

**NASA Advisory Council
Planetary Science Advisory Committee**

June 21–23, 2022

Virtual Meeting

**NASA Headquarters
Washington, D.C.**

Serina Diniega, Acting Chair

Stephen Rinehart, Executive Secretary

Table of Contents

1. Welcome and Introduction	3
2. 2020 Planetary Mission Senior Review	7
3. Mars Exploration Program	9
4. Analysis Group (AG) Presentations	11
5. AG Q&A Session	16
6. Discussion/Potential Findings	17
7. Planetary Defense	18
8. Research and Analysis	19
9. IDEA in PSD	22
10. Here to Observe (H2O) Pilot	23
11. Cross-AG IDEA Working Group	24
12. Advancing IDEA in Planetary Science	24
13. Lunar and Planetary Institute	26
14. Findings and Recommendations	28
15. Astrobiology	30
16. Lunar Update	31
17. Planetary Data Ecosystem	33
18. SPD-41 Update	35
19. Origins, Worlds, Life Decadal Report	<u>37</u>
20. Discussion	38
21. Public Comment	39

Appendix A- Attendees

Appendix B- Agenda

Appendix C- Membership

Appendix D- Presentations

Appendix E- Chat

*Report prepared by
Joan Zimmermann, T&J, LLC*

June 21, 2022

Welcome/Around the Table

Planetary Science Advisory Committee (PAC) Executive Secretary, Dr. Stephen Rinehart, opened the first hybrid (in-person/virtual) meeting of the PAC. Dr. Serina Diniega, sitting in for PAC Chair Dr. Amy Mainzer, offered initial remarks and introduced the day's agenda.

Planetary Science Division (PSD) Update

Dr. Lori Glaze, Director of the Planetary Science Division (PSD), provided an update, introducing Dr. Joan Salute as her co-briefer. PSD has three new Program Executives and a new IPA; respectively they are Barbara Hilton, Karen Gelmis, Melissa Morris, and Nicholas Lang. Briefly addressing the Fiscal Year 2022 (FY22) budget, Dr. Glaze remarked that the FY22 appropriation continues to show strong support for Science, with the top line greater than \$7.6B, representing significant growth over FY21 at both the Agency and Science Mission Directorate SMD level. MSR (Mars Sample Return), Europa Clipper, and the Lunar Discovery and Exploration Program (LDEP) were called out and are well supported with this budget. PSD received \$427.2M above FY21's enacted budget, and is very pleased with the support from Congress. However, the number is still almost \$80M less than the President's Budget Request (PBR) for 2022, which has resulted in some impacts to operations. PSD will need to reassess the Operating Plan to meet the actual enacted budget, and is working on an initial version, which will be shared with the PAC once approved by Congress. Dr. Glaze displayed a new version of the "fleet chart," which offers a more temporal feel rather than spatial, illustrated by two spirals. The inner spiral being Moon and Mars, the outer the rest of the Solar System, with missions represented from oldest to youngest.

Dr. Salute gave flight project updates, noting that one of the solar arrays on the Lucy spacecraft did not fully deploy. The team has been ground testing and examining what will be necessary to meet mission requirements with the current disposition of the array, and has made multiple attempts to redeploy. Each attempt has made some progress, but the array has not yet fully latched. There will be two more attempts. The array has become more stiff with each attempt, thereby functioning better each time.

The InSight probe continues to log marsquakes, but its solar arrays are accumulating more dust, and the mission expects to cease science operations sometime this summer or fall. There may not be enough power to run anything at all by the end of the year. InSight is reaching the end of its second extended mission, so it has already gone over and above the call of duty.

The Psyche spacecraft has arrived at Cape Kennedy in preparation for launch. The launch has been delayed to a contingency window to address problems with flight software, and is now scheduled to launch no earlier than (NET) 20 September 2022 [Since the meeting, the Psyche launch has been postponed and the mission future is under review]. The delay will have effects on downstream rideshare missions, thus Janus (a SIMPLEX-2 mission) is evaluating the impact of the new launch period, to determine whether these windows will allow Janus to reach its targets.

The Europa Clipper ATLO (Assembly, Test, Launch, and Operations) is going well and has been running smoothly over the last two months. Four of its instruments will have been delivered by 24 June: E-UVS (Europa Ultraviolet Spectrograph), E-THEMIS (Europa Thermal Imaging System), PIMS (Plasma Instrument for Magnetic Sounding), and EIS WAC (Europa Imaging System Wide Angle Camera).

Dragonfly, the Titan probe, is still heading to launch in June 2027, and will get to Titan by 2034. Dragonfly passed its preliminary design Review (PDR) in October 2021. The Applied Physics Laboratory now houses a Titan chamber for specialized testing. Drone testing has been performed in desert conditions, and two international agreements were recently signed.

The DART spacecraft is scheduled to impact the double-asteroid system, Dimorphos/Didymos on September 26 of this year. An international contribution, the Light Italian CubeSat for Imaging of Asteroids (LICIA) cubesat will hopefully image the impact, as the mission is poised to help further understanding of how an impactor might change the trajectory of a potentially hazardous near-Earth asteroid (NEA).

Lunar Strategy and News

Dr. Glaze reported on SMD efforts in working with the Exploration Systems Science Integration Office (ESSIO), which coordinates all science activities carried out at the Moon. SMD and ESSIO are also working closely with the Space Technology Mission Directorate (STMD) and Human Exploration and Operations in developing an integrated lunar strategy. The LunaH-Map instrument is now integrated on Artemis I, and is awaiting launch. Lunar Trailblazer has been removed from the IMAP manifest so that it can fly sooner on the IM-2 Prime 1 mission, which will be launching in about a year. Eight new Co-Investigators (Co-Is) have been selected for the Volatiles Investigating Polar Exploration Rover (VIPER) mission, a lunar rover that is now preparing for a Systems Integration Review (SIR).

PSD held a Senior Review in 2022, wherein it assessed Mars Odyssey (Ody), Mars Reconnaissance Orbiter (MRO), InSight, Mars Science Laboratory (MSL Curiosity), Mars Atmosphere and Volatile Evolution (MAVEN), New Horizons, Lunar Reconnaissance Orbiter (LRO), and OSIRIS-REx. Five missions will be extended for three more years. OSIRIS-REx, to be renamed to O-APEX, for Apophis Explorer, and has been extended for nine years; O-APEX will visit Apophis, an asteroid that will make an extremely close approach to Earth in 2029. InSight was approved to the end of calendar year 2022. Because New Horizons had not identified any close fly-by targets, the mission team created an innovative proposal for a two-year extension for a suite of science, jointly funded by the Heliophysics, Planetary and Astrophysics Divisions. New Principal Investigators (PIs) have been named for MAVEN and for OSIRIS-APEX. The Review's final report and the NASA response is available online.

A Venus Science Coordination Group (VeSCoor) is in the process of being established to enhance science return from the three new Venus missions: VERITAS, DAVINCI, and EnVISION. The Group will serve as a forum for dialogue; more details about VeSCoor will be available in July. Its primary goals are to identify new, unanticipated scientific approaches and outcomes based on synergies among the missions to Venus, and to suggest studies that will enhance overall scientific return. The Group will meet twice a year. An EnVISION VenSAR (S-band radar) Science Team has already been competitively selected.

Dr. Glaze presented a science highlight on the dynamics of clathrate formation in Ocean Worlds. Recent advances in thermal modeling techniques have shown how clathrates, in this case methane inclusions in icy shells, can either help sustain a sub-surface environment, or actually limit it. These new insights will help to better design measurements to be taken in future Outer Planet exploration.

Five new Early Career Award (ECA) winners were announced for 2021. The next competition in the ROSES-22 ECA call has a proposal deadline of 8 December 2022.

Future Announcements of Opportunity (AOs) include New Frontiers-5 (NF-5), which was pulled forward to 2023; the schedule for the draft AO and AO has just been released. The Discovery call will now occur after NF-5; timing is to be determined. Updated information will be available on the Science Office for Mission Assessments (SOMA) website: <https://soma.larc.nasa.gov/index.html>.

The NASA Equity Action Plan was launched in April. The Plan is a comprehensive effort to assess and examine potential barriers and challenges for historically underrepresented/underserved communities in aerospace and STEM fields, with much emphasis on recognizing and understanding barriers. NASA is

committed to this pathway. To this end, PSD has a new, internal Inclusion Diversity Equity and Accessibility (IDEA) team.

NASA and PSD is still reviewing in detail the Planetary Decadal Survey, *Origins, Worlds, and Life*, released on 19 April of this year. Dr. Glaze expressed PSD's appreciation for the Steering Committee and the Survey panels. The official timeline for a preliminary response to the Survey is July, and NASA hopes to hold a Town Hall as a platform for the formal response in August.

Findings and Responses

Dr. Glaze addressed PAC findings from February 2022:

Finding 1: SPD-41

There are concerns that the new policy on open data, NASA SPD-41, could disadvantage new proposers and those without institutional resources to aid in compliance. The PAC commends NASA for putting the draft policy out for public review, and encourages NASA to fully address the concerns raised by the AGs and by the community through the public comment process.

Response: The community responses to the draft SPD-41 are currently being given full consideration. An update on the progress of implementing the responses will be given by Steven Crawford during the June 2022 PAC meeting (Day 3).

Finding/Recommendation 2: IDEA

The PAC commends NASA for supporting inclusion, diversity, equity, and accessibility (IDEA) efforts in planetary science and working towards inclusive NASA-supported conferences and meetings.

Recommendation: To continue advancing IDEA principles in the community, the PAC recommends that NASA should leverage existing IDEA efforts, such as the IDEA Inter-AG working group, the NASA HQ IDEA group, or social scientists who focus on IDEA, to ensure that all NASA-supported conferences are as inclusive and safe as possible along multiple axes of representation, and in particular for historically excluded communities.

Response: NASA thanks the PAC for these suggestions and plans to continue to engage with these types of groups to help improve inclusion, diversity, equity, and accessibility within the planetary science community. Further updates on the IDEA landscape in PSD and in the wider community will be the focus of several talks on Day 2 of the June 2022 PAC meeting.

Finding/Recommendation 3: Community Service

The PAC appreciates the initial efforts to identify avenues of community service within the planetary science community and estimated costs and issues associated with potential direct payment for such work. These efforts present an important starting point for a needed discussion and effort.

Recommendation: In response to the request for PAC feedback with respect to prioritization for potential initial PSD efforts, the PAC recommends a first focus on funding surveys/studies of the workforce to assess the state and concerns of the planetary science community, as these seem less complicated to initiate with funding and may help fill important information gaps.

Response: NASA acknowledges this recommendation and would value such studies for determining how to best approach IDEA issues. As noted under Finding 4, commissioning such a study has significant challenges and would take time to implement.

Finding 4/Recommendation: COVID Impacts & Workforce

Finding: The PAC notes that the impacts of COVID have been numerous and are likely to be felt for years to come, by both individuals and larger efforts such as mission teams. Surveys of the workforce can provide critical sources of relevant information, either directly about impact or indirectly by looking at who is participating and in what capacities. The most recent workforce survey for the planetary science community was prompted by the ongoing Decadal Survey and was collected prior to COVID.

Recommendation: The PAC recommends that NASA consider commissioning a new survey, with a primary aim of assessing COVID impacts and institutional support for community service. Input on the construction of the survey should be solicited from social scientists, community groups containing relevant expertise (such as the cross-AG IDEA working group or the AAS/DPS Professional Climate and Culture Subcommittee (PCCS), and/or those involved in constructing and analyzing the last workforce survey.

Response: NASA acknowledges the idea that a robust survey of the Planetary Science workforce would help understand the community, particularly impacts from COVID and the level of current support for community service activities. However, any survey commissioned by NASA must be approved by the OMB—a process that involves a public notice in the Federal Register and an open 60-day comment period, can take at least six months, and may require OMB-requested changes. Even if NASA commissioned a third-party to create, distribute, and analyze such a survey, the OMB may still need to be involved. Professional societies (e.g., AGU or AAS) may be better placed to conduct such a survey.

Q and A

Dr. Jennifer Glass commented on the issues surrounding workforce surveys, suggesting that it might be good to think about working with the various science societies to make the process more efficient. Something along those lines has just been accomplished with the Astrobiology Science Conference (AbSciCon). Societies like the American Geophysical Union (AGU) can distribute such surveys, but not create them. Perhaps NASA might work with the societies to find a way to distribute surveys. In the case of AbSciCon, a sociologist helped to both create the survey and process the data. Dr. Rinehart supported the idea of employing a sociologist and working with the professional societies, but he noted that the Office of Management and Budget (OMB) must be in the loop if NASA is going to pay for it, presenting a bit of a gray area.

Dr. Hope Ishii asked about the Psyche/Janus situation, and whether there was a contingency for both Psyche and the ridealong. Dr. Glaze said that there are some other opportunities for Psyche to launch, one in 2023, and one in 2024. Dr. Ishii asked if there were an opportunity for Janus to “jump ship?” Dr. Glaze explained that the ride shares are class D payloads, meaning that they are riskier, and if the mission has changes, the rideshare must accommodate such changes. There is also a hard cost cap, but when the SIMPLEX missions were selected, the PSD could support only one. However, the Heliophysics Division (HPD) had interest in one of them, as did a lunar team, so they each took on responsibility for those individual SIMPLEXes. HPD now manages ESCAPEDE, and has chosen to launch it as a free flyer. PSD manages LunarH-MAp and decided to fund it through a variety of means. Dr. Glaze was still hopeful that Janus will launch with Psyche; PSD is choosing to take that chance. Asked if there were any thoughts from Headquarters to “normalize” approaches to rideshare missions and class D payloads, Dr. Glaze said that there are now requirements for rideshare missions to carry some communications packages, and PSD is looking for opportunities with guidance from rideshare office. Dr. Salute noted that there is also a new procurement vehicle for obtaining cheaper, standalone launches, allowing higher risk at lower cost opportunities.

Dr. Diniega asked about budgetary threats to the Near Earth Object (NEO) Surveyor and the international Mars Ice Mapper (iMIM) mission. Dr. Glaze said that iMIM had been zeroed out in the PBR, and that at this point, NASA is not involved in iMIM, but other international space agencies are moving forward

with the mission. NASA is still interested in playing a role if appropriate. As for NEO Surveyor, NASA recognizes that this a really hard cut in 2023, but definitely wants to continue the mission. The current expectation is to launch NET 2028. PBR 2023 is on the Hill now, and there is nothing NASA can do until there is an appropriations vote for 2023. The request cannot be changed.

Asked if there were another way to get feedback to Headquarters that is not in the form of a survey, Dr. Rinehart said he did not have an answer. Asked if there were a way to bring new Co-Is on to the OSIRIS-APEX mission, Dr. Glaze said an opportunity would be coming, but she had no details at this point. Dr. Diniega asked if any work was being done on the engineering side, such as for coordination of communications relay, in the new Venus Science Coordination Group. Dr. Glaze noted that as the new Venus missions are PI-led, NASA will not impose any “unintended” direction.

2022 Planetary Mission Senior Review

Drs. Henry Throop and Lindsay Hays briefed the PAC on the results of the 2022 Planetary Mission Senior Review. Senior Reviews are typically held every three years. NASA assesses its missions typically toward their end date, recognizing that extended missions can offer great benefits to NASA at a much lower cost than a new mission. Reviewed missions must make the case that they can still return high-quality science, and programmatic benefits (relay, site selection, international cooperation, etc.). Missions are also encouraged to provide descopes and overguides. Historically, the vast majority of NASA missions have been extended. Some, like Mars Odyssey, are up for review for the ninth time. Missions are not ranked, and they are in not in competition with one another. The most recent review had eight panels, each with a chair and 7–12 panelists, and each mission was independently assessed by review chairs, Mr. Doug McCuiston and Dr. Lisa Pratt. The process began in June 2021, involving an intensive two-week review process for each mission. After a final report was completed, the PSD Director made the final decision on mission extensions.

All eight missions, Mars Odyssey, MAVEN, MRO, InSight, MSL Curiosity, MAVEN, New Horizons, LRO, and OSIRIS-APEX were extended, as previously discussed in the PSD status briefing.

Dr. Hays discussed the New Horizons mission, which is being renewed for two years, although the team had proposed three years. After a multidisciplinary review, it was decided that New Horizons would image Uranus and Neptune, observing them from unique geometries not possible from Earth, enabling astronomers to compare them with distant exoplanets. New Horizons’ cameras can also be used to map the cosmic background in both visible and ultraviolet (UV) light. After the two-year extended mission, New Horizons will be given the opportunity to propose to be part of the Heliophysics System Observatory (HSO).

NASA’s response to the Senior Review outcome can be found at <https://science.nasa.gov/solar-system/documents/senior-review>.

Dr. Diniega asked if budget was considered in the reviews. Dr. Throop said that the Senior Review is strictly a science review, but that the panels do evaluate the overguides and descopes. Budgeting itself is outside of the panels’ expertise. Asked what sorts of criteria for IDEA, succession plans, community growth, and related issues were considered, Dr. Throop said there were 12 evaluation criteria: one criterion is focused on training of future leaders, and plans for bringing on new people, deputy PIs, instrument scientists, etc. In terms of IDEA goals, timing was an issue because SMD was in the process of developing their own IDEA criteria at the time of the review, so rather than have two inconsistent sets of requirements, IDEA was not an integral part of this review. Future Senior Reviews will certainly assess IDEA criteria. Dr. Hays commented that some panels did make note of mission teams that were doing a “great job” in the areas of IDEA. Dr. Throop said that broad use of the data by community was also an important criterion. Dr. Dana Hurley asked about the process for choosing review chairs. Dr. Throop said

that panel chairs were chosen by himself and Dr. Hays, describing the process as just like looking for people for a regular review panel. For the Senior Review, they sought people who were experienced in missions, data, operations, and mission management, to sit as review chairs. For panelists, they make sure there are experts, including interdisciplinary experts in the case of New Horizons, which spanned PSD, APD, and HPD goals.

Dr. Glaze said that when a multidisciplinary proposal comes in that necessitates an evaluation from the PSD side, that PSD commits to the multidisciplinary assessment of all the proposed science objectives. HPD and APD also stood up special panels to look at their own science objectives independently during this review. It was also noted that this year's review, a Code of Conduct (CoC) had not yet been put in place. Dr. Diniega asked if the extended missions had committed to conversion to PDS4. Dr. Throop said that SPD-41 requires that any new data must use PDS 4 format. Missions were encouraged to submit overguide funding to convert PDS3 to PDS4; two Mars missions did this and were approved.

Q&A session

Dr. Diniega asked if any Lessons Learned (LLs) were being recorded at the rideshare coordination office. Dr. Glaze said she knew that the office is working hard for consistency across the divisions, and learned a lot through the most recent round of SIMPLEx. A briefing on the formal LL process was just presented in SMD, and it is in the process of being documented. Mr. Ianson commented that the rideshare office is collecting LLs, but the sample size is small, and each situation tends to be unique. In these small cases, it would take years to really identify trends or consistent patterns. Dr. Glaze added that the landscape is also evolving, with the VADER contract. Mr. Ianson said that the influx of commercial providers changes the rideshare landscape as well. Dr. Glaze mentioned that she didn't think there is a formal process yet for the teams to report back their LLs. Dr. Michael New reported that there is a brand-new LL process in the works, and that if NASA wanted to do something more substantial, it could do it internally, with Booz Allen Hamilton, or Aerospace Corporation.

Regarding community surveys, if the goal is to broaden the diversity of reviewers, Dr. New suggested using Logistics Management Institute (LMI). NASA has done related things, such as the Voice of the Customer exercise, and has changed some processes as a result. It is just a matter of what NASA or the community wants to ask. Asked if such approaches involve OMB, Dr. New said that because these are qualitative analyses, they do not require the attention of OMB. If the subject is broad enough, an Independent Review Board (IRB) might be necessary. Dr. Glaze and Dr. New pointed out that these are labor-intensive processes, based on interviews and detailed notetaking. Booz Allen Hamilton in particular has social scientists on board. It depends on the questions. Dr. New said NASA does not have the best connections to social science, thus it would behoove the Agency to work with the National Science Foundation (NSF) on something like this.

Dr. Justin Filiberto asked when the next SIMPLEx call would be. Dr. Glaze said PSD would offer it again when the budget allows. Dr. Hurley asked how PSD was incorporating COVID impacts into the budget? Dr. Glaze said that from the earliest days of the pandemic, PSD tracked costs closely, with monthly to quarterly reports. There were particular impacts to Psyche and Clipper (which were both in peak spending, phase C), and the division has definitely already accommodated these costs. Going forward, while PSD is still monitoring, it is becoming harder to separate out COVID and normal challenges. There are supply chain issues as well. Overall, the Agency is probably going into a new phase, accommodating longer lead times, and shifting phasing within budget cycles. Dr. Glaze concurred with the sentiment that it sounds like it will be more aftereffects of COVID, inflation, supply chain, etc. These funds will all come out of the existing budget. There is no extra money to cover COVID impacts. In 2021, PSD had to accommodate Psyche and Clipper significantly, re-prioritize, delay calls, etc. Each Spring during the Planning, Programming and Budget Execution (PPBE) period, there will be a chance to re-evaluate.

Dr. Diniega asked how these increased costs were incorporated into Senior Review (SR) proposals. Dr. Hays said she didn't think any specific issues related to COVID were reported during the SR process. Dr. Filiberto asked if there were any discussion at Headquarters as to how to get ahead of what is coming, such as the changes in costs of parts, supply, previous mission costs. Dr. Glaze said that PSD tries to learn from its most recent experiences during each budget exercise. No matter what, it is always a challenge, and the division must stick to guidelines. There is zero to little opportunity to request more money with each proposed budget. Dr. Ishii said she thought inflation will be the biggest impact; Dr. Glaze agreed that inflation will pose a challenge across the board. Dr. Rinehart commented that budgets are not well-timed relative to current events. Dr. Glass asked if it would be possible to have a blanket CoC for all review panels. Dr. New said that at the moment, there is a CoC that encompasses all ROSES peer reviews, and it will be applied to all SRs henceforth. NASA also has made it policy to require CoCs for conferences. Headquarters is working on a template for CoC for missions, and field work. One difficulty in the CoC depends critically on who the perpetrator and victim is, as well as location. However, every recipient of a federal grant or contract must demonstrate that they are in compliance with civil rights laws. NASA does not have the authority to intervene; it can only advise the person being harassed to contact the campus Title IX office, for example.

Mars Exploration Program (MEP)

Mr. Eric Ianson, Mars Exploration Program (MEP) Director, briefed the PAC. In March of this year, MEP conducted a low-cost Science Mission Concepts for Mars Exploration Workshop. The Perseverance rover continues to make progress in its traverse. The Ingenuity helicopter has logged 29 flights in a little over a year; the Ingenuity team recently won the Robert J Collier award. There is a new Chair for the International Mars Exploration Working Group (IMEWG), Dr. Sanjay Vijendra of the European Space Agency (ESA). The WG will hold a face-to-face meeting in Turin in September 2022. Mr. Art Thompson is the new Mars 2020 Program Manager (PM). MEP passed a successful Program Implementation Review/KDP-III, for which Mr. Orlando Figueroa was Chair; its primary finding was to clearly define a plan forward for MEP while MSR is in development. There will be an MEP Strategic Planning Retreat 22–23, June 2022 at the Jet Propulsion Laboratory (JPL), which will address potential science objectives, and take a holistic look at the program.

There were four Mars missions in the most recent Senior Review: MAVEN, MSL, Mars Odyssey, and MRO. Budget planning for all these extended missions is in process. Briefly updating the status of MEP orbiters, Mr. Ianson reported that Mars Odyssey recently celebrated 21 years, but recent propellant gauging system studies estimate that there is only 3–4 kg (vs. expectation of 9 kg) of usable fuel remaining. It has been hypothesized that excessive thrust maneuvering during safe mode activities used the extra fuel, potentially reducing the orbiter's lifetime.

Perseverance has traversed more than 12,000 meters, and Ingenuity has logged 29 flights (24 more than its intended tasking). The mission is now in the Delta Front Campaign, and it is exciting to have entered this second science phase. The rover has collected eight sample cores, plus one witness core and one atmosphere core. There is an amazing diversity of samples already, judging solely by imagery. Ingenuity's 26th flight took an image of Perseverance's Entry Descent and Landing (EDL) gear, its backshell and parachute. Martian winter has just begun; Ingenuity briefly lost contact with Earth in May, and the team is now suspending onboard heaters at night to preserve power, and hopes to renew operations in the Fall when there will be more solar ray incidence.

As noted previously, iMIM funding has been zeroed out, but NASA continues to support the iMIM Measurement Definition Team, while international partners are moving forward in support of the mission. The final report from the Measurement Definition Team (MDT) is expected in early July 2022.

The Sample Receiving Project is under way, and more complex than simply the sample receiving facility. Its primary objective is to enable safe and rapid release of Mars samples to external laboratories for investigation, and to enable future long-term curation. Ground Sample Recovery activities are being studied, to determine when and where the handover takes place. A NASA facility Assessment Study is looking at priorities. A request for proposals (RFP) was released in April to engage architecture and engineering firms for studies to evaluate all modalities and capabilities, to be completed by 2023.

Dr. Michael Meyer presented some science highlights, beginning with exploring aspects of the Jezero Crater, and its gradual change to more sulfate-rich regions, and the implications for Mars' watery past. MRO has been looking at the South polar cap, modeling mismatches with observations on glacier flows. Recent advances in modeling suggest that data on the global distribution of fresh impact craters is skewed toward the north and spotting them depends on the albedo of the surface, keeping in mind there is an observational bias. MAVEN data on upper atmosphere interactions shows the importance of continuity of monitoring and long-term observations for the insights they provide on atmosphere loss at Mars.

Mars Sample Return

Three Decadal Surveys have now prioritized MSR. An area for the first cache depot has been identified, termed the "Landing Strip." This will be the first surface cache. In late September 2022, MEP/MSR is planning for a Science Community Workshop. It has been determined that there are igneous rocks in the collected samples, which will provide the absolute age of Jezero Crater. Cores also contain salts and other products of aqueous alteration. There are organic compounds in some samples, suggesting that analysis can potentially determine if they are biogenic or abiogenic in origin. The samples will also help to fill gaps in knowledge as to the safety of the Mars environment for human exploration. *Astrobiology* will issue a special June 2022 supplement on sample science. Also in progress is a NASA/ESA MSR Science Memorandum of Understanding (MOU) to set the ground rules for sample handling and distribution. A Science Management Plan is also in draft, preparing for signature by September 2022. The MSR Campaign Science Group Phase 1 will be meeting in late June, and will be populated by a diverse array of experts, including Dr. Andrew Steele.

MSR Campaign

Mr. Jeff Gramling briefed the PAC, detailing the flight elements for capture, containment, and return to Earth. The campaign is finishing phase A, and expecting to hold a KDP-B assessment in September of this year. Mr. Gramling displayed an animation of the Vertically Ejected Controlled Tip-Off Release (VECTOR) device, a pre-ignition separation mechanism for launching the Mars Ascent System into orbit. A model of the Earth Entry Vehicle was tested in Utah, without a parachute, in March 2022. Testing is ongoing for the Sample Retrieval Lander. Phase A accomplishments include: primary trades in areas such as single vs. dual Lander architecture, a need for MMRTGs, and launch dates; addressing of pre-formulation architecture issues; and simplification and consolidation of NASA Center assignments. MSR will hold a Systems Requirement Review/Mission Design Review on 12 July, and expects to enter Phase B in early 2023. Mr. Gramling summarized by emphasizing the timeliness of MSR activity, particularly in view of NASA's strong partnership with ESA, and the substantial work that has been performed to validate the elements of sample return.

Q&A

Dr. Ishii, referring to the issues with Mars Odyssey's propellant level, asked if that potential problem might be impacting other missions using similar technology. Mr. Ianson said that this was not the case, to his knowledge, but took an action to double-check (and confirmed by the end of the meeting that no other missions are impacted by this problem). Dr. Filiberto asked if Perseverance would stay in place until Ingenuity flies again. Dr. Meyer said that the intent is to send the rover up the face of the delta and come back, when there will be a good opportunity to put those samples at the Three Forks site. Samples are to be deposited in November of this year, at the earliest. Asked if there will be multiple depot sites, Dr.

Meyer replied that the rover carries 42 tubes, and there will have to be a point in time to decide: Should there be duplicate samples? How many depot sites will be visited? What confidence is there in the performance of the rover? The mission must consider risk against science potential. Asked if the Science Community Workshop is open to the community, Dr. Meyer said the meeting was wide open to everyone, as the program wants to hear from the science community. Asked how MSR would ensure that the right requirements were in place, Mr. Gramling said he thought there were broad requirements in place that will successfully anticipate the various scenarios, as MSR works with the Perseverance operations team. Dr. Meyer pointed out that MSL/Curiosity's route had to be completely re-planned because the terrain was rougher than indicated by orbiter imaging. There is risk mitigation by putting down the first depot site. Mr. Gramling said that Perseverance is also being used to scout for landing sites. Asked if retrieving all the samples at Three Forks would achieve all the science objectives, Dr. Meyer said yes, it checks many boxes: igneous, aqueous alterations, organics. But, the Science Community Workshop will be held to flesh out these objectives. Dr. Diniega asked what was the planned NASA contribution to iMIM; Mr. Ianson said project management and launch services. Asked how the MSR partnership has changed with the impacts of COVID, etc., Mr. Gramling and Mr. Ianson said this was an ongoing discussion, and also includes consideration of ExoMars.

Exoplanet Analysis Group (ExoPAG)

Dr. Michael Meyer, Chair of the Exoplanet Analysis Group (ExoPAG) Executive Committee, presented. Exoplanets are part of the APD, but the subject touches all four divisions of SMD, thus the PAC attempts to have as diverse an Executive Committee as possible by choosing three to four new members every year. The ExoPAG has observers from all the divisions. Dr. Meyer said he would soon be stepping down as Chair, but planned to stay on a year to help the incoming Chair, Dr. Ilaria Pascucci. Several other members will also be rotating off, and new members coming on during this interval. ExoPAG held an in-person meeting June 11–12 of this year. The agenda included research talks, a SIG 3 update (Exoplanet Solar System Synergies), a briefing about NEXSS research coordination, and much discussion about reactions to the Astrophysics 2020 Decadal Survey, which came out in November 2021. ExoPAG recently instituted a CoC, which turned out to be fruitful, a reminder that the ExoPAG indeed follows best practices. The PAG is being more aggressive about cross-PAG activities, and is supporting the Great Observatories Mission and Technology Maturation Program (GOMAP) precursor Science Workshops. Major outcomes from the latest meeting include an update on a new SAG 23 (Debris Disk Properties of Exoplanet Hosts), and a formal vote on a proposed finding concerning Exoplanets Research Program (XRP) funding. New Decadal Survey activities include support for a new cross-PAG SAG in support of GOMAP activities for the proposed 6-meter IR/O/UV Great Observatory, and a review of progress on past suggested actions. There is also community interest in time domain science. APD now has a new Astrophysics Mission School, with a summer session coming up, and the Executive Committee is considering a new format that will make the most of hybrid meetings.

Extraterrestrial Materials Analysis Group (ExMAG)

Dr. Barbara Cohen, Extraterrestrial Materials Analysis Group (ExMAG Chair), detailed the latest activities of the AG, which is composed of *ad hoc* subcommittees that span the categories of NASA's collections of materials, as well as the subjects of facilities and informatics. ExMAG discussed the SPD-41 document at its April meeting. The Spring meeting concentrated on curation and collection reports, "lightning science" talks, and three findings for the PAC. The Fall 2022 meeting will focus on the Decadal Survey, upcoming missions, facilities, and informatics. Dr. Cohen noted that the virtual format has significantly broadened community participation. She mentioned that the AG uses Google Docs for committee business, and asked for feedback on its use: is it an insecure platform?

In regard to SPD-41 feedback, the sample analysis community expressed the thought that it does not have an analogous archive to the Planetary Data Ecosystem (PDE), and that SPD-41 has limited relevance to

the extraterrestrial materials community. In that context, ExMAG has invited Dr. Moses Milazzo to its Fall meeting, to further discuss this feedback.

The Spring meeting included three findings/recommendations:

No Due Date (NoDD) selections and submissions; ExMAG recommends that NASA NoDD programs provide a date by which “selectable” proposals would be informed of their final status.

ExMAG again recommends that NASA and NSF ensure the continuity of terrestrial sample collection efforts by resuming the Antarctic Search for Meteorites Program (ANSMET) field season as soon as practical.

ExMAG continues to encourage NASA to explore a path to permit sample exchange and reciprocal sample loans between NASA and CNSA for the Chang'E-5 and Apollo samples specifically, and potentially to broaden such a program to encompass the substantial Antarctic meteorite collections of both nations and future sample-return missions.

MAPSIT

Dr. Brad Thompson, Mapping and Planetary Spatial Infrastructure Team (MAPSIT) Chair, presented findings from the AG's most recent meeting:

Finding: MAPSIT endorses the reconstitution of Geologic Mapping Subcommittee (GEMS). The goal of GEMS is to identify and plan for geologic mapping-related needs within the PDE.

Finding: MAPSIT is encouraged by MRO Overguide support for conversion of legacy data, but is discouraged by lost science (i.e. CRISM is turned off).

Finding: Body-specific Planetary Spatial Data Infrastructures (including plaudits for existing efforts on the Europa SDI); MAPSIT encourages continued progress in this area.

Finding: MAPSIT applauds the VIPER team for including a lead cartographer in their planning and practices from an early stage. MAPSIT encourages this practice at NASA.

Upcoming events include a Planetary Geology Mappers' Meeting, June 23–24, 2022 in Flagstaff, AZ, hybrid format; an Open Source Science Data Repositories Workshop, September 27–30, 2022; and a Technology Showcase to enable future science, scheduled for October 2022.

Outer Planets Analysis Group (OPAG)

Dr. Amanda Hendrix briefed on behalf of the Outer Planets Analysis Group (OPAG) co-Chairs. OPAG is very pleased with and supports the new Decadal Survey; the OPAG White Paper and Goals are in good agreement with *Origins, Worlds, Life* (OWL), as are the large mission recommendations. Issues of concern to OPAG include discomfort with the fact that MSR cost increases, plus inflation, could delay any new missions to the Outer Solar System to beyond the next decade. In addition, NF-5 might be the only New Frontiers new start in the next decade. The OWL-recommended cost caps are not favorable for Outer Planets missions, as they are capped at \$800M. If inflation remains high, cost caps will be a big concern for OPAG. Lastly, OPAG had recommended a solar system telescope for time-domain science, which is not at all reflected in the current Survey.

Draft OPAG findings:

Finding: Start Uranus Orbiter and Probe in FY24;

Finding: Release the NF-6 ASAP, given its importance to Outer Planet exploration;

Finding: Ensure adequate RPS availability for upcoming missions; there is a significant mismatch between Pu 238 and clad availability, production rates, etc.

OPAG action items from the June 2022 meeting:

- OPAG and SBAG are acting to form a working group sourced from OPAG, SBAG, and the broader Ocean Worlds community to develop a coherent Ocean Worlds strategy, as recommended by OWL, for consideration by NASA.
- OPAG strongly endorses the community-led actionable recommendations to advance Inclusion, Diversity, Equity, and Accessibility (IDEA or DEIA) within the planetary science and astrobiology community, such as those identified in OWL's State of the Profession chapter, the NASEM report "Advancing DEIA in the Leadership of Competed Space Missions", and "A Consensus Report on Recommendations from the 2022 Advancing IDEA in Planetary Science Conference," among others.

Small Bodies Analysis Group (SBAG)

Dr. Bonnie Buratti, Small Bodies Analysis Group (SBAG) Chair, detailed the most current membership, with three new members rolling on. Dr. Buratti announced that she would be rotating off as Chair at the end of this year, and presented findings from the June meeting (SBAG #27):

Findings/recommendations:

Finding: SBAG recommends that NASA continue to work with NSF and other agencies to develop a concerted plan for new national resources for planetary radar. This path follows the Decadal Survey recommendation to "develop a plan for ground-based planetary radar capabilities comparable to or exceeding those of the Arecibo Observatory necessary for achieving planetary defense objectives." As well as serving the needs of planetary defense and the broader area of small body science, new radar resources will enable further scientific studies of objects throughout the Solar System.

Finding/recommendation: SBAG reiterates its previous support for NEO Surveyor and recommends that NASA should seek to fully fund NEO Surveyor for a timely launch in 2026 as previously planned. NEO Surveyor would greatly accelerate the fulfillment of the George E. Brown Congressional goal of discovering 90% of the near-Earth asteroid (NEA) population larger than 140 meters in size. The National Academies of Science, Engineering, and Medicine's report Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes has emphasized the importance of a space-based near-infrared asteroid survey, and the Decadal Report "Origins, Worlds, and Life" states that "Congressionally directed NEO detection goals will be ideally advanced by the Near-Earth Object Surveyor (NEO Surveyor)".

In other SBAG updates, the AG continues to support Early Career activities with lightning talks, travel grants, and one-on-one mentoring. SBAG's next meeting will take place January 24–26, 2023 at IPAC on the Caltech campus. Dr. Buratti closed by expressing her appreciation for the support from PAC and NASA, while emphasizing the importance of addressing SBAG's two critical, and previously offered findings. She added that SBAG is in full support of the newest Decadal Survey, and has also formed an

Apophis Special Action Team to produce a report on how to best take advantage of the asteroid's close approach in 2029.

Mars Exploration Program Analysis Group (MEPAG)

Dr. Aileen Yingst, Chair of the Mars Exploration Program Analysis Group (MEPAG) presented to the PAC, briefly stating the four main science goals of Mars exploration: life, climate, geology, and human exploration. MEPAG held its 39th meeting in May of this year. MEPAG congratulates the Decadal Survey Committee and notes their clear recommendations for the MEP and MSR, and expresses deep sympathy for the suspension of the ExoMars rover launch, and to those who lost science opportunities.

MEPAG strongly concurs with the Decadal Survey OWL report on the importance of returning samples from Mars to Earth by the end of the decade, on increased funding for R&A to cope with the massive return of data by planetary missions, including those at Mars, and to invest wisely in the technologies that can enable future exploration at Mars and across the Solar System. In addition, MEPAG notes that the Survey presents a challenge to MEP to develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars. MEPAG believes that such a “comprehensive architecture” should begin with a new program of low-cost missions (<\$300M) this decade, augmented by medium-class missions after the peak-spending phase of MSR. MEPAG also notes that the Decadal Survey suggests that the next mission would be some version of the Mars Life Explorer (MLE). MEPAG eagerly awaits the results of the MDT study, which may address key goals of the Mars community regarding ice investigations, in light of relevant OWL recommendations.

Dr. Yingst highlighted two MEPAG findings:

Finding: MEPAG encourages a systematic approach to supporting and refreshing Mars orbital science, monitoring, and relay requirements both in the near-term for upcoming missions, and in the longer term (a move that could dramatically enable highly productive Mars small spacecraft concepts). New architecture and aggressive approaches could leverage new technology to substantially increase bandwidth for Mars which could be enabling for small missions.

Finding: MEPAG underscores the importance of discussion and clear communication at all levels as the Mars 2020 and MSR teams work to achieve a balanced mission operations approach that will sustain the goals of both MSR and MEP in an efficient manner during the entire course of the Mars 2020 mission.

Lunar Exploration Analysis Group (LEAG)

Dr. Amy Fagan, Chair of the Lunar Exploration Analysis Group (LEAG), presented. A LEAG activity Continuous Lunar Orbital Capabilities (CLOC; November 2021-August 2022) is being concluded; its draft findings will be released in July, with a full report expected in late August, at the LEAG annual meeting. LEAG held a Town Hall on the Planetary Science and Astrobiology Decadal Survey, and has compiled draft responses to the NASA RFI on Moon to Mars objectives. The next annual LEAG meeting will be at APL on August 23–25; on the agenda are IDEA, Decadal Survey, Headquarters, and mission updates. LEAG expresses excitement gratitude and support for the adaptation of PRISM-based solutions in response to community feedback, as well as for upcoming calls that demonstrate the drive toward the Moon and support for lunar science and exploration. LEAG is pleased that the Decadal Survey strongly highlights the value of lunar exploration for all planetary science.

The Town Hall held in response to the release of OWL was streamed live on YouTube; the entire recording is available. There were 85 live participants, 275 on-line views, vigorous discussion, audience engagement, many questions, and general support for the Survey's recommendations. Most questions received fell into a few categories:

- Endurance-A mission concept and implications
- Artemis and broader lunar exploration and strategy
- Commercial Lunar Payload Services (CLPS) and implication to other programs
- Planetary protection and ISRU
- Plus “other/assorted” (e.g., when to expect report with final images)

Dr. Fagan reported three action requests to the PAC:

- *LEAG recommends the development of consistent messaging/primers on the scientific value of lunar exploration, for presentation to the community and to the public.*
- *Establish a finding that the lunar community is broadly pleased with the wide-spread representation of the Moon in the Decadal Survey and the recognition that planetary science objectives can be achieved at the Moon.*
- *NASA should follow the Chapter 22 finding of OWL and the recommendation of the Decadal Survey regarding setting goals and objectives.*

Dr. Fagan closed by reiterating LEAG’s gratitude for the adaptation of PRISM and for community feedback.

Venus Exploration Analysis Group (VEXAG)

Dr. Jeff Balcerski briefed the PAC, reporting some transitions at the VEXAG. Dr. Noam Izenberg is the new Chair, and there is new Early Career representation on the Steering Committee. VEXAG 2022 is being planned for November. More than 150 participants are expected over the 2.5-day meeting. The community is very excited by the three new Venus missions in development. The meeting Steering Committee meets monthly and the agenda is full. Dr. Balcerski also discussed other topics, including: Exoplanets in Our Backyard 2.0; Venus flybys and opportunistic science; science nuggets; technology and laboratory studies; outreach; IDEA group and documents; social media; the creation of a VEXAG website; Second Planet/Second Tuesday slots for Early Career researchers; aerial platform science and technology working group; and a Next Gen liaison working group. VEXAG recently submitted comments to the Moon to Mars Initiative, and is preparing for the annual AGU meeting; three Venus sessions were proposed and accepted.

Dr. Jeff Balcerski presented a list of abbreviated VEXAG findings:

- *Establish a Venus Program*
- *Support LLISSE maturation and offer as a capability for New Frontiers*
- *Request STMD to restart support of long-duration power systems*
- *Augment SSO program to support Venus observations and support new suborbital and ground-based capabilities*
- *Encourage specific language for Venus-appropriate R&A in Habitable Worlds and Exobiology programs*
- *Encourage a new solicitation of aerial platform capabilities, similar to HOTTECH and COLDTECH*
- *Continue support for EDL thermal protection systems*
- *Create joint Astrophysics and Planetary opportunities to address cross-disciplinary recommendations of the Decadal Survey*

Mercury Exploration Analysis Group (MExAG)

Dr. Carolyn Ernst, Mercury Exploration Analysis Group (MEXAG) Vice-Chair, presented. MEXAG recently brought on a new Steering Committee member (Stephen Parman, Brown University), had its annual meeting in February, and has been collecting comments on SPD-41. The AG held a Town Hall in May on the subject of the Decadal Survey, is working on a Goals Document, and searching for an Early Career Steering Committee member. The Mercury 2022 science meeting was held in June, in Orleans, France.

MEXAG is thankful to everyone who served on the Decadal Survey Committee; Mercury science was highlighted throughout OWL, including the matters of the technological challenges posed by extreme environments, and many mentions of *in-situ* science and the need for samples. Dr. Ernst highlighted the following recommendations from OWL:

- R&A should constitute 10% of PSD budget.
- Technology should be 6–8% of PSD budget.
- New NF concepts, due to new discoveries, should be evaluated before NF-7.
- Plutonium-238 needs be evaluated against mission portfolio and increased as needed.
- Expanded support is needed for ground-based telescope observations of Mercury and planetary astronomers.
- Reviewing current radar infrastructure to meet community needs, including replacing capabilities lost with Arecibo

MEXAG issued a finding:

MEXAG requests that the complete TRACE outcomes be released to the public in a level of detail and fashion consistent with the input to these assessments, the reports of the Planetary Mission Concept Studies.

Upcoming events include a BepiColombo flyby of Mercury on the evening of 21 June.

AG Q&A

Dr. Diniega related a comment about cost caps with respect to Outer Planet missions: would cruise time get augmented funds? Dr. Hendrix said she didn't know if OWL had considered inflation rates as high as 8%, and thought it needed to be looked at more carefully. She did know that Io Volcano Observer (IVO) was considered, but it wouldn't fit in the cost cap as recommended by OWL. A participant asked if there are other radio telescopes available to fill in the gap left by Arecibo, such as a Chinese radiotelescope. Dr. Buratti said that SBAG summarized the capabilities recently, and while Greenbank and Canberra may have some relevance for small bodies, the real issue is Planetary Defense. SBAG has a white paper on the subject on its website. Dr. Diniega asked if the AGs were sharing LLs on hybrid meetings. Dr. Yingt said the AGs meet regularly to talk to each other. Dr. Diniega said she was thinking about a more standardized approach, such as for COVID protocols. Dr. Meyer said that at the last ExoPAG meeting, everyone was required to wear a mask and be vaccinated; he reiterated the readiness to revamp meetings, and to do passive sharing of information on-line as much as possible. Dr. Cohen said similar issues have been discussed at ExMAG; she noted that virtual meetings do help broaden accessibility. Dr. Hendrix said that OPAG feels similarly about the advantages of remote meetings, as they also advance inclusivity; she suggested surveying the community on its importance. Dr. Balcerski said he found that Early Career researchers are more likely to attend in-person, and didn't want to remove networking opportunities, but that he was fully supportive of the hybrid approach. Dr. Yingt said that MEPAG has been doing one in-person meeting per year, and one or two virtual, and recommended the mixed approach. Dr. Glass asked if the Ocean Worlds Strategy Working Group was talking to Astrobiology, and received an affirmative.

Dr. Diniega asked how all these AG outputs would be fed to Headquarters. Dr. Hendrix thought the channeling of AG information to HQ would be different from accustomed pathways. Dr. Buratti said that while TBD, she thought the information would probably come through joint findings, funneled through the PAC. Dr. Glaze thought the PAC conduit would be useful, and the PAC can request briefings from the cross-AG group as well. Dr. Rinehart noted that the PAC can have the Research Coordination Networks (RCNs) come in and brief, as well. Dr. Glaze suggested that with an eye to balance of reporting, for Dr. Rinehart speak with the AG leads and find a viable path. Asked why was the latest ANSMET was cancelled, Dr. Cohen cited the prioritization process within the polar programs; observations that need continuity, as well as time-sensitive issues. She understood why ANSMET drops in priority and was not sure there is much that can be done to bump it up. New Zealand had strict and lengthy quarantine rules, for example.

Dr. Diniega addressed the subject of small-class mission concepts (at Mars), while continuing promotion of infrastructure for relay. Dr. Yingst said there is lots of cross-talk about doing small missions that are beneficial to infrastructure. The forum was great for getting ideas out, but the community would like to see this done in a strategic manner. It is clearly not a point source problem. Asked if the community was engaged in MSR's science capabilities, Dr. Yingst said that this is a fraught question, but that MSR has been assiduous in presenting to MEPAG. There is much MSR engineering and technology capabilities that enables sample return. The MEPAG finding was more about keeping the teams in the loop so that science is aware of any engineering activities that could affect science. Dr. Glaze reiterated that the Fall MSR workshop will be collecting community feedback on just these issues. Dr. Yingst said the MEPAG finding was more about getting in-depth updates regularly, so that science can adapt to any changes and decisions.

Dr. Diniega asked for clarification on LEAG's request for a lunar science goals document. Dr. Fagan noted that the questions that came up in the LEAG Town Hall were related to CLPS vs. Discovery missions with respect to sample return. The request is more for clarification of what NASA really wants in the science goals document. In reference to a prior CoC discussion, Dr. Meyer commented that there can be legal ramifications to how CoCs are decided, enforced, etc. The general feeling is that CoCs are being converged upon by all the AGs, but through no formal channels.

Discussion/potential findings

Dr. Diniega sketched out several potential findings:

- Reaffirming the importance of NEO Surveyor
- Small-sat, high-risk, low-cost program development
- Different ways of obtaining data from a community, other than survey, on the impacts of COVID and the state of the community
- NASA maybe needs a more coordinated effort on CoC
- Mars2020 sample collection and how strategy is communicated; integration between science and engineering
- Discussion about current inflation rates, Decadal Survey recommendations, and cost caps, how to incorporate new information
- New ground-based facilities for Planetary observations
- Appreciation for Decadal Survey efforts

Dr. Glaze noted that there are also recommendations in the Survey about data collection. Asked what type of information is missing, Dr. Diniega quoted OWL as observing that Astrobiology is lacking demographic information. Dr. New said that NASA does have this data about NASA Exobiology, PSTAR, and Habitable Worlds. At the time NASA was talking to the Decadal Survey, however, it did not have the data. The NASA plan is to start publishing a yearbook, collecting this data. Dr. Rinehart noted

that COVID impact is not captured through NSPIRES; this is where PSD would need to hire a sociologist. The Survey highlights questions that could be covered by a study, but that also go beyond what NSPIRES can provide. Dr. New said he didn't think the budget appropriation would cover a study of that size. Dr. Walter Kiefer suggested the PAC hold its thoughts because a few things will be overcome by events. In previous meetings, there has been commonality amongst the AGs, but this time, they are largely one-offs. There is a struggle to find some weighty themes, which will hopefully change.

A participant expressed support for the Uranus Orbiter Probe. Dr. Glaze suggested the PAC consider the Survey's set of decision-making rules, for consistency's sake. Dr. Ishii asked if NASA could fund a workshop on the issue of demographics. Drs. Rinehart and New thought it was a possibility. Dr. New pointed out that NASA will receive a report from the National Academies on what measures the health and vitality of a community; that would be the time to do a follow-up workshop. That study could also be paired up with a recent PI diversity study.

The PAC discussed the disposition of the "legacy" and repeated findings from the AGs. Dr. Glaze said that PSD is very much aware of the issues that Dr. Cohen brought up re: ANSMET, and is trying to have more dialogue with NSF about how decisions are made. Dr. New noted that right before the pandemic, NASA and NSF were talking actively about Antarctica, and not just ANSMET, but also the balloon program. It all comes down to NSF's priority scale. Dr. Glaze said she was not discouraging the finding, and just providing additional information. Asked if Google Docs could be used for one of the AGs, Dr. Rinehart commented that as it's all public discourse, discussions do not need to be secure.

June 22, 2022

Re-opening

Dr. Diniega noted that potential findings were being noted in Google Docs, subject to further public discussion and refinement.

Planetary Defense Coordination Office

Mr. Lindley Johnson, Program Executive of the Planetary Defense Coordination Office (PDCO), opened the briefing by showing data from impact of an asteroid of 2–3 meters diameter on March 11 of this year. The object, designated 2022 EB5 had not been detected by the large surveys in the U.S. because they were in daylight by the time the small object was detectable, but was discovered by an observer in Hungary. 2022 EB5 was detected less than two hours prior to impact. With observations sent to the Minor Planet Center and on to the Center for NEO Studies, potential impact locations were calculated, and the first prediction issued one hour before impact. A risk corridor near Greenland was identified, just over the Norwegian Sea. The last predictions were narrowed down 20 minutes prior to the event, which pinpointed the impact just northeast of Iceland. The impact was confirmed and the energy released was estimated as 4 kilotons by U.S. government sensors. The impact was also detected by the Worldwide Infrasonic Network, which gave additional confirmation of the predicted location. Light curve data (time-dependent intensity of detected signature) of these events has just been released, and has been stored in the database for scientific research on bolide events reported by U.S. Government sensors.

Another interagency tabletop exercise was carried out (TTX4, the first since the release of the National NEO Preparedness Strategy and Action Plan; 4th exercise since 2013), based on a theoretical warning time of 6 months. TTX4 had three overarching objectives: increase the understanding by personnel and U.S. government institutions of NEO threats and agency roles in mitigation; test communication methods both to and among decision-makers; and exercise post-impact protocols, including preparation and response of local governments. Over 200 Forsythe County (North Carolina) emergency responders participated in this exercise, which also featured participation from the Office of Space and Technology Policy (OSTP),

National Space Council, NASA, Federal Emergency Management Agency (FEMA), National Security Council, US Space Command, NSF, and the Department of State.

The cumulative discovery curve for near-Earth objects just exceeded 29,000 asteroids of all sizes, and will probably exceed 30,000 by end of year. In terms of the George E. Brown NEO survey goal, NASA just exceeded detecting 10,000 of these objects of 140 meters or more. The total population of 140m+ objects is estimated to be 25,000; to date, PDCO has found 40.8% of the predicted population. This estimate is re-assessed about every 5 years; PDCO is reassessing that number this year. At the current discovery rate, it will take more than 30 years to complete the survey, with the discovery rate at about 2% per year with current assets. Detection capabilities must be improved to enable a speedier accomplishment of the goal. NEOWISE has a too-narrow field of regard to serve as an adequate surveyor: it takes six months for the telescope to look at the entire sky. The best solution is NEO Surveyor, a space-based infrared telescope, which would be able to detect 65% of potentially 140-m+ hazardous asteroids (PHAs) within 5 years, and more than 90% in 10 years. The telescope would also help to estimate object size.

Mr. Johnson provided an update on the DART mission, its impact on Dimorphos/Didymos coming up on September 26 at 7:14 pm EST. The spacecraft is doing well, testing the camera and smart navigation system as it approaches; the system will use Jupiter and Europa as target image test subjects in July.

Asked if there were plans for another tabletop exercise, Mr. Johnson said they are usually held every two years. The TTX4 report is being finalized, and then planning will begin for 2024. There is also a regular exercise with the international community during the planetary defense conference, which will be held in Vienna in 2023, including involvement by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). Dr. Diniega asked if any areas of coordination needed improvement, and if there had been timely access to science expertise. Mr. Johnson said that one of the post-exercise findings is that up-front warning notification is pretty good, but it could be improved. As there are visuals associated with the estimation of impact effects, it is preferred that there would be science SMEs present to accompany the showing of relevant imagery/warning; this could be improved as well. Dr. Glaze said there had been a lot of discussion at TTX4 about the importance of a trusted source for such communication. Most thought NASA should be this trusted source. Mr. Johnson said that both FEMA and the White House should also be considered as trusted sources, depending on the scenario and where in the timeline to possible impact.

Research and Analysis (R&A) Update

Dr. Rinehart presented. ROSES-21 is almost complete, only the OSIRIS-REx Participating Scientist Program (OREx-PSP) remains, and the panels have met. The drop in proposal pressure continues for LDAP, while XRP is flat relative to last year. The first year of the No Due Date (NoDD) experiment is nearly done. PSD will be also be expanding the use of dual anonymous peer review (DAPR) to all programs over the next few years. Regarding proposal pressure, Dr. Rinehart said there is not much new data to indicate any probable causes. He said he had gotten anecdotal reports that it is becoming more difficult to recruit reviewers, and also didn't know why this would be the case. Could it be COVID exhaustion? In FINESST-21, for the first time, the number of female students exceeds the number of males, and the fraction of female PIs is up to 30%. In ten years' time, at this rate, the ratio in PSD should be 50/50. Gender statistics are about proposers, not selections, but the selections have been roughly tracking. Last year, NASA unified the FINESST funding into a single program line; this has been a great move. There are more proposals at boundaries between programs, and it is good to see the crossover. The mission DAPs still fund their own awards however.

In the area of NoDD submissions, a large number of proposers treated March 2021, as ROSES-21 closed out, as a deadline. The last two months have seen very few proposals coming in. Overall, PSD has gotten

about 30% of the proposals it normally sees in a year (20–40% depending on the program). NoDD program selection rates are good across the board, and higher than normal. Even with the low proposal pressure, there is much excellent science in the proposals. The 50% notification time statistic is at about 180 days. Dr. Rinehart felt it was too long, and said that PSD is trying to do better, and improving. Every proposal over 270 days has been reviewed. The current goal is to notify 50% of PIs in 150 days, and 90% in less than 235 days. The new goal should be 80% within 180 days (this is the current requirement for all non-NoDD programs). Informal feedback on NoDD after one year, based on unsolicited feedback, has been largely positive, although Program Officers do say that NoDD is more work. Concerns remain, however, about low proposal pressure, and excessive time to notification. If proposal pressure increases, the process will get more efficient. At the end of one year of a three-year trial, so far, Dr. Rinehart thought it was going well and would thus continue the experiment.

The latest Decadal Survey called out PSD's No-Budget Experiment with DDAP, and approved of it. Proposers were only asked to define their budgets as small, medium, or large. The experiment is seen as having been successful, with no evidence that sizes of the boundaries could be "gamed." PSD received honest, real, credible estimates. Budgets have been coming in lower than anticipated, and there is zero evidence for bias in scoring based on proposal size. There was also very positive feedback from proposers. PSD is going to continue the experiment in FY22, but is not expanding it yet.

Dr. Rinehart presented the DAPR status for PSD. Habitable Worlds (ROSES-2020), Exoplanet Research Program (ROSES-2021); five Data Analysis Programs (DAPs; Cassini, Discovery, Lunar, New Frontiers, and Mars; ROSES-2021); and Mars Science Laboratory Participating Scientist Program (MSL PSP; ROSES-2021), are complete. OSIRIS-REx (ROSES-2021) is in progress. Habitable Worlds, Exoplanet Research Program, MMX-PSP, and five DAPS will be covered in ROSES-2022). DAPR will become standard practice for SMD reviews in the future, with an opt-out option. SMD is currently bolstering technical capabilities in order to facilitate this expansion of DAPR, and a dedicated SMD-wide DAPR lead is in the process of being identified. DAPR success metrics thus far show that the vast majority of proposals submitted are compliant, with the exception of one program (30% noncompliance rate). Program officers have been lenient until now, but will have to start cracking down. XRP has improved greatly. In general, reviewer surveys have been very positive; only 2% responded negatively. Reviewers say that the reviews and discussion are very focused on science (66% strongly agree, 25% agree). A reduction in gender gap is being measured over three cycles; this data is being collected by SMD. Right now, signs are positive.

The FY22 budget as enacted is \$79.6M less than the PBR, but R&A has been protected. Dr. Rinehart reminded the community that with ROSES-22, the experiment will continue with no-budget proposals for DDAP; DAPR will be the norm for all DAPs; and NoDD programs are open (always open!). Proposers must remember the rules on duplicate proposals; compliance will be getting stricter, regardless of intrinsic merit scores. Other changes are the previously announced PMEF turning into PSEF in ROSES-22.

Dr. Rinehart detailed some budgetary items for the benefit of the community and for transparency's sake. The Planetary R&A portfolio includes everything funded under the R&A budget line. The Planetary Research Program (PRP) includes all research activities, activities funded under R&A, and those funded through mission lines; and includes both openly-competed and closed-competition research. "Openly competed" means a competition is announced publicly and is available for proposals. However, an openly competed program may have restrictions on those who may apply: for example, the Early Career Award is restricted to proposers in their early career, or calls could include a preference for particular institution types, such as MSIs. Support tasks are not included in the PRP. The Astrobiology budget still has both money for fellowships, and some support, so PSD is still working to separate those things out cleanly. A snapshot of the Planetary R&A portfolio shows that 13.5% of the funding goes to support (overhead).

PRP has also started to carry a little reserve (1.4%), which will get funneled back into research if it isn't spent.

Within the Planetary Research Program, everyone funds a little bit of FINESST, and program lines sometimes contribute to R&A for specific items. ESSIO is expanding research over the next few years in ways that are to be determined. PRP still includes ISFM/directed research because it is still research (9.0%). For future work, it will be important to not put IDEA in a silo, because it should be intrinsic to how PSD does business. This may introduce more mixing of support and research, which could potentially reduce transparency.

Q&A

Dr. Kiefer asked if detailed budgets are written once a "no-budget" proposal is selected (in the DDAP experiment). Dr. Rinehart said that was the case, as proposers can't be given money until there is an institutionally approved budget. Answering a question about selectable (NoDD) proposals, Dr. Rinehart said he wanted to see what comes in over the next few months. Almost all selectables are being notified within 180 days or less. The target is to tell proposers they are selectable within 90 days. With regard to NoDD, PSD has to wait for a "critical mass" of proposals before getting a panel together. Because pressure has been low, the program has been doing short mini-panels to keep on top of the timeline. If proposal pressure goes up, some efficiency will be regained. The primary driver of the timeline depends on the program; the biggest problem is how to deal with the small number of proposals. PRP has considered putting proposals into panels to take advantage of overlap, as it turns out program lines are pretty well defined, overall. It has not been necessary to push many things from one program to another. Dr. Kiefer asked if PRP was having to lump together disciplines, and if there were a mechanism for checking for expertise. Dr. Rinehart said that the short answer is no; he felt that generalists should be able to review every proposal. Too specific a proposal is a mistake. Thus far there haven't been any issues with expertise, but it should be noted that there are field-adjacent experts as well. Dr. Kiefer agreed with the need to write to a broader audience. Dr. Rinehart thought there were opportunities to expand boundaries without having to artificially carve out subjects. Asked what would turn NoDD into a "real program," Dr. Rinehart said that one concrete metric is notification time, and the other is consistent funding of good work. Thirdly, a Town Hall discussion could be used to get feedback. NoDD will start doing this in year three of the pilot. The average score of selected proposals has gone down slightly because more Very Goods are being funded, similar to the non-NoDD programs, by coincidence. NSF saw similar drops in their NoDD programs, but they did come back up eventually. With NoDD, there is no pressure to submit a proposal that is not ready.

Dr. Tyler Robinson asked if there were concerns about the pressure being high in XRP during the current round. Dr. Rinehart said he was very concerned about XRP, and felt the pressure came from changes in APD that led to shifting some of their exoplanet research into XRP and that the exoplanet field is growing. Being cross-divisional makes it complicated. PSD/PRP only has approval for NoDD for seven programs, which must finish out the three-year period. He thought the pressure would continue until PRP figures out what to do about it. Dr. Robinson proposed a finding about finding ways to address pressure in XRP. Dr. Rinehart said that he was looking for suggestions on how to address the pressure, recognizing that there is no new money, and that PAC cannot make a finding on a specific R&A program because it runs into conflict of interest rules.

Dr. Glass asked whether IDEA should be regarded as a separate item or silo; there could be some benefits to a siloed program. Dr. Rinehart said the current thinking is to build IDEA into the program, without a separate budget, based on the argument that IDEA is part of the cost of doing research. One issue with the silo is that it paints a target on it; separating out the concept is not conducive to bringing diverse people together. Dr. Glass suggest checking with NSF and their approach to IDEA. Dr. Rinehart said he was

thinking about IDEA as a meta-question, trying to build partnerships with different communities, and getting buy-in from everyone on the ground floor. He agreed that integrating IDEA into everything may also complicate the transparency effort at PSD. Dr. Diniega suggested an approach such as requiring a data management plan with each proposal. Dr. Rinehart agreed.

Dr. Diniega asked if PRP was having difficulty in recruiting reviewers. Dr. Rinehart said he had not tracked actual numbers; all reports have been anecdotal. Reviews are still virtual. At least 80% of all panels are planned as virtual for the foreseeable future, but it will be possible to have a small number of in-person panels in the future. Virtual reviews are more inclusive and dramatically broaden the number of people involved, but with the loss of inherent networking opportunities. Dr. New added that SMD is trying to move to a position that unless otherwise announced, panels will be virtual 80% of the time, the reason being that there is anecdotal evidence that it is easier to recruit people in this way. The disadvantage to the approach is that there have been reports that virtual reviewers are less focused on the task at hand. Dr. New also acknowledged the reduction in networking, but the purpose of a panel is not to network; there are other ways of accomplishing this. The other advantages of virtual panels are lower costs and smaller carbon footprints. SMD will be collecting the demographics of the reviewers in the Fall, from NSPIRES. The analysis will be straightforward, but collecting the data will take a few iterations. Dr. Rinehart said that on the PSD side, there are two good reasons for in-person reviews: one is the preponderance of international or bicoastal reviewers, and it is better to get them together. And if there is a need for sequestering a panel, the meeting should be in-person. Dr. Rinehart said that those conditions notwithstanding, he still expected most panels to be virtual. As for micro-panels, it is easier to agree to a few days. SMD is discussing it across the divisions.

Dr. Glass asked how long it would take the NEO Surveyor to find 90% of 140m+ PHAs. Mr. Johnson reiterated that it would take 10 years to complete the survey to 90%; the number is at 40% now. Dr. Glass noted that there was a recommendation in the Decadal Survey to survey 50–100m objects. Mr. Johnson noted that 40–50m objects caused such large events as Tunguska, and the Arizona Meteor Crater. There are some ideas, but it would probably take more than one spacecraft, but NEO Surveyor can probably find a good proportion of 100-m-sized objects.

IDEA Activities in PSD

Ms. LaJuan Moore, Lead for the PSD IDEA team, presented a status of IDEA activities in the division. The IDEA team was created to initiate positive change, and was tasked to collect, track, and communicate the different initiatives across the division, as well as to provide specific responses to the Decadal Survey's Chapter 16 on the State of the Profession. The IDEA team has participated in several major conferences this year, at an IDEA Special Session at LPSC which included IDEA Planetary Science conference presentations and breakout sessions, and at AbSciCon with an IDEA Special Session. The team will also participate in The Second National Conference: Justice in Geoscience in August, and in SACNAS in October. Currently the focus is on a number of tasks, such as responding to the Decadal Survey, piloting the Here to Observe (H2O) program, as well as Inclusion Plans for PRISM and SSERVI. The entire PSD IDEA team is working with the SMD IDEA Working Group in the formulation of SMD IDEA's strategic plans, while "cross-educating" each other for positive change.

Answering a question about lines of communication, Ms. Moore said that the IDEA initiative was joined across SMD largely by points of contact at present. Dr. Glass asked for thoughts on funding. Ms. Moore said she personally believed each program would need specific funding to create IDEA functions within each program. Dr. Diniega asked if abstracts were typically presented at the conferences. Ms. Moore said this was the case, but with SACNAS, the team is considering a booth platform to encourage interaction. The team is still trying to grow and identify lines of communication within the science community, so as to create better ties to the conferences. Asked who the point of contact is with the core programs (to ensure that progress is being made, and to identify where the money is going to be sitting), Dr. Rinehart

said that the IDEA team has a direct link with him, explaining that Ms. Moore took the first step to identify what the IDEA activities would be. The money part will follow, but the initiative is not there yet. Dr. Diniega asked what the plan was for the budgetary side. Dr. Rinehart said the IDEA interactions with the conferences are meant to identify the people PSD should be talking to, and to expand the circle, and find the partners with whom PSD can co-create, and build the right relationships. The entire effort is still in work, and depends on the current budgetary cycle. Dr. Rinehart said more information will be available in December. He added that for too long, IDEA decision-making had been done by old white guys, and PSD is trying to get beyond that. However, the funding element is always going to be a challenge.

Here To Observe (H2O) Pilot Program

Dr. David Smith, introduced an overview of the Here To Observe (H2O) pilot program, as efforts go forward to build it “from the ground up.” He acknowledged the participating missions, Europa Clipper, Lucy, and Dragonfly, and the NASA Centers, for making the science accessible and for mentoring students. H2O is trying to reach undergraduate students who may not be thinking about planetary science, by building cohorts at institutions and through direct mentoring. Howard University, University of Puerto Rico (UPR), and Virginia State University (VSU) were the three institutions involved in the pilot. The idea was to try things out and see how they go, starting small and figuring out how to make it sustainable by “letting someone else choose the music.” The pilot lasted a year and encompassed about a dozen activities. There were many bright spots, and the effort also resulted in a good number of APL internships. There were a number of co-created activities, as well as orientations about how missions work. All the participants got amazing time and teaching activities from the missions. The proximity of VSU to APL was also helpful for enabling site visits.

UPR Perspective

Ms. Andrea Ortiz, student co-leader at the University of Puerto Rico presented the goals and achievements of the activities at her institution, describing intense student interest amongst the twelve students who were chosen to participate. She presented what worked well during the experience: Use of student leaders as mentors to freshmen and sophomore selectees; provision of Meet and Greet opportunities; use of a Slack channel to maintain communications; use of surveys; and selecting students with little or no previous experience in STEM. Mr. Jorge Coppin Massanet, student co-leader, presented items that needed improvement: students would benefit from earlier match-up with mentors; an official Europa Clipper Instagram page should be created to increase engagement around the world, and a fully populated calendar of activities should be prepared a year in advance, to enable students to understand the nature of the program and plan accordingly. Students also asked for more “day in the life of a planetary scientist” seminars. Proposed activities for 2022–23 will include an earlier start (in July) to match up students with mentors; harassment training; a proposal writing seminar, lifecycle of missions; and curriculum vitae (CV) and resume workshops.

Ms. Ortiz presented student highlights, including interaction with mentors, assistance in identifying and applying for internships, and observations of mentors “at work in the field.” Mr. Coppin Massanet presented a word cloud depiction of the experience, in which “engineering” and “space community” loomed large. Ms. Ortiz summarized by sharing that students felt their voices were heard. Mr. Coppin Massanet concluded that the H2O experience was a necessary step for inclusion and to an Early Career path, and that it had been the highlight of his academic career.

VSU perspective

Ms. MaKhaila Bentil, student co-leader with the VSU H2O pilot, identified herself as a computer engineering major, with a minor in engineering; her co-leader was Ms. Kailyn Haye, and their faculty advisor was Dr. Nasser Ghariban. Ms. Bentil described her experience participating in the Dragonfly mission, which took place through mostly virtual communication and a few in-person events. Ms. Haye described the chief advantages being the networking and mentorship with the APL staff, enabling

students to understand how projects are run, the PSD environment in total, and the mission development cycle. For the next term of 2022–23, Ms. Haye said she and her fellow students would like to see further expansion of the program, more conference engagement and Center engagement, to enable students to see what opportunities exist, as well as increased funding for scholarships, co-ops and grant work, and professional development. Assistance and accommodation for internship programs could improve the H2O program for the next term.

Ms. Bentil addressed “the who and what,” by describing working with different NASA scientists, engineers and APL faculty, who introduced the students to the rocket launch experience (with the launch of Lucy), and showing them that learning never stops, and that there are many different roles to inhabit in the STEM experience. The pilot also helped students explore doctorate programs by getting the inside scoop. Ms. Bentil described her experience as student leader as a way to help expand her consciousness through viewing the huge team effort in developing and launching a mission, and said she was using her network connections, and better understood her interest in space.

Cross-AG IDEA Working Group Update

Dr. Maggie McAdam, co-Chair of the Cross-AG IDEA WG, presented an update on the group’s activities. The WG is fully open for participation, and currently has around 100 self-nominated and unfunded members, with representation from the 8 AGs and the Division for Planetary Sciences (DPS) Professional Culture and Climate Subcommittee (PCCS). The WG has slots for two co-chairs, and is looking for a co-chair currently. Dr. Parvathy Prem presented recent suggested findings:

- *The WG conveys thanks and respect to the IDEAcon conveners, for a welcoming, engaging meeting.*
- *The WG eagerly awaits NASA response to the Decadal Survey and Chapter 16.*
- *The WG appreciates the NASEM report, released in May, on Advancing DEIA in the Leadership of Competed Missions.*

Dr. McAdam presented IDEA WG recommendations, for possible adoption by the PAC:

- *The WG recommends that NASA create an outward-facing, more-community-facing IDEA position within SMD.*
- *The WG recommends that NASA consider team diversity when selecting and extending missions.*
- *In order to retain that diversity, the WG recommends that project teams implement policies for creating safe and inclusive environments.*

Advancing IDEA in Planetary Science Conference Report

Dr. Edgar Rivera-Valentin opened the presentation by acknowledging the Juneteenth holiday, Pride Month, and the commemoration of the Stonewall riots. The Advancing IDEA in Planetary Science Conference was held to bring together the planetary, astrobiological, and social science communities to facilitate the advancement of IDEA principles in the workforce over the next decade, and resulted in a consensus report. The conference received 70 abstracts, and had 427 registrants, with 100 people online. The conference was fully virtual, had no registration fees, to help reduce barriers. Dr. Rivera-Valentin encouraged PAC members to read the report and access the recorded conference. The conference had daily keynote speakers, including Orlando Figueroa, to start off each day, and held end-of-day workshops and working group sessions. Workshop subjects included designing and sustaining authentic partnerships; there were also listening sessions; a proposal writing workshop; and readings of the OWL SOP and white papers. Working group sessions were asynchronous. The conference used a Slack channel to foster discussion, had Zoom breakouts, and had two co-facilitators for each working group. Workshops are available online to serve as continuing resources.

The seven working groups developed a total of 46 recommendations, of which 21 were priority recommendations. Themes and recurring recommendations can be found in the Executive Summary of the report.

The primary recommendations for the funding agencies are:

- *NASA should create an outward-facing position within SMD for an individual and/or office for IDEA in the science community, including missions.*
- *NASA should consider team diversity when selecting missions, projects, facilities, and other large teams.*
- *NASA should fund members of the community for service work.*
- *The community and NASA should define professional ethics more broadly than only financial conflict of interest and, in particular, should treat harassment the same way as any other type of research misconduct.*

The primary recommendations for the universities are:

- *The university community should develop a centralized hub to increase access to information for students, faculty, and scientists at institutions.*
- *Universities should create a framework and resources to develop and sustain research and teaching partnerships across institutions with reciprocity.*
- *Universities should provide resources to support faculty and students in the creation and evaluation of IDEA efforts.*

The primary recommendations for research groups are:

- *Research group leads should implement interpersonal support as a tool for building authentic relationships.*
- *Research group leads should formalize preferred communication practices and expectations for research groups and field teams by using tools such as Mentor Contracts and Field Guides.*
- *NASA should consider funding a workshop that brings together researchers of all career stages, coupled with industrial/organizational psychologists to discuss best practices for small research group management.*

The primary recommendations for professional organizations are:

- *Professional organizations should employ a multi-faceted approach to ensure meetings and conferences are welcoming, friendly, and inclusive.*
- *Professional umbrella organizations for planetary science (e.g., AAS, AGU, GSA) and AGs should develop relationships and partnerships with professional organizations serving underrepresented populations in the planetary science community (e.g., NSBP, SACNAS, AISES, AAPiG).*

The primary recommendations for employers and about employment are:

- *Employers need to fully (1) support the professional endeavor of planetary science, as well as (2) mitigate financial and administrative burdens faced by researchers.*
- *Our community and employers must proactively and broadly inform current and prospective researchers on the range of jobs in the field, their scope of work, funding profiles, and benefits (e.g., freedom of location).*
- *Employers, managers, and institutions must work to support best practices to cultivate a positive mental health culture.*

The primary recommendations about safety and accessibility:

- *The community should build accessibility and safety from the beginning into programs and activities via consultation with existing resources and experts.*
- *Organizations convening conferences should budget for costs related to safety and accessibility (e.g., interpreters and live captioning).*
- *The community should develop and maintain a publicly accessible set of resources by and for those within our community who are working to increase accessibility and safety.*

The primary recommendations about public engagement and Outreach are:

- *The community should implement best practices in public engagement rather than recreating or redeveloping such practices.*
- *The community, supported by NASA and/or other funding agencies, should develop an online central public engagement hub for best practices, community building, resources and diverse voices.*
- *The community should prioritize intentional partnering with underserved communities in all public engagement efforts.*

The primary message of IDEA is that it is not possible to separate “doing science” from “how we do science.” Dr. Rivera-Valentin averred that harassment and bullying does occur, and that “if you don’t hear about it, you’re probably not considered a safe person to tell.” Dr. Filiberto commented, from their perspective from having served on the Steering Committee, that they had had a hard time to find a place to archive this sort of work, which speaks to the need for a common hub. Dr. Diniega asked what the PSD IDEA coordination team’s role was here. Ms. Moore said she would like to take these recommendations to the coordination team and see what it can and cannot do. The recommendations can also be elevated to other decision makers at the PSD and SMD level.

Lunar and Planetary Institute

Dr. Lisa Gaddis, Director of the Lunar and Planetary Institute (LPI), presented a history and status of the Institute, which was established in 1968 near Johnson Space Center (JSC) to support and maintain a relationship with the Houston Center, and to run the annual Lunar and Planetary Science Conference (LPSC). LPI is not a for-profit body, is managed by the Universities Space Research Association (USRA), and its funding comes primarily from NASA PSD through a cooperative agreement. Most LPI event expenses are funded through registration fees; all meetings must be cost-effective to NASA and with reasonable registration fees.

In the wake of the cancellation of LPSC in 2020 and given the rising need for hosting virtual and then hybrid meetings, LPI convened an LPSC Advisory Committee in 2020 to address changes in LPSC organization and operations. After receiving community input on naming, identity, and inclusion, an IDEA Advisory Committee was convened in 2021. In terms of venue selection and timing, LPI generally likes to plan ahead multiple years. In 2021, LPI moved to virtual meeting planning for LPSC and other events, and learned many new technologies and apps for holding hybrid and virtual meetings. Polling indicates strong interest in returning to in-person meetings, but hybrid meeting planning continues for 2022 and beyond. LPSC 2022 was held in The Woodlands, TX. Attendees were required to have proof of vaccination, and to mask and social distance. Most attendees were supportive of these steps. The meeting had about 2050 registrations, split about 50/50 between in-person and virtual; student registrations constituted about 34% of the total (comparable to recent years). One lesson learned was that hybrid events are more expensive; AGU (see <https://fromtheprow.agu.org/registration-fees-for-agu22-support-a-robust-hybrid-meeting-experience/>) showed a similar result. Hybrid meetings cost about 35% more than traditional meetings.

LPSC 2022 featured posting of safety information for attendees and was preceded by conversations with local law enforcement. The conference also supported personal names and pronouns on badges. Several items were instituted earlier and remained available in 2022: gender-neutral restrooms, a Family Room, a Bulletin Board for sharing of rides, childcare, etc. The LPI Code of Conduct (CoC) for meetings was recently updated and is available on the website, as well as information on accessibility accommodations. There is also improved IP information on the website, with added information for underrepresented community (URC) groups. Reactions on social media for LPSC 2022 were very positive, and the first-ever IDEA session had a great turnout. Dr. Gaddis offered a quote from attendee Kirby Runyon, who said LPSC 2022 should be a model for other meetings. LPSC 2023 has been scheduled for The Woodlands, TX again, based largely on parameters of cost and convenience. As was the case in 2022, the hybrid format will support virtual participation and a tailored attendance experience for those who prefer not to attend in person.

As part of the LPSC IDEA initiative in 2021, LPI hosted an URGE (NSF-sponsored Understanding Racism in the Geosciences program) pod, designed to strengthen internal discussion on practices such as hiring, and additional training was undertaken on topics such as microaggressions, identity, and bystander intervention (with external trainers). LPSC 2021 also included several informal events (organized by attendees) for URC: Women in Planetary Science, Queers in Planetary Science, and Planetary Scientists of Color. LPSC 2022 had its first IDEA session. LPI is working with the IDEA Advisory Committee to work on actions resulting from their recommendations. LPI also sponsored the Advancing IDEA in Planetary Sciences community workshop in April 2022 (“IDEACon”); a report outlining community recommendations was recently published and was described here separately by Dr. Rivera-Valentin of LPI. The USRA Meeting Portal (a single point of access for LPI meeting services) has had several updates in 2021 and 2022 to support improved management of names, use of pronouns, and meeting planning. Before the end of 2022 the portal will roll out a new look and feel for users.

LPI Q&A

Dr. Diniega asked if LPI had received any negative feedback about LPSC 2022. Dr. Gaddis said there had been some negative comments from those who chose not to attend. At the IDEACon, there was a presentation about being uncomfortable in Texas because of recent laws on guns, abortion, immigration, and/or gay and trans persons. Dr. Gaddis said she would not defend or refute the political positions taken in Texas, but noted that there are also many supporting voices in the community for remaining in Texas. Similar laws are changing rapidly in Texas and many other states, and it is hard at present to know where to hold LPSC that would not be objectionable to someone in our community. There were also strong opinions aired about vaccination. Dr. Gaddis said she heard many people say there were very happy to be in the familiar Woodlands locale, and had been glad to attend the conference in person. Although the intention in 2024 is to find a location outside of Texas, but there are other ‘popular’ locations that can be just as problematic to someone. Dr. Diniega asked if the hybrid meeting gave people a good choice. Dr. Gaddis said she believed the hybrid meeting format provided a helpful choice to those choosing not to travel to Texas for whatever reason.

Asked to comment on results of the post-conference survey, Dr. Gaddis said that the “survey” was largely a collection of social media comments; mostly positive comments, and some strongly negative comments, especially about vaccination and masking. No big surprises there. Dr. Danielson thought social media was perhaps not a great representation. Dr. Gaddis said people seem very willing to express their opinions on both social media and in the survey; the comments are not data, but they are useful input. As to how well “remote interaction” worked at LPSC 2022, Dr. Gaddis commented that the newly adopted use of a moderator helped enormously to support both in-person and remote session chairs, speakers, attendees, and those who had questions. There were no in-person-only sessions. An AbSciCon participant commented that the LGBT+ event had been organized on the spot; more people probably would have attended if they knew it was on the schedule. Dr. Filiberto noted the QUIPS events were not formally

scheduled; QUIPS has a closed Facebook page for networking. They have been at LPSC for the last 5 years. Dr. Diniega suggested the conference feedback could be a resource for the LPI IDEA WG.

H2O Q&A

Dr. Diniega asked how the H2O pilot was measuring success. Dr. Smith said a longitudinal follow-up would be a great idea, and thus far the program has been doing a survey every quarter. If successful, the program will retain the information of the participants that stay in the alumni network. Mr. Coppin Massanet offered some short-term observations: one student switched out of a psychology major to a STEM field. Further, all students wanted to stay on the H2O email list. Dr. Glass asked the students if they enjoyed interactions with the other students. Ms. Ortiz commented that all the students were so grateful for the mentorship opportunities to help with communication; the feedback from the students was ecstatic. The interaction between mentors and students was fantastic as well. Ms. Bentin thought the student–student interaction was great, and felt it opened many doors. She reported that she did a lot of proselytizing to other students, which broadened the view of her own future. She witnessed much enthusiasm and engagement between the students. Mr. Coppin Massanet added that UPR is a system of 11 campuses, which also includes some private university students. While the program was mostly virtual, students did want more personal interaction, and to engage in in-person meetings as COVID allowed. Dr. Diniega commented that there needs to be more than these one-off experiences; there needs to be a support network. As the program expands, how would select missions be selected, and what feedback should be given to mentors. Dr. Smith said the program should be more reliant on faculty partners, and thought there were ways to go about that, and put resources behind it.

Ms. Bentin felt H2O could merge well with the National Society of Black Engineers; she thought it would be worthwhile to have a “Met Gala” event to invite and engage corporations into the program. NASA and APL could help with longevity, and traction. Ms. Bentin credited Dr. Smith for giving the space for students to speak. Other ideas would be to do some rocket launches through the universities. Mr. Coppin Massanet agreed, noting a key partnership with the Puerto Rico Space Grant Consortium that helped with reach and recruitment for the pilot. There was immense interest at UPR. The program had to downselect from 119 applicants to 13, so there are still 119 students in Puerto Rico who are interested in planetary science. The RockSat research project could be another link, and H2O could also work directly with mission partners to engage more students. There is interest in hosting a PSG Clipper mission science team meeting in Puerto Rico. Ms. Ortiz said Space Grant has offered some backup help, and thought the application period should be longer than two weeks. The students are working toward a bigger program with RockSatX next year, and there are students working with RockSat C now.

Q&A/Findings and Recommendations

Dr. Diniega and PAC members discussed findings and recommendations. Dr. Robinson felt there had been much exciting conversation around the room about H2O, meriting a finding. Dr. Glass suggested a finding on money for IDEA, surveys, etc. Dr. Diniega said the PSD IDEA Coordination Group didn’t seem to be coordinated with other IDEA groups at NASA. Dr. Weider thought some roles had not been finalized. Dr. Rinehart said the IDEA liaison can bring ideas to the PAC, or to Headquarters; it’s not a coordination role. Much of the IDEA stuff is very unofficial, and almost everyone doing this in their spare time; it is important work and NASA values it, but it is hard to “officialize.” It’s hard work and there are a lot of barriers. The question should be what the PAC could do to get these roles paid, acknowledged and permanent. Dr. Weider said that at the SMD leadership level, IDEA is now in performance plans. Ms. Moore noted that IDEA is still very much in the growing phase, and the Coordination Group must determine what rules it can set on its own; to that end, the Group is still working with the Office of General Counsel. Every member of PSD has been working very hard for years; and there is always more work. IDEA comes in on top of all that stuff. Dr. Diniega didn’t agree with IDEA as zero-sum; it has to be integrated. Dr. Rinehart said that NASA is not there yet and more work is needed to get it integrated. Dr. Prem noted that one recommendation from IDEAcon for NASA was to create an outward-facing

position at SMD to advance IDEA principles. That might be something for the PAC to consider. It is work that takes dedicated time and effort, and it needs to be integrated into the PSD/SMD ecosystem. Dr. McAdam said that NASA needs to get beyond the grass-roots effort and formalize/integrate IDEA. Dr. Weider said that Dr. Mainzer had recently brought a specific IDEA finding to the full NASA Advisory Council (NAC). Dr. Ishii asked if the PSD IDEA Coordination Group was a paid effort. Ms. Moore said she was the paid person for this work, since January, which she performed in addition to her other duties. She said her other roles will go to other NASA staff so that she can concentrate on IDEA alone. Dr. Rinehart said there were a number of IDEA-focused, internal-facing groups throughout PSD and SMD. The Black Lives Matter movement of 2020 spurred on a lot of work at NASA and elsewhere. Dr. McAdam commented that she wanted to acknowledge that the reason that “we are here” is because it took decades of effort, all thanks to courageous people speaking up and speaking out. People are so grateful that IDEA is happening, and they don’t want to lose the momentum. The community knows that NASA cares, but it will continue to push for change. Dr. Prem echoed Dr. McAdams’ comments, and reiterated a recommendation for advancing DEIA in the leadership of competed space missions: NASA should empanel a NAC committee on IDEA, and provide consistent and adequate funding for STEM/IDEA.

Dr. Diniega noted that the IDEA recommendations for an outward-facing position and hub are important, but will need more resources, and more full-time employees with relevant expertise and connections with planetary community. Dr. Rinehart said it was important to acknowledge that the community and NASA must work together toward this end, and figure it out (i.e. “co-create” it) together. Dr. Glaze said that if the outward-facing position were to sit at the SMD level, the recommendation should go through the Science Committee. Dr. Diniega reiterated the proposal/data management plan analogy, to help IDEA permeate through NASA in a similar way. Dr. Filiberto said this was a reason an IDEA hub/repository is needed; one of the initial motivations for IDEAcon. Dr. Kiefer said he thought LPI already hosts a page for the Cross-AG IDEA WG; a hub could reside there if it doesn’t already. LPI does have finite resources, however. It is often a zero-sum game: what are you willing to give up for what you want? Dr. Keifer felt LPI had been unfairly attacked on the Texas issue. Dr. Filiberto said that LPI was hosting the page, but the hub can’t be static; it needs to be an active place, like a wiki. A static LPI page could be a good landing page. Dr. Kiefer confirmed that LPI hosts the Cross-AG IDEA WG, but agreed it can’t be left uncurated; the WG would have to be involved somehow. Dr. Rinehart felt a wiki would produce too much noise, and that a hub would need something there to ensure standards. Dr. Glass said there was a wiki at APL, in which people must request an account; this type of page would not be hard to moderate. Drs. Rinehart and Diniega felt the PAC should focus on what is needed for the hub rather than specify a vendor; rather, the PAC needs to define what the hub should look like. Dr. Rinehart suggested having a static page at the SMD level. Dr. Prem thought the main problem is that there is a lack of ability to share information with each other, and a lack of institutional memory. She suggested a model called www.includesnetwork.org; her group is also developing content.

Dr. Diniega, reviewing notes, asked if the PAC could request a NASA response to IDEAcon recommendations. Dr. Glaze and Dr. Rinehart felt PSD could respond without the need for a formal PAC finding.

Other potential findings:

- H2O and importance of co-creation rather than imposing.
- Commending R&A for work on NoDD, greater transparency, aiming to improve efficacy and efficiency.
- Micropanels are an interesting area that can address concerns about NoDD; compare quality of score distributions in deadline vs. NoDD panels?
- PDCO and reaffirmation of the importance of NEO Surveyor

- General approbation of the newly released Decadal Survey

The PAC discussed a finding on assessing the planetary science community, while understanding the barriers to getting the information. Dr. Rinehart said the finding could be as simple as emphasizing the Chapter 16 in the Decadal Survey; Dr. Glaze agreed, saying that the chapter's enormous number of recommendations will require NASA to prioritize them, so PAC should identify the highest priority items as well.

Regarding a finding on the development of a small sat high-risk, low-cost program, similar to SIMPLEX, to address the Psyche/Janus situation, Dr. Robinson commented that while the rideshare office serves most needs, one concern is the need of primary spacecraft vs. secondary payloads, and the suggestion was more about formal methods for collecting Lessons Learned. Dr. Kiefer felt that there was nothing really actionable here, if it's simply a reaction to launch delay. Dr. Glaze said the whole point of SIMPLEX is that it is an experimental program, and NASA is still learning. When the experiment is complete, it will be subjected to a formal Lessons Learned exercise. The finding was tabled for another time.

The PAC discussed the need for a CoC, which could be expanded to COVID protocols, reporting of outbreaks, hybrid meetings, and Early Career support. Current COVID protocols are governed by state laws. Dr. Filiberto commented that PAC issued a previous finding on accessibility, that a CoC is a living breathing thing that requires continued attention. Dr. Kiefer recalled a harassment incident in which the perpetrator claimed his action was a sign of respect, noting that any CoC will have to contain standards that hold people to account.

A finding on communication pathways between MSR and the science community was tabled until the December meeting.

A finding on ANSMET cancellations, NASA/NSF coordination was briefly discussed, as was a finding on the Uranus Orbiter and Probe in relation to adequate RPS availability.

A finding expressing PAC concern about inflation affecting Decadal Survey cost caps for missions was tabled until December.

The PAC briefly discussed the need for ground-based observations finding based on multiple AG findings, and the replacement of Arecibo.

Dr. Rinehart acknowledged PAC members who would be rotating off before the next meeting, expressing gratitude to Drs. Mainzer, Hurley, Filiberto, and Hagerty.

June 23, 2022

Astrobiology

Drs. Mary Voytek and Lindsay Hays presented an update on the Astrobiology program. Dr. Voytek announced proposal requirements that reflect new rules on the impacts of research in the field, as well as new rules of conduct, and reminded proposers to always read C.1, as "nobody's harassment will be grandfathered in."

Dr. Hays addressed ExoBiology NoDD issues and misconceptions, which appear to be related to the closing dates for each of the calls, and what they mean. Some feel that there is a "secret schedule" behind the scenes, however NoDD really does mean that one can just submit proposals. There is no secret

schedule, and if one closing date is missed, another one will come along. The other issue she highlighted is the increased importance of external reviewers to the NoDD process.

Dr. Voytek noted that Habitable Worlds (HW), which was not solicited last year, will be this year, and will be under the DAPR process again. She reminded proposers to pay close attention to the rules, which are particularly important for DAPR. In the Interdisciplinary Consortia for Astrobiology Research (ICAR), cooperative agreement notices have replaced the NASA Astrobiology Institute NAI; ICAR is having a call this year, at \$5M for 5-year proposal durations. Step-1 proposals are due 15 September, and Step-2s due on 17 January 2023. ICAR is linked to two Research Coordination Networks (RCNs) that Astrobiology and PSD participate in. AbSciCon 2022 was held in May in Atlanta, with over 1000 attendees (virtual and in-person combined). The very successful meeting was a hybrid of virtual and in-person, with 260 participants onsite, and 35 countries represented. A third of the attendees were students; there were many young faces and lots of energy. The conference featured a number of keynote and plenary speakers, and highlighted women in astrobiology, science and engineering. Venus was a focus of one of the plenary sessions, and included discussions of climate and habitability, and the likelihood of any extant life on Venus.

Dr. Voytek recommended consulting the Astrobiology website to further understand the nature of RCNs, and how RCNs relate to the goals of the Astrobiology program in understanding the origin, evolution and distribution of life on Earth, and whether life might exist elsewhere in the universe. There are a total of five RCNs: Prebiotic Chemistry in Early Earth Environments (PCE3) aligns with OSIRIS-Rex science; Habitability and Detection of Life on Exoplanets (NEXSS) is important for JWST; Biosignatures and Life Detection (NfoLD) is important for the science underlying Perseverance; and the Network for Ocean Worlds (NOW) is relevant to the Europa Clipper. Evolution of life is covered by the newest RCN, Early Cells to Multicellularity (LIFE), which features four co-leads. Earth is the only planet known to harbor life. LIFE will be holding a workshop on the Reconstruction of Ancient Metabolism. LIFE created a kickoff video, available on their website, that enumerates the goals of the RCN.

Highlights of past year include much activity in the Network for Ocean Worlds, which is planning a Fall workshop on OW analogues, in Denver. NASA has interdivisional interest in OW research with respect to Earth's ocean as well as other worlds. Oceans Across the Solar System, based on a workshop held in 2019, will be the subject of a special issue of *Oceanography* in Summer 2022. There is also an interdisciplinary ROSES element originated by the Earth Science Division (ESD), called OW, Research at the Interface. The notices of intent for this element are due in October, and proposals due in November.

The Network for Life Detection recently held a two-week, virtual workshop on the Future of the Search for Life, meant to develop new and creative approaches to *in-situ* searches for life in the Solar System, and to foster relationships between scientists and engineers. There was a good mix of participants, many of which were from outside the usual backgrounds. The workshop charge was to think 20 years into the future and to imagine targets, levels of detection, and dream biosignatures for life detection. Deliverables were a science traceability matrix (STM), with flowdown to quantifiable measurements, and written context to support the STMs, and a full final report. There will be a Town Hall to get more input from the community on workshop results.

Asked if the ROSES call, Oceans Across the Solar System, was to be jointly funded by ESD/PSD, Dr. Voytek said NASA was waiting to see what it receives, and that she had spoken to Dr. Rinehart about co-funding, but emphasized that it is a test case. Dr. Glass asked how the RCNs can communicate to the PAC. Dr. Voytek said she had given thought to an Astrobiology AG, but felt that it was just another way to stovepipe disciplines, so it's been a deliberate practice to keep astrobiologists embedded in all the processes. A lot of what Astrobiology is about is the enabling research behind future Astrobiology

missions. She said she had been talking with Drs. Rinehart and Glaze about how to report out, and how frequently. This is almost exclusively a volunteer activity for all these participants. Dr. Glaze suggested periodically inviting RCN leads to give a short briefing at the PAC. Asked to express her expectations for reviewing the RCNs, Dr. Voytek said that when NASA reviews RCNs, it looks at effectiveness, and how the RCN is aligned with Astrobiology and the rest of PSD to ensure it is a relevant topic. Each RCN has foci related to the most burning questions in their own areas. They have about three years to get up and running, and then after five to six years, NASA does a broader review; it is doing that now for NEXSS. This Fall, Dr. Hays of PSD will lead the assessment of that group, along with the Astrophysics Division (APD).

Lunar Updates

Dr. Sarah Noble, who sits in PSD and the lunar Exploration Systems Science Integration Office (ESSIO), presented updates. Dr. Brad Bailey has moved to the position of Associate Deputy Associate Administrator for Exploration (ADAAX). ESSIO is hoping to add more Program Scientists later in the Summer. The Commercial Lunar Payload Services (CLPS) program is very busy with deliveries; there are up to seven deliveries on the books thus far. She noted that these will be first launches to the Moon for each of these companies. All NASA instruments have been integrated into the Astrobotic Peregrine Lander, and Intuitive Machines lander is right behind them. Program Scientists have been assigned to each of these missions/payloads, to help maximize the science. PRISM-1 FSS held their critical design review (CDR) last month, and LVS held its preliminary design review (PDR) in May. PRISM-2 selections were announced in early June, and a PRISM-3 community announcement will come later this summer.

There are two new PRISM selections. The Lunar Vulkan Imaging and Spectroscopy Explorer (Lunar-VISE) will address Decadal science in its exploration of the lunar Gruithuisen Domes, a location of rare silicic volcanism. The Lunar Explorer Instrument for space biology Applications (LEIA) was selected to explore the Moon's south polar region in 2026. LEIA will study how yeast responds in the lunar environment. Future Artemis calls in ROSES include calls for deployed instruments for the Artemis III and V missions, an Artemis III Geology Team, and instruments for the Lunar Terrain Vehicle.

The Artemis Science Team is continuing to build on what NASA learned from the Apollo and Constellation programs. The lunar science community is larger than it was 50 years ago, and NASA is also very different now, thus a great deal of science is being incorporated from the start, and there is a greater reliance on commercial and international partners. The Artemis Internal Science team is comprised of NASA scientists already working with Artemis, and is currently funded by Human Exploration, but starting next fiscal year, will be funded by SMD. The overall Artemis Science team will include this internal team, as well as competed geology teams and payload teams for each Artemis mission, beginning with Artemis III. The competed geology team will have about 10 scientists, and will be supplemented by a Participating Scientist Program. The roles of internal vs. competed teams have been fleshed out: the internal team will ensure that the architecture can support science, they will function as a "rapid response" team to requests from across the Agency, serve as an interface between NASA and the competed teams, and provide mission-to-mission continuity. NASA is currently looking for a contamination/control scientist in the samples group. Dr. Ryan Ziegler has stepped in as Acting Lead for Artemis Curation, while JSC seeks a permanent replacement. The competed team will focus on the Artemis III sortie, developing field science goals, traverse plans, and sampling strategies and providing real-time operations support.

A contractor was recently hired to create the Lunar Discovery and Exploration Program (LDEP) Web presence, which will emerge in two stages. The first stage will be CLPS-focused, and the second will include LDEP guiding principles and long-term lunar science strategies, solicitations and science planning. Ten team members were selected last month to participate in analog activities to support

Artemis Lunar Operations; they will be testing pressurized rover operations, and doing a separate analog test for Artemis III traverses (which will not include a pressurized rover). The team will also explore science con-ops: for example, how long does it take to drill in a permanently shadowed region (PSR)? The Sun will be very low on the horizon, and everything will be heavily shadowed—how do you do lunar geology in these conditions? Another analog activity call will be held this year, and will be open to US persons (including green card holders), and “senior” graduate students.

In the Apollo Next Generation Sample Analysis Program (ANGSA), the 73001 lower sealed drive tube has been opened; this tube captured the gas from Apollo 17 sample 73001. The Apollo 17 ANGSA workshop is scheduled for October 2022 at LPI. The SSERVI Senior Review is now complete, and its report and NASA response are available on the LPI website (www.lpi.usra.edu). SSERVI’s cooperative agreement notice (CAN4) draft has been released; a Town Hall was held in April, and the comment period is now closed. Lunar Surface Science Workshop (LSSW) activities continue about once a month, and cover a wide range of topics. A session on ISRU is planned for 27 June.

Dr. Ishii asked if the high-level architecture, prior to current team engagements, relied on LSSW or LEAG inputs. Dr. Noble said there had been much give and take between SMD and Human Exploration; conversations are ongoing and they happen at many levels. Dr. Ishii said it feels like competed teams are coming in late. Dr. Glaze noted that for mission requirements like down and upmass, volume, and power constraints, the lunar effort is very different from purely SMD missions; SMD has a seat at the table but it can’t drive the architecture. Dr. Noble agreed, and commented that the internal teams are a way of injecting science concerns, and why the Artemis SDT was done so early on. Dr. Keifer asked what the architecture allows: number of extravehicular activities (EVAs), duration of EVAs, traverse radius, sample mass? Dr. Noble said that some of these parameters are known for Artemis III, but it is a very constrained mission, and the current plan is that Artemis IV will be Gateway only. Dr. Glass asked if there were any discussion of looking for Earth rocks on the Moon, which could be very impactful. Astronauts are certainly trained well to look for exotic things. Dr. Noble said that the Artemis III mission is scheduled for NET late 2025, and Artemis V in 2028. Dr. Robinson asked how Level-1 science requirements, interfaces, de-scopes, etc., are dealt with, in the commercial program: is there a formal signature process? Dr. Noble said that the first pre-PRISM landers are individual payloads with their own science goals, overseen by each Program Scientist. The PRISM payloads do, however, have Level-1 science requirements, via ongoing conversations with scientists in the CLPS office at JSC. All the missions also include a data management plan (for archiving). Dr. Ryan Watkins commented that the Program Scientist (PS) ensures that each CLPS mission meets its objectives, and deals with such issues as payload conflicts. Dr. Glaze added that the PS also ensures that when there is engineering data from the lander itself, there is a coordinated effort to make sure the data goes where it needs to go. Dr. Filiberto asked if CLPS were to be considered as an asset in the evolution of the program from Moon to Mars. Dr. Watkins said that NASA was considering it, and Dr. Glaze added that the idea was fertile ground, and that the Mars program recognizes this as well; there is also interest from commercial providers. Dr. Diniega asked what plans PRISM had for incorporating IDEA into its calls. Dr. Watkins said that CLPS had used Lessons Learned from APD, which went well. There was unanimous support from the review panel to continue and to consider some changes and clarifications and to also give the community more resources as they write inclusion plans, while addressing team sizes and institution rules. This will be done again for PRISM-3. Dr. Glaze said that while it was a good experience overall, another Lesson Learned is that NASA will have to have the right expertise to help develop and assess inclusion plans in the future. Dr. Watkins said there was IDEA social science expertise on the panels; inclusion plans are not currently part of the selection criteria, but they will be part of them in the future.

Dr. Diniega addressed the LEAG finding on getting more consistent messaging on the lunar strategy to Dr. Noble. Dr. Noble said that PSD/ESSIO was working on writing an overarching strategy that includes messaging on Artemis, CLPS, Discovery, etc. Dr. Ishii said the discussion of the Moon as a stepping

stone seemed to be the sticking point for LEAG. Dr. Noble noted that (Federal) space policy makes specific reference to sustainable presence on the Moon, and the Moon as a stepping stone to Mars, while NASA is very much campaigning internally for the importance of lunar science. Dr. Glaze offered to talk with the Headquarters Office of Communications to make sure that very senior leaders be asked to reflect the desired change in tone.

Dr. Diniega asked if there were efforts to record Lessons Learned and generate best practices from the lunar conferences, and share them with the community. Dr. Noble said that NASA had been relying heavily on SSERVI on getting these out to the community. Dr. Rebecca McCauley Rench said Lessons Learned have been collected from the community through AGU, and discussions have been held as to what they mean for future AbSciCons, but a centralized hub has not yet been created. It would be nice to have fully hybrid conferences as much as possible, and she thought those could easily continue for AbSciCon. Recordings can take up to a month to get on the website, it should be noted. SSERVI also has many focus groups that do things on the scale of the RCNs; the PAC should get an update from them. Asked how RCNs are connected to missions, Dr. McCauley-Rench said that RCNs connect through the topics that are directly relevant to the science objectives of those missions. The new LIFE RCN, in particular, feeds forward to many future planetary missions. Asked why the ICAR call had been expanded to more areas, Dr. Glaze said that for the first call, there had some concerns about dilution. Because the first call went well, PSD decided to open it more broadly thanks to feedback from the community. Dr. Rinehart added that there is a desire to be strategic with ICAR and to focus on areas of interests “of the moment.” The intent is to not make a call for every RCN every time.

Dr. Filiberto and others on the PAC suggested a finding or recommendation on the use and power of the CLPS model for Mars and other planets.

Planetary Data Ecosystem (PDE) Update

Dr. McCauley Rench presented a status on the Planetary Data Ecosystem (PDE). After receiving the PDE IRB report in April, Dr. Moses Milazzo was appointed PDE Chief Scientist, and a TWSC proposal was selected to support Planetary Data training (PI David Williams). Future actions in process are to fully respond to the PDE IRB, hold a PDE Workshop series, and identify an internal Planetary Data Officer. A recently launched PDE webpage includes announcements relevant to the planetary community. The webpage serves as a point of access for various elements of the PDE, providing links to various elements of PDE, and a list of community-identified data needs.

The migration to the PDS4 data standard continues; extended missions are now including conversions to PDS4s as overguides (as was done in the case of MSL and MRO, most recently). Planetary Data System (PDS) is working on web modernization activities, with the principal hope of improving the discoverability of data. Planetary Data training workshops are now in the planning phase, including the provision of two travel grants for participants in underrepresented communities. PDE is also leveraging SMD initiatives to advance PDE goals through two pilots, one in AI/ML and the other in Cloud-ready data, as PDE moves towards a Cloud environment. PDE continues to make progress in responding to IRB recommendations, such as addressing barriers to data use and development.

Dr. McCauley Rench highlighted a recommendation to address data preservation needs by identifying an archive; the PDE is working to see if Astromat can be the repository. The goal is to work with PDS in an interoperable way, and to create an archive with high-quality data, PDS4-compliant data, such that users can access all the data in one place, Astromat is currently doing a study that should be final at end of the fiscal year.

Dr. McCauley Rench introduced the new PDE Chief Scientist, Dr. Milazzo, to give the remainder of the presentation. Dr. Milazzo sat on the PDE Independent Review Board (IRB) as co-chair for the archiving

subcommittee, and helped to write the report. Recommendation #4, a non-consensus recommendation, was responded to by creating a Chief Scientist position instead of a PDE AG. The reasoning behind the decision is that Dr. Milazzo is not a NASA employee. He is an independent subcontractor, and it is felt that he can bring concerns from the community to NASA with relative simplicity. Dr. Milazzo averred that PDE is not a “history of failures,” rather it is an evolution of NASA understanding as the data ecosystem has evolved to date. In fact, NASA has recognized the long-existing PDE before it was given a name.

The IRB developed a set of core values, with an emphasis on practicality. The only way to go forward and learn is by making mistakes as NASA tries to improve the PDE. The solution might not always be perfect, but it is imperative to move forward. The entire IRB report has 67 findings and 65 recommendations that are organized into five main themes. The “Pathway Toward an Ideal State” section contains the report’s highest priority recommendations that fall into three main groups: Develop the Ecosystem; Address Data Preservation Needs; and Address Barriers to Use and Development. Within the Develop the Ecosystem theme, NASA responded by establishing the CS position in the PDE; NASA continues to refine the full scope of the PDE as an ongoing process, and is working to explicitly define and clearly articulate to the community the prioritized goals and scope of PDS

Under the Address Data Preservation Needs theme, NASA is working to establish an archive for planetary radar data either within the PDS Small Bodies Node or in a separate archival node. PDE is seeking community feedback in establishing a carefully crafted strategy to identify and prioritize the data preservation needs of the planetary science community that are not currently being addressed; and in considering ways of archiving outside of the PDS that are amenable to creating FAIR and standards-based archives of these growing data sets.

Under the Address Barriers to Use and Development theme, the main question concerns foundational data products, in terms of mapping a body that is under study, for example. Plans for data product development will need to be made well ahead of time. Dr. McCauley Rench said that ongoing efforts under this theme include developing a Github for best practices, and that PDE will be looking to the AGs for further guidance.

SPD-41 Update

Dr. Steve Crawford gave an update on the evolution of the NASA Science Information Policy document, SPD-41. In 2019, SMD released a Strategy for Data Management and Computing for Groundbreaking Science, one goal of which was to “develop and implement a consistent open data and software policy tailored for SMD.” In August 2021, NASA released SPD-41, followed by SPD-41a in November, which contained proposed additions based on other agency and community input. An RFI was released to the community for a period of public comment, which closed in March 2022. NASA received 63 responses, about half from the science community (many of them planetary scientists), as well as from NASA Centers, and private responders. Overall responses were positive, but some voiced concerns for data and software issues. SMD is now reviewing responses and revising, and aiming to adopt a final document by August. Each division will be provided an information policy providing further guidance on these specific areas for their communities. It is important to note that SPD-41a applies to future solicitations, so current grants or missions should adopt the policy consistent with available resources. During the Summer, NASA will hold Transform to Open Science sessions that will include SPD-41 material in core modules. In February 2023, each division will release their updated data policies prior to ROSES23, but compliance requirements will not begin before January 2025. SPD-41 is just one part of the Open Source Science Initiative. In addition to policy development, the initiative includes core services for science discovery, TOPS, and ROSES elements. Transform to Open Science will be kicked off in 2023; this is a \$40M 5-year NASA SMD mission, partnered with AGU. Its objectives are to increase understanding &

adoption of open science, accelerate major scientific discoveries, and broaden participation by historically underrepresented communities (HUCs).

Dr. Diniega asked about plans for reaching out to HUC. Dr. Crawford said that his team is currently discussing metrics, and also ways in which success can be assessed. TOPS materials are available on the Github site, and there is a lot of outreach toward and work with different HUC groups and organizations. NASA is doing listening sessions and hoping to integrate results with TOPS. Dr. McCauley Rensch noted that PDE training workshops have goals related to HUC outreach, including the previously mentioned travel grants. Dr. Robinson said that discoverability of data is linked to the ability to publish upon a data set, but much focus is on archiving right now: how is PDS/PDE taking input for data discoverability? Dr. McCauley Rensch said the first job of the PDS is archiving, but she did think it needs to improve in the area of discoverability, so converting to PDS4 and building APIs have been addressing that area. Surveys have had low response rates; PDS is trying to figure out how to improve the response rate. PDS nodes do have user groups that provide feedback. Meanwhile, PDE is listening to the PAC and the AGs, and looking for pathways. Trying to meet folks where they are is challenging. Dr. Milazzo added that PDS also needs to think about machine discovery, which has to do with standardization and the principles of FAIR. The other issue is: can the public find it? Generally the answer is no, at present, which has more to do with search engine optimization (SEO), and other issues. NASA needs to partner with experts who know how to do this, and learn from them. This is being addressed at the SMD/PSD level.

Dr. Crawford said that a major initiative is the Science Discovery Engine, which aims to provide a search of data sets across SMD. NASA is doing internal testing now, and hopes to get some external testing by the Fall. Dr. McCauley Rensch said the original idea for the website was as a point of entry. The inputs are responsive to the IRB report; PDE is building on these, and looking at data-relevant posters from AGU, AbSciCon, etc. It is not yet user-friendly; it is a training toolkit that does not have much content yet, but it should grow. Asked who decides what content goes onto the website, Dr. McCauley Rensch said that a call out to the AGs got a very limited response, i.e., one data set from VExAG. Dr. Filiberto asked if PDE had presented to all the AGs, Dr. McCauley Rensch said discussion would be more effective. ExMAG and MEPAG data are not yet in the PDS. Dr. Milazzo added that PDS/PDE has been meeting with the various AGs, and is still building the communication with the rest of the AGs. There are other communities beside the AGs that also need to be folded in. Dr. McCauley Rensch commented on her role as an AG liaison, in that she does bring up these issues. She thought that as PDART gets revamped, it will be a good time for the PDE to go out to the AGs again. Dr. Milazzo also recommended that AG representatives attend the training workshops. Asked if the CS position has a term limit, Dr. Milazzo said his contract was for 3 years, and he hoped to have some overlap/mentorship opportunities before leaving. Dr. McCauley Rensch said that PDE is considering succession plans. Asked if the position was important and effective, Dr. Milazzo affirmed that having an independent person was an important aspect to communicating without intimidation. He appreciated that something was done with the recommendation for an AG. Dr. Glaze noted that the rationale for going with a CS, rather than a limiting AG approach, encourages more proactive engagement with a greater variety of people. Dr. McCauley Rensch said she hoped that something will grow from the CS model, and that it will also help to keep touch with the community through different people in the CS position. Dr. Milazzo said he had been terrified of the AGs as a grad student. Both Drs. Diniega and Milazzo thought the PDE Chief Scientist model was also a good model for IDEA.

Asked if the responses to SPD-41 would be shared with the community, Dr. Crawford said a narrative description would be provided. The SPD will also be assessed every 3–5 years to track progress and derive metrics. Further updates will also include chances for community comment.

Origins, Worlds and Life

Dr. Robin Canup and Dr. Phil Christensen presented a briefing on the Planetary Decadal Survey 2023–2032, *Origins, Worlds, Life* (OWL). Key changes in this Survey are the inclusion of Astrobiology, Planetary Defense, and Diversity, Equity, Inclusion, Accessibility (DEIA), as well as organization by cross-cutting priority science questions and topics, instead of destinations. There were just under 100 participants in the steering group and panels, and this was the first Decadal Survey to be done remotely. More than 500 white papers and more than 300 presentations from external speakers served as input. OWL features twelve priority science questions that fall under 3 themes: Origins; Worlds And Processes; and Life and Habitability. Question 12 is a cross-cutting theme that encompasses the understanding of exoplanets. For each question, there is roughly a 30-page chapter in the report with about 6 sub-questions, and the strategic research needed to address each main sub-question. A few key takeaways from science question chapters include the crucial role of sample return and in-situ analyses, the dearth of knowledge about the ice giant systems, and the importance of primordial processes to compositional reservoirs, planetary building blocks and primitive bodies, and early solar system dynamical evolution.

The State of Profession chapter, Chapter 16, was truly a labor of love. Its core principles recognize broad access and participation as being essential to maximizing excellence, and that a strong system of equity and accountability is necessary to recruit, retain, and nurture the best talent. Recommendations from this chapter cite four themes for action: Evidence gathering imperative; Education about bias and improvement of practices, and policies; Broadening outreach to under-represented communities (URCs); and creating and sustaining an inclusive community free of hostility and harassment. In addition, OWL includes a chapter that illustrates the importance of R&A, stating that it serves as the intellectual foundation for NASA’s activities in expanding knowledge. The report recommends that the annual investment in R&A should be a minimum of 10% of the annual PSD budget, with this achieved through an increase in funding allocated to openly competed R&A programs. Astrobiology has a central role in 3 of the 12 priority science questions and in many current and planned missions.

Dr. Christensen addressed the major mission and program recommendations, beginning with strong support for continuing the Europa Clipper mission, while closely monitoring its cost. For Mars and MSR, the Survey recommends that if the MSR budget grows by 20% or more relative to the budget assumed in the report, a budget augmentation to PSD should be sought, to maintain programmatic balance. It is also recommended that MEP, which is seen as a scientific success story, should have its funding levels ramp back up after MSR. The report prioritizes Mars Life Explorer as the next medium-class strategic mission for MEP, and recommends that NAS should continue to manage MEP within PSD, maintaining MEP’s focus on the scientific exploration of Mars, and developing and executing a comprehensive architecture of missions, partnerships, and technology development.

In Human Exploration, the Survey states that the advancement of high-priority lunar-science objectives should be a key requirement of the Artemis human exploration program, and that PSD should execute a strategic program to accomplish planetary science objectives for the Moon, with an organizational structure that aligns responsibility, authority, and accountability. In addition, SMD should have the responsibility and authority for integrating Artemis science requirements with human exploration capabilities. Dr. Christensen said OWL was particularly enthusiastic about Endurance-A, a 1000-km robotic lunar rover mission that would collect 100 kg of samples from South Pole–Aitken Basin, and which would deliver samples to Artemis astronauts to return to the Earth. The mission is seen as a good way to expand the partnership between human and robotic science, at the cost of a medium-class mission.

In Planetary Defense, OWL supports the development and timely launch of NEO Surveyor, as well as a follow-on flyby mission to a more challenging NEO of 50–100 m in diameter. OWL also recommends replacing the ground-based radar capabilities that were lost when the Arecibo telescope collapsed.

OWL made several infrastructure recommendations, in particular for maintaining sufficient plutonium stores to supply high-energy launch vehicles and space propulsion; and for maintaining and improving uplink/downlink Deep Space Network (DSN) capabilities.

Within Technology Development, OWL's top recommendations are that NASA fund technology development at an average of 6–8% of PSD budget; that PSD create a Technology Program Plan; and that STMD should ensure that its level of investment in SMD mission technologies is balanced at approximately 30% of its overall budget, with the PSD portion at no less than 10%.

For the Discovery program, OWL recommends that the Discovery Phase-A-through-F cost cap should be \$800M in FY25 dollars, exclusive of launch vehicle costs, and periodically adjusted for inflation.

OWL recognizes the SIMPLEx program as very innovative and as providing good opportunities for early- and mid-career researchers, and recommends increasing its cost cap to \$80M.

Dr. Canup addressed recommendations for the New Frontiers cost structure; OWL recommends that its cost cap be increased to \$1.65B in FY25 dollars and there be an addition to this cap of \$30M per year of quiet cruise phase. Mission themes called out for New Frontiers-6 (NF-6) include a Centaur Orbiter and Lander; Ceres sample return; comet surface sample return; Saturn probe; Titan orbiter, and a Venus In Situ Explorer. For New Frontiers, OWL recommends all non-selected NF-6 missions, plus a Triton Ocean World Surveyor. The highest priority flagship is a Uranus Orbiter and Probe, given that Uranus-type planets may be the most common class of planets in the universe, based on current knowledge of exoplanet distribution. This mission was chosen for its flexible launch opportunities (2031–32), as it has a 15-year cruise time. There is strong international interest in this mission as well. The second priority new flagship is an Enceladus Orbilander that will search the moon's plume materials for evidence of life. Launch conditions for this mission are favorable in the late 2030s, for a landing in 2050.

Dr. Christensen closed by discussing the two budget planning assumptions underlying the Survey recommendations: one that is level, starting with PSD's FY23 budget and increasing it by 2%/year to account for (nominal) inflation, and one that is "aspirational and inspirational."

In summary, the recommended program for the coming decade:

- Continues support for missions in operation and development
- Continues the Mars Sample Return campaign as currently planned
- Increases R&A funding to 10% of the annual PSD budget by mid-decade (\$1.25 billion increase)
- Initiates the Uranus Orbiter and Probe Flagship mission in FY24
- Initiates five new Discovery missions at recommended cost cap
- Initiates one NF 5 and two NF 6 selections at recommended cost cap
- Provides robust plutonium production to meet the needs of the decade
- Continues support for the Lunar (LDEP) Program with mid-decade start of Endurance-A
- Restores MEP to pre-MSR funding level with late decade start of Mars Life Explorer
- Maintains support for Planetary Defense, with NEO Surveyor and a new NEO characterization mission
- Initiates the Enceladus Orbilander in FY29

The OWL provides traceability of recommended missions to science objectives, and the portfolio is felt to provide a balance across all the science questions. The Decadal Survey rollout has included numerous presentations to the community, which will continue with briefings to SSERVI, APL, etc., in the near future. Dr. Christensen credited Dr. David Smith for shepherding the Decadal Survey process.

Discussion

Dr. Robinson asked if there were a way for PAC to meet with NASA sooner than December, to comment on the contents of the Survey. Dr. Diniaga endorsed the Survey's recommendations on R&A. Dr. Canup said the panels had heard much concern for R&A funding through white papers, community presentations, a panel of external speakers, and briefings from Dr. Rinehart. Knowing that it was a big issue, the Survey adopted the approach of a consistent level of PSD investment for their R&A recommendation. Dr. Christensen said he thought the R&A chapter was realistic about the size of the community, as well as for considerations for the future, and other fields for scientists. Dr. Diniaga noted that inflation rates are nowhere near 2% at the moment. Dr. Christensen advised the PAC to not get hung up on numbers, rather to look at intent. *Visions and Voyages* came out during an economically restrictive period and still achieved a tremendous amount of its content. Dr. Canup said the structure is there to help NASA proceed. Dr. Diniaga related concerns from OPAG on how higher cost caps would affect Outer Planet missions. Dr. Canup said that OWL's Chapter 22 contained the rationale behind setting caps. Dr. Christensen said that smaller spacecraft, innovative mission operations, and other partnerships can also provide innovative ways to get to the outer Solar System. Asked for an elaboration of the Uranus Orbiter and Probe, Dr. Canup said the desire would be to see that mission development starts in 2024, to make the 2032 launch. It is a different type of mission in terms of its target, but the technologies are relatively high heritage so that it falls into low-medium technical risk. The "level" program defers the start. Decision rules can be found in the level vs. recommended program comparisons. Dr. Hurley commented that a finding or recommendation on international partnerships should help NASA get Uranus Orbiter and Probe going in 2024. Dr. Rinehart said that PSD will be responding to the OWL, and recommended endorsements from the PAC, and not much more.

Dr. Diniaga asked if the OWL finding on RCNs considered the current implementation of ICAR. Dr. Canup said the former NAI, now ICAR, was and is hugely important to Astrobiology; the OWL findings were based on how the RCNs had been defined, and were more concerned about how the structure could adapt to changes or community input, and to having ICAR calls restricted to certain topics within the RCNs. The concern is only about the ICAR structure, and does not undermine the importance of Astrobiology.

Dr. Diniaga asked if there had been any Artemis science concerns. Dr. Christensen said the OWL deliberately identified issues, but not implementation of solutions. Dr. Canup said the intent of Endurance-A was to design transformative science at the Moon to leverage partnership between science and HEO.

Asked for any additional comments about the OWL's observations on the community, Dr. Canup said that part of the R&A chapter deals with the need to understand trends, demographics, and how policy changes affect the state of the profession (SoP). Tracking data consistently over time not only yields information about the SoP but also builds trust. Dr. Christensen said the Survey recognized the difficulty of getting the requisite data, and tried to make a positive statement about how beneficial it would be to get the data. Dr. Robinson asked if there had been discussion of a need for community feedback on what has happened over the last two years (of the COVID pandemic). Dr. Christensen said the hope was to raise public discussion to enable more immediate change. Discussions with CAPS could help, henceforth, as will be the midterm assessment. Dr. Canup noted that there are some comments on COVID in the R&A chapter, and some guidelines on how to assess the community, regularize the definition of R&A, and how frequently. Dr. Diniaga asked Dr. Noble to comment on the OWL's Artemis finding. Dr. Noble said that ESSIO is building the train as it rolls, building structures within NASA to have the science voices heard at every step. An internal science team is now in place, at both management and worker-bee levels.

A question was posed to Dr. Voytek on OWL comments concerning RCN structure. Dr. Voytek said that ICAR had been structured to be able to respond to changes in priority and discovery. The former NAI had asked Dr. Voytek to provide more structure and schedule with regard calls, which she responded to by starting doing Step-1 proposals that were binding, and selecting topics based on the complement of proposals that had remained at NAI. This year is flush, with \$10M available, which is why ICAR did a full round. Additional effort is being put into subject/things that are thought to be critical.

Public Comment Period

Mr. John Whitehead asked if the Decadal Survey had discussed Mars Ascent Vehicle (MAV) challenges. Dr. Christensen said they had tried to be conservative, listening to feedback and IRB recommendations. The number used for MSR was based on the best information available. Considerations like the MAV and rover structure were not discussed, only noting that delaying MSR increases its total cost. Dr. Canup said they endorsed the IRB report on MSR, and echoed Dr. Christensen's comments on the conservative approach to estimating the cost.

Final discussion

Dr. Diniaga and the PAC refined findings and recommendations

- Gratitude for the Decadal Survey effort, and expression of strong endorsement, especially for R&A, recommended program, SoP, NeoSurveyor, and Uranus mission start by 2024
- Concerns about science in Artemis, structure of ICAR and RCNs (tabled)
- Dr. Hurley suggested adding in Pu development for RTGs to support Solar System exploration. Dr. Glaze raised a caveat, being that the OWL assumes that if every mission recommendation is implemented in this decade, then the current Pu supply would be insufficient. (Suggested Finding not taken forward)
- Endorsement of SoP Chapter to support gathering data, survey.
- Inclusion of CoC in all NASA activities, and a recommendation that NASA develop the CoC along the lines of OWL recommendations. Dr. Kiefer commented that details, interpretations, etc., could be problematic for implementers. Dr. Rinehart thought a CoC template would be most useful here.
- NSF collaboration with ANSMET, encouraging NASA to pursue conversations. NASA activities impacted by inflation rates (tabled until December). Finding on ground-based radar replacing Arecibo. Dr. Glaze said that work with NSF is just getting kicked off. Ability to get (optical) telescopic observation time? Need clarification from MExAG on need for time for ground-based observations of Mercury (not necessarily limited to radar observations).
- R&A finding: glowing support for NoDD, DAPR, striving for transparency, targeted response times.
- Recommendation to continue the H2O program, with co-creation as key and model for IDEA.
- Commend NASA for IDEAcon; recommendation is to endorse IDEAcon recommendations, particularly for an outward-facing position and repository for resources.
- PRISM/CLPS extension to other bodies in Solar System, like Mars. Dr. Kiefer suggested including SIMPLEX. Dr. Glaze said such an inclusion could have budget implications, and suggested this finding be wrapped up in the Decadal Survey endorsement.

In response to some concerns, Dr. Glaze said the PSD budget has been set for 2024, and was not subject to change; the December PAC input would be more useful for the FY25 budget.

Dr. Diniaga closed the meeting at 5:46pm.

Appendix A

Attendees

Planetary Science Advisory Committee

Serina Diniega, **Acting Chair**, Jet Propulsion Laboratory
Lisa Danielson, Los Alamos National Laboratory
Justin Filiberto, NASA Johnson Space Center
Jennifer Glass, Georgia Institute of Technology
Justin Hagerty, United States Geological Survey
Dana Hurley, Johns Hopkins University Applied Physics Laboratory
Walter Kiefer, Lunar and Planetary Institute
Hope Ishii, University of Hawaii
Tyler Robinson, Northern Arizona University
Joseph Westlake, Johns Hopkins University Applied Physics Laboratory
Stephen Rinehart, Executive Secretary, NASA Headquarters

Attendees at Headquarters

Moses Milazzo
Lisa Gaddis
Sarah Noble
Lori Glaze
Megan Ansdell
Shoshana Weider
Kathleen Vander Kaaden
Karen Gernis
David Smith
Lindsay Hays
Henry Throop
Michael New
Raha Hakimdavar
Michael Meyer
Joan Salute
Leela Fredlund

Webex Attendees

Vanetta Wilson	Joe Gasbarre (he/him)	Jessica Noviello
Jeff Herring	Joel Kearns	Kathy Mandt (she/her)
Erin Morton	Kristen Bennett	Julie Rathbun
Alana Johnson	Delia Santiago-Materese	Jeff Balcerski
Louise Procktor	Galen Fowler	Jamie Riggs
Ed Rivera-Valentín	Rich Zurek	Bill McKinnon
Jennifer Glass	Rosalind Armytage	Bonnie Buratti
Brad Thomson	Chris German	Michael R. Meyer
Bo Trieu	Jeff Grossman	Amy Fagan
Cynthia Dinwiddie	Jason Callahan	Etienne Dauvergne
Concha Reid	Elaine Denning	Fran Bagenal
Mike Fanelli	Melissa Kirven	Sylvie Espinasse
Anne Verbiscer	Jemma Davidson	Lucas Paganini NASA HQ

Cameron Thompson
Naomi McGill
Marcia Smith
Amanda Nahm (she/her)
Mini Wadhwa
Saki Hirama
Emma Bullock
Griffin Reinecke
Jack Szykowski
Douglas Isbell
Aaron Burton
Chad Hill
Christina Viviano
Renee Leck
Azita Valinia
J Andy Spry
Jamie Shumbera
Patrick Taylor
Alejandro S. Borlaff
James Lochner
Mia Mace
Brad Zavodsky
Tiffany Morgan
Chris Dateo
Terry Trevino
Prajakta Mane
Enidia Santiago-Arce
Taylor Raines
Paul Voosen
Michael Lienhard
R Aileen Yingst
David H. Smith
William Kahle
Lori Feaga
Tyler Robinson
LaJuan Moore
Dave Murrow
Marchel Holle
Gene Mikulka
Grant Tremblay
Mike Barker
Shelby Osborne
John Cooper
Lindley Johnson
Elisabeth Morse
Van Kane
D Smith
Raha Hakimdavar
Lewis Groswald
Tom Gardner
Shelby Osborne

Natalie Wolfenbarger
Louise Prockter
Stephen Rinehart
George Tahu
Michael Meyer
Daisy Detwiler
Lucas Paganini (he/él)
Caleb Fassett
Stephen Clark
Brett Denevi
Alfred McEwen
Amanda Hendrix
David Millman
Kelsey Evezich
James Tuttle Keane (he/him,
JPL)
Nick Lang
Michael Veto
Walter Kiefer
Stanley Merritt
Hope Ishii
Jolita Ilieva Moriceau
Robbie Herrick
Linda Karanian
Jeff Foust
James Roberts
Paul Abell
Kathy Mandt [she/her]
Lisa Danielson
Becky McCauley Rench
Abigail Rymer
Tammy Dickinson
Barbara Cohen
Meghan Bartels
John Whitehead
Jeffery Hollingsworth
Monty Di Biasi
Moses Milazzo (he, him, his)
Rosaly Lopes
Shoshana Weider -loaner
Serina Diniega
Joan Zimmermann
John Brown
David J. Smith
Kathleen Vander Kaaden
Megan Ansdell
Sarah Noble (she/her)
John Rummel
James Keane (he/him)
Daniella Scalice
Carolyn Wilson

Randy Dodge
Nasser Ghariban
Shannon MacKenzie
Gerardo Morell
Michael New (he/him/his)
MaKhaila Bentil
Andrea Ortiz
Maggie McAdam
Ryan Watkins
Linda Billings
Kailyn Haye
Parvathy Prem (she/her)
Justin Lawrence
Nicolle Zellner
Jorge Coppin-Massanet
Tammy Dickinson
R Fogel
Lindley Johnson
Alistair Funge
Mark Elowitz
Kim Reh
Majd Mayyasi
Bill Knopf
Kate Burgess
Flora Paganelli
LaJuan Moore
Andrea Riley
Lindsay Hays (she/her)
Mary Voytek (she, her)
Jason Hofgartner
Kurt Retherford
Tom Wagner
Jeff Moore
Parvathy Prem
Phil Christensen
B Harvey
Julie Stopar
Nancy Chanover
Robin Canup
Larry Nittler (he/him)
Kevin Murphy
Miguel Cruz
Mitch Gordon
Brad Bailey
Debra Needham
James Tuttle Keane (he, him)
Alexandra Witze
Amy Reis
Shoshana Weider

Appendix B

Agenda

NASA Planetary Science Advisory Committee (PAC) Meeting

June 21–23, 2022

NASA Headquarters (MIC3A) and WebEx

Agenda

ACCESSIBILITY

Captioning will be provided for this meeting. We are committed to providing equal access to this meeting for all participants. If you need alternative formats or other reasonable accommodations, please contact Ms. KarShelia Kinard, Science Mission Directorate, NASA Headquarters, Washington, DC 20546, (202) 358-2355 or karshelia.kinard@nasa.gov.

Day 1: June 21, 2022

Public WebEx Connection Information:

<https://nasaevents.webex.com/nasaevents/j.php?MTID=mda51ad787d5b7783fca775b4e68c3f80>

Webinar number: 2762 055 5578

Password: XJgRNbNB353 (95476262 from phones)

Join by phone: +1-415-527-5035 United States Toll (Access code: 276 205 55578)

Item & Speaker	June 21 (Eastern)
Welcome/Around the table Stephen Rinehart	12.00–12.05
Planetary Science Division (PSD) Update Lori Glaze and Joan Salute	12.05–13.05
Planetary Mission Senior Review 2022 Report Henry Throop and Lindsay Hays	13.05–13.35
PAC Q&A/Discussion	13.35–14.00
Mars Exploration Program (MEP)/Mars Sample Return (MSR) Updates Eric lanson, Michael Meyer, Jeff Gramling	14.00–14.45

PAC Q&A/Discussion	14.45–15.00
BREAK	15.00–15.30
Assessment/Analysis Group (AG) Updates AG Representatives	15.30–17.00
1. ExoPAG	15.30
2. ExMAG	15.40
3. MAPSIT	15.50
4. OPAG	16.00
5. SBAG	16.10
6. MEPAG	16.20
7. LEAG	16.30
8. VEXAG	16.40
9. MExAG	16.50
AG Q&A	17.00–17.30
Additional PAC Discussion	17.30–18.00
Adjourn Day 1	18.00

Day 2: June 22, 2022

Public WebEx Connection Information:

<https://nasaevents.webex.com/nasaevents/j.php?MTID=m70025abdb5bbacc34d2e6981bbc504>

Webinar number: 2762 423 0318

Password: kiNQPeF4V52 (54677334 from phones)

Join by phone: +1-415-527-5035 United States Toll (Access code: 276 242 30318)

Item & Speaker	June 22 (Eastern)
Welcome/Around the table Stephen Rinehart	10.30–10.35
Planetary Defense Coordination Office Update Lindley Johnson and Kelly Fast	10.35–11.05
Research and Analysis (R&A) Update Stephen Rinehart	11.05–12.05
PAC Q&A/Discussion	12.05–12.30

BREAK	12.30–13.30
PSD Inclusion, Diversity, Equity, and Accessibility (IDEA) Update LaJuan Moore et al.	13.30–13.45
Here to Observe (H₂O) Program Update David Smith (NASA); Jorge Coppin-Massanet, Andrea Ortiz Cana, Oscar Resto Hernandez, Gerardo Morell (UPR), MaKhaila Bentil, Kailyn Haye, Nasser Ghariban, Dawit Haile (VSU)	13.45–14.15
Cross-AG IDEA Working Group Update Maggie McAdam and Parvathy Prem	14.15–14.30
Advancing IDEA in Planetary Science Conference Report Kennda Lynch and Edgard Rivera-Valentin	14.30–15.00
Lunar and Planetary Institute Update (LPSC plans and IDEA Initiative) Lisa Gaddis	15.00–15.30
PAC Q&A/Discussion	15.30–16.00
BREAK	16.00–16.30
Additional PAC Discussion	16.30–18.00
Adjourn Day 2	18.00

Day 3: June 23, 2022

Public WebEx Connection Information:

<https://nasaevents.webex.com/nasaevents/j.php?MTID=mo3f1b23e2883867of76363f664819fao>

Webinar number: 2762 920 8201

Password: 8yiSPwY3MM2 (89477993 from phones)

Join by phone: +1-415-527-5035 United States Toll (Access code: 276 292 08201)

Item & Speaker	June 23 (Eastern)
---------------------------	--------------------------

Welcome/Around the table Stephen Rinehart	10.30–10.35
Astrobiology Program Update Mary Voytek and Lindsay Hays	10.35–11.05
Lunar Science Update Sarah Noble	11.05 – 11.50
PAC Q&A/Discussion	11.50–12.15
BREAK	12.15–13.15
Planetary Data Ecosystem (PDE) Update and SPD-41a Update Becky McCauley Rench, Moses Milazzo, Steve Crawford	13.15–14.15
PAC Q&A/Discussion	14.15–14.30
Decadal Survey Presentation Robin Canup and Phil Christensen	14.30–15.30
PAC Q&A/Discussion	15.30–16.00
Public Q&A period	16.00–16.15
BREAK	16.15–16.45
Additional PAC Discussion	16.45–18.00
Adjourn Day 3	18.00

Appendix C
PAC Membership

Amy Mainzer, **Chair**
University of Arizona

Lisa Danielson
Los Alamos National Laboratory

Serina Diniega
Jet Propulsion Laboratory

Justin Filiberto
NASA Johnson Space Center

Jennifer Glass
Georgia Institute of Technology

Justin Hagerty
United States Geological Survey

Dana Hurley
Johns Hopkins University
Applied Physics Laboratory

Walter Kiefer
Lunar and Planetary Institute

Hope Ishii
University of Hawaii

D'Arcy Meyer-Dombard
University of Illinois at Chicago

Conor Nixon
NASA Goddard Space Flight Center

Tyler Robinson
Northern Arizona University

Joseph Westlake
Johns Hopkins University
Applied Physics Laboratory

Stephen Rinehart
Executive Secretary, NASA Headquarters

Appendix D

Presentations

1. Planetary Science Division Status Report; *Lori Glaze*
2. 2020 Planetary Mission Senior Review; *Henry Throop, Lindsay Hays*
3. Mars Exploration Program; *Eric Ianson, Michael Meyer, Jeff Gramling*
4. Analysis Groups
 - ExoPAG; *Michael Meyer*
 - ExMAG; *Barbara Cohen*
 - MAPSIT; *Brad Thompson*
 - OPAG; *Amanda Hendrix*
 - SBAG; *Bonnie Buratti*
 - MEPAG; *Aileen Yingst*
 - LEAG; *Amy Fagan*
 - VEXAG; *Jeff Bulcerski*
 - MExAG; *Carolyn Ernst*
5. Planetary Defense Coordination Office; *Lindley Johnson*
6. Research and Analysis Update; *Stephen Rinehart*
7. IDEA Activities in PSD; *LaJuan Moore*
8. Here to Observe Pilot; *David Smith, selected students*
9. Cross-AG IDEA Working Group; *Maggie McAdam*
10. Advancing IDEA in Planetary Science; *Edgard Rivera-Valentin*
11. Lunar and Planetary Institute; *Lisa Gaddis*
12. Astrobiology Update; *Mary Voytek, Lindsay Hays*
13. Lunar Updates; *Sarah Noble*
14. Planetary Data Ecosystem; *Rebecca McCauley Rensch*
15. SPD-41 Update; *Steve Crawford*
16. Origins, Worlds, Life: Planetary Decadal Survey, 2023-2032; *Robin Canup, Phil Christensen*

Appendix E

Chat Transcript Public Q&A

Did the Decadal committee discuss the Mars Ascent Vehicle challenge? The cautionary concerns from the MSR Independent Review Board, presented to the Steering Committee on 2021 December 16, do not seem to be reflected in the Decadal Report. This question has been answered verbally. This question has been answered verbally. My three white papers explained the MAV problem in detail, do Phil and Robin remember reading those? This question has been answered verbally. And the events of the past two years since I wrote those white papers, have shown that those white papers were "right on." On another topic, please explain the nature of the Feedback button on the Decadal website. What really happened to the comments that I submitted? To clarify, I used the Feedback button on at least 5 occasions, and wrote "Dear Steering Committee members," and also "Dear Mars Panel members." Late in the Decadal process (September 2021), I asked NASEM staff what was done with my comments. Daniel Nagasawa, Program Officer, Space Studies Board, wrote back to me without answering my question.