

OPAG Findings from February 21-23 meeting in Hampton, VA

1. Europa Exploration and the Decade of Darkness

OPAG heard updates from the Europa Clipper project, which is making good progress towards PDR, and about technology development efforts for Ocean Worlds/Europa Lander. However, the President's FY19 budget supports a 2025 launch for Europa Clipper rather than the 2022 launch mandated by Congress, proposes use of a commercial launch vehicle rather than SLS, which delays arrival by another 5 years, and proposes no support for Europa Lander. Europa Clipper arrival at Jupiter in 2032-2033 would mean at least a decade with no new spacecraft data from the outer solar system, for the first time in 40 years. Since R&A funding and Participating Scientist opportunities follow active missions, there may be little support for outer Solar System science for a generation.

Finding 1:

OPAG supports the earliest possible arrival date for Europa Clipper, to maintain a healthy outer planets science community. OPAG further supports continued technology development towards follow-up ocean worlds missions such as Europa Lander.

2. Status of CDAP and NFDAP

Cassini Data Analysis Program (CDAP) supports a large proportion of the OPAG community. This program is necessary for enhancing the science return of the Cassini mission by funding the work both of scientists who are and are not members of the mission teams. At the OPAG meeting there were reports that scientists who are paid by the Cassini project to support the mission were systematically not selected for R&A grants in the most recent CDAP awards. Similar anecdotal reports from New Horizons scientists were given regarding their non-selection in the most recent New Frontiers Data Analysis Program (NFDAP) awards announcement. At this time of writing, neither CDAP nor NFDAP have publically posted the selected investigations, making it difficult to evaluate the situation.

Additional concern has been expressed that the Data Analysis programs, (at least those which primarily support the OPAG community) receive inadequate resources to sustain, in particular, the young researchers who will bear the lion's share of work on Outer Planet missions in the next few decades. This problem is especially acute with regards to the lack of new missions returning data from the outer solar system in the next decade or two, which might otherwise, in part, sustain them.

Finding 2:

OPAG is concerned about the sustainability of CDAP and NFDAP programs. In particular, we encourage NASA to ensure that these programs are funded at or above their current levels now and in the future and thereby optimize the science outputs from these successful missions and maintain the vibrant research community needed to support future exploration. After funding for these missions ceases, if proposal selection rates drop below the current percentages then a CDAP and/or NFDAP funding augmentation should be implemented to bring the proposal selection percentages back to their current values.

3. Ice Giant Exploration

OPAG expresses continued strong support for an Ice Giant Flagship mission. The recent Ice Giant Flagship SDT study showed that the science to be done is compelling, as it will address important questions we currently have regarding planetary interiors, atmosphere, rings, satellites, and magnetospheres, as well as questions regarding solar system formation, exoplanets, and ocean worlds. We also expect that, as Cassini demonstrated at Saturn, having a well instrumented platform orbiting within an ice-giant system will yield surprises that fundamentally alter our understanding across many disciplines. We thank NASA for its expressions of support for completing development of key technologies, such as eMMRTG and HEEET, which an ice giant mission will require.

OPAG also notes that the recently completed Pre-Decadal-Survey study of ice giant missions considered a broad range of parameter space, giving NASA and its potential international partners an idea of what science can be done for a given commitment of resources. That study also highlighted the fact that each ice giant system has something to teach us that the other cannot and that exploration of both the Uranus and Neptune systems is ultimately needed. Several specific ice giant mission concepts are now being discussed in the U.S. and European communities (e.g. a two-spacecraft concept presented at the February 2018 OPAG meeting which would target both ice giants as well as KBO planets and other smaller bodies). It would be extremely useful to the next Decadal Survey if NASA and ESA refined their estimates of resources and potential collaborations that could be brought to an ice giant mission and study how to optimize those resources.

Finding 3:

OPAG encourages NASA to continue investment in the technologies and ground-based science that enhance an Ice Giants mission. We also encourage NASA and

ESA to refine estimates of the programmatic factors related to such a mission (e.g. cost, partnerships, launch time-frames) and undertake a follow-up mission study focused on optimizing the science return within the current best estimate of available resources.

4. Workforce Issues in the Next Decadal Survey

Dr. Calvin Lowe from Hampton University graciously presented to OPAG on NASA's role in training a diverse next generation of planetary scientists. He pointed out that racial minorities are underrepresented among STEM professionals, and that the number of new college graduates who join the STEM workforce is decreasing with time in the recent decade. This is a major issue in planetary science as it suggests that opportunities to participate in planetary exploration are not equally opened to people with diverse backgrounds. The last Astrophysics Decadal survey included a chapter on Astronomy in Society with a section on the demographics in astronomy and made recommendations for increasing diversity in Astronomy. The most recent Heliophysics decadal survey included an Appendix on Education and Workforce Issues. OPAG encourages the planetary community to request that NASA and the NSF include a similar directive in the Statement of Tasks for the next Planetary Science decadal survey so that whitepapers on the topic are explicitly solicited and the panels actively consider the issue. We thank Dr. Lowe for presenting the latest concerns to OPAG.

Finding 4:

OPAG supports the inclusion of workforce issues in the next planetary decadal survey. Specifically, OPAG asks that a survey of workforce issues be included in the Statement of Tasks.

5. RPS for the next Discovery Mission

A NASA information announcement about the 2019 Discovery AO stated that radioisotope power systems (RPS, for which the MMRTG is the only available option at present) will not be allowed. In part, we suspect that this was based on the belief that 3 MMRTGs would be needed for such a mission, which would be difficult to supply without impacting other RPS missions in the next decade. However, the New Frontiers 4 Dragonfly mission concept, now funded for Phase A, requires only a single MMRTG, as do MSL and Mars2020 rovers. There are experienced teams working on Discovery concepts that require only 1 or 2

MMRTGs. Furthermore, we have been told that Pu-238 production is scalable to the needs. David Schurr (NASA HQ) told OPAG that this decision is being reconsidered and a decision will be made within a couple of months.

Finding 5:

OPAG supports NASA's reconsideration of allowing RPS in future Discovery mission AOs, even if the number of MMRTGs is limited to only one or two units, as nuclear power is necessary to open up the solar system beyond Jupiter or Saturn to new exploration.

6. Ocean Worlds National Academies study

An update from the Roadmap for Ocean Worlds (ROW) committee was presented at OPAG. At this point the ROW committee has documented science questions that drive research on Ocean Worlds in a systematic progression from finding Ocean Worlds, to assessing their habitability, and to ultimately searching for life on them. The ROW committee has also prioritized missions that address each sub-goal within the ROW science document and identified technology needs to continue to explore these worlds. However, Ocean Worlds are important enough beyond OPAG that a National Academies study is warranted as input to the next Decadal Survey.

Finding 6:

The OPAG committee finds that NASA should initiate a formal National Academies study to explore how NASA can create an exploration strategy addressing Ocean Worlds.

7. Pre-Decadal Mission Studies:

As the time for the next Decadal Survey approaches, OPAG recognizes that the opportunity to provide input to NASA regarding new mission studies that could be completed in time to be useful to the next Decadal Survey is limited. There was the suggestion that OPAG might indicate some degree of prioritization among new outer planet missions for the Decadal Survey's consideration. A number of targets were suggested in open session during this recent OPAG meeting, including Io, Callisto, Enceladus/Titan, Saturn atmosphere, Triton, Pluto ocean characterization, Ariel and/or Miranda, and a dedicated Solar-System Space Telescope. It was also observed that ROW came out strongly in support of an Enceladus life detection mission. The reality is that only a few additional studies can be supported by

NASA within the pre-Decadal time frame. One possibility that was discussed would be to use redacted New Frontiers and Discovery proposals as surrogates for such studies, where applicable and desirable. OPAG requested from NASA how OPAG could provide such timely (pre DS) mission study suggestions in our Fall 2017 findings, but no action (to our knowledge) was taken.

Finding 7:

OPAG requests clarification of the process NASA intends to use for identifying targets for mission studies. Specifically, we encourage NASA to provide timely input regarding the scope, prioritization, and limiting number of new mission studies that can be completed in time to be useful to the next Decadal Survey. It is very desirable to have this information well before the next OPAG meeting scheduled for September 2018.

8. OPAG Technology:

The Technology Forum held of 23 February was the first in a series of discussions about the technology needs for future outer planet missions. The purpose of the Technology Forum was to identify technologies that support near-, mid- and far-term outer planetary system missions. These technologies will then be captured in an OPAG Technology Plan, which can then be fed into the PSD Technology Office and the next decadal survey. Since time did not allow for all technologies to be discussed, overviews of some of the critical technologies were given as well as informative study results. In addition, the Europa Lander study provided an overview of the technologies needed for that mission as currently envisioned, and some other Ocean Worlds missions. Some of the technologies, e.g. Thermal Protection Systems and Radioisotope Power Systems are funded and good progress is being made. Similarly, the Europa Lander team is making progress in developing some technologies for Ocean Worlds. However more work is required to enable a broader swath of mission implementations for the ocean worlds, including a variety of instruments, sampling, handling and processing tools. While the forum was not an exhaustive list of technologies required for ocean world and other outer planet missions, there was broad interest and participation signaling the importance of future investment. It is clear that PSD needs to have a sustained

funding line for the technologies discussed since both the Ice Giant mission and Ocean Worlds missions could benefit substantially from technological advances.

Finding 8:

OPAG encourages PSD to have a sustained technology program for outer planetary missions. ColdTech has been advantageous, but it was a single call and should be repeated with direct application to the OPAG goals. A sustained investment in these technologies is needed. Some technologies, Astrodynamics for one, are not funded at all and could enable many new mission concepts.