OPAG findings from August 11-12, 2016 meeting

We are currently reaping the rewards of investments made in the Outer Solar System in the last three decades. We celebrate the achievements of Cassini at Saturn and New Horizons at Pluto, and look forward to Cassini observations in the new environments that the proximal orbits will explore. We applaud Juno’s arrival and Jupiter orbit insertion this year, and progress on Phase A of Europa Clipper. Continuing challenges to OPAG are how to plan and propose for future missions, and how to keep outer planet science and the community healthy in the ~10-yr gap in new data coming from outer planet missions after the end of Cassini and Juno and preceding the arrival of Europa Clipper.

1. R&A

OPAG thanks Jared Leisner (NASA HQ consultant) for presenting data about the effects of R&A restructuring on OPAG-relevant funding. Overall, there is no clear evidence for decline in absolute funding levels. OPAG has several residual concerns:

(i) Big, omnibus programs such as SSW are less transparent in terms of where funding is going—it is more difficult to understand how well outer planet science is doing compared to more focused programs such as the old Outer Planets Research Program.

(ii) OPAG is concerned that fundamental research, and the associated long-term benefits, is being marginalized at the expense of focused programs and mission-related research. See discussion below about ROW.

(iii) The old R&A structure had multiple avenues for submitting proposals. The new R&A structure has gone too far in the other direction – possibly excluding good proposals with its specificity. For example, Cassini data analysis has a home in CDAPS, Juno data will be in the New Frontiers DAP, but it is not clear where comparative data analysis across the two projects has a home. SSW does not fund data analysis covered by other programs, and so some projects may fall through the cracks, or researchers may not apply.

OPAG Finding: We hope that the new keyword analysis will address concerns about the lack of transparency in the new, large R&A programs. We encourage the PSS to discuss what keywords would be most useful to the entire planetary science community, including target and type of research. OPAG requests that NASA release the total budget in each of the different R&A programs in order to enable transparency in the funding of different types of research, including fundamental research. Further, we request that PSD continue to actively consider whether there are gaps within the new R&A structure that preclude the submission and acceptance of good proposals.
2. Participating Scientists.

In response to a finding at the last OPAG meeting, Louise Prockter is leading a white paper task force composed of members from each solar system Assessment Group to investigate Participating Scientist Programs. OPAG thanks Louise and the Task Force for their work so far. The task force surveyed Participating Scientists about their experiences. This work continues, and in particular the group has not yet completed discussions with Principal Investigators and Project Scientists. However, work to this point indicates that Participating Scientist programs provide increased science return from missions by adding intellectual diversity and expertise to teams. They also serve an important role in developing the planetary science workforce so that we have qualified proposers for future opportunities.

The long-term nature of outer planet exploration makes these roles even more critical for OPAG than for communities studying closer targets. Participating Scientist programs for outer planet missions provide an on-ramp for early-career scientists that were (in some cases) in grade school when the mission teams were initially formed. Prior selected Participating Scientists have been broadly distributed among seniority groups, with roughly a third being early career, a third mid-career, and a third later-career. Participating scientist programs also provide a mechanism for team inclusion by researchers who are not well known to the experiment teams.

**OPAG Finding:** Participating Scientist programs provide particularly high value to NASA and to the scientific community, and should be a standard feature of future missions. OPAG requests that NASA be guided by recommendations in the white paper that results from this task force.

3. Responses to New Frontiers 4 (NF-4) Draft AO

The New Frontiers 4 draft AO was released just before the OPAG meeting, and was discussed by Curt Niebur (NASA HQ). OPAG applauds progress on NF-4, and was generally positive about the draft AO. We have a few concerns.

**eMMRTG development:** Long duration missions require long-lived power sources. Development of the eMMRTG is coming along, however not very quickly. In order to be ready for the upcoming missions there needs to be more of a sense of urgency in pursuing this target.

**OPAG Finding:** eMMRTG are an enabling technology for the outer solar system and we encourage them being ready and available as soon as possible. We are disappointed that they are not expected to be ready for the NF-4 AO.

**Launch expenses with RPS:** NASA has made great strides toward leveling the playing field for outer planet missions to be competitive with inner solar system missions given the challenges inherent in operating at large distances from the sun. The
availability of radioisotope power supplies is a major step for viability of missions beyond Jupiter.

All spacecraft must have a power system with costs included in the price of the mission. There are, however, extra costs associated with flying radioisotope power supplies beyond the power system itself – the additional launch service costs. In the draft version of the New Frontiers AO these are counted against the total mission cost.

**OPAG Finding:** OPAG suggests that, in order to level the playing field for missions to challenging locations, costs associated with NEPA and launch service/approval not be counted against the PI mission cost cap.

### 4. Europa lander:

The Europa Lander SDT chairs presented a progress report on their activities, and Curt Niebur invited OPAG to comment on this presentation. This mission has ambitious science objectives with very constrained resources, a combination that seems challenging to mission success. Draft science goals include: (1) Search for evidence of life on Europa (with 5 investigations), (2) Assess the habitability of Europa via in situ techniques uniquely available to a lander mission (3 investigations), and (3) Characterize surface properties at the scale of the lander to support future exploration (3 investigations). Expected resources include a lander payload of 35 kg, total mission energy of 2500 W-hr, and a 20-day surface lifetime. OPAG is concerned that some of the current draft mission objectives are high-risk, and the mission would be perceived as a failure in an event of non-detection of life. OPAG fully supports the COLDTech program to address these concerns, but, to be effective, this technology effort needs to be completed prior to release of an AO for flight instruments.

**OPAG Finding:** We are concerned that resources available for the Europa Lander mission may not be sufficient to achieve the ambitious objectives to search for life on Europa. We recommend that mission objectives be structured so that the mission would not be characterized as failure in an event of a non-detection of life. OPAG also recommends that, prior to the release of a lander instrument AO, potential proposers are given sufficient time and resources to develop appropriate technologies to address the investigations to be defined in the SDT report.

### 5. Roadmap to Ocean Worlds (ROW)

OPAG thanks the Roadmaps to Ocean Worlds committee, led by Terry Hurford and Amanda Hendrix, for their ongoing work, and looks forward to their report at the end of the year. The goal of this study is to define a long-term program to understand ocean worlds and search for life beyond Earth. In their interim report to OPAG, they shared some early preliminary findings:
• Existing (or new) R&A investments should support fundamental research vital to Ocean World exploration in order to maintain the momentum of the Ocean Worlds program. The ROW effort has identified fundamental science questions that can support the identification of new Ocean Worlds, the knowledge needed to assess their potential habitability, and the means to identify bio-signatures to find extant life. Such fundamental research will have immediate science impact on the Europa Clipper mission and potential Europa Lander and New Frontiers and Discovery missions.
• R&A investments to support maturation of instruments and technologies vital to Ocean World exploration should build on the augmentation of funding to PICASSO, MATISSE and the COLDTech programs.
• Efficient, capable, robust energy sources and frequent launch capability are critical for supporting a healthy Ocean Worlds exploration program.

**OPAG Finding:** The Ocean Worlds initiative has great promise for Solar System science. For its success, investment must be continued or augmented in related fundamental research, instruments and technologies, power sources, and launch capabilities.

6. **The Legacy of Cassini and Cassini Data Analysis Program (CDAP).**
Cassini’s data return from the Saturn system continues to inspire, captivate and challenge us. During its final year, the Cassini Grand Finale Mission will produce many hundreds of gigabits of fundamentally new data, including unique near-field gravity measurements, novel in-situ sampling of atmospheric constituents, ring particles, and magnetic fields and plasmas. OPAG is very pleased that NASA expects to continue the Cassini Data Analysis Program (CDAP) after the conclusion of the Cassini/Huygens Mission. We are concerned that to accommodate the need to analyze Cassini’s wealth of unique new data at the end of the mission the normal level of support for the CDAP program may be inadequate. We encourage PSD to monitor the selection levels and be prepared to augment CDAP funding if needed in the future.

**OPAG Finding:** The CDAP program has been incredibly successful in funding analysis and modeling of the wealth of data collected by Cassini. Continuation, and possibly augmentation, of CDAP will help to bridge the large gap before the next outer Solar System mission and ensure that a knowledgeable cadre of outer planet scientists will be ready to analyze data from the Europa mission, as well as other future outer planet missions. We expect that there may be an increase in the number of CDAP proposals once the Cassini mission ends. We request that NASA follow the submission rate and augment the budget if the proposal rate increases after Cassini.

7. **Ice giants SDT**
OPAG is pleased with the progress made to date by the Ice Giant mission study (being done in preparation for the next Decadal Survey). We again thank NASA PSD for undertaking this effort, and thank the engineering and science teams for their work. We note that the community continues to have a strong interest in this effort, and look forward to the final report. As discussed at our meeting, the parameter space of missions is large, and we encourage the study to carry out their plan to—in addition to the solar-electric propulsion missions already studied in detail—report on chemical-only trajectories to both Uranus and Neptune, and make a preliminary assessment of a dual-spacecraft mission on a single launch vehicle which visits both Ice Giants. The high science return from a two-planet mission warrants this attention.

**OPAG Finding:** OPAG is pleased with the progress being made by Ice Giant pre-decadal mission study, notes that high-science-return ideas are emerging, and looks forward to having the complete report at our next meeting.

### 8. Io Mission Study for next Decadal Survey

New mission studies across the solar system are needed to inform the next Decadal Survey. OPAG is pleased that the Ice Giant Mission Study is progressing, but more are needed for the outer solar system. An Io Observer was listed by New Frontiers in the Solar System, the 2003 Decadal Survey, as a Deferred High-priority mission, and by Visions and Voyages, the 2013 Decadal Survey, as one of seven high-priority medium-class mission candidates. Visions and Voyages recommended an Io Observer for inclusion among the candidates for the New Frontiers Mission 5. Since the NF-4 AO is only being released in 2016, it is unlikely that NF-5 will be solicited in the current decade. An Io Observer, is, therefore, a top OPAG priority for including in the next Decadal Survey and a mission study is an important preliminary step. There have been significant recent advances in technology and scientific understanding relevant to Io driven by the Europa Clipper and Juno missions.

**OPAG Finding:** OPAG urges NASA PSD to convene an Io Observer Science Definition Team (SDT) to steer a comprehensive mission concept study.

### 9. Juno Mission

OPAG congratulates the Juno mission for its successful Jupiter Orbit Insertion on July 4th, 2016, and we look forward to the results from the science orbits. The OPAG community finds it unfortunate that a Participating Scientist Program (PSP) did not materialize (announced at the OPAG meeting in February 2016) as originally proposed as part the mission. One of the preliminary findings of the OPAG-led whitepaper on the benefits of PSPs is to expand the science team to incorporate new members of the community and recent scientific development in the field. The white paper also found that Participating Scientists are most effective when they are integrated into the science teams early enough to participate in mission operations and planning of the science phases of their missions. Furthermore, a recent study (see finding 2 above) notes the value of participating scientists to missions and the field. As the Juno mission will soon start its relatively short science phase, the
benefits of a Juno PSP would be limited even if an opportunity were to be offered today.

**OPAG Finding:** OPAG congratulates the Juno mission for its successful Jupiter Orbit Insertion, and we look forward to the results from the science orbits. We are disappointed that the Participating Scientist Program did not materialize for Juno, and we encourage PSD to offer such opportunities for future missions.