

## NASA ADVISORY COUNCIL

### HELIOPHYSICS ADVISORY COMMITTEE

December 18-20, 2018

NASA Headquarters  
Washington, D.C.

#### MEETING MINUTES



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Michael Liemohn, Chair



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Janet Kozyra, Designated Federal Official

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Tuesday, December 18

Welcome

Dr. Janet Kozyra, Designated Federal Officer (DFO) for NASA's Heliophysics Advisory Committee (HPAC), opened the meeting.

Overview of Agenda

Dr. Michael Liemohn, HPAC Chair, welcomed the members and reviewed the meeting agenda.

Heliophysics Division News, Updates, and New Initiatives

Dr. Nicola Fox, Heliophysics Division (HPD) Director, welcomed the HPAC members and asked for their input throughout the meeting. This is the dawn of a new era for heliophysics, with significant collaborations in strategically advancing the understanding of solar and space physics. HPD is also working on space weather initiatives, engaging with the public, and developing the next generation of heliophysicists. Dr. Fox thanked Ms. Peg Luce for her work as Acting Division Director; Ms. Luce will stay on as Deputy Director. There have been some staff changes within HPD, which Dr. Fox described.

New heliophysics launches include the Global-Scale Observations of the Limb and Disk (GOLD) mission and the Parker Solar Probe (PSP). The Ionospheric Connection Explorer (ICON) and the Space Environment Testbed (SET) were both scheduled to launch early in 2019, while the European Space Agency's (ESA's) Solar Orbiter Collaboration (SOC) is on track for an early 2020 launch. Both Voyagers have left the heliopause, Voyager 2 just recently. The Deep Space Network (DSN) was very helpful in tracking them. Voyager 2 has a working plasma instrument that allowed NASA to watch the solar wind dwindle away outside the heliosphere.

HPD is gearing up for the mid-term decadal assessment. The most recent Decadal Survey (DS) for heliophysics was issued in 2013, so the mid-term assessment is a bit overdue. However, the committee has been appointed and will meet early in 2019 to assess how the DS has been implemented and how HPD can optimize science for the remainder of the 10 year period. For the next DS, HPD is exploring how the community can participate. NASA must invest in technology to enable missions like PSP, so it is important to determine a direction. To that end, there will be some planning workshops on new technologies in order to get community input. HPD will look at a 30-year timeframe, seek white papers, and use lessons learned from the Planetary Science Division (PSD). However, the midterm should be underway before these activities occur.

The 2013 DS recommended a budget above what HPD has received. While funding levels have precluded some of the recommended missions, HPD is largely aligned with the DS. Dr. Fox showed the President's Budget Request (PBR) and the level of Fiscal Year 2018 (FY18) support. The Diversify, Realize, Integrate, Venture, Educate (DRIVE) Program is fully funded, and the Division has accelerated and expanded the Explorer program, with a Small Explorer (SMEX) call issued and an omnibus Mission of Opportunity (MoO) call for two missions and technology development. The Solar Terrestrial Probes (STP) line is now a moderate, Principal Investigator (PI) -led program. GOLD was launched as part of the STP Program.

PSP was launched in August, flying into the outermost part of the sun's corona to improve our knowledge of how a star works and to contribute to our knowledge of space weather. Data began coming in on November 16. The mission is already exceeding expectations, and Popular Science magazine called it the single greatest innovation of 2018.

ICON will launch out of Cape Canaveral in early 2019, to study the conjunction of terrestrial and space weather. SET-1 will launch on an Air Force Research Laboratory (AFRL) Demonstration and Science Experiments (DSX) spacecraft no sooner than April, and will look at the effects of space weather on technology. ESA's SOC, which will study the inner heliosphere, is scheduled to launch in February, 2020. The mission will carry some U.S. instruments, and plans are to coordinate certain measurements with PSP. It is currently in thermal vacuum testing.

The Two Wide-Angle Imaging Neutral-Atom Spectrometers (TWINS) mission operations have ended. The Interface Region Imaging Spectrograph (IRIS) had an issue with its star tracker, which had been diagnosed; the team was working on a return to fine-scale pointing mode.

The FY19 PBR had a healthy \$175 million budget line for the DRIVE program. This encompasses the Heliophysics Technology and Development for Science (HTIDES) and Guest Investigator programs, along with supporting research, Grand Challenge research, the Early Career (EC) Investigator Program (ECIP), and Living with a Star (LWS) science. HPD launched 22 NASA and 4 reimbursable suborbital missions in 2018, many of which were sounding rockets. The program also selected 13 sounding rockets and 2 balloons. The year-long Grand Challenge Initiative just started, with U.S. PIs participating in seven of the nine missions. Grand Challenge is an international collaboration. Dr. Fox next reviewed CubeSat highlights, including space weather CubeSats and the Compact Radiation Belt Explorer (CeREs). HPD selected five CubeSats in 2018 and had several balloon launches from Norway. HPD is also investing in future heliophysics leaders, an example being ECIP, which is part of DRIVE. The Division also offers fellowships, the Heliophysics Summer School, RockSat-X sounding rocket, and the Frontier Development Lab.

Dr. Fox noted missions in formulation and the overall program through 2028. Upcoming opportunities include SMEXes, MoOs, the Interstellar Mapping and Acceleration Probe (IMAP), and a Medium-Class Explorer (MIDEX). The 2016 MoOs were in the midst of the selection process, and there had been five SMEX selections. IMAP was the highest recommendation from the 2013 DS, though it is now smaller than described in the DS. This mission will go to an L1 orbit and study the outer boundary of the heliosphere. There are MoOs related to this mission, as well as opportunities for a follow-on.

Proposals in response to the Stand Alone Missions of Opportunity Notice (SALMON) Announcement of Opportunity (AO) were received in November, and Step-1 proposals responding to the Research Opportunities in Space and Earth Science (ROSES) Science Centers call would be due in February. While Dr. Fox could not say much about the MoO responses, she did note that HPD was pleased. The Science Centers deadlines shifted due to the level of planning and effort required on the part of proposers. An announcement had just gone out for MIDEX 19, with a draft AO release planned for early 2019 and a final AO in the summer. This call would be for a PI-managed mission having a cost cap of \$250 million and a launch readiness date (LRD) no later than 2026.

All elements of ROSES 17 had been selected and awarded. For ROSES 18, supporting research and ECIP were pending, while there were still open solicitations for LWS, DRIVE science centers, and the second of two ROSES calls for Space Weather Operations to Research (O2R). Ms. Luce added that HPD's R&A funding had increased from \$77 million in FY17 to \$112 million in FY18. HPD has been receiving additional funds for targeted space weather research, which had been in the LWS budget line but now has its own line.

Dr. James Klimchuk noted that the community is very interested in having a detailed breakdown of the R&A budget so that they can know what is in the core grants program. Ms. Luce said that funding for the core programs has doubled, from \$60 million to \$120 million. Success rates have gone up as well. Responding to concerns expressed at HPAC's April meeting, HPD put more money into sounding

rockets. Not all of these increases can be relied upon going forward, however. Dr. Klimchuk advised more broadly informing the community about the increases. He added that the bookkeeping details have been hard to pin down, leading to frustration. Ms. Luce agreed, noting that the ups, downs, and trades are not always an easy story to tell. The increases to core programs are sustained, with bumps in space weather, CubeSat, and other budgets. The DRIVE increases are sustainable. In addition, selection rates are up to 30 percent.

Dr. Liemohn suggested that HPAC consider a finding about publicizing the DRIVE funding increase and the changes in success rates. Dr. Larisa Goncharenko added that this would help bring in the future workforce and those considering space physics as a viable career. Dr. Vassilis Angelopoulos said that the community is used to a low success rate. It would be simple to reinforce the change with a table HPAC can point to and put in the public record. Dr. Michael New added that success rates for all SMD programs are posted in the Service and Advice for Research and Analyses (SARA) website, as well. Ms. Luce said that HPD had not awarded all the programs for that year. The HTIDES success rate was 38 percent for the most recent awards. The open Guest Investigator program was 26 percent, the Magnetospheric Multiscale (MMS) Guest Investigator was 34 percent, and a recent space weather call was 47 percent. She agreed that HPD needs to package this better and noted that Dr. Fox planned to hire an R&A lead.

Dr. Daniel Moses described the ROSES 18 HTIDES restructuring. About 40 proposals were in the Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) Program and Instrument Technology Development (ITD), with selection rates in the 30-40 percent range. However, CubeSats underperformed in this situation. In 2019, there will be a dedicated \$5 million budget for CubeSats. He described the concept study phase selections. HPD is trying to adjust the numbers and expectations together. There is currently no cap on the R&T flight program. The goal has been to give the PIs the greatest flexibility in what they propose, minimizing the risks and paperwork while seeking the best science.

NASA now has an expanded role in the Space Weather Science Applications Program (SWSAP), consistent with the DS and National Space Weather Strategy. The Office of Science and Technology Policy (OSTP) Space Weather Group includes all of the interested agencies, and the National Space Weather Strategy developed an action plan with community input. The plan targeted specific agencies, and HPD received a funding bump as a result, rather than an unfunded mandate. A lot of the added funding is under DRIVE, and some is under the O2R call.

Dr. James Spann explained that the Space Weather Action Plan (SWAP) currently has six goals and a huge number of actions within those goals. For the sake of expediency, the plan was simplified to address protection, planning, and communicating space weather information. The Department of Homeland Security (DHS) and Department of Defense (DOD) would be involved in protection. Planning would include DHS. NASA, the National Science Foundation (NSF), and the National Oceanic and Atmospheric Administration (NOAA) play a role in communicating and disseminating information. The revision of the plan is ongoing, the commercial sector is becoming involved, and there is some activity in Congress.

Dr. Tomoko Matsuo asked for more detail regarding commercial involvement. Dr. Spann said that there are several areas of focus, like Geomagnetically Induced Currents (GICs) and space assets, in which industry has both an interest and a role. Dr. Matsuo asked if there had been any discussions of O2R, compared to R2O. Dr. Fox explained that NASA used to focus on the latter and push out its models, but is now working with users to learn what they care about most, like GICs and what they do to the power grid. This effort began with ROSES 17 to identify areas in which NASA can do good science with real world applications. In Space Weather O2R (SWO2R), the roles have been better defined. For example, DOD has a more focused role, to determine what needs to be done to protect, be resilient, and recover. Dr. Spann added that DOD plays a huge role in all of this and is becoming more visible. The new SWAP has a better understanding of the leaders and supporting roles in the various areas. NASA will help provide

DOD with undergirding science and preliminary observations that can help meet the mission goals. It will be a more effective framework. Dr. Fox said that HPD had a good session on space weather at the American Geophysical Union (AGU) meeting. Space weather is currently being done via NASA observatories for the most part, and there is a need to identify the measurements that make this more actionable, whether with new assets or the current suite of missions. Those could include models.

ROSES 17 and 18 included calls related to SWO2R; Dr. Fox reviewed the focus areas. In addition, the Small Business Innovation Research (SBIR) Program selected two space weather proposals for 2018 and will continue with space weather in 2019. There are also investments being made to improve infrastructure, and the Next Steps Benchmarking Activity is about to begin. The latter encompasses how to set levels within benchmarking, and the effort will seek community input. There will be a community steering group chaired by OSTP, with a mid-year workshop.

Dr. Spann noted the challenge of transitioning and being responsive to users. As part of that, he has set up a study team to determine how best NASA can transition its research to users. There will also be an effort to study implementation of an Agency-level strategy. Many NASA activities have transitioned to the user community, and there are lessons to be learned. NASA will have the Community Coordinated Modeling Center (CCMC) bring in its capabilities, as well. Dr. Fox emphasized that this effort is focused on science applications. HPD does not touch its core science, under LWS. This message needs to get out to the community. The research budget is intact and remains important. Dr. Goncharenko described the issue of people within the community disconnecting from CCMC. Dr. Liemohn responded by suggesting that there be a finding on existing metrics.

Dr. Liemohn also noted that he heard that another advisory committee completed the annual Government Performance and Results Act (GPRA) Modernization Act (GPRAMA) review much more quickly than HPAC did. He wondered about the appropriate level of effort. Ms. Luce said that what HPAC did was appropriate, but she would check further. Dr. New added that it was probably Earth Science that moved quickly; they do a lot of advance reading. Dr. Liemohn pointed out that HPAC used to do even more work than they did this time. Ms. Luce explained that there was less input requested for the recent review. HPD appreciates the effort.

Dr. Fox next reviewed partnerships within NASA and elsewhere in the Federal government, and noted the many international collaborations. Dr. Matsuo explained that ESA has different sections, and asked if HPD had reached out in regard to some of the space science work that overlaps the Division's efforts. Dr. Fox replied there are science and operations sections; NASA and ESA have met about the science, while it is more appropriate for NOAA to interface on operations. SWARM meetings include a fair number of NASA scientists.

She would like community input on some new initiatives. The new "Whole Helio" campaign enables innovative coordination. It would involve benchmarking for integrated knowledge and assessment of gaps throughout the system, and would be truly interdisciplinary. A Whole Helio Month is planned across agencies and disciplines, to include modeling. There is some overlap with astrophysics. The test run will be over the summer, centered on the solar minimum, with an interdisciplinary scientist program to drive connected research and discovery. There will be follow-up workshops and a regular workshop schedule.

SMD has embraced the HPD Rideshare program, which is now policy. Now the Division would like to see how it can expand the program. One of the issues is how to solicit payloads on a short timeframe, given that they should not sit on a shelf indefinitely waiting for the right ride to come along. Finally, HPD would like to be able to use the planned Lunar Gateway as a platform for geospatial studies, including space weather. The Gateway could also provide options for the staging and deployment of multi-spacecraft missions.

Dr. Fox summarized by stating that HPD wants to know about community research, publications, talks, and other news. She provided a link for submissions: [bit.ly/SubmitHelioScience](http://bit.ly/SubmitHelioScience). This is supposed to be user-friendly, and HPD wants to know if it is not. She would be available for further discussion.

#### NASA-NSF Ideas Lab on Astrobiology

Dr. Mary Voytek, Senior Scientist for Astrobiology, explained that the Ideas Lab is an experimental mechanism for interdisciplinary research to encourage riskier, high-reward proposals. It also advances emerging fields. NSF initiated the first Ideas Lab in 2007. In seeking data against a control, NSF found that ambitious proposals were identified as too risky and reviewers were risk-averse. NASA, which subsequently joined the effort, offers Ideas Lab as a Grand Challenge topic, for which the outputs are ambitious and innovative.

It begins with mentors who focus on the topic. Dr. Voytek gave the example of there being two camps of astrobiologists in determining origins. The Ideas Lab decided to move to the intersection area and skip the origins debate. There were also professional facilitators present to help discussion flow. The Lab occurs for a week and takes place in a secluded location. NSF and NASA each put up \$4 million, and there is a 50 percent chance of selection. The application for participants is short, asking about expertise and experience, and it has a teamwork and communication section. Participants need to be comfortable sharing ideas and listening. The goal is to bring together people who can and will collaborate. The applicants had a range of experience, from early career through senior people. NSF and NASA then jointly selected 29 participants. Ideas Lab had them interact, clarify, ideate, and develop ideas that would lead to full proposals in 2 months, with the theme being the Origin of Translation. The group selected 11 ideas to move further, in what amounted to real-time peer review. Five participants were then asked for full proposals, two of which were funded by NSF and three by NASA.

Dr. Cora Randall asked whether those who finally proposed had to be from the original workshop. She also wanted a description of a typical day during the workshop. Dr. Voytek replied that 26 of the 29 people were involved in funded activities. A proposal requirement was to use the people who were there unless there was a unique skill required; postdoc support was also allowed. Days began with an activity set up by facilitators to develop trust and understanding. Then small groups discussed a question or brainstormed. There was a lot of space, and there were game rooms on site. People would write, go to the bar, etc. Some participants were overwhelmed. A number of smaller proposals came out of the effort, as well. Most of the resulting teams are pretty tight. The Ideas Lab is trying to turn this into an educational opportunity.

Dr. Paul Cassak asked about transferability beyond this program. Dr. Voytek explained that astrobiology had used the facilitators previously. It is worth the expense, as there is a need to have someone who can understand enough to move things forward but is not invested in the specific science. Dr. New added that it was crucial to have the organizational psychologist for the Ideas Lab. Dr. Liemohn observed that selection to be in the group is the point at which someone becomes likely to get funding, which is interesting. Dr. Voytek noted that another issue is their willingness to spend a week on this effort. These people were all known to the participating agencies, but they had never worked together. Those with the best ideas rose to the top.

Dr. Matsuo asked how NASA came to collaborate with NSF on this. Dr. Voytek explained that the appeal to NASA was that NSF had done this before and so had both the background and logistics experience. The solicitations were separate. NASA hopes to do this again, possibly without partnering. In answer to a question about AI, Dr. Voytek noted that astrobiology generates a lot of data, so AI is very common. There were at least two proposals with an AI component. Dr. Goncharenko observed that 26 out of 29 is a good sign that the selection process succeeded. Often, she sees people talking at the same time and not

hearing each other. She asked if any people like that made it through the selection process. Dr. Voytek replied that there are people who like to talk and do not listen, and the selection process was meant to screen them out. Applicants had to give examples of collaboration where they changed their own line of inquiry due to what they heard. At least one third of the participants were energized. A few talked and did not listen, however, so the facilitators had people put ideas up on Post-its, or talk to one person at a time. They did a lot to get people into the right style of communication. This format will not work for people who do not listen, and the people Dr. Goncharenko described would not be selected.

#### SMD Research and Analysis Program Topics (including PI Diversity and Innovation)

Dr. New, SMD Deputy Associate Administrator for Research, said that SMD has been trying to determine whether there are large-scale gender biases in the R&A programs. To do so, SMD used a system that infers gender, and chose to have an analysis at a 95 percent confidence level for male, female, and unknown. This system only analyzed first names, not gender identity or anything else. The effort looked at 4,000 proposals, excluding the Astrophysics Division (APD) Guest Observer programs. The overall selection rate was 24.1 percent, the inferred female proposals were 20 percent, and female proposers awarded were 21.6 percent. SMD cannot look at race, age, or other demographic data. The Office of the Chief Scientist (OCS) has permission from the Office of Management and Budget (OMB) to ask people to self-identify on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). The PI demographics do not match the PhD population demographics – 20 percent of PIs are female while up to 40 percent of PhD holders in relevant fields are female.

Dr. Goncharenko said that she recently saw a paper discussing a significant rise in the number of people in the research community who are involved in only supporting research. They are not PIs, and it seems like a large percentage are females. Dr. New said that something like that is going on because the demographics of the field are different from the demographics of the proposers. Dr. Matsuo asked how the gender breakdown tracks by proposal cost caps. Dr. New said he would examine it.

The analysis looked at the PI-led mission programs and found that across five mission lines between 2001 and 2018, less than 10 percent of the PIs were female, and 88 percent of those women applied to PSD. That led to questions about what PSD does differently. There are two suggestions. First is recruitment by a high-profile woman in the planetary field, Dr. Maria Zuber. However, APD should have had a similar effect with Dr. Fiona Harrison. Another difference is that PSD is the only division for which NASA is the only funder. SMD is trying to sort this out. There are too few data to compute success rates. Dr. Randall asked if it might reflect career level. Dr. New said that that analysis has not been done, though PIs tend to be about 20 years post-PhD. Nor has SMD looked at co-Is.

SMD also looked at impact versus risk and had previously asked the advisory committees to discuss high-risk/high-reward research. Peer reviewers were also asked to rate it. The analysis defined impact as the effect on current thinking methods or practice, whether high, medium, or low; risk was defined by extent, whether it be great, some, or little or none. This is not about implementation risk, but rather about the intellectual risk. Ten percent of proposals were judged to be high-impact, high risk. Twenty-four percent of all proposals were selected, but 35 percent of the high-impact/high-reward proposals were chosen. The merit score was driven by the perceived impact regardless of the risk. The panel process seems agnostic to risk level if there is high to moderate impact. The average proposal was medium risk/impact, which is what one would expect.

SMD has added language in ROSES and AOs stating that NASA wants diverse teams. Also included is information on how to report discrimination and harassment. SMD created a new position, a Diversity and Inclusion Lead, to determine the best ways to report harassment and discrimination. All review panels start with a discussion of implicit bias. Many see a short video. Dr. George Ho observed that this is all nice, but no one pays attention until there are penalties. Dr. New explained that it is illegal to discriminate

against discriminators. SMD is trying to figure out a legal way to implement excellent and innovative teams, which require diverse opinions and perspectives, where everyone feels safe. People tend to go to people they know, who tend to look like themselves.

NSF changed its grant terms and conditions regarding the code of conduct. NSF's grants terms and conditions are not part of the code of Federal regulation. NASA is now outside of the code as well, and is therefore crafting something similar to NSF's stance, in which the Agency can insist on the replacement of grantees being investigated for harassment. NASA had a requirement that grantees report their harassment issues, but it was not always signed by the responsible party. The terms and conditions have to do with academic suspension for harassment or discrimination. This cannot be an allegation.

APD is piloting a code of conduct to reduce bullying at panels. Not all reviewers are happy about this, but most are. SMD is also investigating barriers to diversity and inclusion, and tracking the paths PIs took through proposal calls. Another effort evaluated the effectiveness of the NASA Earth and Space Science Fellowship (NESSF) program. Students who apply are more likely to finish their PhDs, and recipients are even more likely to finish. Dr. Randall said that she would have interpreted that as likelihood to succeed in the first place. Dr. New said that there is a correlation, not causation. Dr. Angelopoulos asked about NESSF recipients becoming PIs. Dr. New replied that SMD has not followed them long enough to know.

SMD recently held a PI diversity workshop that was extremely emotional and not quite clear on the purpose. There was a lot of frustration that NASA had not yet gotten rid of some of the barriers. Dr. Matsuo said it was positive that that came out, and it is good that NASA is paying attention to it. Dr. New said that SMD learned that there is a surprising level of lack of knowledge in the community about NASA's processes, from publicizing calls through selecting missions. For example, some participants did not know what Technology Readiness Levels (TRLs) are. Dr. Lynn Kistler said that that speaks to the need for PIs to be experienced in flight projects. Dr. New said that a number of PIs have not had much flight experience. PIs need skills related to management of a multi-disciplinary team. Dr. Angelopoulos related his early-career experience of being mentored by PIs. Institutions can consider having explicit mentoring. It might also be made part of NASA calls. Dr. New agreed. SMD is exploring how to require or evaluate that in the framework of institutional support for PIs.

Dr. Randall said that the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado has been very concerned about bringing people up through the ranks. To the extent NASA can help figure this out, it would be very helpful. Dr. New explained that at the workshop, SMD learned that there are gateway institutions where one can easily learn and get involved with missions, and there are also institutions with no real direct connections to NASA, where people have trouble with the process.

Mr. Darko Filipi asked if there might be something similar to the small business mentoring program. Dr. New said that SMD has thought about that and a PI incubator. One idea is to have "PI 101" presentations before the major meetings like AGU, etc., for which a sequel would be the PI incubator, similar to a business incubator. These are programs to which an individual applies with a concept, and is then given resources to help start and grow their activity. SMD wants to have something like this for potential PIs, though there are limits to what can be done. However, SMD can provide resources. In addition, soft skills need to be addressed – how to do an elevator pitch, talk to industry, etc. SMD is still determining how NASA will do this.

NASA categorizes mission risk by an A-D rating. A is highest risk, involving potential loss of life. D is the least risk. For smallish missions, even Class D is too tough. SMD has developed streamlined Class D for missions under \$150M lifecycle costs. Part of that will involve evaluation of PI expertise rather than experience, with the team evaluated as a group rather than individually. The streamlined Class D would cover CubeSats and some SMEXes, and make it easier for new people to come in and lead missions.

Dr. Randall said that it would be helpful for the incubator to offer a version focused on graduate students, which would have a better gender ratio. Dr. New thought that was a good idea. Dr. Matsuo asked about the gender ratio among those proposing CubeSats. Dr. New replied that it depends on the field. APD put out a smallsat concept call, and PSD did a small mission concept call. PSD had 11 percent women proposing and 16 percent selected, with an average 18 years experience. APD had a median of 30 years post-PhD. He noted that the Office of Small Business Programs has gone to some Historically Black Colleges and Universities (HBCUs), and SMD will do something similar.

Dr. Goncharenko explained that at MIT, the principal research scientists are ensconced until they leave the university. The system would preclude her from being a PI, and she might not ever be one due to this structure. She wondered how many people face a similar system. Dr. New explained that NASA has a loophole for this scenario, in which an investigator can submit a ROSES proposal designating the principal research scientist as a co-I. There are situations like this in which NASA has no control.

Dr. Ho said that at the workshop, he learned that the issue is often how a person even gets on the team. Dr. New said that SMD is discussing this. In PSD, there are rules of the road for the roles. NASA might decide to address that kind of thing. Some barriers have to do with how PIs put together their teams, and NASA's relative leverage or lack thereof. There was discussion of mentoring and training, not all of which the Agency can do. There is a problem with people not having much guidance once they have been selected for the first time. He will be talking to APD about having a balloon program information exchange, and may want to do something similar for new grant PIs. There will be a new page of PI resources on the NASA website, with links and explanation of why each link is there. Dr. Fox asked HPAC for further input on the PI incubator idea.

#### Data Management and Computing

##### (SMD-Wide Strategic Planning; HPD High-End Computing Issues: Open Source/Open Science)

Dr. Jeffrey Hayes explained that HPD is doing well with its High-End Computing (HEC) consumption. In FY17, HPD had 44 million Standard Billing Units (SBUs), 13 percent of SMD capacity. This dropped to 41.3 million in FY18, when the Earth Science Division (ESD) gave HPD 3 million SBUs. The FY19 allocation will be 71 million. The average size of the jobs is about the same, as is the requested number of SBUs. Unused SBUs accounted for 52 percent of the total in FY17, but in FY18, that was down to 27 percent. In FY19, Dr. Hayes is taking a new approach: for those who have used their entire allocations in the past, he will provide most of it up front. For those who historically used less than half, he will give less than half right away and they will have to ask for more if they need it. He is managing it more tightly and actively, which was an HPAC finding. All of the ROSES elements now require proposers to state whether they will need HEC. This enables better planning. Missions across SMD need HEC, as well. HPD has purchased more CPUs, but that is not sustainable. Any official policy would have to come from SMD, which has been considered. He will continue updating HPAC on this.

Dr. Hayes also works on SMD's Strategic Initiative for Scientific Data and Computing. SMD data curation is out of date, which is untenable. There is a 5-year plan to improve discovery and leveraging of data, identify large users, and encourage robust theories. SMD divisions will soon generate more than 100 petabytes annually, so they are looking at data systems. SMD needs a strategy that also includes commercial providers, like the cloud – large, scalable, accessible, and in situ. The virtual observatories experiment did not work well; they were brilliant for the 1990s but not 20 years later. The Initiative grew out of the Big Data Task Force (BDTF). A small team is developing a strategic data plan for HEC, and the first principle is to enable free and open access to data. There are a lot of things to take into account. He needs a way for those who are not subject experts to answer questions without having to become domain experts. Another aspect is the accessibility of the code and the models. Code providers still

provide the updates. Dr. Matsuo expressed concern, as she works with people who actively contribute and feel ownership. It is tricky. Dr. Hayes agreed. Partly, it is social – this is hard because people are invested. If NASA is going to do this right, it should be holistic and deal with everything having to do with data.

Dr. Klimchuk noted that there are advantages and concerns in making code available to the field, but people are now just looking at the results of the code, and not the instrument or the science. He asked how the field can avoid these pitfalls. Dr. Hayes said it is an issue for the community. HPD has a flat budget for this that will not grow. Dr. Cassak said that another pitfall is the incorrect use of data, including lack of attribution. Dr. Hayes observed that those in the field are bombarded by so much information that they do not know what is right. No one wants “fake science,” and yet there are not enough referees to screen it. The answer will be nuanced, and the science community has to buy in from the ground up.

There have been two meetings, and replies to the RFIs, which SMD will evaluate. The Directorate will brief OMB, OSTP, and Congress on the promise offered by adopting current techniques. ROSES is soliciting, via pilot programs, proposals to implement aspects of the strategic data management plan. The National Academy of Sciences (NAS) found it was almost impossible for a civil servant to put a free domain license on software. He remains optimistic that the HEC scientists will change the field fundamentally.

Dr. Hayes showed a list of working group members, then presented Hubble Space Telescope (HST) publication data. Seventy percent of the refereed papers are coming from the archives, which illustrates the importance of properly archived data. Dr. Matsuo said that while the move to open source models is encouraging, there is concern that it is not well written, useful, or documented. Users of open source models worry that it might be creating “garbage.” That has happened in machine learning. Dr. Hayes replied that the plan is for something like a peer review for code. The Agency is struggling with how to incentivize an academic institution to give a person credit or tenure for writing useful code. If someone made their name on it and it is the gold standard, it matters. Dr. William Matthews, participating by phone, noted that there is a loss of attribution, which affects documentation. Dr. Hayes suggested that this could be a finding.

Dr. Randall asked where NASA would begin with sponsoring open source code development. Dr. Hayes said that that has not yet been determined. The government has to archive everything. The Space Physics Data Facility (SPDF) has problems, but the work has to be archived even though it is not scaled for that. If he put everything from heliophysics on the cloud, the question arises as to who owns it. As the query and code are different, one could argue that heliophysics data has commercial value. So what if everyone can access it globally? That is a different issue. The discussion of how to interact with and curate data over the long term is in the early stages. The data are permanent.

Dr. Matsuo advised that HPAC discuss this. Dr. Hayes noted that Dr. Kozyra is author of a case study for putting some data in the cloud, on Amazon, as a pilot. ESD has already tested it. Dr. Matthews said that in regard to some data management requirements, the Department of Energy (DOE) has similar issues. It seems there is a need for an archive with all the data that went into the analysis, but that is impossible for some situations. However, the regulations make it sound like the institution needs its own data center. People might be getting carried away with the requirements. It might be counterproductive to spend time on archiving intractable amounts of data. Dr. Hayes said that he would not argue that point, but NASA is facing the outcome of Federally funded research that must be captured for the future. Dr. Matthews said there should not be a need to archive the data if the users can explain what they used and how they got it.

Dr. Jared Leisner explained that NASA came out with a policy that those with NASA grants must make the data behind their research available so it can be validated and people can move to the next step. It does not require archiving of everything, but grantees need to make their work replicable. PSD made the

requirements applicable immediately. The NASA plan stated that NASA funds a range of research and cannot write one-size-fits-all policy, so the communities will need to have their own discussions. HPD is now having that discussion, and should consider what makes sense. The second part of the requirement is for open data.

Dr. Hayes explained that software, archiving, and metadata were a topic of discussion more than 10 years ago. The lawyers weighed in and said the final product is all that is needed. These discussions are reaching fruition. Dr. Liemohn added that the journals are implementing these policies, that the data can be replicable and the author should not be in charge of access. Dr. Hayes said that while the journals have always been supportive, it is also a matter of educating the community.

Dr. Angelopoulos cited the value in publishing the code used to manipulate the data. He asked if the open source development is a requirement, and Dr. Hayes replied that it must be transparent. Dr. Angelopoulos noted that it is a huge amount of work to develop code just for personal use. Where commercial products can be used, they are more efficient. Dr. Hayes pointed out the need for backwards compatibility. For example, if Adobe goes under, what would be done about PDFs? Dr. Matthews advised not spending time on unsolvable problems. Open source and replicability constitute a rabbit hole. Some computer optimization changes from one compiler to another. He would rather do science.

Dr. Randall said that while she agreed with some of the points, it was a slippery slope to mandate software. It would stifle innovation. Also, the data and code going into a figure being available could lead to fake science – usually those data are not the original data. She saw a need to discuss the requirements and the usefulness of the results. She was not sure open science is always doing the world a favor. Dr. Matsuo cited Python as an example of a programming language that has been great but does not cover everything. There are also license issues. She advocated additional discussion. Dr. Hayes agreed that Python is an example, but it has to be open source and readily available. NASA has come up with various ways of discussing this, and it is very complicated. Dr. Angelopoulos recommended making the structure more flexible by allowing commercial software. Dr. Hayes said that the Agency has gone back and forth on this. It could be a finding.

#### HPAC Work Session

Dr. Liemohn said that his preliminary list of potential findings and recommendations was up to 16 and needed to be culled. He presented the topics for triage:

1. Kudos to Ms. Luce for her tenure as Acting Division Director
2. Kudos to the Voyager team
3. PSP launch
4. DRIVE funding for R&A/publicity finding/proposal selection rate is going up
5. Space weather and R&A leads – get out message that this does not pull funds from elsewhere
6. Funding metric success of existing models
7. Kudos on partnership with the U.S. Geological Survey (USGS) on completing the Magneto-Telluric Survey in the Southwest
8. Whole Helio campaign
9. The innovative Rideshare program
10. Kudos to SMD efforts to address disparities in the funding environment
11. Recommendations on PI actions that NASA might take.
12. HEC allocation
13. Maximizing return on data models
14. Open source code
15. Nuts and bolts papers
16. How much data should accompany a study?

Dr. Klimchuk suggested a finding praising Dr. Fox for talking about science being the foundation of what they do. Dr. Randall said that for the PI mission pipeline, the incubator is a good idea, but participants should go through a mock proposal submission through operations and data analysis. They could learn a lot of the vocabulary that stops people from doing it in the first place. A hands-on, mock exercise is a good training activity for an incubator.

Dr. Matsuo raised the issue of more communication with ESA Space Science. Regarding data, she thought they could discuss making it available through CCMC. Dr. Goncharenko asked if Canada's contributions should be noted. She also sought kudos on the Ideas Lab approach, and suggested looking at and learning from the experience of other communities. She would like to see the risk/impact effort include models and data.

Dr. Matthews wanted further discussion of some diversity issues. He asked about HPD's plan to achieve parity for under-represented groups. The University of Delaware has had a separate channel for making awards, using alternative evaluation techniques rather than doing an evaluation and choosing the top ranked. NASA could have similar non-traditional selections. He also clarified the comment he made about uploading huge amounts of data. There is an "escape route" and he was concerned that review panels will not recognize that. Finally, he asked for clarification on the rules for collaborating with people who work in China.

Dr. New explained that data management plans are not included in the final evaluations, though they are considered. China is a complete ban. Students can be funded as long as they are not professors in China, and papers can be cited if the work has been done here. It is forbidden to use NASA funds to support them if a Chinese institution is also funding them. NASA cannot fund collaboration with China, and this cannot be in a proposal. He recommended that further questions be sent to NASA's legal office. It would be best to err on the side of caution. Dr. Ho suggested kudos for the publicity on PSP. Regarding PI diversity, PSD has a Jet Propulsion Lab (JPL) summer school, which is a good program for EC people and students. He thought HPD might consider something similar. Also, the EC professionals can learn a lot from writing a grant proposal. Dr. New said that proposal writing workshops have been run in the grants area, usually at conferences and at the ROSES level, but there can be more of them. Dr. Cassak wanted to applaud Dr. Hayes for his efforts to improve the HEC program. Mr. Filipi advocated PI mentorship, which should include writing proposals and getting feedback. He also liked the new split on R&T and removing the constraint on LCAS.

Dr. Angelopoulos said he would like to see institutions be more proactive in supporting younger PIs, which goes beyond NASA to the institutions themselves. Models need to be inclusive with the code and use commercial software; he wanted that as a finding. Dr. Kistler asked for more analysis of the PI pipeline. Requiring diversity is a double-edged sword and warranted further discussion. Dr. Goncharenko agreed. She asked about involving NASA with the private sector in a pilot program on data. Dr. New said that ESD is running a pilot program of buying data from commercial providers. Dr. Goncharenko then noted that with smallsats and CubeSats, and access to space, the field might be in a new era of data collection, which NASA should consider.

Dr. Liemohn said that he would start color-coding and merging items on the list, then make tentative assignments. Dr. Goncharenko advised that HPD convey the funding success rate to the community, which received some agreement, though Dr. Cassak recommended caution. Dr. Klimchuk thought they should include funding amounts along with the rates, but Dr. New said that funding was too irregular compared to scores.

It was decided to cover space weather leadership under R&A, partly because it has not yet been proven effective. Dr. Randall noted that HPAC should state that whatever is being done with space weather is not affecting core R&A. Dr. Liemohn said they would put the kudos on the NASA/USGS survey in the overall statement. The Whole Helio campaign is a new plan with coordinated measurements; Dr. Liemohn planned to note it without creating a finding. HPAC wanted to discuss the Rideshare program before making a statement. There would be kudos for SMD quantifying R&A Diversity, Equity, and Inclusion (DEI) metrics and identifying actions to address disparities. Dr. Ho wanted to offer kudos to SMD for looking at historical data and taking on the responsibility. Dr. Goncharenko asked for more analysis to understand where the numbers come from, and for data specific to heliophysics.

Dr. Liemohn said that additional candidate topics for the letter included models, and a kudo to Dr. Hayes on his Heliophysics Data Environment Enhancement (HDEE) work. There was to be further discussion on a recommendation about open source availability. Another topic was the PI incubator, which might engender further suggestions. Dr. Matsuo agreed to write an international collaboration piece, to include Canada and note the ESA section in which there could be more HPD involvement. CCMC hosting assimilation models would go with other data comments. Dr. Goncharenko said that NASA should learn lessons from the atmospheric science community in forecasting advancements regarding R2O and O2R. Dr. Liemohn observed that the high-impact/high-risk work was in the range of what HPAC said it should be. They would discuss more on model Verification and Validation (V&V).

The PI summer school concept and proposal writing workshop would go with the related recommendation. The summer school would be for PI development, as part of encouraging NASA to think of ways to encourage EC researchers. The comment on more analysis of the diversity pipeline should be HPD-specific and include alternative evaluation strategies. Future HPAC meetings would tentatively discuss companies that collect their own data, Rideshare and Gateway participation, and funding of related concept studies.

#### Adjourn

The meeting was adjourned at 5:26 pm.

### Wednesday, December 19

#### Welcome to Day 2

Dr. Kozyra opened the meeting and welcomed the participants.

#### Overview of Agenda

Dr. Liemohn welcomed the participants and reviewed the agenda, which was to include a public comment period, a work session to discuss findings and recommendations, and time with Dr. Fox. Dr. Liemohn had emailed findings and recommendations options to the HPAC members the night before. Drs. Matsuo and Goncharenko were to craft a recommendation on international issues; Drs. Mari Paz Miralles and Matthews would write about the Whole Helio initiative; Dr. Ho was to write recommendations on diversity and on the Rideshare program, while also collaborating with Dr. Randall on a PI incubator recommendation; and Dr. Klimchuk was to develop something on R&A. There were still some findings to write. Dr. Goncharenko offered to handle a data model statement, but Dr. Matsuo thought there needed to be more discussion of open source code before making a recommendation. Dr. Liemohn agreed that this should be a topic at the next meeting, along with software issues. Dr. Angelopoulos observed that this seemed to be an evolving theme; he also wanted more information at the next meeting.

### Senior Review Requirements Discussion

Dr. Spann said that the Senior Review (SR) in late 2017 had been slightly delayed. The next SR is likely to occur in the first half of 2020. A couple of issues came up in 2017. For background, he explained that as missions have been repeatedly extended over time, they have not been required to reassess their Level 1 (L1) operations to see if there should be adjustments or other changes that might lead to a revised operations plan.

Dr. Randall pointed out that some missions become more difficult over time, requiring more money. Dr. Spann replied that while that is different from requirements, the SR has never called for reassessments. As a result, extended missions continue operating as if they trace back to the original requirements. Reevaluation of operations would offer an opportunity to look at extended missions in the context of new missions coming on. While he was not sure of the incentive beyond helping more disciplines, the more NASA puts into existing missions, the fewer opportunities the Agency has to bring on new missions.

Dr. Ho observed that new missions have a lengthy process to develop L1 requirements, and that can be worrisome to adjust. Dr. Spann agreed that this can be a huge effort. He said he may have been loose in his terminology, but he wanted to get ahead of it. Like PSD, HPD PIs can propose new science questions that trace back to the core mission. Dr. Hayes added that HPD introduced Prioritized Science Goals (PSGs) in 2015. He has to report each year on the assessment and wondered how strictly the original L1 should be enforced. Dr. Spann reminded HPAC that the discussion was more about operations requirements than science requirements. Is the mission operating in a way that makes sense now compared to when it launched? HPD needs to think through potential unintended consequences.

Ms. Luce asked about formalizing situations in which a requirement can no longer be met due to instrument failure. Dr. Spann said that that is not yet done. Dr. Randall added that HPD should consider that if the community is depending on data from a mission, they still want the full data coming in even if the extended mission science requirements change.

Dr. Spann described the second issue, involving missions entering their first SR. These missions are often just meeting peak productivity, so there is a mismatch with expectations. It is possible that the prime phases are too short, especially for the large, strategic missions. PSP has 7 years for its prime phase, but most missions have 2-3 years, and Dr. Spann wondered if that is really enough. The catch is that extending the prime phases also changes the design requirements, which might not be what HPD wants to do, especially on Explorers. He asked HPAC for input.

Dr. Angelopoulos asked about the budget impact of extended prime phases and the impact on other missions. Dr. Spann said that designing for more time would carry a cost impact that would affect funding overall. Dr. Angelopoulos observed that missions propose their prime phase length, and the impact of a change could be huge, affecting mission cadence. Dr. Kistler suggested that HPD say that if everything is working fine, there will be an extension. Dr. Spann explained that the extended phase has a drop down. Dr. Hayes added that there is a “gate review” when the prime phase ends. Also, the SR itself usually extends the mission, but there is a ramp down. SR panels are likely to accept more risk in the extended phase, with less worry about down time, instrument issues, etc. Dr. Spann said that missions receive less funding in extended phase. If they are still producing data, that would be a rationale for continuing. Dr. Klimchuk suggested letting PIs extend their science if they are doing great things.

Dr. Randall noted the ramp-down in funding and wondered if mission design is the real issue. She asked how many missions designed for 2 years last for 4 or even 20? She was concerned that SRs might be too conservative. Dr. Ho pointed out that large missions that fail usually do so in the first year, but if they get up to space, they tend to last. Dr. Randall said that that would be true for a 2-year mission, as well. Dr. Hayes explained that a 2-year SMEX will have less redundancy than a large mission. He gave the

example of the Solar Terrestrial Relations Observatory (STEREO), for which there were assumptions that were proven untrue. Dr. Randall said that there is probably a difference between missions that have different environments as they extend, and those that do not. Dr. Ho asked if the current system penalizes proposed long-term investigations. Dr. Spann said that that is the case for Explorers, which are specific and transient. Dr. Ho noted that the hardware is almost 90 percent of the mission.

Dr. Angelopoulos said that the sooner the data get up, the better off everyone is. It is to the benefit of the community for the PI to obtain the data, then get them out to the community. Dr. Spann wondered if the discussion might be less applicable to strategic missions. Dr. Kistler suggested that missions in their first SR could possibly have a continuation so that they are ongoing. Dr. Spann said that while HPD still needs to set the expectation of a lower budget, it might work to let them propose continuation with budget cuts.

Dr. Liemohn asked if it would make sense to have the first SR be different from subsequent reviews. Ms. Luce saw a lot of merit in that. MMS especially had a short time, which was difficult. She liked the idea of not perturbing newer missions. Since the first SR is special, she asked if it might be modified. Dr. Ho said that if the mission teams have new science questions and can back up their budget, it could work. Dr. Liemohn noted that at the time of a mission's first SR, it is usually doing great things and should keep going. Dr. Hayes said that there is not a lot of flexibility to fund new science unless there is a limit on the number of extensions. Other SMD divisions are thinking of this. Ms. Luce pointed out that HPD has "system science," unlike the other divisions. Dr. Spann added that the measurements have to be considered in that context.

Dr. Randall pointed out that allowing PIs to propose additional prime mission time beyond the 2 years would cause investigators to write proposals in an artificial manner when they know they can get around the prime length. The review panels will see through that. Dr. Klimchuk added that there are budget issues among new, extended, and R&A missions that the community has never really discussed. Dr. Angelopoulos asked if HPD had considered having a metric on papers per dollar or something like that. Dr. Spann replied that that information is required in the extension proposals, where teams are asked for evidence of productivity and impact, including papers and citations. Some missions are cited often without being the primary focus, though. That complicates how to gauge the impact in that context. Dr. Hayes added that each mission is supposed to be able to stand alone. The fact that the observations can be coordinated is a tribute to the community. But if the missions were to be designed together, they might not look like what currently exists. Dr. Spann added that the Whole Helio initiative will pull that together more. Nonetheless, HPD has a lot of serendipity.

Dr. Klimchuk asked if an HPAC finding would be helpful. Dr. Spann replied that an affirmation of the conclusions reached in the discussion would be good to articulate. It would also help HPD move forward with the next SR and be clear with the mission teams as to the input they provide. The preparation for SRs has a big impact on the community, as it is a lot of work, so the Division wants to make the process as efficient and effective as possible.

Dr. Liemohn said that the first issue was whether to allow missions to change their L1 requirements. Second was whether to have longer prime missions, especially the cost capped ones. Dr. Randall said that it is good to have a cadence for the L1 requirements. For the PSGs, the mission teams develop new ones with each SR. She maintained that missions should be required to reassess their L1 requirements in light of all of the work that can be done with their science. The longer missions can generate legacy data. Dr. Matthews pointed out that missions find new things they can do with the data, and they can leverage that. Voyager is an example.

Dr. Spann noted that L1 science requirements drive the operations requirements. Dr. Matthews said that it is a good idea to reconsider the operations requirements because they could affect the costs of continuing.

Dr. Angelopoulos noted that the mission could have to spell out a new set of science requirements. Dr. Randall stated that this has to be considered separately from the PSGs. The mission team should articulate the need for the data sets in the community. Dr. Spann said that the teams need to demonstrate value, and that needs to be part of their story. HPD can ask the teams to make that case.

Dr. Klimchuk said that operations requirements should flow from the science requirements, which can change. It is legitimate to have science requirements of longer data sets. Dr. Hayes agreed that there is a need for long-term data sets. In addition, phenomena that come up that teams see they can measure now. In that regard, it is almost an infrastructure element, with localized elements on top of that. The SR is a snapshot. The question is how to maintain a long-term record while encouraging different types of science? Dr. Randall said that the teams want to think about new science, so these are two separate things. Future science may have implications for operations, depends on the missions. The teams need to think about the PSGs, the long-term data sets, and new science. That conversation needs to occur. She was glad HPD raised the issue of a reassessment.

Dr. Liemohn asked what the SR call to mission teams looks like, and what the panel is told. Dr. Hayes said that both are covered in the same document. Panels come up with ideas about what would be better in a review, and the panels try to be explicit about science merit and operations. He has considered the European system of doing an operations assessment that goes to the science review panel, where if the mission could go on, that is passed along to the panel, and they then decide if the science is still of value. HPD panels look at science and mission operations, which is not the same as having engineers look at the mission operations. That has been considered, though it would be hard to implement for 2020. There are other ideas under consideration as well. Federal Advisory Committee Act (FACA) requirements are an issue, as the heliophysics community is very conflicted and small, and panelists must be U.S. citizens.

#### Updates on the Living with a Star Program Analysis Group (LPAG) Activities

Drs. Mark Linton and Anthea Coster, Living with a Star Program Analysis Group (LPAG) Co-Chairs, provided an update. Dr. Coster explained that LPAG had just begun meeting again but the members have gelled quickly. She listed the Executive Committee members and liaisons. LPAG has solicited community input to develop new science topics for upcoming ROSES calls, discussed strategic capabilities, and looked at methods for evaluating progress by Focused Science Topics (FSTs) in advancing LWS goals.

LPAG developed 46 distinct LWS FSTs, sought community input, and ultimately drafted 21 topics by combining them and looking at previous uncompleted topics. After soliciting further feedback and making additional changes, the Group came to 20 FSTs, plus 2 “others.” One of the latter involved data science and analytics, and the other concerned artifacts. Those were both outside the LWS scope, however. Dr. Linton said that the goal was to have at least four in each of the key science areas. LPAG emphasized community input, which is a huge strength to this. It took a lot of effort. The extra two topics were community inputs that came in but did not fit the structure. LPAG passed the information along to NASA as part of the report. The thought was that the machine learning proposals get downgraded, so LPAG sought to encourage that community while also ensuring that they bring in science.

Dr. Linton listed seven Strategic Science Areas (SSAs) from the LWS 10-year vision. The FST effort pointed to revisiting the SSA on understanding space weather effects and developing mitigation strategies for human deep space flight, to focus more on forecasting potential radiation impacts. Another suggested revision was to change the SSA on atmospheric evolution and loss to space near a star, with emphasis on the heliophysics of planetary habitability. LPAG will seek community input on these.

A review of the strategic capabilities indicated that the basic idea was still sound. This is a program to fund development of models for an operations capability and cross-disciplinary science. The goal is to deliver these to CCMC. LPAG encourages teams to have a plan for communicating with CCMC early on.

Other priorities identified by LPAG include model compatibility; robustness; user utility, training, and timely consideration of modeling advances. Dr. Matsuo asked how to define and assess “useful.” Dr. Linton said that CCMC has information on data, and tracking papers would be great. Some of these could be requirements for future proposals. Dr. Matsuo noted that archiving will require resources. Dr. Linton said that the capabilities would call for more resources in some cases. If all of the models are delivered to CCMC, it will be an issue of funding for storage. Dr. Coster added that CCMC would be involved in test data instead of the entire archive. Dr. Matsuo was concerned about CCMC infrastructure.

Dr. Goncharenko reported that she had heard from community members that this is time consuming, which is an issue. LPAG might need to develop benchmarks and assess models. This also requires assessment of data providers. The effort has been going on for a number of years, and people cannot volunteer their time indefinitely. There is a need to understand where things are and look at how models are progressing. Dr. Liemohn said that researchers often develop models for themselves, resulting in gaps. Dr. Matsuo suggested that the validation effort should be part of this. Dr. Linton said that including a plan for developing benchmarking and robustness measures would be useful. Dr. Goncharenko added that continuing on with an unfunded effort like this is unrealistic.

Dr. Linton said that LPAG also discussed metrics for evaluating progress toward archiving LWS Targeted Research and Technology (TR&T) goals. There is a lot of anecdotal evidence, but it is not clear how to quantify it or transfer knowledge from one team to another. The data are all there, but they are hard to search for. The final report is internal to NASA. LPAG focused on having final and interim reports on the FSTs and LPAG’s challenge in addressing them. LPAG concluded that there would be a great benefit to FST team leads preparing final reports to be posted on the LWS TR&T website. An extended summary and list of bullet points would also be helpful.

Dr. Randall said that LWS once had targeted teams with a big proposal. She wondered if that might happen again and whether it had been deemed a good idea. Dr. Linton said that it did not come up at LPAG, and it was noted that this was a headquarters issue. Dr. Simon Plunkett of HPD explained that it limited community proposals. HPD gets more ideas if people propose; teams can be put together afterwards. The Division has been giving guidelines to the team leads. Dr. Kozyra added that HPD is evaluating what happens when teams are assembled like that. HPD is trying to provide information on what is needed for an integrated team.

Dr. Liemohn observed that FSTs are smaller versions of the Ideas Lab, discussed on the previous day. They are supposed to leave room to work together. He led one a long time ago in which only the PIs would come together, rather than the full team. He wondered if that was still the case. Dr. Linton said that it depends on the PIs and team leaders. FST teams benefit when they bring in more people. Dr. Liemohn suggested bringing in full teams. Dr. Kozyra said that when PIs constitute teams, the key thing is to have roles and responsibilities, know who to go to, and have a plan that focuses everyone on a single objective. The meetings should be to put together a strategic plan for the team. The recommendations from NAS encourage that. However, it is currently up to the individual PIs, since these are grants. Dr. Plunkett added that team leads get additional funding for team meetings. Dr. Linton noted that they must also have funding for travel to team meetings.

Dr. Linton listed possible discussion topics for LPAG in 2019, noting that the Group will review topics that NASA has not yet selected, obtaining community feedback on them. Dr. Kozyra clarified that the topics supplied by LPAG are informational to HPD. NASA is responsible for developing the FSTs using

this material as a resource. Dr. Linton said that there is some overlap with the SSAs. LPAG will review them again in 2019. In answer to a question, Dr. Kozyra explained that there are science topics, such as inputs to the ITM propagating upward from lower altitudes, that may not be adequately covered in the SSAs. The SSAs were written before the latest space weather information came up, and LPAG is looking at adding a new SSA. Dr. Linton noted that it is helpful to know what is missing so LPAG can update the document. He was not yet clear on how LPAG will solicit community input on the SSAs, but the system used to solicit ideas for FSTs works well and LPAG can ask the community to focus on SSAs in 2019. Dr. Liemohn pointed out that since HPAC oversees LWS, it was possible there might be a finding or recommendation on this.

Dr. Plunkett said that he is the LWS science lead going forward. He described the FST development and selection process, which has changed. LPAG, which is a community group, provides information and analysis to HPD. HPD puts the LPAG input together with FSTs from prior years to come up with topics for ROSES. There will be a ROSES amendment in February, with Step 1 proposals due in October 2019 after the ROSES 2018 selections are made, and Step 2 proposals due in January 2020. LPAG input led to HPD having a strategic capabilities call with ROSES 2019. He showed how the LWS FSTs map to specific SSAs from 2004-19. Dr. Matsuo noted the need for a discussion about data. Dr. Plunkett agreed, and Dr. Kozyra observed that there was a corresponding FST.

Dr. Kistler asked for more detail on how the initial list of 22 topics became 4. Dr. Plunkett said that LWS looked at the list, and tried to maintain balance and avoid redundancy. Further discussion clarified that LWS is more based on understanding of physics, while space weather is user-based. However, users can provide input to LPAG. Dr. Klimchuk asked why there was little emphasis on photon radiation. DOD is interested in it. Dr. Plunkett noted that there is currently a team addressing it.

#### Update on the Geospace Dynamics Constellation Science and Technology Definition Team

Dr. Leisner, along with Drs. Allison Jaynes and Aaron Ridley, discussed the Geospace Dynamics Constellation (GDC) Science and Technology Definition Team (STDT). This is an HPAC subcommittee, with a mid-term report. Dr. Leisner, of HPD, explained that the 2013 DS recommended GDC as the next LWS strategic mission. The STDT was formed to update the science objectives and develop potential mission implementations. Since they first convened in May, a lot has happened. The STDT will deliver its report in mid-2019, then disband, and HPAC will deliver recommendations to HPD.

Dr. Leisner listed the members, most of whom came out of the call for letters of application. They represent diversity in expertise, geography, science institution, and other areas. The Terms of Reference (TOR) called for up to three HPAC members to be on the STDT, so Drs. Randall, Matsuo, and Goncharenko joined. After discovering conflicts between the TOR and the process that the STDT is allowed to implement, Team members decided to produce a report on identifying the important science and a compelling mission concept. The team removed Design Reference Missions (DRMs) and other scientific studies. Since the DRM is outside the STDT, the group is exploring parameters rather than a particular implementation. The STDT is not considering resources.

Dr. Angelopoulos asked about the mission concept in this context. Dr. Leisner said that he does not see it as requiring a mission concept. Dr. Angelopoulos asked if the report gives a range of options, with the decision to be made based on resources and other possibilities. Dr. Leisner explained that FACA committees cannot advise on procurement activities from which members could benefit. There is no GDC at this moment, so the STDT is providing information NASA could use if the Agency were to move forward. It explores options that could work; these are independent but could be combined. This is NASA's first FACA STDT.

Dr. Ho asked about HPAC's role. Dr. Leisner said that the STDT is a subcommittee of HPAC, so it is HPAC that receives the report, not NASA. HPAC members will read the report, then make a recommendation. However, the TOR states that the original report must accompany HPAC's recommendation, so NASA will receive the report. Dr. Liemohn asked Dr. Leisner to identify the entity to which HPAC would present any serious issues: the STDT or NASA. Dr. Leisner explained that the TOR does not address sending the report back to the STDT. He would not consider it the best use of resources, but that was off the top of his head. He expects the report to be delivered to HPAC, with time to read it. There may need to be a special meeting for this unless one is already scheduled.

Dr. Spann said that there have been groups reporting to HPAC, and the process would be similar. HPAC can give feedback to the STDT. Dr. Klimchuk noted that with the SR, HPAC approved the process, not the output. He wanted to know if that would be an option here. Dr. Leisner said that the intent was to discuss the content, as the process is mandated by NASA. Dr. Liemohn pointed out that there were a lot of people conflicted on the SR content, so having the vote on the process was the unconflicted option chosen. Dr. Klimchuk added that not all HPAC members know all of the science. Dr. Angelopoulos suggested determining the process before the final report. Dr. Leisner said that HPAC cannot advise about procurement activities. He asked for time to return with a more complete answer.

Dr. Jaynes explained that the STDT seeks to have a focused, achievable mission with community input. The schedule is very aggressive. Subgroups work on tasks offline, on topics including goals and objectives; implementation; measurements; and modeling support. At least one co-chair is on each subgroup. Nothing is done and decided in the subgroups; everything comes back to the larger group. The two main GDC goals are to understand how the dynamic high latitude ionosphere-thermosphere (IT) responds to solar wind/magnetospheric inputs during quiet to disturbed conditions, and to understand how internal processes redistribute mass, momentum, and energy. Dr. Randall added that the STDT reviewed community RFIs. Those that noted solar radiance suggested it be part of the science but not an objective.

Dr. Jaynes described the objectives related to each of the two goals. Dr. Ridley explained that the STDT is not being specific about what will be measured, but is stating what must be measured to close the objectives. Dr. Matsuo added that they had to focus on what exists in the IT instead of what happens elsewhere. It is a difficult process in terms of setting priorities that will go to NASA. Dr. Ho recommended grouping priorities by high, medium, and low, but Dr. Liemohn noted that there is difficulty in separating them. Dr. Goncharenko explained that the STDT is emphasizing elements of a compelling mission so that it becomes clear what can be achieved. Dr. Jaynes added that the goal was to provide options. Regarding community buy-in, while the STDT has not polled the community, the meetings are open. Dr. Leisner stated that the meetings are not announced, and the TOR says that HPAC would have to make the announcement after deliberation. Everything that becomes public has to go through HPAC. The community can only listen, and comments go to him in order to prevent conflict-of-interest (COI) issues.

Dr. Jaynes presented four implementation architectures, which can be mixed: a mix of satellites across multiple orbit planes; a main instrument with CubeSats; high-low circular with satellites at different altitudes; and over-under having orbits off-set by 180 degrees. The report will include constraints and trade studies, and will cover the full range of altitudes, with the feasibility noted per range. Dr. Ridley added that they will include the cost-benefit of each. Dr. Jaynes then described the report-writing process. The intent was to provide the report to HPAC in April.

GDC is a constellation mission, meaning it will use smaller satellites in formation. It will also require technology development, so it will be helpful if HPD can proactively fund that support. The high TRLs required will call for flight demonstrations to test instrumentation. Dr. Kistler said she thought the STDT

was to come up with an implementable design. Dr. Jaynes said that they would like to present more options for implementation. Dr. Ridley added that if the goal is to measure neutral winds, the options have been limited thus far. However, there might be someone with a new idea. If funding support could help groups to measure winds with smaller resource requirements, that would be fantastic. Therefore, technology development is necessary.

Dr. Jaynes noted that the team would also like to pull in ground-based complements. NASA should consider that, while also looking at overall ground-based assets. Dr. Ridley added that the STDT cannot make recommendations but will instead speak to the success of other missions using ground-based assets. Dr. Klimchuk said that ground facilities are part of the infrastructure. The solar community values and uses them. Dr. Fox pointed out that NASA does not fund such facilities, but rather funds work done at them, in partnership with NSF. Dr. Liemohn thought this would be an opportunity for NSF to become involved with the GDC, and suggested making it into a finding. Dr. Fox encouraged HPAC to do this.

#### Public Comments

Dr. Kozyra opened the meeting for public comment, but no one came forward to speak.

#### Preparing for the Decadal Survey Midterm Report

Dr. Art Charo of NAS explained that the Academy is just starting the midterm assessment and would like HPAC feedback. Dr. Charo participated in the 2013 DS and will direct the midterm study. He presented the Statement of Task and the TOR for the 2013 DS, described the scope of the report, and detailed the organization of the DS work. DS recommendations, in order of priority, were to: complete the program of record, much of which has been done; initiate the DRIVE program; execute a robust Explorer program; and launch strategic missions in the STP and LWS lines.

Congress mandated the midterm assessments. Prior midterms have been more like report cards, but NAS now wants to also discuss lessons learned and the best paths forward, in hopes of being more constructive. The Statement of Task therefore calls on the evaluators to identify where the science is, actions to optimize the science, guidance on the portfolio, and actions for the next DS. While NASA sponsors this activity, the DS and midterm assessment address NSF and NOAA as well.

Dr. Charo presented a list of midterm assessment committee members. Member expertise is such that all DS topics are covered well. In addition, a number of members have experience on prior DSes. A chart on DS recommendations indicated progress thus far. The midterm report committee will need the budgets to evaluate progress and see how to move forward.

Next, Dr. Charo presented some items for discussion in regard to the next DS. These include: making it executable; utility of decision rules; best practices for the Cost and Technical Evaluation (CATE) process; missions versus point designs versus science targets; and, actions ahead of the Survey. The most recent DS, for ESD, was written in terms of science targets and what measurements might be needed; that went through CATE. Both APD and PSD have done studies in advance of their DSes, but those are not cheap. Workshops or studies can feed into the DS, and community engagement efforts are useful.

Committee diversity and EC membership are issues. The steering committee tends to be older and experienced, but the study panels are more open to EC people. DSes tend to be conservative, reflecting the fact that executable options also tend to be conservative. The Agency wants a plan it can execute, given budget realities.

Dr. Matthews asked about the coupling complexity initiative. Dr. Charo did not believe it was active, and Dr. Kozyra noted that the science centers are not another name for it. Rather, they are a new initiative

from the last DS, part of DRIVE, with no reference back to coupling complexity. Dr. Matthews said that the initiative had some science directions involved, and DRIVE is fairly agnostic about important science topics. Dr. Kozyra explained that the science centers were meant to address cutting edge issues in heliophysics that require more than a single PI grant. They are not focused on a specific topic, but are left to the ingenuity of the community. Dr. Charo added that there was a sense that the theory and modeling program needed to invest more and do more. Dr. Matthews agreed. He pointed out that there was concern that the big heliophysics problems involved couplings and a systems approach. He no longer hears that. Dr. Kozyra replied that the centers are a way to attack those issues, acknowledging that the complexity of some issues requires a multi-disciplinary approach.

Dr. Fox said she was interested in advice on how to tie up this decade, given the real budget. She observed that the current DS discussed what could be achieved in the decade but did not look further. She would like to know about the technology that might be needed 20 to 30 years in the future. For example, she would like the 2013 DS to describe what a solar sail will do, so HPD can direct the technology budget to that. Ms. Luce noted that HTIDES covers HPD technology.

Dr. Klimchuk observed that the NAS committees are very important, and in that light, the selection process struck him as odd. As an example, for solar physics, there are three people from the same institution. Dr. Charo replied that the NAS geospace section makes suggestions. Dr. Klimchuk said that heliophysics has four subdisciplines. NAS has a huge overrepresentation in one of them and will be biased as a result. Dr. Charo answered that his group talks to people and did not go to the community on the midterm. Since this is a review, they needed people who are familiar with the DS. Dr. Klimchuk explained that many people in the field feel it is not representative of the community. There are good people on the committee, but the community sees it differently than NAS. The community has not been happy with NAS committees. NAS could ask for volunteers, and ask more broadly for input. Dr. Matthews pointed out that there was not much theory presence, for example, and Dr. Liemohn added that there was no one from the Midwest. Dr. Ho said he hears similar comments from the community. Dr. Charo responded that there are no guidelines. Dr. Klimchuk said it is frustrating, especially for something so important. Dr. Fox agreed. On the DS, there will be more spots. She sent Dr. Charo a long list, and he said he had not heard of some of those people. Dr. Leisner had mentioned a NASA program for which people can volunteer, and that might be a model instead of just tapping the people the NAS committee lead already knows. Others agreed.

Dr. Liemohn asked about the panels and working groups from the 2013 DS, observing that the working groups were not listed in the final report. Dr. Charo explained that they were more informal. In terms of the cross-communication, there were meetings, and it was a challenge. Dr. Angelopoulos asked how well NASA is doing. Ms. Luce said that HPD is on cadence with AOs and Explorers, selecting more Phase A Explorers than anticipated. The cadence is 2.5 years. Dr. Charo explained that the DS worked off of a budget and assumed a low rate of inflation, but the actual budget was flat. In addition, PSP cost more than anticipated, and there were extension costs for missions that had not yet launched. Ms. Luce pointed out that PSP came in on budget and schedule from where it was confirmed. HPD even got money back. Dr. Matsuo noted that the Magnetosphere Energetics, Dynamics, and Ionospheric Coupling Investigation (MEDICI) and Dynamics missions are out of scope for the current budget projection. Ms. Luce said that they will not get started in this decade, but the expectation had been that they would be no further than formulation. HPD is feeling the pinch most on GDC. IMAP was slow to start, pushing out that budget and affecting the ability to ramp up GDC.

Dr. Charo showed the projected schedule, which was to include four meetings and an October publication date, if possible. Dr. Matthews said that this group is no more exciting than the DS committee. The big ideas in the field that inspire new missions come from people with vision, which he did not see in this group. He did not see much attention paid to theoretical issues, and yet PSP grew from ideas. Dr.

Liemohn suggested that the midterm report committee reread the appendices from 2013. The report is more than just the chapters.

#### HPAC Work Session

Dr. Liemohn asked if there was a need for a finding or recommendation on LPAG, or if HPAC should just acknowledge the report. Their development of the SSAs was to be a topic at a future meeting. Dr. Randall said she had noticed that LPAG did not have an SSA about the neutral atmosphere. Dr. Liemohn said that the PAG is supposed to address the science needed to understand and mitigate space weather effects. They have a plan for community input with the next round. Dr. Randall suggested a kudo on that, and Drs. Goncharenko and Klimchuk agreed that this was quite positive. Dr. Liemohn said the report would include a kudo on their community input.

On GDC, he asked if there should be a finding or recommendation to NASA to obtain feedback on the format, level, and scope of assessment HPAC is to implement upon receiving the report. Dr. Kozyra noted that Dr. Leisner said that if HPAC gave him the parameters on how the Committee wants to do this, he can run it by the policy people. Dr. Liemohn was still unclear on the HPAC charge regarding assessment of the report. Dr. Kozyra said they might ask Dr. Fox. Dr. Matsuo also noted the timeline issues. Dr. Angelopoulos saw it as an invitation for HPAC to let NASA know how it wants to do these things. He was concerned about overreaching. Dr. Cassak reminded the Committee that LPAG reports to HPAC.

Dr. Liemohn asked whether the STDT was having a cost assessment. Ms. Luce said it was outside the HPD budget window. The DS estimated GDC at just under \$1 billion. There is a concern that the DS concept of GDC did not take into account smallsat technology and other things that have come into play since the DS was published. However, the STDT is not looking at types of instrumentation. Dr. Randall explained that while there has been some time spent on mission architecture, the STDT charge does not include anything beyond it being a constellation. The effort is in defining science requirements, but not how they will be met. The Team is defining the objectives, and that is it. Dr. Matsuo thought the STDT would note some fuel costs associated with orbits, but Dr. Randall said that that relates to science requirements. Dr. Goncharenko explained that looking at the orbits gives a good idea of resolving spatial/temporal questions. Dr. Randall added that the question is about in situ versus remote sensing, which cannot be assumed.

Dr. Liemohn wondered whether HPAC needed clarification on what the Committee can do. He had heard conflicting information. NASA will do the costing after the report is released. This is the first FACA-level STDT. Dr. Randall said that if the STDT is not recommending instruments or a number of satellites, HPD might also need an implementation study. Ms. Luce said that HPD has thought of perhaps competing multiple funded studies. She offered to try to get more information. STDTs will be FACA committees going forward, and it has been hard to navigate this first one. The acquisition strategy for GDC is also still undetermined, though she would not expect it to be led by a single PI.

Dr. Matsuo asked if it would be helpful to have a finding stating that FACA puts restriction on STDTs. Dr. Fox said that HPAC can write whatever findings they want. If they feel the constraints were too great, that is their opinion. She cautioned that FACA is a Federal law, and it was possible the STDTs could be lost if there were a statement that compliance is too difficult. There is benefit to what the GDC STDT has done. The process has been challenging for HPD to support, and the Division is still figuring it out. No one wanted to preclude the STDT members from proposing. The priority is to get good science, then figure out how to go forward.

Dr. Cassak asked if it would be helpful to craft a finding referencing the HTIDES program and technology development. Dr. Fox thought it was an excellent idea to have a finding that notes the importance of traceability in enabling the science. It is then a natural progression to pick up that boundary

and move forward. Most of the people in the room were used to doing point design, which was why many of them were reacting to it from that perspective. However, the bones of a mission are present. It would be a bad idea to exclude the best people from being on the STDT or proposing to the mission. There is nothing wrong with HPAC saying that once the STDT is disbanded, a further architecture study should do a real costing. The other piece is that HPAC was discussing partnering with different agencies, and that would be a good finding. She noted the use of NSF facilities in some ongoing missions. If the science is too big, others can play as well in the general science area.

Dr. Liemohn said that he would write a recommendation about encouraging NSF involvement. Dr. Matsuo stated that inter-agency coordination should be present from the beginning. Dr. Randall asked what NASA would do if HPAC recommended that the Agency support an undefined mission? Dr. Fox said that after the STDT finishes its report and disbands, NASA can move on with further studies. Dr. Leisner said that FACA precluded certain discussions until after the STDT is disbanded. HPD was not yet talking about what may follow. Potential implementations are a search through flight dynamics space. It is not possible to put out solicitations without knowing the observations and instruments that will drive the mission architectures. The STDT will provide steps toward the mission.

Dr. Liemohn noted that the April deadline was ambitious and asked if it might be moved. Dr. Leisner replied that the schedule issues occurred in part because of the time it took to stand up the STDT, given the guidance they received. Slippage would have a domino effect and conflict with other commitments, so there was little, if any, flexibility. Dr. Randall asked where community input might occur. Ms. Luce said that it could be through a solicitation, noting that the various types of solicitations are very different. Dr. Leisner said that he would seek guidance from NASA policy experts on what kind of input HPAC might give. He would get back to the Committee early in 2019. Dr. Liemohn said HPAC wants to be helpful, while staying within the bounds of what might work. Dr. Fox replied that an honest opinion is important, as well as constructive feedback. This was a learning experience, and she thought the next STDT might go smoother.

Dr. Kozyra wondered if there might be opportunities for HPAC to discuss drafts, so that the Committee would be in agreement by the time the final report was complete. Dr. Leisner said that the schedule and logistics would make that difficult. Dr. Matsuo said it would be beneficial to have the feedback, if at all possible. Dr. Leisner pointed out that the three HPAC members had to be appointed as Special Government Employees (SGEs) to the STDT, separate from being appointed to HPAC. He wondered if people giving feedback might need to be appointed as part of the STDT. Dr. Fox said that a finding could address how to set up dialogue for STDTs, but the post-employment issues are the real question. Dr. Kozyra further explained that since HPAC would not be dissolved, the post-employment issues would be a problem. Dr. Liemohn said that Dr. Matsuo would work on a GDC recommendation on coordinating and being proactive; Drs. Angelopoulos and Randall would write about the need for an architecture study; and Dr. Kistler would craft a finding on LPAG community engagement.

Drs. Goncharenko and Ho had been planning on writing about companies that collect their own heliophysics-related data. It was suggested that HPAC might seek further input at its next meeting. Dr. Klimchuk added that the review process should be on the agenda for the next meeting, as well. Dr. Cassak was to write the overall kudo for HPD, and Mr. Filipi took the separate thanks to Ms. Luce.

Dr. Liemohn reviewed the two issues discussed regarding the SR. One was on the assessment of operations requirements; Dr. Randall agreed to write the HPAC statement on that. The second issue had to do with longer prime missions, which had been recast as giving missions special status at their first SR. Dr. Randall stated that mission development costs are too conservative, with too much redundancy. If missions fail, it is usually in the first year. It is a related issue that NASA should be considering. She asked if it would be reasonable for HPAC to say NASA should be less risk-averse. Dr. Angelopoulos

thought that was a separate discussion. Dr. Ho agreed it might be a good idea to have the first SR be different, but missions need to finish their L1 requirements in the prime phase. Dr. Angelopoulos said that in many cases, a mission is at its peak when entering its first SR. Dr. Randall added that there is an artificiality to having a mission of 2 years when the PI plans on 3 years. An example was MMS, which was still going full bore after meeting the L1 requirements. Dr. Klimchuk added that there is a lot of good work that can be done after meeting the L1 requirements. Dr. Liemohn suggested that at the first SR, the PSGs could look like the prime phase. Dr. Angelopoulos felt like the review process already factored that in. Dr. Klimchuk thought Dr. Spann's point was that the teams are stressed out going into their first SR, so HPD should cut them some slack on the first extension.

Ms. Luce said that MMS had an issue with the timing of the SR and the ending of the prime phase. She liked Dr. Klimchuk's idea. Dr. Fox wondered if, at a mission's first SR, the team could show they met their science goals so they can then go on without proposing new science. They would still have to justify continuation and show they met the criteria, but without proposing new science. They would also have to show that the community is benefitting. Dr. Angelopoulos observed that this would formalize what already happens. Dr. Liemohn said that that was the recommendation – to formalize it. Dr. Randall confirmed that the recommendation was that missions should not be required to write new PSGs for their first SR, but they will still be required to justify continued funding. Dr. Liemohn agreed that that was the recommendation, noting that it is less applicable to strategic missions. The recommendation would state that HPAC wants to leave the prime mission length alone, but adjust the SR.

In answer to a question, Dr. Fox explained that SR panels look at whether missions achieved their PSGs, and goals proposed for the extension. The recommendation would have new missions proposing a continuation of the prime phase science goals, and the SR would evaluate whether those science goals had been achieved during the prime phase. Dr. Matthews wondered if it might make sense to ask mission teams to suggest the best-case science, whether they are continuing current work or proposing new science. Dr. Angelopoulos said that the SR would not require the first extension to have new PSGs. It was agreed that Dr. Angelopoulos would write the recommendation, and Dr. Matthews would review it.

*Discussion with Dr. Fox*

Dr. Liemohn opened the floor for further discussion with Dr. Fox. Dr. Cassak asked about a question at the AGU meeting regarding NASA's support of faculty hiring. Dr. Fox replied that someone asked if NASA should force space weather hires. That is not what NASA does. The question was about putting space weather into courses. NSF has a faculty program that might leverage the course work, but NASA does not do this. The Agency enables science and opportunities. Dr. Cassak thought that PSD had something for those without tenure track positions. Dr. Fox said that that was different from pushing the curriculum. Dr. Leisner explained that PSD had a program for EC fellowships, which involved checking a box on a proposal. That was discontinued. The community is pushing to bring it back, but there was no evidence that it worked. The only people who wanted it were those who were already succeeding. Ms. Luce explained that HPD's ECIP is aimed at the same population but has different criteria. Dr. Leisner said the PSD program was for non-tenure track or non-civil-servant positions. The award was given when the awardee received tenure or a civil servant position. It was noted that in a comparable NSF program, the institution applies for the position. Dr. Fox said that NASA could look into the different balance.

She added that Dr. New discussed the development of new PIs, and there had been discussion of the PI incubator. She has a lot of ideas on this and received good feedback at AGU. She has been feeding this back to Dr. New and the SMD Associate Administrator, Dr. Thomas Zurbuchen. Since this is not just a single course, the question comes up as to how to factor in mentoring. The institution has to provide support, or the program needs to pair the person with a NASA center. She was hoping that HPAC could consider this. Dr. Klimchuk said that Goddard Space Flight Center (GSFC) does some mentoring, but it is

not clear how people at smaller institutions would team up. Dr. Ho, who was at the PI diversity workshop, mentioned JPL's planetary school. Those are the opportunities NASA can provide.

Dr. Matsuo said this requires a general cultural shift. She cited the University of Colorado's training on how to spot bias and asked if something like that could be done to support the young women coming up. People have to want them to succeed. It goes beyond training the individual, but it is not clear how to do that. Dr. Fox said that there are many elements, including having a safe space for airing grievances. The anti-harassment clauses are a big milestone. It takes a while. The incubator will help build the network. There was a lot of emotion at the workshop the first day, and Dr. Zurbuchen moved them forward the next day. Dr. Klimchuk said that a lot of these discussions have an effect, as he is becoming more aware; others are, too. Dr. Matsuo said that while she feels positive about this, it is sad that people feel isolated. Moving this forward is a positive thing that may create the needed shift.

Dr. Fox cited PSP as having an engineering team that is predominantly female. That is powerful. Dr. Angelopoulos suggested that the AOs call for EC people. Dr. Fox replied that Dr. New has talked about that at length. There needs to be teaming of EC and senior people. Regionalism is another issue. How can NASA support and bring along those who are outstanding but are not at universities with the right infrastructure and support? It is not clear how to bring them along and give them the tool set. Dr. Kistler added that there are not that many new missions per year. Dr. Fox pointed out that there are instrument PIs, science PIs, or theory and modeling PIs. A PI is not just for a major mission. In her perfect world, the mentees become the mentors over time.

Dr. Matsuo said that people from under-supported institutions will often be male. She liked the inclusiveness, but could see a backlash. Dr. Fox said that NASA did not exclude, which is the worst thing that can be done. The discussion is about diversity across the board – if the first incubator is all of a type, like all women, NASA will have done it wrong. The Agency does not have to specify groups.

#### Adjourn

The meeting adjourned for the day at 5:51 p.m.

#### Thursday, December 20

#### Welcome to Day 3

Dr. Kozyra opened the meeting for the third day.

#### Overview of Agenda

Dr. Liemohn reviewed the agenda for the day, which included a work session, review of items for the letter to Dr. Fox, and reporting out. HPAC agreed to take some time to complete their writing.

#### HPAC Work Session

Dr. Liemohn began the review of the draft letter to Dr. Fox. It began with praise for HPD in: maintaining contact with Voyager as it left the solar system; the successful launch of PSP; the partnership with USGS on the magneto-telluric survey; the plan to split HTIDES/LCAS by suborbital and orbital rather than cost cap; and public outreach efforts, especially for PSP.

Dr. Klimchuk's piece on R&A praised HPD for its attention to this program, and noted the increased funding under DRIVE. HPAC recommended that the Division publicize the additional funding to the community, with specific information by individual program element. In the area of space weather, HPAC praised HPD's growing efforts and urged a continued emphasis on science rather than operations.

Dr. Matsuo read the finding encouraging further international collaborations, including the ESA Earth Observations Directorate. It stated that HPD could expand the LWS Institute activities to enable this. Dr. Goncharenko noted the importance of science-centric interactions, as opposed to the focus on missions. Dr. Matsuo added that ESA uses the European Community's resources, which Dr. Goncharenko also endorsed. Dr. Liemohn pointed out that HPAC had not actually talked about this yet. Dr. Matsuo explained a funding issue she had with the ESA program because there was no HPD counterpart. Dr. Angelopoulos thought she could have gone through a U.S. PI program for participating in international missions. Dr. Liemohn added that the LWS Institute has been very application-focused thus far. If HPAC were to propose something like this, he would keep it out of LWS. Dr. Angelopoulos was not sure the concept was appropriate. Dr. Goncharenko explained that under the International Space Science Institute (ISSI), ESA funds a place to meet for workshops and meetings, and provides some hotel support for teams. When Dr. Klimchuk said that HPAC needed more discussion, Dr. Goncharenko protested that the issue keeps getting postponed. Dr. Kozyra explained that the LWS Institutes were patterned after ISSI, but there would be difficulty funding international components. Dr. Liemohn suggested the statement be reworked as a request for information on how NASA could fund and/or host international people to enable ISSI-type activity. HPAC had discussed the mismatch of the NASA and ESA structures. It might help to have HPD input on how to enable some of this work.

Dr. Miralles presented her kudo on the Whole Helio initiative. Dr. Liemohn suggested adding a statement encouraging HPD to work with other divisions, and specifying inter-agency coordination as well. Dr. Ho's recommendation on the Rideshare program advised HPD to investigate how the program might be included in concept development through ROSES, and to investigate ways of obtaining science observations through non-traditional providers such as commercial entities. Dr. Klimchuk cited a DOD model worth reviewing, and Dr. Ho noted the APD and PSD efforts in this area.

Next, Mr. Filipi presented the statement of praise for and thanks to Ms. Luce for her tenure as Acting Division Director. Dr. Goncharenko provided a paragraph on incremental, medium-risk research, and the need to support it. She noted that the statement was a work-in-progress because HPAC had not discussed it much. Dr. Matthews was unclear about the recommendation, and Dr. Liemohn thought it should really address model assessments. Dr. Randall added that it suggested that NASA does not support assessment of models, but it does. Dr. Klimchuk agreed. Dr. Goncharenko explained that people get funding for model development, but when someone else wants to use the model, there is no support for that work. It is not systematic. She clarified that the statement was about testing several models with the same problem. Dr. Kozyra said that there was a lot of discussion about CCMC's activities, which include validating the science of a model. This requires that the model developers help in the assessment. Dr. Randall noted that it would not be funded in a science study. Dr. Liemohn did not hear consensus and wanted to move on. He advised rephrasing the piece as a question for more information about NASA support for this activity.

Dr. Randall presented recommendations noting the diversity incubator concept and advising HPD to host workshops on proposal writing and mission development, and to support faculty development. In addition, HPAC was recommending that the Division collect diversity metrics and pay special attention to graduate students in offering the workshops. Dr. Matthews questioned the extension of PI training to graduate students. Dr. Liemohn explained that the effort is supposed to mirror the mission-oriented PSD summer school at JPL, and Dr. Angelopoulos thought it would be easier to provide training to students than to people already with jobs. Dr. Randall pointed out that under-represented groups tend to leave the field early, at the postdoc level, so it was important to reach them beforehand.

Dr. Randall then presented the first of two recommendations on the SR. This recommendation would have the missions in extended phase reassess their operations for the SR. For the second recommendation,

Dr. Angelopoulos wrote that HPAC disagreed with the idea of longer prime missions, instead recommending the alternative of a “soft SR” for missions entering their first SR.

Dr. Kistler read a draft kudo to LPAG for its community engagement, with a suggestion to reassess the topics. Dr. Matsuo presented a recommendation that GDC coordinate with NSF on ground-based measurements. Finally, Dr. Angelopoulos presented concerns and recommendations related to the GDC STDT. He noted that HPAC was perturbed by the STDT process under FACA rules, especially since the result could be an unaffordable mission or programmatic delays. The recommendations were that NASA conduct a feasibility study before moving into an acquisition plan; that NASA follow the orbital recommendations from the study; that the Agency seek broader community input; and that NASA move quickly to assemble a technical feasibility team once the report is issued.

#### HPAC Report Out to HPD Director

Dr. Liemohn reviewed the findings and recommendations for Dr. Fox, as follows:

1. Thanks to Dr. Fox for her time.
2. Acknowledgement of mission and operational successes.
3. Thanks to Ms. Luce for her leadership as Acting Division Director.  
Ms. Luce thanked and praised HPAC in return, and said she looks forward to working with them and Dr. Fox.
4. Praise for DRIVE implementation and success rates.
5. International collaboration recommendation from Dr. Matsuo.
6. Praise for the Whole Helio initiative.
7. Rideshare recommendation.  
Dr. Fox replied that she would like to discuss this at the next HPAC meeting, as she would like guidance on issues such as the short timeframes and selection criteria. Ms. Luce suggested also addressing the types of instrumentation that would be most valuable on the various potential platforms. Dr. Liemohn pointed out that FACA rules preclude doing a survey. Mr. Filipi suggested that there be a presentation from the Air Force, which already does this. Dr. Kozyra was to look into that, and HPD would collect information for the Committee.
8. Recommendation that the HPD website promote accomplishments.
9. Praise for Dr. Voytek and the Idea Lab.
10. Thanks to Dr. New for the briefing on gender and SMD actions, which are commendable.
11. Request for more information about assessment of modeling, and R&A converting research code to open source platforms.
12. Praise for Dr. Hayes’ activities addressing data management and computing issues.
13. Regarding the SR process, the recommendation to reassess L1 operations requirements, and the recommendation to have a “soft SR” for missions just entering the extended phase.
14. Reassessment of the LPAG process and praise for the Group’s community engagement.
15. Two GDC STDT recommendations. First, concern about the impact of FACA, with a recommendation for a technology feasibility study with community input. Second, a recommendation to coordinate with NSF on ground-based support for GDC.

Dr. Fox explained that the FACA rules were required, not inadvertent. She asked that the final letter express this as a consequence of FACA. As for the second recommendation, Dr. Fox said that that is the intent. HPD needs the support of the entire community in order for this mission to go forward.

Dr. Liemohn thanked HPD and the support staff. Dr. Fox said that this was her first HPAC meeting, and they set a high bar. The findings gave HPD something to act on, and she appreciated everyone’s time.

Dr. Miralles asked whether DRIVE funding might end. Ms. Luce explained that it received both overall and smaller increases. The latter have no mechanism to continue into the long term, but that is possible. They are over and above the steady increase from DRIVE. HPD will package the messages better and spread the word. Dr. Fox confirmed that HPD could send material to HPD members individually for independent responses. She would appreciate feedback on the messaging for the community.

There was discussion about the scheduling of the next meeting, which could occur in May of 2019, with an additional telecon if needed.

Ms. Luce praised the HPD team for its cohesiveness and cited Dr. Spann's role in making that happen.

Adjourn

The meeting adjourned at 12:25 p.m.

## Appendix A Attendees

### *Heliophysics Advisory Committee Members*

Michael W. Liemohn, University of Michigan, *Chair*  
Vassilis Angelopoulos, UCLA  
Paul Cassak, West Virginia University  
Darko Filipi, Adcole Maryland Aerospace  
Larisa Goncharenko, MIT Haystack Observatory  
George Ho, Applied Physics Lab  
Lynn Kistler, University of New Hampshire  
James Klimchuk, NASA Goddard Space Flight Center  
Tomoko Matsuo, University of Colorado at Boulder  
William Matthaeus, University of Delaware (remotely)  
Mari Paz Miralles, Harvard-Smithsonian Center for Astrophysics  
Cora Randall, University of Colorado at Boulder  
Janet Kozyra, NASA HQ, DFO

### *NASA Attendees*

Gallen Fowler  
Nicola Fox, *Heliophysics Division Director*  
Roshanak Hakimzadeh  
Sam Haurie  
Jeffrey Hayes  
Mona Kessel  
Jared Leisner  
Peg Luce  
Michael Mesarch  
Jeff Morrill  
Daniel Moses  
Michael New  
Vanessa Patrick  
Simon Plunkett  
James Spann  
Katya Verner

### *Other Attendees*

Francesco Bordi, Aerospace  
Art Charo, NAS  
Anthea Coster, MIT  
Adam Grazzaw, Booz-Allen  
Allison Jaynes, University of Iowa  
Ben Kallen, Lewis-Burke  
Mark Linton, NRL  
Aaron Ridley, UM  
Elizabeth Sheley, Electrosoft  
Ana Wilson, Electrosoft

*Remote Attendees*

Sarah Brothers, NAS  
Heather Butrell, NASA  
Stephen Clark, Space News  
Monte DiBiasi,  
Jeff Foust, Space News  
Allison Hannigan  
Grace Hu, OMB  
Matthew Landon  
Mark Linton, NRO  
Michael Mesarch  
Gene Mikulka, Talking Space  
Valerie Nenteed  
Rachel O'Connor, Ball Aerospace  
Robert Pfaff, NASA Goddard  
Dipak Srinivasan, Johns Hopkins University  
Erik Syrstad, Space Dynamics Laboratory  
Ashley Wilkins, American Astronomical Society

## Appendix B Advisory Committee Membership

**Michael W. Liemohn, Chair**

University of Michigan

Janet Kozyra (Executive Secretary)

NASA HQ

Vassilis Angelopoulos

UCLA

Paul Cassak

West Virginia University

Darko Filipi

Adcole Maryland Aerospace

Larisa Goncharenko

MIT Haystack Observatory

George Ho

Applied Physics Lab

Lynn Kistler

University of New Hampshire

James Klimchuk

NASA Goddard Space Flight Center

Tomoko Matsuo

University of Colorado at Boulder

William Matthaeus

University of Delaware

Mari Paz Miralles

Harvard-Smithsonian Center for Astrophysics

Cora Randall

University of Colorado at Boulder

## Appendix C Presentations

1. *Heliophysics Division Overview*, Nicola Fox
2. *Ideas Lab Briefing*, Mary Voytek
3. *SMD Actions and Research*, Michael New
4. *SMD Strategic Initiative for Scientific Data and Computing*, Jeffrey Hayes
5. *Senior Review Considerations*, James Spann
6. *NASA Living with a Star Program Analysis Group*, Mark Linton and Anthea Coster
7. *Geospace Dynamics Constellation Science and Technology Definition Team*, Jared Leisner
8. *GDC STDT Mid-term Report*, Allison Jaynes and Aaron Ridley
9. *Midterm Assessment of the Heliophysics Decadal Survey*, Art Charo

## Appendix D Agenda

**Heliophysics Advisory Committee (HPAC) Meeting**  
 NASA Headquarters, Washington, DC  
 December 18-20, 2018

Tuesday, December 18, Room 1Q39		
9:30	Welcome	Dr. Janet Kozyra, DFO, NASA
9:35	Overview of Agenda	Dr. Michael Liemohn, HPAC Chair
9:45	Heliophysics Division News, Updates, and New Initiatives	Dr. Nicola Fox, NASA
10:50 BREAK		
11:05	Q&A	Dr. Nicola Fox, NASA
12:00 LUNCH – Presentation: NASA-NSF Ideas Lab on Astrobiology		
1:00	Science Mission Directorate (SMD)- Research & Analysis Program Topics (including PI Diversity & Innovation)	Dr. Michael New, NASA, NASA HQ
2:00	Data Management and Computing (SMD-Wide Strategic Planning; HPD High-End Computing Issues: Open Source/Open Science)	Dr. Jeff Hayes, NASA
3:15 BREAK		
3:30	HPAC Work Session	
5:00	ADJOURN	
Wednesday, December 20, Room 1Q39		
9:30	Welcome to Day 2	Dr. Janet Kozyra, DFO, NASA

9:35	Overview of Agenda	Dr. Michael Liemohn, HPAC Chair
9:45	Senior Review Requirements Discussion	Dr. James Spann, NASA
10:45	BREAK	
11:00	Updates on the Living with a Star Program Analysis Group (LPAG) Activities	Drs. Mark Linton and Anthea Coster, LPAG Co- Chairs
12:00	LUNCH	
1:00	Update on the Geospace Dynamics Constellation Science and Technology Definition Team	Dr. Jared Leisner, NASA Drs. Allison Jaynes and Aaron Ridley, Co-Chairs
2:00	Public Comments	
2:10	Preparing for the Decadal Survey Midterm Report	Art Charo, National Academy of Sciences
3:10	BREAK	
3:25	HPAC Work Session	
5:00	ADJOURN	

Thursday, December 21, Room 1Q39

9:30	Welcome to Day 3	Dr. Janet Kozyra, DFO, NASA
9:35	Overview of Agenda	Dr. Michael Liemohn, HPAC Chair
10:00	HPAC Work Session	
10:50	BREAK	
11:00	HPAC Report Out to HPD Director	
12:00	ADJOURN	