going in order to support future missions opportunities.

Dr. Louise Prockter asked for clarification on NASA's participation in the European Space Agency's (ESA) JUpiter ICy moons Explorer (JUICE) mission, as it appears that NASA will not be funding some of the instruments that ESA had planned on. Dr. Green explained that the PSD worked hard to obtain budget approval to move forward with supporting JUICE. There is now a $100 million cost cap for NASA participation in the mission. This cost cap will be honored as it would for any mission. JUICE is an ESA mission, and the invitation to be a minor partner is greatly appreciated. Based on the model payloads and proposal rankings, NASA and ESA agreed on instrument selection, based on the ability of the proposers to deliver the associated hardware. NASA has one principal investigator (PI) associated with the mission, and two co-investigators with substantial hardware contributions to JUICE. The hardware on the instrument NASA selected is quite extensive. ESA is confident that U.S. participation in instruments that extend beyond the cost cap can be accommodated by the other participating countries.

Dr. Luhmann thanked Dr. Green. She asked if he had heard anything from the Administrator regarding some NAC findings that originated in PSS and went forward. Dr. Green said that the responses are being developed and though they may be released to the NASA by the end of the month.

Mars 2020 SDT Report Briefing

Dr. Mitch Schulte, Mars 2020 Program Scientist, presented a summary of the Mars 2020 SDT report. The full report text is available online at http://mars.jpl.nasa.gov/m2020/ .

The SDT's vision is for a Mars Rover that will: conduct rigorous *in situ* science investigations that address the geological context and history, as well as astrobiology; enable a future sample return, human exploration, and technology; and, respect current financial realities. The SDT's task was to define detailed objectives, measurements, payload options, and priorities for an integrated mission concept that will address past habitability, potential biosignature preservation, progress toward sample return, and contributed technology and human exploration payloads.

The SDT defined habitability as requiring raw materials, energy, water, and other favorable conditions in balance. The Rover will look for several types of potential biosignatures. In order to find them, however, preservation of both the evidence and the biosignatures themselves constitute potential issues. Dr. Schulte reviewed the SDT's mission objectives, assumptions, and constraints, which he elaborated on further in the presentation.

The SDT roadmap began with a set of mission objectives, assumptions, guidelines, and constraints. In looking at the first phase, Objective A was to "Explore an astrobiologically relevant ancient environment on Mars to decipher its geological processes and history, including the assessment of past habitability." The team determined that this requires assessment across a range of scales, from orbital down to microscopic. The footprint and spatial resolution of measurements is critical to ensure that observations can be correlated across scales, and to put the observations into context.

To examine the elements of habitability, the Rover must look at the geological record, which would require detection of essential elements and the amount and persistence of available water, as well as energy sources and their accessibility. Other favorable conditions, such as protection from radiation, are also important. With those ideas in mind, the implementation priorities became looking at the measurements required, as well as what would be interesting but less crucial. Dr. Schulte listed the required measurements to meet Objective A, along with some additional baseline measurements.

Objective B was to "Assess the potential for preservation of biosignatures within the selected geological environment and search for potential biosignatures." Dr. Schulte explained that to determine if something

in a rock is a biosignature or potential biosignature, there are favorable preconditions that had to have been met. The 2020 Rover will investigate these. The best way to recognize a strong biosignature candidate would be to return the samples to Earth for study here. Further, biosignatures can exist in different forms, meaning that there are many potential targets. The Rover will need to be capable of detecting as many of these biosignatures as possible. Dr. Schulte listed the required implementation priorities for Objective B, along with the additional baseline measurements.

The SDT's Objective C was "Demonstrate significant technical progress toward the future return of scientifically selected, well-documented samples to Earth." One of the issues that took a good deal of thought and attention from the SDT was why it is necessary to return samples to Earth. The Rover will have limitations that obviate a detailed analysis on Mars. Therefore, samples will have come to Earth to be examined in a lab that can use advanced instrumentation, techniques, and a wide range of analytical tools. Sample return will involve significant technical steps. The first is to select samples and assemble a returnable cache on Mars as a core part of the 2020 Rover mission. This will be a new capability, but the team saw it as essential in meeting the mission's major objective. A returnable cache has three characteristics: a) sufficient scientific value to justify returning it; b) compliance with planetary protection; and c) returnable from an engineering standpoint. The required and baseline measurement priorities for Objective C are similar to those for Objectives A and B, which are also linked by their reliance on *in situ* science to decipher geologic history and processes while also assessing habitability.

Objective D has Mars Rover 2020 providing "an opportunity for contributed Human Exploration and Operations Mission Directorate (HEOMD) or Space Technology Program (STP) participation, compatible with the science payload and within the mission's payload capacity." Dr. Schulte noted that STP is now the Space Technology Mission Directorate (STMD). NASA wants humans to visit Mars by the 2030s. Therefore, Rover 2020 must provide proof-of-concept for oxygen production, Mars Science Laboratory (MSL) Entry, Descent, and Landing (EDL) Instrument (MEDLI), surface weather, and biomarkers.

In situ resource utilization (ISRU) is the HEOMD top priority, to demonstrate oxygen production on the surface. There is also a need to understand the Martian dust environment and its effects on ISRU. The Mars 2020 Rover offers excellent opportunities for synergy between planetary science and preparation for human exploration objectives. In addition, STMD has a number of high-priority candidate payloads, four of which are particularly compelling.

The second phase of the SDT process addressed reference payloads. Dr. Schulte reviewed the threshold measurements, then discussed two hypothetical instrument lists that were developed as examples that would meet the functions needed. The threshold total funded by SMD comes to about $90-$115 million for both examples, depending on the addition of baseline payloads. Dr. Schulte listed six threshold measurements, which would have to be of good quality.

Next, Dr. Schulte discussed the mission concept for the flight system, landing site, and operations. Plausible mission scenarios have a foundation in field work, driving, and caching. Landing site considerations include the needs of *in situ* science and creating a returnable cache. This will require, in turn, a process to perform careful and full evaluation of diverse new and existing candidate landing sites. The SDT examined several sites, and has proposed to eliminate the drive to Mt. Sharp in Gale Crater.

A hypothetical spacecraft accommodation scenario has the launch occurring in the summer of 2020, using an Atlas V launch vehicle, and a cruise time of 8 or 9 months. This and the EDL are the same as for MSL. The surface mission will have a prime mission lasting one Mars year (669 Earth days), and the Rover will have the ability to drive out of its ellipse. It will also be able to accommodate the cache.

Major findings include the following:

- The measurements needed to explore a landing site on Mars to interpret habitability and the potential for preservation of biosignatures and to select samples for potential future return to Earth are identical.
- Significant technical progress towards MSR requires a returnable cache.
- Arm- and mast-mounted instrument data are necessary and sufficient to achieve the required science.
- An instrument set capable of the necessary measurements would be the foundation of an efficient, lower cost Rover.
- The payload needed to achieve the scientific objectives of the mission fill much, but not all, of an MSL heritage Rover. The available payload capacity creates a valuable opportunity for HEOMD to address long-lead strategic knowledge gaps.

The AO will be released in mid-September at the earliest, with proposals due 90 days from release date.

Discussion
Dr. Schulte explained that the AO will call for instruments to address the measurement objectives. Dr. David Draper asked why organic detection is not part of the requirements, given that the science objective is astrobiology. Dr. Schulte replied that it is a threshold measurement included under Objective B. He added that all landing sites are on the table, not just Gale Crater. There is no need to commit to a site this early. Caching of samples will be a new factor in site selection.

There was concern expressed about caching. A sample return cache must be clean enough it does not come back with Earth organisms that were brought along, and there is also engineering involved in what is returned. It was suggested that the SDT addressed the latter well, but not the former. Forward contamination is also a factor in landing site selection; there are landing sites that will be precluded on this basis.

Astrobiology Roadmap Report
Dr. Chris House presented the Astrobiology Roadmap report, noting that such roadmaps have been done about every 5 years since 1998. The 2013 Roadmap is in process. NASA involved knowinnovation.com, tried to bring in a wide range of participants, and sought to inspire rather than just list topics.

The process began with five webinars, each of which was followed by a week of online comments and a live online discussion. There was also a 4-day, in-person workshop at Wallops. The intent was to look 10 years out in free form, with user-defined groups and few, if any, limitations. The five webinars were:

- Astrobiology for Solar Systems Exploration;
- Prebiotic Evolution;
- Evolution of Advanced Life;
- Early Evolution of Life and the Biosphere; and,
- Planetary Conditions for Life.

The process also involved the astrobiologyfuture.org web site. This was all done online in order to cast as wide a net as possible. The result was almost 600 members worldwide, participating in 82 discussions, 621 posts, and 11 user-generated groups. During the face-to-face meeting at Wallops, topics clustered in a free form manner, with the outcome being 21 three-page concept papers. Of the 131 researchers invited, 53 attended even though it was on short notice. The team will soon post the 21 concept documents, and will probably have another webinar. There will then be updates based on comments, and another workshop will integrate the documents into a draft roadmap.

Discussion
Dr. Julie Castillo-Rogez said that there have been concerns in the community about the concepts. This is compounded by the website, which she found to be quite unclear. Others have expressed confusion about engaging in this process. She asked if there was a plan to involve the greater community, as it seemed the team had not reached out widely enough. Dr. House had not realized that people were not accessing the site. Dr. Mary Voytek explained that notifications had been sent out through multiple channels. There were very active discussions, and while not everyone likes the free-form manner, those who participated found it rich and inclusive. She was open to suggestions as to how to get more people involved. Opportunities to comment and engage will continue for another 6 months. Dr. Castillo-Rogez pointed out that people talked to her about their concerns. She could not find things on the site, and others had issues as well.

Dr. Prockter said that while she did receive many messages about the process, the invitation to the Wallops meeting came too late for her to attend. It was noted that this was a factor of the new travel restrictions within the Federal government. Dr. House agreed that the lead time was tight, but this process included more people than in the past and generated more comments. The team will be dropping some concept papers and expanding others. The 21 papers will be available, and the keepers of the documents will engage with the community about the topics. PSD has research programs that answer fundamental questions that guide the Division. The missions feed into those programs by answering the questions. Astrobiology has been essential in many of the recent questions. The roadmap will enable researchers with the fundamental science and understanding of life in our solar system and beyond.

Dr. Luhmann wanted to know the connection with Mars 2020, which is focusing on astrobiology. There is an AO coming out soon that will target astrobiology in Mars 2020. Dr. Voytek said that the guidance for that will have to come from the 2008 Roadmap, as the 2013 document will not be ready for some months. She added that astrobiology is integral to the DS. PSS members will be able to participate and look at the final report as a committee in the spring.

NASA 2014 Strategic Plan Discussion
Dr. Rall explained that he had sent out copies of the draft strategic plan, and asked for PSS input on content. Dr. Paul Steffes said that there was no mention of campaign science, which should be included. Dr. Luhmann thought there was too little discussion of future missions and wanted more discussion of ongoing activities and missions in the text. Dr. Prockter suggested making a greater distinction between NASA and ESA missions. Dr. Rall agreed to address all of these concerns.

R&A Discussion and Next Meeting Planning
Dr. Rall said that he was not free to discuss the research and analysis (R&A) budget due to the Federal embargo on budget information. He is pushing for full funding of R&A, but it is not clear what the budget will be. He explained that there is an ongoing exercise to completely reorganize the R&A program, which would affect the Research Opportunity in Space and Earth Sciences (ROSES) call for 2014. He will present the plan to PSS at the next meeting. PSD is looking at a logical strategy that incorporates technology readiness levels (TRLs). NASA's Astrophysics Division (APD) and Heliophysics Division (HPD) R&A programs have already reorganized their R&A programs, and PSD is looking at them as examples of what might be done.

Dr. Jessica Sunshine said that there was talk of examining the astrobiology institute concept. Dr. Rall said that the idea of the institutes is a good one. The National Research Council (NRC) evaluated the astrobiology institute in 2008. Dr. Luhmann suggested having a presentation on that. Dr. Rall noted that it

is difficult to evaluate the success level of a program, as they all produce results in some form or another, but the question remains as to whether the institute is a good way to do R&A.

Dr. Rall added that one aspect of the R&A reorganization is identifying and separating the facilities funded through that program. There are set costs associated with the infrastructure, and those costs do not change with the R&A budget. For FY15, PSD will request an R&A budget that separates out the facilities. The facilities are referred to in the budget as "mission science support activities."

Dr. Luhmann pointed out that this meeting had generated no findings for the July meeting of the NAC Science Committee. Dr. Rall said that the intent of this teleconference was to brief PSS on Mars 2020.

Dr. Candice Hansen said that she had just started as the Outer Planets Assessment Group (OPAG) chair. There were no findings ready to take forward, but she noted that the Group is concerned about making sure that the Cassini mission remains fully funded through 2017. They also see value in the early participation of U.S. scientists on JUICE, and are pleased to see Pu-238 being produced again. There is general concern about a gap in exploration of the outer solar system if there is no mission soon, and that would be unprecedented. There is no such mission planned, however, and JUICE is not the same as a U.S. mission. There is also full support for the Clipper mission as a flagship.

Dr. Mark Sykes said that SBAG had just met and was soon to have a teleconference on its findings. There is still concern about NASA's lack of compliance with the DS recommendations for Discovery and smaller missions. The Federal travel restrictions have impeded progress. There were other findings, including several about the asteroid retrieval mission.

Dr. Rall thanked everyone for their perseverance and said that he would take steps to schedule a face-to-face meeting for late August or early-to-mid September.

The meeting was adjourned at 12:08 p.m.

Appendix A
Attendees

Subcommittee members
Janet Luhmann, University of California, Berkeley, *Chair, Planetary Science Subcommittee*
Jonathan Rall, NASA, *Executive Secretary*
Julie Castillo-Rogez, Jet Propulsion Laboratory
Nancy Chanover , New Mexico State University
David S. Draper, Johnson Space Center
Louise Prockter, Johns Hopkins University Applied Physics Laboratory
Paul Steffes, Georgia Institute of Technology
Jessica Sunshine, University of Maryland
Donald Yeomans, Jet Propulsion Laboratory

NASA attendees
James Green, NASA HQ, *Director, Planetary Science Division*
Gale Allen, NASA HQ
David Beatty, NASA HQ
Kristen Erickson, NASA HQ
Kelly Fast, NASA HQ
Chris Flaherty, NASA
Robert Fogel, NASA
Lori Glaze, NASA GSFC
Jeff Grossman, NASA HQ
Jeffrey Hollingsworth, NASA Ames
Jennifer Kearns, NASA HQ
Mike Kelley, NASA
Rob Landis, NASA
Michael Meyer, NASA HQ
Marian Norris, NASA HQ
Betsy Pugel, NASA Goddard
Kim Reh, JPL
Christy Rivera, NASA HQ
Mitch Schulte, NASA HQ
George Tahu, NASA HQ
Timothy Tawney, NASA
Shannon Valley, NASA HQ
Gregg Vane, JPL
Michael J. Wargo, NASA HQ

Non-NASA attendees
Brent Archinal, U.S. Geological Survey
Deborah Bass, Denver Lab
Ed Belte, Orbital Sciences
Nancy Chanover, NM State University
Dominick Conte, Millennium Space System
Rich Dissly, Ball Aerospace
Lisa Gaddis, U.S. Geological Survey
Eric Goode, Morningside
Candy Hansen, Planetary Science Institute
Mihaly Horanyi, Univ of CO
Chris House, Penn State

Mackenzie Lystrup, Ball Aerospace
Steve Mackwell, USRA
Jonathan Malay, Lockheed Martin
Hap McSween, University of Tennessee
Barry Miller, Lockheed Martin
Jack Mustard, Brown Univ
Doug Ross, Lockheed Martin
John Rummel, East Carolina University
Elizabeth Sheley, Zantech
Marcia Smith, spacepolicyonline.com
Mark Sykes, Planetary Science Institute
Patricia Talbert, Mars Group

Appendix B
Membership Roster

Janet Luhmann, Chair
Space Sciences Laboratory
University of California, Berkeley

Jonathan A. R. Rall, Executive Secretary
Planetary Science Division
Science Mission Directorate
NASA

Julie Castillo-Rogez
Jet Propulsion Laboratory

Nancy Chanover
New Mexico State University

David S. Draper
Astromaterials Research and Exploration Science Directorate
NASA Johnson Space Center

Louise Prockter
Department of Space Physics
Johns Hopkins University Applied Physics Laboratory

Anna-Louise Reysenbach
Department of Biology
Portland State University

Paul Steffes
School of Electrical and Computer Engineering
Georgia Institute of Technology

Jessica Sunshine
Department of Astronomy
University of Maryland

Donald Yeomans
Jet Propulsion Laboratory

Appendix C

Presentations

1. *Planetary Science Division Program Overview*, Jim Green
2. *Final Report of the 2020 Mars Rover Science Definition Team (SDT)*, Mitch Schulte
3. *Astrobiology Road Map Report*, Christopher House

Appendix D

Agenda

Planetary Science Subcommittee Meeting
July 19, 2013
Teleconference

9:00 – 9:10	Introductory Remarks	Janet Luhmann/Jonathan Rall
9:10 – 10:00	Planetary Science Division Update	Jim Green
10:00 – 10:45	Mars 2020 SDT Report Briefing	Mitch Schulte
10:45 – 11:30	Astrobiology Roadmap Report	Chris House
11:30 – 11:45	NASA 2014 Strategic Plan Discussion	
11:45 – Noon	R&A Discussion & Next Meeting Planning	