NASA ADVISORY COUNCIL

SCIENCE COMMITTEE

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MEETING (TELECONFERENCE) REPORT

Bradley M. Peterson, Chair

Elaine Denning, Executive Secretary

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Opening Remarks/Introduction of Members

Science Committee (SC) Executive Secretary Ms. Elaine Denning opened the teleconference meeting and made administrative announcements. Dr. Bradley Peterson, Chair for the NASA Advisory Council (NAC) Science Committee called the meeting to order and welcomed members. Members of the committee identified themselves on the teleconference and over the Webex application.

Big Data Task Force

Ms. Denning provided a briefing on the progress of the Ad Hoc Big Data Task Force, which was created at the NAC's behest in April 2014 and which will ultimately report to the SC. The ten-member task force seeks to catalogue best practices to enable better use of data and data sets to facilitate new science, and better use of data for decision support in the various disciplines. The membership reflects representation across industry, academia, and Federal agencies. There is one representative from aerospace, two from industry, and six from the subdisciplines of the NASA Science Mission Directorate (SMD): two each from Earth Science and Heliophysics, and one each from Astrophysics and Planetary. The task force will focus on exploring the existing and evolving science data infrastructure. The Terms of Reference (TOR) document has been signed, and the Executive Secretary, Dr. Erin Smith, has been named. Eight nominees are pending appointment, and two are in the clearance process. The Chair currently is engaged in gathering ideas, while a teleconference is being planned in the next few months, probably occurring before the end of the year. At the July SC meeting, feedback was requested from the five subcommittees dealing with big data, and all but the Planetary Protection Subcommittee (PPS) (which did not meet) discussed the creation of a needs statement, as well as goals, objectives, tasks and deliverables for the task force. Thematic types of feedback have been received concerning the necessary linkages and dialogues. The consensus has been that the task force should link with other groups working on big data, and invite modelers, etc. to join the discussion. The four responding subcommittees feel that it is important to leverage existing partnerships with industry, academia, and government agencies. Within disciplines and across disciplines, there is ample opportunity for cross-pollination of ideas. The task force deliverable remains open; it is hoped that the best way to gather data can be identified, perhaps by implementing a survey or holding a town hall meeting. Some issues identified thus far are the usability of data, data sets, and databases; management and access; and ease of data querying. Utilization, and the importance of near-real-time access; interoperability; integration of heterogeneous datasets; harmonization of data with different time frames; and data storage and visualization are other issues to be addressed.

Discussion

Dr. Robert Lindberg shared a prior concern that the charge to the task force didn't explicitly identify output, and asked if that concern had been addressed. Ms. Denning replied that since the summer Science Committee (SC) meeting, the task force has retained the same TOR, and has the initial feedback from the subcommittees, but is still looking for dialogue between the SC, subcommittees and the task force as to the charge. It remains a work in progress. Dr. Lindberg asked if the SC should provide more guidance, such as suggesting topics of focus. These topical questions might be: to what extent does the cross-utilization of tools and techniques hold promise for cost reduction? Is there a local minimum where a level of sharing tools and methodology might save NASA money? Pushing the envelope on tool-sharing

may in fact cost more money. Also, to what extent are publicly available and open source tools and techniques relevant to NASA programs? How can these tools and techniques best be utilized? How can one create tools when open source is not available? Big data tools and techniques and data structures evolve over time; how do we deal with backward compatibility and the risk of creating obsolete formats as the effort goes forward? Dr. Peterson felt that these questions are something the SC needs to formulate, and therefore the committee should continue the dialogue with the task force as soon as everyone is appointed. He expressed concern that the TOR extends the task force until January 2017, meaning that the effort will have to move rapidly in order to have anything worthwhile to report. Dr. Mark Robinson distributed a Lunar Reconnaissance Orbiter (LRO) mission document that seconded the urgency of the problem, as the paper's last paragraph contained recommendations on some short-term action items, such as how to handle large data sets in Phase A and Pre-Phase A, and ensure the Planetary Data System (PDS) has enough funding to stay current and innovative. At present, PDS is stuck in a rut and is probably hemmed in by low funding. He recommended that members look at the LRO document. Ms. Denning took an action to transmit the paper to the task force and to communicate resulting feedback. Dr. Susan Avery asked to what extent the task force had engaged groups that handle big data. The effort would benefit greatly from dialogue with and people who are trained, who understand information science and services. This is different from the knowledge to be gleaned from hardware and software experts, and discipline scientists. Ms. Denning noted that there are two industry representatives on the task force who have this background, and are knowledgeable about NASA's specific big data needs. For instance, at the Earth Science Subcommittee meeting, it was brought out that commercial data analytics experts are different from science data analysts. Dr. Avery commented that one can learn from other people's failures.

Ms. Denning briefly reviewed the upcoming notes on findings and recommendations from the four most recent subcommittee meetings:
Earth Science Subcommittee (ESS): 4 recommendations, 3 findings
Planetary Science Subcommittee (PSS): 4 findings
Astrophysics Subcommittee (APS): 5 ideas
Heliophysics Subcommittee (HPS): numerous observations

Discussion with Science Mission Directorate (SMD) Associate Administrator

Dr. John Grunsfeld spoke with the SC, commenting that the big message is that science never sleeps; this is very busy and exciting time for SMD. A Mars Human Landing Site workshop was recently held to start the dialogue about potential sites for human exploration. Communities are working together on identifying high priority science that could be done on the Mars surface. Possibilities such as sending a sterile robot to a Mars "special region" are under discussion, as well as exploring resource zones where one might easily extract water; sites containing magnesium perchlorate are one example. A serious discussion has begun. One presenter in a landing zone workshop session was a 15-year old, evidence that future astronauts and astrobiologists are being generated. Dr. Grunsfeld reported having met recently with the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF) and the U.S. Geological Survey (USGS) to release the latest policy on space weather. Deep Space Climate Observatory (DSCOVR) operations, formerly supported by NASA, have been handed over to NOAA; its daily views of the rotating Earth have been well distributed in the media.

Invited to ask questions, Dr. Peterson began with the Big Data Task Force, noting that the TOR are vague as to what NASA wants, and interpreting this vagueness as requiring the SC's help in developing an appropriate charge. Dr. Grunsfeld agreed, and suggested that the Committee try to identify potential near-term gains, as well as investments in opportunities to transform science. This is a particular challenge for the astronomy community regarding its ability to process data from the future Large Scale Synoptic Telescope; another challenge will arise from the future Transit Exoplanet Survey Satellite (TESS). The most pressing current need is in ESD, which is well served by its Data Acquisition and Control System (DACS) components, but is affected by the existence of many different data standards. NASA would appreciate the SC identifying high leverage points.

Dr. Robinson asked about the fiscal year (FY) 2017 budget. Dr. Grunsfeld explained that NASA transmitted a budget proposal to the Office of Management and Budget (OMB) in September. OMB will use that information to give feedback to NASA, followed by radio silence until the FY17 President's budget request is released in February 2016. There is recognition from OMB and the Office of Science and Technology Policy (OSTP) that NASA is efficiently handling its science budget, meeting its obligations, and achieving goals. For FY16, there are House and Senate versions of the budget, which will hopefully be resolved in December 2015, when the Continuing Resolution (CR) ends. There are some elements, such as ESD, that have very high variance in the congressional appropriations. NASA has been working under a CR since October 1, 2015, and can't start new programs without working with Congress. NASA is required to fund its programs throughout the CR; this can sometimes work to NASA's benefit.

Dr. Lindberg asked about the current status of policy with respect to potential collaboration with the Chinese science community, reporting that he had been at a European Space Agency (ESA) meeting where he had attended a briefing on a new ESA program that is developing planetary protection guidelines for the outer solar system. This ESA-funded program starts January 1 and will continue for three years, and will involve the cooperation of the Japanese, Canadians, the Chinese Academy, and the Indian Space Research Organisation (ISRO). Participation on the U.S. end is currently limited to the Space Studies Board, with NASA appearing to be sitting on the sidelines. Dr. Grunsfeld noted that NASA cannot bilaterally negotiate with, nor have discussions with the Chinese. This restriction, however, does not apply to multilateral discussions. There has been progress on specific issues related to earth science, for which NASA obtains specific approvals. Dr. Grunsfeld was thrilled to hear that China is involved in discussions of planetary protection.

Dr. Robinson mentioned an announcement by Russia and ESA on returning humans to the Moon in the late 2020s, as well as a recent talk by the Human Exploration and Operations Mission Directorate (HEOMD) Director William Gerstenmaier about exploiting the resources on the Moon for the purpose of leaving cis-lunar space. He asked if there were any chance NASA could participate in future human or robotic exploration of the Moon. Dr. Grunsfeld noted that Administrator Bolden has been clear that the current NASA focus is on the Journey to Mars. The concept is that NASA is not planning on extensive lunar activities; however the entire Journey to Mars is going to be collaborative with commercial companies and international partners. If the Space Launch System (SLS), for example, can help these

partners, such collaboration could be possible. Plans to exploit lunar resources are all relatively preliminary. The goal is to use cis-lunar space to enable science; it is still too early to talk about specific plans or solicitations for working in cis-lunar space. Dr. Robinson felt the community needed to start assessing the presence of resources. Dr. Grunsfeld agreed that there is little ground truth about lunar resources at present, and that there are technological hurdles to be overcome, such as operations in very cold conditions. Dr. Robinson felt that there was enough information to know where to go on the lunar surface, to explore the possibilities. Dr. Grunsfeld agreed with the last point, and departed the meeting by thanking the committee members for their hard work.

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

Dr. Priscilla Cushman of the University of Minnesota reported on an interim draft of an Astronomy and Astrophysics Advisory Committee (AAAC) study regarding proposal pressures in the research community. A final report will be published in March 2016. The study group was established in the summer of 2014 with AAAC members, who subsequently worked with numerous NASA contacts. The study's mission was to gather relevant proposal and demographic data, which is currently gathered in a wiki; the data's eventual placement is to be determined. The study has thus far answered some outstanding questions in the Astrophysics Division (APD), and NSF astronomy. There is still a need to fill in gaps. The study group is also trying to measure science output, and is tracking the population, with a future intent to fold in the Department of Energy (DOE) Cosmic Frontier program. Several questions informed the study output: What is effect on young researchers? How often are proposals resubmitted, and how does this affect outcomes? Is there an optimum success rate?

The final report will compare funding models across agencies; the study group is currently relying on data from NASA only. The desire is to provide data-driven models, ultimately, while continuing to obtain data from NASA, NSF and DOE. The NSF division of astronomical sciences has a very extensive database. The study group's immediate goal was a short status document. Thus the interim report defines the problem across the agency, identifying effects on agencies and researchers. The other purpose of the report was to inform the mid-decade committee, and to provide AAAC a document to be used in drafting a final report.

The interim report found that based on its limited data, success rates across the evaluated agencies from 2004 to 2014 have been reduced: at NSF, from 30% to 15% and at NASA, from 30% to 18%, all while funding has trended upward. When corrected for inflation, the research budgets are either flat or reduced. In NASA's Planetary Science Division and Heliophysics Division, proposal success rates have dropped from 40% to 20%, and 35% to 15%, respectively. In the NSF Physics Particle Astrophysics, rates dropped from 45% to 39%.

DOE's High Energy Physics at Cosmic Frontier program (dark energy, high energy gamma ray, etc.) is characterized by block grants with multiple Principal Investigators. A stable number of university applicants apply every three years, with proposals staggered by years. Most proposals are not funded at the requested rate (usually about 50% of the request). Success rates in this program, from 2012 to 2015, ran about 60%.

In summary, the interim report shows that proposal success rates have been cut roughly in half over the last decade. It is harder to see trends in the smaller programs, and some programmatic changes are also interfering with data trends. In terms of demographics, the actual number of PIs is rising. The number of submissions per PI is seen as generally flat. There is no "post-doc" problem. It is also not true that there are more proposers from small nontraditional institutions. There is no evidence that the budgets themselves are increasing, or that researchers are seeking soft money support to pay their own way. There is increased pressure, however, on faculty for bringing in outside funding. About 7% of AAAC members proposed in 1990, compared to 15% for 2015. There is slight evidence of a proposal downward spiral; i.e. if ever more unique PIs reapply in consecutive years, this will accelerate the rise in proposal numbers and fuel a falling selection rate. This is not a driver at present, but it may become one if the success rate falls below 10%.

Do these numbers just reflect a growth in the community? More people are putting in proposals, at the rate of 2.6% per year. If poor proposals are increasing, good science is still being performed. However, if Excellent proposals are being rejected, then good science is not being done, and it becomes important to come up with a figure of merit (FOM). Are the number of meritorious proposals funded going down? The loss in 2012-2014 (NASA/APD Research & Analysis (R&A)) is seen thus far in the Very Good category, while Very Good/Excellent proposals and Excellents remain stable at 75% and 90% selection rates, respectively. Anecdotal evidence for NSF and DOE is in line with NASA data. Thus far, based on data from NASA and NSF, the number for the proposers is not going up. Is there a proposal success rate floor? It is thought that a healthy level of competition identifies the best science and boosts productivity.

The study recruited the authors of the von Hippel study, which sampled 113 astronomers, and 82 psychologists at the National Institutes of Health. This study found a "Matthew Effect," showing that new, previously unfunded researchers suffer decreased success rates. An average 20% rate for all proposers means 10% for recently unfunded proposers, reflecting a disproportionate effect on young researchers. Is there a Matthew Effect for NSF? There seems to be, as success rates were seen to be worse for new PIs. At the DOE High Energy Physics Program, the new PI/old PI figure is 26%. There are clear differences depending upon the agency funding model.

With success rates at 20%, the time cost of writing a successful proposal is greater than the time it takes to write two papers. The typical astronomy grant results in 8 publications. Success rates greater than 30% are healthy; anecdotally, people are leaving and new researchers are not entering the field. The solutions are not clear: these were identified by the study group as more funding, rebalancing the program, fiddling with the process, changing the grant sizes and number of opportunities, or decreasing the size of the U.S. astronomical science community, strategically or not.

The study effort will continue. The AAAC is committed to a new survey to acquire higher statistical samples, combined with improved data, with the goal of publishing a white paper by summer 2016. Dr. Janet Luhmann asked if the study included proposers who relied on soft money alone. Dr. Cushman replied in the negative adding that, overall, faculty salaries have remained the same. A limited percentage is going to PIs, Co-Is, and students. According to NSF, there has not much change in this area. In the matter of block funding, Dr. Cushman commented that the DOE model comes close to this form; people

know in advance whether it is worth applying. Dr. Robert Kirshner noted that calculating success rate assumes that you don't learn anything as you re-try writing proposals. When people propose again, they may do it better. He didn't think the Matthew Effect is actually based on random behavior. Dr. Cushman agreed that the statistics could be more sophisticated. The von Hippel study did look at factors in re-proposing, however. Dr. Jill Dahlburg felt it was a good report, and was surprised that the demographics haven't changed. She felt that the community hasn't grasped this truth; they still have the view that young people are flooding the field. She did think the community would have a workforce problem in 5-10 years. Dr. Cushman noted that young people might well be discriminated against, given the interim findings. Dr. Dahlburg cautioned against having the message discourage young people, adding that some of the HPS members remembered that in the past, instruments had more funding from NASA, when the budget was not so constrained. Is flight cost eating instrument cost? Where did the money go? Dr. Cushman requested any suggestions to help give a little more direction to the research.

Planetary Protection Subcommittee Report

Dr. Lindberg gave a briefing on the Planetary Protection Subcommittee (PPS), which had not met since the last SC meeting. He mentioned that he and a subset of PPS members participated with ESA in a joint working group on planetary protection, an information-only meeting. There were interesting briefings, starting with the results of two efforts by the Committee on Space Research (COSPAR) Panel on Planetary Protection (PPP), during which drafts were developed for updating the COSPAR Planetary Protection Policy. Specific policy updates were developed for Mars special regions (regions that might conceivably support or harbor life), and "water worlds"—icy moons with liquid water—Europa and Enceladus in particular. PPS will hear the updates at its upcoming December meeting. Other briefings included data from European investigators on Curiosity on results from the Rover Environmental Monitoring Station (REMS) instrument; as well a proposal for an ExoMars payload called HABIT (HAbitability, Brine Irradiation and Temperature). The meeting heard from the program manager from the United Arab Emirates (UAE) on a Mars orbiter mission. Dr. Lindberg noted that the UAE was forward leaning on planetary protection guidelines and was interested in becoming more committed to COSPAR rules.

There is also a development of standards effort known as European Cooperation for Space Standardization (ECSS), a joint space agency/space industry organization that is developing space system standards for Europe. ECSS has released one planetary protection standard thus far. Also at the joint meeting, NASA Planetary Protection Officer (PPO) Dr. Catharine Conley provided an update on a planetary protection Research Opportunities in Space and Earth Sciences (ROSES) selection for technology development, with an eye to developing synergistic technologies with international partners. ESA Planetary Protection Officer Gerhard Kminek provided an update on European research and development investments on sample return technology. There was a briefing about the previously mentioned three-year European Commission Planetary Protection for Outer Solar System Bodies (PPOSS). The program is funded at 3M euros per year, and plans to develop a wiki for planetary protection techniques, as well as to hold four seminars in Europe, Japan, China and India. The Space Studies Board is signed on to the program as an observer only, and there is no NASA participation at this time. There were briefings on biodiversity studies, including an emerging interest on using modern molecular methods (lipid-based, protein-based, etc.) to better characterize bioloads to assess spacecraft

cleanliness. Current measures are assay-based and are surrogates for the presence of biological species. Better techniques will lead to better identification of extremophiles. Meeting attendees also toured the Deep Space Network in Madrid. Dr. Lindberg noted that the round-trip communication time to the Voyager spacecraft now exceeds 24 hours.

Dr. Peterson asked about the presence of extremophiles on spacecraft, and how one could be certain about their elimination. Dr. Lindberg replied that it is assumed that extremophiles can survive the traverse time in space, therefore the assays are an important step in determining cleanliness. There are a number of standards that must be met depending on the spacecraft's destination. One of these is a standard for orbiters and fly-bys (including an assessment of the probability of impact on the planet/body surface). Landers destined for special regions must avoid depositing an Earth microbe that is able to replicate. If a spacecraft is not expected to be in contact with special regions, it must be clean, but not sterile.

Citizen Science

Dr. Amy Kaminski presented a briefing on citizen science. Citizen science projects are growing in number, directly involving the public in science activities. NASA has been supporting these projects on an ad hoc basis. NASA has been trying to think more strategically to optimally support ongoing and new citizen science projects. There is a lot of government attention to this effort at very high levels.

Citizen science is defined as having the public participate in the scientific process to address real-world problems in ways that include identifying research questions, designing/conducting investigations, collecting and analyzing data, developing data applications and technologies to advance science, and solving complex problems. Citizen science employs methods such as crowdsourcing, community-based research, challenges, prizes, gaming, and making. Examples include the Audubon Society's annual bird count, a successful 115-year-old program. With new technologies, sensors, smartphones, etc., opportunities are increasing. The Zooniverse platform, in which the public is invited to look at data to pick up patterns that are not efficiently recognized with machine vision, includes efforts such as classifying galaxies and identifying individual whales by their markings. An NIH-funded program called Eyewire uses a game-like interface through which participants help map neurons. The Environmental Protection Agency's (EPA) Air Sensor Toolbox provides tools and guidance to people interested in environmental monitoring (localities are incorporating citizen measurements for air quality monitoring). These projects can help science get done more efficiently, and can help to analyze big data more efficiently, while generating new ideas for data applications and technology.

In 2009, the Obama administration unveiled the Open Government Initiative, emphasizing public participation. In September 2015, the government released a federal citizen science toolkit, along with an OSTP memo promoting citizen science, and Senator Coons introduced the Citizen Science Act. NASA has supported or provided data for many activities in this area: these activities include, but are not limited to the Cassini Rings Challenge, Mercury Mappers, Moon Mappers, Moon Zoo, Stardust@home, Target Asteroids, Asteroid Mappers, and the Mars Ascent Vehicle Challenge. Funding has come from Education, SMD, Office of the Chief Scientist (OCS), and Office of the Chief Technologist, although many of the projects are not funded by NASA. Some opportunities have been solicited through or funded within ROSES (e.g. Citizen Science Asteroid Data, Education, and Tools (CADET)). Many successes have

emerged, including the Students' Cloud Observations On-Line (S'COOL) program's gathering of more than 130,000 observations from all 50 states to validate atmospheric data gathered by the NASA CERES instrument. Disk Detective, a NASA project on the Zooniverse platform, obtained 1.5 million classifications of 278,000 stellar debris disk candidates over 19 months. The Mars Balance Mass Challenge has awarded $20,000 for ideas for studying the Martian atmosphere. Recent programmatic developments include the creation of NASA policies endorsing citizen science, a NASA citizen science community of practice and listserv, and internal efforts to create internal awareness. The OCS Science Innovation Fund made two citizen science project funding awards in September. The NASA Solve website has also been established to offer a one-stop-shop for the public to find opportunities to participate in NASA science and technology. NASA is considering new avenues through which to create internal awareness, and there are ongoing discussions with SMD, as well as with other science-relevant directorates, to assess where and how citizen science can be supported. Dr. Robinson asked if papers are actually submitted by citizens or professional researchers. Dr. Kaminski reported that papers are generally led by the scientific teams, but they often include credit to the citizen participants. She noted that Disk Detective has generally been validated through multiple viewers. Dr. Douglas Duncan cited a paper that compared the performance of large numbers of citizen science participants vs. a small number of experts, which showed pretty comparable classifications in terms of accuracy. Dr. Kaminski was aware that the issue of data quality is a principal concern for citizen science, and ways to deal with it include proper scoping of a project and providing training protocols, tutorials, and clear interfaces for volunteers.

Public Comment

No comments were noted.

Discussion

Dr. Peterson, referring to a recent non-concurrence from NASA regarding an SC finding on travel policy, asked SC members to continue to record any encountered difficulties with centers, contractors, etc., and to forward such instances to him.

Planetary Science Division/Subcommittee Update

The Director of the Planetary Science Division (PSD), Dr. James Green, gave a division update, first reviewing some spectacular events of the last few months. Dawn entered its orbit at Ceres, and step-1 selections were made in the Discovery program. NASA will be playing a small role in the attempt to insert the Akatsuki Venus Climate Orbiter in December. The Mars lander (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT)) and ESA's ExoMars will be launched at approximately the same time in March 2016, and the Juno mission to Jupiter in July. The step-2 selections in the Discovery program will be made in September 2016. Cassini will enter its ring orbit phase around Saturn in late 2016.

The MESSENGER mission ended its fabulous career of over 4000 orbits and collecting 10TB worth of data, and impacted Mercury's surface in late April 2015. The impact is believed to have been located, and ESA's 2017 Bepi-Colombo mission should be able to see the fresh crater. MESSENGER collected data indicating a dynamic planetary magnetosphere with its dipole pushed northward. Mercury was seen to be a volatile-rich planet, even in the polar regions. Dawn was captured into orbit on 6 March 2015, by the

asteroid Ceres. The first science orbit began on April 23. Dawn has just left its high-altitude mapping orbit and entered its low-altitude mapping orbit, comprised of 404 orbits over 92 days, with a total of 400 operations planned. End-of-mission will occur in March/April 2016. Ceres topography varies by ±7 km, comparable to that of the Earth, while Ceres itself is the size of Texas. The body also contains active water vapor regions, as seen by Herschel. The Occator crater with its bright spots, is large enough to have a central peak, but instead has a central pit. The bright spots are believed to be salts, for the most part, and might have vapors associated with them. Low-altitude operations will reveal more.

New Horizons flew by Pluto on July 14, 2015, at 16 km/s, and imaged two occultations, one of Pluto, and one of Charon. In the polar region of Pluto, images revealed methane ice (yellowish on imaging), and carbon monoxide (cream-colored) ice on top of white-colored nitrogen deposits in the "heart" region. Pluto's atmosphere was seen to be mainly nitrogen, at a ratio of 10:1 in favor of other volatiles. Foggy hazes were seen, as well as 11,000-foot ice mountains. Tholins (complex carbon compounds) are believed to comprise the haze seen above the body's surface. Pluto received vast media coverage, and data continues to come in.

In the current Discovery program, PSD has Dawn, LRO, InSIGHT, and an instrument on Bepi-Colombo. Step-1 selections for the next Discovery mission were announced in September. These are: Psyche, NEOCam (Near-Earth Object Camera), the Lucy Trojan Tour, a VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, And Spectroscopy) investigation, and DAVINCI (Deep Atmosphere Venus Investigations of Noble gases, Chemistry, and Imaging). In the New Frontiers program, the Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-Rex) will launch in 2016, as will Juno. Instruments have also been selected in the new Homesteader program, in anticipation of their use for New Frontiers. The New Frontiers 4 call includes five missions: comet surface sample return, a Venus in-situ explorer, lunar south pole sample return, Saturn probes, and Trojan tour and rendezvous. New Frontiers-5 contains two missions, a lunar geophysical network and an Io observer. Radioisotope power system (RPS) mission planning continues, with a potential of a 5-6 year cadence for New Frontiers mission opportunities. There are three multi-mission radioisotope thermal generators (MMRTGs) available for New Frontiers-4.

The NASA Mars Exploration Program (MEP) is going well, and continues to leverage international partnerships. ESA will launch its Trace Gas Orbiter to Mars in 2016. NASA continues developing the Mars 2020 rover, and held a recent workshop on identifying human landing sites. The program is acquiring data for 40 more sites, and will continue to do in-situ resource utilization (ISRU) analysis and trafficability studies.

The Europa mission is in Phase A, and will study the moon's ice shell and ocean, geology, while collecting high-resolution imaging for future landers. Instrument selections have been made. Europa is a multiple flyby mission meant to avoid radiation exposure while obtaining get global coverage. Advances in solar energy will allow this mission to use solar panels. Cubesat selections have been made: 1) a lunar polar hydrogen mapper (LunaH-Map), 2) a particle-collision investigation - CubeSat Particle Aggregation and Collision Experiment (Q-PACE), and 3) Diminutive Asteroid Visitor using Ion Drive (DAVID), an asteroid mission. New studies have been initiated, one with the National Academies to examine the PSD

R&A restructuring in response to recommendations; and a study on Uranus and Neptune orbiters for $2B or less. NASA will also consider how the SLS might be able to benefit such planetary missions, and has also just started working with Russians on the Venera-D Venus mission. There is a new communications policy pertinent to mission PIs, which directs the managing center to create a mission communications plan for each mission. This was recently done for both Curiosity and New Horizons, and is now an SMD-wide policy, which will be instituted in the next New Frontiers call. NASA held a second comparative climatology workshop, and Dr. Green commended the community's efforts on reaching across the disciplines.

Dr. Janet Luhmann reported on the most recent PSS meeting, held in early October, where members heard briefings on Big Data; NExSS (NASA Exoplanet System Science); SMD Education Cooperative Agreement Notice (CAN) selection; the Near Earth Object Observation (NEOO) Program and Asteroid Redirect Mission (ARM); Mars Exploration and Mars 2020; COSPAR; and the AAAC Report on Proposal Success Rates.

Division-specific findings centered around the Mars 2020 orbiter. PSS members raised a concern that the required coordination on the orbiter development, across NASA directorates, should not place an undue burden on planetary science missions. In Discovery and New Frontiers, PSS was very pleased to see the announcements occur on time, and applauded the division for keeping to the schedule, while looking forward to next steps.

PSS was also pleased that the National Academies will assess PSD's R&A reorganization, but was concerned about NASA's lack of internal tools for analyzing databases. As tool availability was connected to resources, PSS recommends that resources be allocated to that purpose. PSS encourages continued participation of the analysis groups (AGs) in the PSS, despite their exclusion from the NAC infrastructure. The AGs keep the advisory committees well informed, and while it has become awkward for the AGs to meet, PSS acknowledges their value. The AGs are still meeting in a sub-optimal situation, and PSS does not want to lose this very effective means of receiving independent advice. The next PSS meeting will take place in February 2016, where the subcommittee hopes to hear about the next planetary Decadal Survey, and the National Academies Survey of Surveys report. PSS will hold a joint meeting with PPS later in 2016, where it expects to receive updates on the Education CAN, NExSS, and PSD cubesats.

Dr. Luhmann presented science nuggets, ranging from the global ocean inferred from Enceladus's wobble; the surprisingly complex Pluto surface; the mysterious bright spots in Ceres' Occator crater; LRO camera evidence suggesting that the Moon is alive, as inferred from images of global thrusting; carbon sequestration as evidenced by carbonated rock on Mars; to evidence for methane in Martian meteorites. Venus Express found evidence for active volcanoes on Venus as deduced from imagery of bright and dark terrains, and detection of sulfur. Sample return data from the Stardust mission has revealed the diversity (different origins) of the fine-grained materials found in comet Wild-2. Dr. Luhmann noted that PSS made a response on the Big Data Task Force as a matter of formal documentation. Regarding the AAAC report, PSS feels more that more discussion needed, as the present situation pains the community, and impacts lives and productivity.

NASA's Journey to Mars/Mars Liquid Water

Dr. Michael Meyer, lead scientist for MEP, presented the latest evidence for the Mars water inventory. Near-subsurface ice from craters has been indicated through gamma ray spectrometry and neutron detection from Mars Odyssey. There is new evidence for ice in the above 30-degree latitude sites. There is now spectral evidence for hydrated salts in the recurring slope lineae (RSLs) at Mars (Nature Geoscience paper), based on successive imaging over the last 4 years of the dark lines on steep slopes, enlarging through the Mars summer and disappearing by fall. RSLs seem to occur in southern latitudes and at Valles Marineris. The CRISM spectrometer on the Mars Reconnaissance Orbiter (MRO) found RSLs at Palikir crater that were large enough to fit into the footprint of the spectrometer. This is the first spotting of perchlorates from orbit (it is speculated that Viking also may have found perchlorates), which has also been confirmed by Curiosity and the Phoenix lander. A perchlorate signature is also seen (from orbit) at the Horowitz crater, observed at a time when it is probably not an ideal time to look for damp features on Mars. Evidence of water is also seen at Hale crater. The stability of liquid water is extended with the addition of perchlorate; the best analogy is that of a sponge: until it's saturated, there can't be much flow. Perchlorate is hygroscopic, and can take water out of the atmosphere at 20% humidity. At higher temperatures, with the right perchlorate concentration, there can be water in liquid form on the surface of Mars, but it is thought to be well outside the range of what terrestrial life can use for reproduction. There is now data that indicates an expanded range of the distribution of perchlorate on Mars, thus there may be more habitable regions than previously thought. However, there is still a mystery as to where is the water coming from. An atmospheric origin is unlikely, as there are only has 10 precipitable microns of water in a column. Some RSLs have been seen on the tops of peaks of central craters. Dr. Robinson commented that perchlorate is highly oxidizing, and might be thought of as a "poison" to life. Dr. Meyer noted that there are some microbes capable of using perchlorate as an energy source (such as archaebacteria in deep sea "smoker" vents). There are other microbes that can live in highly acidic conditions. Dr. Green added that some microbes on Mars may have evolved to survive even harsher conditions.

Education Cooperative Agreement Notice (CAN) Update

Ms. Kristen Erickson, Director of Science Engagement and Partnerships, briefed the SC on the restructuring of SMD science education. Communications has been consolidated, separate from the education effort, with press and social media/public engagement. NASA has a new policy document associated with missions and communications, and has also updated the policy along six campaign lines—SMD has three of the six campaigns. Education is supported by $42M in FY15. In FY16, there is $32M (House), and $42M (Senate) in the appropriations language. The restructuring of education occurred in response to the removal of funding in FY14. The new education office seeks to take advantage of the strengths of education at NASA, and to engage more effectively and efficiently with learners of all ages. The current goals of education are to enable STEM education and to improve scientific literacy, to advance national educational goals, and to leverage education through partnerships. The new Cooperative Agreement Notice (CAN) was released in early 2015, and after a rigorous peer review process, 27 selections were announced on September 25, 2015. The new education initiative is passionately supported by Dr. Grunsfeld.

About 80 people participated in the peer review process, and 25% of the reviewers were from outside of NASA. NASA also consulted with the Board of Science Education at the National Academies, which provided excellent reviewers who were conversant with policy and implementation. Reviewers also included discipline scientists, education and public outreach professionals, and representative from underserved communities. Of the 27 selectees, 55% are from legacy institutions. Fifteen of the 27 are from the four SMD science disciplines. The selection rate was 37%. Many grantees have ties to NSF and space grants. NASA is in the process of stitching together the various selectees, and expects to have awards by the end of the year. Three selections support the 2017 Solar Eclipse. Ms. Erickson noted that the map of selectees doesn't reflect the "reach" of grants. The big gap in the middle of the nation, indicating lack of proposals, generally, graphically represents the forward work necessary to extend the reach of NASA education efforts.

A face-to-face kickoff meeting of selectees is planned for January 2017, and there will be an annual review of the grants each November. The community should be aware of other opportunities connected with education, such as the Competitive Program for Science Museums, which closes on Dec 7, 2015. The education office is concerned that 2014 was the first year that the nonwhite population was higher in K-12 than the white population. Education will hold a targeted call in 3-5 years to address this major gap in representing the changing demographic. It should be a NASA science concern. The second gap is in formal education; NASA must figure out how to get science content into the formal setting, through recruitment of science teachers. The NASA Education Business Lines, STEM Engagement and Educator Professional Development, have some intersection with SMD. Dr. Peterson asked what the community could do to help. Ms. Erickson felt that the legacy folks would have the toughest transition under the new cooperative agreement; they will need to research what's happening in the learning environment, and must take a different approach to reach the learners. This might be done through clubs, museums, or other forums. Dr. Duncan seconded this sentiment, adding that it would be necessary for community members to volunteer their time, but in doing the assessment, include other professionals in the planning process. It would be advisable to bring a middle school teacher onto the team, and maybe an assessment professional as well, or people familiar with state scholastic standards. Dr. Robinson asked if there were any connectivity with ongoing missions, such as between legacy engineers and scientists and new selectees. Ms. Erickson said there is an effort to identify a need that will lead to an assessment activity. Presumably with new missions, there will be new data, which will hopefully validate the model of the cooperative agreement.

Dr. Luhmann commented that there are things that NASA already does very well, and asked if that figured into decision-making. Ms. Erickson replied that NASA doesn't want to impose so much overhead as to squelch ideas. There is an effort to adopt some science and engineering indicators from NSF, such as the metric that a full quarter of U.S. inhabitants couldn't identify whether the Earth revolved around the Sun; NASA wants to improve that metric, as well as to improve public understanding of the scientific method. Ms. Erickson felt NASA was well represented to work with citizen science. Dr. Avery commented that reaching out to more diverse groups is more successful when the effort is connected with an idea of their experience. There is a growing concern with how the narrowly scientific method is represented. Education seems to be neglecting the inductive end that addresses patterns of data in a noncontrolled laboratory environment. Conveying this part of the experience can generate much more

excitement than some conventional representations of science. Ms. Erickson added that current research clearly supports the importance of personal relationships with the community. This is a tough issue. If NASA can support these relationships, so much the better. Ms. Erickson agreed that the current didactic approach to the scientific method is depressing - the Eureka moments are very valuable, as is the creative aspect of science. There is also the unfortunate depiction of scientists in the media; stereotypes are very damaging. Dr. Duncan observed that many professors act very differently in front of their students (i.e., grayer than life), and was coming close to finishing a draft recommendation to this effect with Dr. Carlé Pieters, who also concurs that it's important to help visualize the scientists in their milieu, and avoid the stodgy classroom persona. He further noted that there is enormous diversity in K-12 teaching methods. There is the Process Oriented Guided Inquiry Learning (POGIL) program, which sets up each student as a scientist, illustrating the fact that there are hundreds of schools that teach science right, while there are thousands that do it wrong.

Astrophysics Division/Subcommittee Update

Dr. Paul Hertz provided a status of the Astrophysics Division (APD), which is awaiting the 2016 appropriation to allow continued work on the James Web Space Telescope (JWST) and the Wide-Field Infrared Survey Telescope (WFIRST), the highest priorities of the last two Decadal Surveys. All operating missions are doing well and will undergo a Senior Review in Spring 2016. The Stratospheric Observatory for Infrared Astronomy (SOFIA) will first be considered in the 2018 Senior Review. Great progress is being made against Decadal Survey recommendations, and NASA's progress and plans are described in the Astrophysics Implementation Plan, NASA Science Plan, and 30 Year Roadmap. A mid-decade review is underway for Astrophysics. APD had a successful balloon campaign in Ft. Sumner in Fall 2015, and two balloons are scheduled for launch in Antarctica in December 2015/January 2016. The first ultralong duration balloon (ULDB), carrying a science payload is due to be launched from New Zealand in Spring 2016. The LISA Pathfinder, an ESA-led technology demonstration mission, will carry a NASA experiment when it launches in December 2015. NASA is also providing a primary spectrometer on the Japan Aerospace Exploration Agency (JAXA) Astro-H mission launching in early 2016, as well as infrared sensors for Euclid, an ESA-led dark energy mission scheduled for 2020. The NASA Explorer mission of opportunity (MoO), Neutron Star Interior Composition Explorer (NICER), will launch to the International Space Station (ISS) in 2016. The Transiting Exoplanet Survey Satellite (TESS) mission is the next exoplanet mission, an Explorer launching in 2017, which will use the transit method on the nearest and brightest stars. TESS just held a critical design review (CDR), with a few open items.

JWST is just ending its manufacturing phase. The sunshield is now in manufacturing, with 2 of its 5 layers finished. Pathfinder optical testing currently is being done to test ground support equipment in the large test chamber at Johnson Space Center. The telescope structure now resides at Goddard Space Flight Center (GSFC), where mirror installation will begin later this year. The flight cryocooler is in testing, and the Integrated Science Instrument Model (ISIM) is in the large thermal vacuum chamber at GSFC for its third and final cryovac test. Watch items include schedule reserve, ¾-inch actuator development, sunshield manufacturing pace, and Optical Test Equipment (OTE) pinned joints. JWST currently has 8.75 months in funded schedule reserve in the critical path, and still has more reserve than anticipated at the re-plan from 2011.

Three Small Explorer (SMEX) missions were selected for Phase A studies: All-Sky Near-Infrared Spectral Survey (SPHEREx; PI J. Bock, Caltech), Polarimeter for Relativistic Astrophysical X-ray Sources (PRAXyS; PI K. Jahoda, GSFC), and Imaging X-ray Polarimetry Explorer (IXPE; PI M. Weisskopf, Marshall Space Flight Center). The SMEXes will be downselected by January 2017. MoO selections include U.S. participation in JAXA's Litebird (PI A. Lee, UC Berkeley) and the Galactic ULDB Stratospheric TeraHertz Observatory (GUSTO; PI C. Walker, U. AZ).

For WFIRST, APD has made huge progress over the last two years, with Science Definition Team (SDT) studies confirming that the WFIRST-AFTA (Astrophysics Focused Telescope Assets) mission exceeds the science goals set in the Decadal Survey. A technology development burndown plan was established two years ago, and since that time the mission has met every milestone, and is on schedule to meet technology readiness level (TRL) requirements set for the end of FY16, for both the coronagraph and widefield detectors. Proposals have been received for the WFIRST Science Investigation Teams, which will be kicked off in early 2016. No decision has been made on when formulation will begin, and planning is being done to the current budget. As JWST approaches launch, there will be opportunities to begin formulation on WFIRST.

APD has made the necessary hard choices, and continues to make every effort to implement the Decadal Survey, while trying to be transparent through many town hall meetings and white papers. Some recommendations will be implemented through partnerships with international space agencies. APD is also increasing funding in the R&A program as per Decadal Survey recommendations, to recover beyond where the program had been in 2005. R&A is being increased by about 22% since the Decadal Survey. APD also provides R&A through guest observer (GO) and postdoctoral programs, and through a mid-TRL technology program. The latest selection rates were 23% in R&A and 28% in the GO program, while achieving a 4-5 month turnaround in selection notices to the community. APD has implemented Decadal Survey missions from Hubble to Chandra to Spitzer/SOFIA to JWST, and would like to make impactful inputs to the next Decadal Survey. Formulation for the next mission after WFIRST could begin as early as 2022/2023, even with a flat budget. To that end, APD is going to undertake four large mission concept studies, each of which will include a science advocacy case, technology readiness assessment, a design reference mission (DRM) with a notional science payload, and cost assessment. The various Astrophysics PAGs are working on identifying the four mission concepts, after which a science and technology definition team (STDT) will be appointed, and a Center study office assigned, to conduct the study. The division is looking for technology gap lists that could be funded as early as 2017, and the STDT could be ready to report to the Decadal Survey in early 2019. Dr. Kirshner asked whether APD was studying an AURA mission concept. Dr. Hertz said that this was one possible version of an ultraviolet-optical-infrared (UVOIR) observer. GSFC is also studying a version called ATLAST. Both precursor studies will be informative to the UVOIR STDT. There has been no endorsement by NASA of either mission. Dr. James Green asked if a starshade were being considered for inclusion on WFIRST. Dr. Hertz replied that APD has done nothing in the planning phase to preclude a starshade, and is looking to define a path to get to TRL-6. A starshade could join WFIRST after the initial launch, which would require a transponder and the right orbit. The L2 orbit is the only one being actively studied at the moment. The community needs to be engaged, and NASA is waiting for the new Decadal Survey to prioritize this.

Dr. Scott Gaudi, Chair of the APS, gave the subcommittee report. APS last met on October 22-23 at GSFC. Some APS members have recently rolled off, and one new member, Dr. Beth Willman, has just been named. Another member will be coming on shortly. Some notable science findings from Hubble's ultraviolet (UV) sensor include an observation that the Markarian quasar had a less-than-expected UV emission, indicating a second black hole around a primary black hole. This was construed as evidence of what is thought to be a common process; i.e. as galaxies merge, black holes probably merge. Hubble also uncovered some infrared background in tidally stripped stars between galaxies. Given this result, it is expected that the more capable JWST should be able to detect the first galaxies in the universe. A precocious black hole in CID-947 was detected, based on mass. SOFIA observed water around the protostar AFGL 2591, marking the first time water has been detected around a protostar. Spitzer also confirmed the existence of the closest rocky exoplanet, HD 219134b, an excellent target for future follow-up by JWST. Other events of note included an Exoplanets 20/20 meeting at the Smithsonian National Air and Space Museum, celebrating the pioneers of the exoplanet field and imagining the next 20 years of exoplanet exploration, and a Jet Propulsion Lab (JPL) Open House featuring an Exoplanet Theme, both in October.

APS heard presentations from the three SMEX missions under study, progress on JWST, and various activities from the Cosmic Origins, Exoplanet, and Physics of the Cosmos Program Analysis Groups (COPAG, ExoPAG, and PhysPAG). There was also a briefing on preparations for Cycle 1 Observations with JWST, which raised a concern in APS that these first proposals must be submitted before the science capabilities of JWST are well understood. The three program analysis groups (PAGs) have been responding to the APD charge on assessing which large missions should be studied going in the next Decadal Survey, with the Far IR Surveyor, a Habitable Exoplanet Imaging Mission, a UVOIR Survey, and an X-ray Surveyor being suggested as possible mission concepts. Responding to this charge involved many meetings and telecons. The most important joint meeting occurred in March 2015, at which time the PAGs agreed to issue a joint executive summary detailing all the agreed-upon recommendations. The PAGs concurred that all four missions should be studied, with additional recommendations that their development must follow the implementation phases of JWST and WFIRST, and that NASA will partner with ESA on its L3 Gravitational Wave Surveyor. There is strong community support for all four missions, and strong support for a line of probe-class missions within the astrophysics mission portfolio. The community will continue this discussion with Dr. Hertz. Dr. Gaudi noted that all final reports for the PAGs are available online.

APS findings and recommendations: APS concurred with PAG conclusions on the four mission concepts. With respect to the AAAC proposal pressure study report, APS noted the suggestion that declining success rates were due to the accumulation of a number of small effects, as well as a decline in GO funding that is causing people to turn to R&A grants. APS also noted that APD selection rates were higher this year, possibly reversing the trend of declining success rates. APS also expressed gratitude to Ms. Erickson, and Drs. Hertz and Grunsfeld for strong advocacy in education. Responding to requests for feedback on the Ad Hoc Big Data Task Force, APS suggested that the force assess both current and future big data needs in each science division, and take advantage of the synergies therein.

Earth Science Division/Subcommittee Update

Dr. Jack Kaye, standing in for Earth Science Division (ESD) Director Dr. Michael Freilich, provided an update on the division. The flight program is healthy, with Suomi National Polar-orbiting Partnership (Suomi NPP), Orbiting Carbon Observatory-2 (OCO-2), and Soil Moisture Active Passive (SMAP) in their primary mission phases. Recent accomplishments include the release of the second Earth Venture-class Announcement of Opportunity (AO). The SMAP radiometer continues to work well, while a radar mishap investigation is ongoing to uncover the root cause of the active radar failure. A Venture Class Launch Services request for proposals (RFP) was released in June of this year, with the goal of procuring launches for small satellites before April 15, 2018. Major activities in progress include the Arctic Boreal Vulnerability Experiment (ABoVE), to study the Arctic ecosystems; this is a ground-based effort that will be followed by an airborne component. Other activities in airborne include IceBridge Arctic and Antarctic, ICESat-2 (Ice, Cloud, and land Elevation Satellite-2) and Suomi NPP. AfriSAR is a collection of radar and lidar sensors being flown over Gabon. A number of Venture-class suborbital investigations, such as Ocean Melts in Greenland (OMG), have all had their kickoff meetings and are under way. Other airborne campaigns include OLYMPEX (Olympic Mountain Experiment), a calibration/validation mission for the Global Precipitation Measurement (GPM), which will fly over Northwest Washington. ESD will fly the airborne KORUS-AQ mission in a collaboration with Korea, which is preparing to launch a geostationary air-quality satellite called GEMS (Geostationary Environmental Monitoring Spectrometer), for the assessment of air quality. The In-Space Validation of Earth Science Technology (InVEST) program is developing instruments such as infrared radiometers and infrared atmospheric sounders for future U-class satellites, advancing TRLs for Earth science measurements. OCO-2's first year of measurements have shown carbon dioxide concentrations over the globe over time. The 2015 Antarctic Ozone hole, the fourth largest in 24 years, was seen to have formed more slowly this year. The Arctic sea ice extent is the fourth lowest on record; the 10 lowest minimums have occurred in the last 11 years.

There has been much interagency interaction between ESD and NOAA, USGS, etc. in response to various shared responsibilities. The media has covered spectacular images of lunar transit provided by the Earth Polychromatic Imaging Camera (EPIC) camera on the Deep Space Climate Observatory (DSCOVR). Dr. Avery asked about the evolution of the U.S. Global Change Research Program (USGCRP) and raised a concern that it is slighting science, NASA being the largest contributor to USGCRP. Dr. Kaye said that at the administrative level, there is more of an emphasis on societal impacts, but ESD is still actively engaged in advancing science. It is still a cooperative and collaborative activity. Asked about the next Decadal Survey, Dr. Kaye noted that co-chairs have been identified, and NASA has released a solicitation for white papers. The statement of task will involve NASA, NOAA and USGS, and will be focused on approaches and balance issues.

Dr. Steve Running, Chair of the Earth Science Subcommittee (ESS), presented a report on ESS's most recent meeting, and reviewed draft findings on modeling. The meeting centered on Earth system modeling, which was philosophically based on the Bretherton Diagram (1980s), at a time when few satellites were providing input. Since 1997, however, Earth science has acquired a variety of satellite platforms, and modeling is becoming a key integrator in bringing the model together. ESS issued a

finding on a new international agreement for full data sharing, recognizing it as a critical first step to integrating new data for inclusion in models.

ESS issued a second finding on the Earth System Modeling Summit 2015, which was recognized as a very positive step. ESS made a recommendation on how NASA can better coordinate with NOAA on weather forecasting models by expanding its contribution to the operational weather prediction services (which are provided by NOAA). ESS also felt that ESD could better coordinate the land modeling activities amongst the various NASA teams, improving science and work efficiency. ESS also found the NASA Earth Exchange (NEX) system to be an innovative idea for unifying datasets and improving modeling efficiency.

ESS recommended that ESD spearhead a new type of global carbon model to exploit multiple global datasets more completely. ESS found that giving program managers (PMs) the option of using the 2-step proposal process in the R&A program, when appropriate, so as to retain optimum flexibility.
ESS recommended that ESD challenge Earth system-modeling teams to clearly prioritize and optimize needs for future increased power, beyond simply requests for increased spatial resolution. ESD has an embarrassment of riches, and should format these platforms to promote more effective use.

Dr. Kirshner noticed that most of the recommendations were procedural, and asked if there were any open scientific questions requiring the kinds of data that are not currently available. Dr. Running thought that the next Decadal Survey would spend some time answering that question, given that there is now an amazing array of live data streams that the community can consider. The constellation is weak in some radar bands (e.g. loss of L-band on SMAP). Dr. Avery commented that today's Bretherton diagram could incorporate much of the good work being done in process models; e.g., the rapid acceleration of ice melting in terms of ocean-ice-atmosphere dynamics, as well as whole ecosystems, taking the model beyond physics and chemistry.

Heliophysics Division/Subcommittee Update

Mr. Steve Clarke reported on recent activities in the Heliophysics Division. In September, the Solar and Heliospheric Observatory (SOHO) discovered its 3000th comet through the Citizen Science program. The Balloon Array for RBSP (Radiation Belt Storm Probes) Relativistic Electron Losses (BARREL) team returned from Sweden after flying several science payloads on balloons, coordinating data with the Van Allen probes, concluding a very successful campaign. In September, the Solar Dynamics Observatory (SDO) observed an Earth eclipse and lunar transit on the same day. The Van Allen probes mission celebrated its third anniversary in 2015. The Magnetospheric Multiscale (MMS) spacecraft achieved the tightest flying formation ever (10-km spacing in a tetrahedral formation). HPD continues to measure the Earth's pulsating aurora with a variety of assets, and published 14 papers in October based on data from the Interstellar Boundary Explorer (IBEX) and Ulysses. The Solar TErrestrial RElations Observatory (STEREO), observing the comet Encke (a "solar windsock"), provided imagery of the comet's ion tail movement, which helped to improve the understanding of solar wind motion.

HPD held a Senior Review in which all missions reviewed were recommended for continued operations. The Ionospheric Connection (ICON), a mission in development, continues to make good progress after

overcoming some issues with its UV detectors. Global-scale Observations of the Limb and Disk (GOLD) passed its CDR and is moving to a launch readiness date of April 2017. Solar Probe Plus's thermal protection system (TPS) completed a fracture toughness test and is making good progress on software builds, while working some issues with a whip antenna, resolving them with a new clamshell design. There had also been a spacecraft structure fabrication delay that is being resolved. The Solar Orbiter Collaboration (SOC) mission had been concerned about an overall schedule delay and hoped to get a briefing from ESA later this week. U.S. instrument development for SOC continues to progress well.

The sounding rocket program continues to make great strides within a busy schedule for 2016. The Black Brant Mark IV rocket had a successful test flight in October, and delivered a test payload built by Langley interns. The HPD 2015 ROSES call has been conducting panels for supporting research, data archiving, and guest investigator (GI) programs, and anticipates making awards in the January or February. OSTP rolled out the National Space Weather Strategy on October 29, detailing strategic goals for improving forecasts for severe space weather events. Several agencies are participating in the effort, enhancing the research to operations pathway and emergency preparedness. There will be a follow-up meeting with agency representatives on the various actions. HPD is developing a technology investment strategy, and has brought on staff to carry it out. HPD also continues to participate in OSTP-led space weather activities, and has established a Heliophysics Working Group with the Indian Space Research Organisation (ISRO). HPD has also held bilateral discussions with ESA and JAXA on the path forward for Solar-C, and is now talking potential collaborations with JAXA and ESA to look at science objectives. Community engagement activities included a visit to the Southwest Research Institute (SWRI) in early October and a meeting of the Committee for Solar and Space Physics. HPD is also scheduled to meet with the University of Michigan and the Smithsonian Astrophysical Observatory.

Dr. Jill Dahlburg, HPS Chair, presented a briefing on the latest Heliophysics Subcommittee (HPS) meeting. The HPS welcomed new HPD Deputy Director, Dr. Margaret Luce, and anticipated that her broad experience with Earth Science missions will immensely benefit heliophysics. HPS held the annual Government Performance and Research Modernization Act (GPRAMA) activity, and voted on the three performance goals detailed under Strategic Objective 1.4 (understanding the Sun and its interactions with Earth and the Solar System, including space weather). The subcommittee voted Green for all three HPD performance goals, and also found that HPD achieved new and generative results. The HPS substantiated its Green rating by elucidating specific advances in heliophysics science, such as advancing understanding of coronal heating, interactions between the Sun and the subsurface of Mercury, interactions of solar wind with the interstellar medium, and making improvements in the ability to detect and predict extreme conditions in space (such as noting that coronal dimming before a coronal mass ejection was correlated with the mass of the ejection).

HPS also heard briefings on the AAAC report as well as the Big Data Task Force. HPS noted that data transparency would be a boon for big data. HPS also suggested an exit interview for ROSES review panel members, and issued some observations about TRL elucidation and the GSFC Community Coordinated Modeling Center (CCMC). HPS embraced the findings of a Geospace Management Operations Working Group (G/MOWG) report to consider Phase C/D proposals, suggested that strategic planning should be done more often than on a decadal basis, and that HPD increase flexibility in the Explorers program by

using non-binding Notice of Intents (NOIs); and suggested that GI funding be provided for MMS. Two other areas of discussion included the impact of risk intolerance on flight projects, and the competitive use of payload adapter fittings. In the latter case, Mr. Clarke offered to have HPD headquarters staff assess the possibility of using such fittings.

Discussion/Wrap-Up

Dr. Peterson suggested issuing a finding on the Mars 2022 orbiter focused on coordination across the directorates without putting undue pressure on PSD. Dr. Luhmann suggested doing further fact-finding rather than criticizing or questioning on the 2022 orbiter. Dr. Peterson deferred the issue until it could be addressed in full committee at a later meeting. He also noted that ESS findings seemed to be largely operational, and asked ESS to consider which findings should directed toward the division.

Dr. Luhmann noted that there is an interesting discussion about sample return going on in MEP at the moment. Dr. Lindberg added that from the PPS perspective, the subcommittee had been talking about requirements about a sample collection and caching system that leaves the technology completely open-ended. The requirements must ensure that samples are pristine, and protected from an Earth environment-dirty rover. Thus far there can be no discussion about breaking the chain with the return vehicle, which is an unbudgeted program.

Dr. Lindberg noted that while PPS has submitted a categorization recommendation for the Mars 2020 mission to be considered as a Category-V restricted sample return, the NAC has tabled the recommendation. PPS will take it up again in December and proceed with a letter to the SC Chair, cc'd to Dr. Green. Dr. Peterson reiterated that the categorization doesn't require a formal endorsement from the NAC, and that the categorization authority rests with the Director of PSD. The NAC isn't clear as to why it needs to get involved.

Dr. Luhmann suggested that the SC endorse NExSS across SMD as an opportunity to adopt a cross-discipline initiative to foster and grow science. Dr. Peterson asked Dr. Luhmann to write up a recommendation for later committee discussion. Dr. Lindberg suggested having a briefing at the February PSS meeting on how planetary protection works, in advance of the June joint PSS/PPS meeting, and Dr. Luhmann concurred. Dr. Peterson adjourned the meeting at 5:43pm.

Appendix A
Attendees

NAC Science Committee Members
Bradley Peterson, ***Chair,* Science Committee**
Susan Avery, Woods Hole Oceanographic Institute
Jill Dahlburg, Naval Research Laboratory
Douglas Duncan, University of Colorado
Scott Gaudi, Ohio State University, Chair, Astrophysics Subcommittee
James Green, University of Colorado
Robert Kirshner, Harvard University
Janet Luhmann, UC Berkeley, Chair, Planetary Science Subcommittee
Robert Lindberg, Jr., University of Virginia, Chair, Planetary Protection Subcommittee
Carlé Pieters, Brown University
Mark Robinson, Arizona State University
Steven Running, University of Montana, Chair, Earth Science Subcommittee
Harlan Spence, University of New Hampshire
David Spergel, Princeton University, *ex officio*
Elaine Denning, **NASA Headquarters, *Executive Secretary***

NASA On-site Attendees
James Green, NASA Headquarters
John Grunsfeld, NASA Headquarters
Paul Hertz, NASA Headquarters
Amy Kaminski, NASA Headquarters
Jack Kaye, NASA Headquarters
Michael Meyer, NASA Headquarters

Non-NASA Headquarters Attendees
Joan Zimmermann, Ingenicomm, Inc.

Teleconference/Webex Attendees
Sara Barber, Congressional Science Fellow
Ralph Beaty, NASA Headquarters
Dominic Benford, NASA Headquarters
Heather Bloemhard, AAS
Stephen Clark, Space Flight Now
Steven Clarke, NASA Headquarters
Dom Conte, Millenium Space
Alberto Conti, Northrop Grumman
Priscilla Cushman, University of Minnesota
Casey Dreier, Planetary Society
Dennis Gallagher, NASA Headquarters
Michael Goodman, NASA Headquarters
Grace Hu, OMB
Hashima Hasan, NASA Headquarters
Charles Holmes, NASA ret.
Louis Kaluzienski, NASA Headquarters
Keith Karuntzos, ULA
Jennifer Kearns, NASA Headquarters

Irene Klotz, Reuters
Dan Leone, Space News
William Lightsey, NASA Headquarters
James Lochner, USRA
Margaret Luce, NASA Headquarters
Robert Meurer, Orbital ATK
Mike Mineiro, Congressional staff
Jon Morse, Boldly Go Institute
Doreen Neil, NASA Headquarters
Jeffrey Newmark, NASA Headquarters
Mario Perez, NASA Headquarters
Raul Pineiro, Harris Corp
Patricia Rausch, NASA Headquarters
Jennifer Read, NASA Headquarters
Kurt Retherford, SWRI
Richard Rogers, Stellar Solutions
Jennifer Rumburg, NASA Headquarters
John Rummel, Eastern Carolina University
Martin Ruzek, USRA
Rita Sambruna, NASA Headquarters
Theresa Schwerin, Schwerin Strategies
Kartik Sheth, NASA Headquarters
Eric Smith, NASA Headquarters
Marcia Smith, Space Policy Online
William Smith, Science Works DC
James Smoot, NASA Headquarters
Renee Weber, NASA Headquarters
Dan Woods, NASA Headquarters

Appendix B
NAC Science Committee Membership

Dr. Bradley M. Peterson (Chair)
Ohio State University

Dr. Susan Avery
Woods Hole Oceanographic Institution

Dr. Jill Dahlburg
Naval Research Laboratory

Dr. Douglas Duncan
University of Colorado

Dr. B. Scott Gaudi
The Ohio State University

Dr. James Green
University of Colorado

Dr. Robert Kirshner
Harvard University

Dr. Robert Lindberg
University of Virginia

Dr. Janet Luhmann
University of California, Berkeley

Dr. Carlé Pieters
Brown University

Dr. Mark S. Robinson
Arizona State University

Dr. Steve Running
University of Montana

Dr. Harlan Spence
University of New Hampshire

Dr. David Spergel (ex officio)
Princeton University

Ms. Elaine Denning (Executive Secretary)
NASA Headquarters

Appendix C
Presentations

1. Big Data Task Force Update; *Elaine Denning*
2. AAAC Proposal Pressures Study Group; *Priscilla Cushman*
3. Planetary Protection Subcommittee Report; *Robert Lindberg*
4. Citizen Science; *Amy Kaminski*
5. Planetary Science Division Update/Planetary Science Subcommittee Report; *James Green, Janet Luhmann*
6. Mars Liquid Water; *Michael Meyer*
7. Education Update - Cooperative Agreement Notice (CAN) Results; *Kristen Erickson*
8. Astrophysics Division Update/Astrophysics Subcommittee Report; *Paul Hertz, Scott Gaudi*
9. Earth Science Division Update/Earth Science Subcommittee Report; *Jack Kaye, Steve Running*
10. Heliophysics Division Update/Heliophysics Subcommittee Report; *Steve Clarke, Jill Dahlburg*

Appendix D
Agenda

Dial-In (audio) & WebEx (view presentations online) information is located on page 2.

NASA Advisory Council
Science Committee

November 2, 2015
Telecon Meeting
(Eastern Standard Time)

Agenda

10:00 – 10:10	Opening Remarks / Introduction of Members	Ms. Elaine Denning Dr. Bradley Peterson
10:10 – 10:30	Big Data Task Force Update	Ms. Elaine Denning
10:30 – 11:00	Discussion with SMD Associate Administrator	Dr. John M. Grunsfeld
11:00 – 11:35	AAAC Proposal Pressures Study Group	Dr. Priscilla Cushman
11:35 – 11:50	Planetary Protection Subcommittee Report	Dr. Robert Lindberg
11:50 – 12:10	Citizen Science	Dr. Amy Kaminski
12:10 – 12:15	Public Comment	
12:15 – 12:45	Discussion	
12:45 – 1:30	*LUNCH*	
1:30 – 2:00	PSD Division Update Planetary Science Subcommittee Report	Dr. James Green Dr. Janet Luhmann
2:00 – 2:30	Mars Liquid Water	Dr. Michael Meyer
2:30 – 3:15	Education Update – CAN Results	Ms. Kristen Erickson
3:15 – 3:25	*BREAK*	
3:25 – 4:00	APD Division Update Astrophysics Subcommittee Report	Dr. Paul Hertz Dr. Scott Gaudi

Dial-In (audio) & WebEx (view presentations online) information is located on page 2.

4:00 – 4:30	ESD Division Update Earth Science Subcommittee Report	Dr. Jack Kaye Dr. Steve Running
4:30 – 5:00	HPD Division Update Heliophysics Subcommittee Report	Mr. Steve Clarke Dr. Jill Dahlburg
5:00 – 5:30	Discussion, Findings and Recommendations	
5:30	*ADJOURN*	

Dial-In and WebEx Information

For entire meeting November 2, 2015

Dial-In (audio): Dial the USA toll-free conference call number 1-800-988-9663 or toll number 1-517-308-9483 and then enter the numeric participant passcode: 8015. You must use a touch-tone phone to participate in this meeting.

WebEx (view presentations online): The web link is https://nasa.webex.com, the meeting number is 995 409 586, and the password is Science@Nov2.

" All times are Eastern Standard Time "