Perspectives on NASA planetary programs from a mission implementation center

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We offer this perspective as one of the mission gateway institutions on the aspects of NASA planetary mission programs that are impactful on the way we carry out the Nation's important work developing and executing planetary spacecraft missions. It is important to reaffirm that most of the processes currently in place for NASA Planetary Science Division (PSD) are working well. In this white paper, we make suggestions for some of those that the Decadal Survey may be considering changing that we argue should continue unchanged. We also make suggestions of aspects of the mission programs that deserve further consideration.

APL is deeply involved in NASA planetary science missions. As a mission implementation center, APL is one of a very few institutions that can execute deep space missions from end to end. Our institution's guiding principle is to make critical contributions to the Nation's critical challenges. The perspectives offered in this white paper are motivated by our assessment of the best way to produce innovative solutions to the challenges of spaceflight in order to enable the highest science return for the taxpayers' investment.

1. Planetary Science Division Mission Categories

The present categorization of missions into SIMPLEx, Discovery, New Frontiers, and Flagship class missions is an efficient use of funds to achieve maximum science return. We offer some suggestions on those categorizations for the Decadal Survey to consider as they consider overall balance in PSD's mission lines.

1.1 SIMPLEx

Consideration should be given to slightly increasing the cost cap for SIMPLEx to increase the diversity of concepts that could be achieved. This should be done in a way such that it does not impact the ability to support other flight programs or to affect the cadence of other flight programs.

We support the use of cross-divisional support for SIMPLEx proposals that address cross-divisional science. There are many potential applications for cross-divisional, and even cross-directorate, small satellites that would accompany planetary missions, leveraging the launch into deep space to enable focused science return.

1.2 Discovery

Discovery mission proposals need to be developed to a level of maturity for the review team and decision makers to have confidence that the proposed science can be accomplished by the proposed implementation. Developing these concepts to that point requires time and resources. Formally adopting the strategy NASA has used recently where they select two concepts for flight out of every Announcement of Opportunity (AO) is a more efficient use of time and resources. It allows for Discovery calls every 4 years, which is frequent enough that Discovery would remain nimble to incorporate new ideas in response to recent scientific findings or technological advances, yet

minimizes the investment required to respond to biennial AOs. We suggest making this approach a policy and adjusting the cadence for Discovery AOs in order to be able to fund the selection of two for flight with every AO.

Programmatic balance is an important consideration for both NASA and the community. At the same time, it is important in Discovery not to stifle potential responses from the community. Thus, NASA should not categorically eliminate potential targets for any Discovery call. However, if NASA were to articulate programmatic considerations, priorities, and balance before the AO, it would be well-received by the mission implementation centers in prioritizing which mission concepts they develop and submit. The understanding should be that there can be highly compelling proposals that were not foreseen by NASA that would still allow them to select missions that were not on the programmatic priority list. But if there is a different standard for selection being applied based on programmatics that can be communicated in advance, it is extremely useful to mission management centers in downselecting from among the numerous compelling missions to a final bid portfolio.

1.3 New Frontiers

One of the considerations for the 2023-2032 Decadal Survey for Planetary Science and Astrobiology is whether the New Frontiers missions should be constrained to a prescribed list of targets and science goals. Given the ten-year cadence of decadal surveys, there will likely be new results after the Decadal Survey is completed that will suggest new targets and new science questions that are extremely exciting. Having flexibility to accommodate new findings is appealing. However, it is also important to note that mission implementation centers put significant investment into technology development, buying down risk, and devising innovative approaches to make significant scientific advances through New Frontiers missions. Having a study by the National Academies that incorporates the input of the entire planetary science community provides a healthy guide for where to focus those efforts and investments. Therefore, we believe that the Decadal Survey should continue to prescribe the list of New Frontiers missions.

The recent report by CAPS [National Academies, 2020] is an appropriate way to provide revised guidance to keep the New Frontiers call timely and to keep alignment with the most recent Decadal Survey. The NAS should continue to revisit the list if new data arises that suggests different priorities well in advance of the next New Frontiers AO.

An issue that has arisen with New Frontiers proposals is that there has been a mixture of candidate missions where the implementation is prescribed and where the science objectives have been prescribed. In order to allow innovative approaches to address the science questions and the incorporation of technology developments between the time of the Decadal Survey and the time of the AO, implementation should be left to the proposing team. The list should specify science goals and priorities and not specify implementation to allow for innovative approaches to answer the science questions.

1.4 Flagships

The rising costs of Flagships should continue to be carefully watched so that they do not infringe on the ability to conduct the more rapid, PI-led missions. While Flagships are important for conducting comprehensive investigations, they represent a significant wedge of the NASA PSD budget. Small increases in costs on a percentage basis of Flagship missions translates into significant cost impacts on PSD's smaller programs, including research and analysis. In order to maintain overall balance, potential overruns should be detected early and acted upon.

2. Other considerations for NASA planetary science missions

2.1 PI-led missions

We support the PI-led model of missions. The competitive nature of PI-led missions has many advantages. It leads to innovation, which enables investigations that can achieve high science return per dollar. Another benefit to PI-led missions is that they encourage all of the mission implementation centers to keep costs in check. Also, it increases the diversity of participation in missions. APL routinely is the mission implementation center for missions with PIs from universities or other research institutions which lack the infrastructure needed to implement the mission on their own.

PI-led missions provide a flexible venue for training for the next generation of space scientists. All missions should maintain easy avenues for providing on-ramps for early career workers through participating scientist programs and incorporation of new co-investigators as the mission progresses. Development of future leaders through deputy roles and explicit mentoring programs would ensure that future leaders have the preparation to continue the vibrancy of planetary science for decades to come. Costs associated with training and workforce development should be evaluated with the understanding that developing the workforce is a critical part of enabling the future of planetary science.

There are cases where directed missions are a more appropriate choice. When NASA has a focused need or an urgent new priority, directed missions are an effective solution. In particular, applied science results, e.g., planetary defense and planetary resources, often fill goals that are not easily comparable to pure science goals. If it is possible to compete the payload for the directed mission, doing so is beneficial because it increases community involvement. In any case, directed missions should incorporate a participating scientist program to allow broad participation and maximize science return from the mission.

2.2 Ability to plan and prepare for opportunities

Because significant investments of development funds and staffing go into producing mission proposals, mission implementation centers must plan those resources out for a given fiscal year by anticipating the expected AOs in many different NASA divisions, or even directorates. A consistent cadence for mission AOs is important for planning of investments for a mission implementation center. While these opportunities must adjust to many factors, especially budgetary uncertainties and cost overruns, NASA should communicate expected changes to the expected cadence as soon as changes are recognized.

2.3 New venues for missions

The landscape for planetary mission implementation is expanding. The growth of commercial providers for orbital, lunar delivery, and even deep space missions introduces a different paradigm for planetary missions. Also, the emergence of multiple, highly capable, international partners increases flight opportunities. All of the new opportunities for cost effective flight investigations are highly beneficial.

The Decadal Survey should consider how to integrate missions of opportunity, secondary payloads, technology demonstrations, and commercial delivery services into mission lines. These are cost-effective ways for NASA to achieve their science goals, but often have price structures that do not

fit into existing mission program lines. Commercial Lunar Payload Services (CLPS) for commercial delivery to the lunar surface is a good example. CLPS contracts include both the launch costs (which are not normally included in the PI-managed cost cap) and the lander (which is included in the PI-managed cost cap). Prescribing a mechanism for how a proposing team can make use of these services within the existing competed lines will result in innovative flight investigations to provide groundbreaking science. At the same time, NASA should advise the community on the risk posture NASA will adopt for proposals using these new venues for access to space or the surface of the Moon so that proposing teams can evaluate their options.

2.4 Cross-divisional and cross-directorate opportunities

The continuing advancement of planetary science leverages and interweaves with the science disciplines of Biological and Physical Science, Earth Science, Astrophysics, Exploration Science, and Heliophysics. Now more than ever, there is a need for cooperation and support across NASA science divisions, and across NASA mission directorates [NASA Science Plan, 2020]. We recommend that NASA value and incorporate cross-division science objectives into its flight projects. AOs should encourage and incentivize proposals that have broader applications than the specific target of the AO. Such applications might include data return, technology developments, supporting infrastructure, and complementary measurements. Further, continuing to coordinate actively between NASA mission directorates would be mutually enabling for exploration, technology development, and science.

3. Conclusion

As a mission implementation center, APL has the privilege to design, build, and fly spacecraft that unlock the mysteries of planetary science and astrobiology for our Nation. We partner with other mission implementation centers, academia, research institutions, industry, and international partners to return the data that lead to impactful discoveries. The suggestions, recommendations, and comments in this white paper convey our perspective on how to accomplish these things effectively.

Most aspects of NASA PSD's planetary science missions should continue with the existing mission categories of SIMPLEX, Discovery, New Frontiers, and Flagships. To facilitate planning, NASA should keep the competed lines on a steady cadence and should use the prescribed target list for New Frontiers missions. An action that will help to incorporate the benefits of the growing field of commercial and international contributors would be to describe how these partnerships will be incorporated and evaluated in mission competitions. For efficiency, NASA should formally adopt the practice of selecting two Discovery missions with each competition and adjusting the cadence accordingly. We also recommend the continuation of the PI-lead mission model for efficiency and for expanding participation. Finally, we encourage the cooperation of NASA's science divisions and NASA directorates to enable interdisciplinary science.

References

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