Boldly Increase the Planetary Science Research & Analysis Budget by 50% Immediately

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Executive Summary

The trend in the past two decades has been to provide lean funding to scientists involved in missions during development phases especially, which has had the notable benefit of allowing mission and instrument managers to focus on cost growth containment while providing other cultural improvements to teams and the science enterprise. Missions in extended phases similarly tend to be squeezed with canonical 80% cost reduction guidelines regardless of whether or not operations and other non-science analysis tasks are able to be streamlined. Contrarily, our programmatic paradigms and preconceived expectations for funding the planetary scientist workforce with research and analysis (R&A) grants has fundamentally remained unchanged for decades. Hence, a disconnect exists between expectations for scientists to supplement their mission involvement with R&A funding and the opportunities for such funding. The recommendations here advocate for a bold set of actions to fix the funding levels of the R&A program to sustainable levels and thereby reconcile the modern expectations for relatively reduced scientist funding through mission related activities with the reality that many scientists are lacking sustainable funding sources. Decadal recommendations for this historical course change are the best hope for sustaining a robust, diverse workforce of planetary scientists.

Recommendations:

- 1) Keep R&A as the top priority above mission funding and other priorities, as has been the recommended order of importance in past decadal surveys, and add recommendations to ensure NASA's implementation of the R&A program reflects this priority in its submission of the budget to OMB and the Congress.**

- 2) Increase PSD Planetary Science Research funding levels by 50% relative to the enacted \$276.6M FY2020 overall operating plan (including mission DAPs) in order to correct the deficiencies in R&A funding evidenced by dismal selection rates, and continue to maintain a sustainable R&A program with additional increases each year at 5% above inflation through the next decade.**
- 3) In the event of another fortunate and dramatic doubling of the PSD budget in the next decade we recommend NASA tie the overall PSD Planetary Science Research & Analysis funding level increases, and the core Solar System Workings (SSW) program budget especially, to parallel increases in the overall planetary budget, while also clearly delineating no-less-than funding levels targets.**
- 4) Tailor the programs for planetary R&A to consistently achieve no less than 30% selection rates for any given regular program, and target >15% selection rates for \$1M/year award class tech development programs such as MatISSE and PSTAR.**

Introduction: Needs for Expanded R&A Funding

The growing needs and pressures for the R&A programs include:

- 1) A paradigm change in the relative percent of funding for an average scientist provided by mission CoI funding levels (e.g., more like 10-20% currently, versus 50-100% funding going back to Voyager).
- 2) Universities turning away from the traditional tenure system with more reliance on non-tenured research scientists and lecturers within their institutional structure.
- 3) A growing role of soft-money research institutes, non-profits, and FFRDC-equivalents in conducting the nation's planetary research (AAS/DPS workforce survey: 31.3%).
- 4) Exciting growth in number and scope of planetary missions, seeing a doubling of the mission budgets but only half as much increase in R&A activates over the same period, risking the nation's ability to provide a return on the full science value of these missions.
- 5) Other nations are set to surpass the U.S. in terms of allocated funding for basic science, and will continue to increasingly capitalize on the availability of under-analyzed mission datasets in pursuit of growing leadership in theoretical modeling and laboratory investigations.
- 6) Early-career researchers are more diverse, but risk leaking out of the pipeline before mid-career stage owing to historically low proposal selection rates (with more diverse populations facing higher risks).

Discussion of Recommendations

We next address each of the recommendations listed above with additional rationale and narrative.

Recommendation #1:

Keep R&A as the top priority above mission funding and other priorities, as has been the recommended order of importance in past decadal surveys, and add recommendations to ensure NASA's implementation of the R&A program reflects this priority in its submission of the budget to OMB and the Congress.

The prioritization of programmatic balance amongst R&A funding as the top importance followed by missions of Flagship, New Frontiers, Discovery, and smaller (SIMPLEX, CLPS) classes has served the planetary community well in the past two decadal surveys and should be repeated.

Hendrix & Rathbun, white paper, 2020 report that 55% of planetary scientists identified spacecraft observation analysis as a primary research technique. Additionally, 41% reported theory or numerical modeling and 38% listed laboratory work as a primary technique amongst all that applied to them. R&A programs focused on laboratory studies are sorely absent in the planetary portfolio, yet lab-focused studies often have different implementations and criterion for success than the majority of proposals a typical set of panel experts will be familiar with. A successful R&A program will strive to balance the needs for scientists to complete their studies by offering funding proportional to these types of techniques.

Recommendation #2:

Increase PSD Planetary Science Research funding levels by 50% relative to the enacted \$276.6M FY2020 overall operating plan (including mission DAPs) in order to correct the deficiencies in R&A funding evidenced by dismal selection rates, and continue to maintain a sustainable R&A program with additional increases each year at 5% above inflation through the next decade.

Increasing the currently available operating budget for FY2020 enacted at \$276.6M by 50% raises the program total to \$415M. This one-time correction with an infusion of \$138M amounts to a reasonable 5% increase relative to the total \$2.713B budgeted for PSD in FY2020. When finalizing the decadal report be sure to inflate these real year dollar amounts from FY2020 to the appropriate start of the decadal recommendations (FY2023 or FY2024).

The yearly increase in R&A recommended in the Vision & Voyages (V&V) 2013 Planetary Decadal Survey of an initial 5% relative to enacted FY2011 followed by increases per year of 1.5% above inflation was well intended and structured, but would not account for the demonstrated needs of the R&A program for the community in the past decade even if NASA had achieved it (which other white papers assess). To account for the newly-appreciated, still-changing paradigm of the majority of scientists needing support from R&A programs more so than mission Co-I funding sources, a yearly increase of 5% above inflation is recommended to sustain the community throughout this time of change.

Recommendation #3:

In the event of another fortunate and dramatic doubling of the PSD budget in the next decade we recommend NASA tie the overall PSD Planetary Science Research & Analysis funding level increases, and the core SSW program budget especially, to parallel increases in the overall planetary budget, while also clearly delineating the no-less-than funding levels targets.

The increased number of proposals and increased amount per proposal recently reported for the Solar System Workings (SSW) program to be an endemic trend for PSD both point to an increase in need from the community for more R&A funding in total. Proposal pressure is often cited as the metric by which a given R&A program's funding level is assigned, but that appears to not be an influential consideration within the budget request process since the SSW funding level has remained fixed since its inception.

Recommendation #4:

Tailor the programs for planetary R&A to consistently achieve no less than 30% selection rates for any given regular program, and target >15% selection rates for ~\$1M/year award class tech development programs such as MatISSE and PSTAR.

Assertions that soft-money scientists are writing more proposals than needed to sustain their careers or that improvements to the review process will ameliorate the low selection rates are not substantiated. Rather, we must realize that assigning a higher programmatic priority to the overall R&A funding level within NASA PSD is warranted. Canonical selection rates of ~30% for research and analysis programs across all of science are deemed sustainable, with the average scientist writing 3 proposals to attain one selection.

Decadal Survey as a Tool for R&A Advocacy

Congress has demonstrated a strong support for planetary sciences in the later part of the past decade with a willingness to provide yearly budget increases of order 5%. In past years these increases have been targeted to support particular missions and program lines, owing to strong advocacy and lobbying by vested interests. Apart from professional societies and the efforts for example of the AAS/DPS Federal Relations Subcommittee (for which this author has been the chair/officer for over the past 4 years), planetary R&A advocacy goes largely unmentioned in the halls of congress much less the cubicals at OMB. In contrast, NASA centers and aerospace companies frequently communicate to key subcommittee and congressional staff regarding particular missions of parochial interest. Strong language and direct actionable recommendations within the present decadal survey to support the R&A enterprise is therefore vitally important to the entire planetary community, since policy makers indeed rely on it for providing objectivity and integrity in the allocation of national funds. Appreciative of the budget realities that NASA leaders face, the language in the decadal should provide every option for NASA PSD to expand the R&A program; the will to support R&A even at the expense of mission new-starts must be embedded within the decadal recommendations in order to ensure overall balance for the program and the future sustainability and growing diversity of the planetary workforce.

Anticipated Results

Following adoption of the recommended bulk 50% increase immediately, we can expect to double the real year values for R&A by decade end with continued 5% increases above inflation. This plan achieves an increase for R&A analogous to the doubling of the PSD top level budget witnessed between ~2015-2020. Continued lag in this needed correction would risk derailing the effectiveness and reputation of the overall planetary program for the nation in the coming

decade. Targeting an overall fraction of the planetary budget at >15% versus the present 10% is another reasonable approach for balancing R&A with mission and other costs.

Acknowledgements

I'll express my appreciation to those who have served on the AAS/DPS FRS and DPS Committee for all the useful conversations we've had on this important topic on behalf of the community. Brief reads of other white papers on R&A and related topics, community emails, and other sources that are unattributed here are also recognized and appreciated in these unusual circumstances. Exclusion of coauthors, co-signers, and supporters is driven by the difficult times rather than any intended slight and I appreciate understanding in this regard.

APPENDIX: A Primer of NASA R&A Topic Mentions in the V&V Survey

We provide these pointers to the V&V document as a reference and starting point for refinements to NASA R&A funding discussions in the new report. See first Chapter 10, especially pages 10-1 to 10-6.

[V&V ES-5 \(pdf page 19\)](#)

NASA-FUNDED SUPPORTING RESEARCH AND TECHNOLOGY DEVELOPMENT

NASA's planetary research and analysis programs are heavily oversubscribed. Consistent with the mission recommendations and costs presented above, the committee recommends that NASA increase the research and analysis budget for planetary science by 5 percent above the total finally approved FY2011 expenditures in the first year of the coming decade, and increase the budget by 1.5 percent above the inflation level for each successive year of the decade. Also, the future of planetary science depends on a well-conceived, robust, stable technology investment program. The committee unequivocally recommends that a substantial program of planetary exploration technology development should be reconstituted and carefully protected against all incursions that would deplete its resources. This program should be consistently funded at approximately 6 to 8 percent of the total NASA Planetary Science Division budget.

[V&V S-11 \(pdf page 33\)](#)

Following the priorities and decision rules outlined above, two example programs of solar system exploration can be described for the decade 2013-2022. Both assume continued support of all ongoing flight projects, a research and analysis grant program with a 5 percent increase and further growth at 1.5 percent per year above inflation, and \$100 million FY2015 annually for technology development.

[V&V S-14 \(pdf page 36\)](#)

Supporting Research

Research and Analysis Programs

The research related to planetary missions begins well before a mission is formulated and funded, and continues long after it is over. Research provides both the foundation for interpreting data collected by spacecraft, and the guidance and context for identifying new scientifically compelling missions. Ground-based observations can identify new targets for future missions, and experimental and theoretical results can pose new questions for these missions to answer. Research and analysis programs also allow the maximum possible science return to be harvested from missions. And along with analysis of spacecraft data, the portfolios of research and analysis programs include laboratory experiments, theoretical studies, fieldwork using Earth analogs, planetary geologic mapping, and analysis of data from Earth-based telescopes. All of these fields are crucially important to NASA's long-term science goals, and all require funding.

Current NASA research and analysis funding in most programs supporting planetary research is distributed as multiple small grants. An unfortunate and very inefficient aspect of this policy is that researchers must devote an increasingly large fraction of their time to writing proposals instead of doing science. **The committee strongly encourages NASA to find ways (e.g., by merging related research programs and lengthening award periods) to increase average grant sizes and reduce the number of proposals that must be written, submitted, and reviewed by the community.**

The number of good ideas for planetary research surpasses the funding available to enable that research. More funding for research and analysis would result in more high-quality science being done. However, recommendations for increased research funding must be tempered by the realization that NASA's resources are finite, and that such increases will inevitably cut into funds that are needed to develop new technologies and fly new missions. So an appropriate balance must be sought. After consideration of this balance, and consistent with the mission recommendations and costs presented above, **the committee recommends that NASA increase the research and analysis budget for planetary science by 5 percent above the total finally approved FY2011 expenditures in the first year of the coming decade, and increase the budget by 1.5 percent above the inflation level for each successive year of the decade.**

See V&V 4-13 (pdf page 113) for specific discussions relative to Primitive Bodies.

V&V 9-1 (pdf page 281)

Underlying Programmatic Requirements

Increase funding for fundamental research and analysis grant programs, beginning with a 5 percent increase above the total finally approved fiscal year (FY) 2011 expenditures and then growing at an additional 1.5 percent per year above inflation for the remainder of the decade (Chapter 10). This increase will enable the full scientific benefits of ongoing and future flight projects to be reaped.

V&V 9-19 (pdf page 299) Figure 9.1 shows notional budget wedges, with Science R&A "SRA".

V&V 9-21 (pdf page 301)

It is also possible that the budget picture could turn out to be less favorable than the committee has assumed. This could happen, for example, if the actual budget for solar system exploration is smaller than the projections the committee used. **If cuts to the program are necessary, the committee recommends that the first approach should be descoping or delaying Flagship missions. Changes to the New Frontiers or Discovery programs should be considered only if adjustments to Flagship missions cannot solve the problem. And high priority should be placed on preserving funding for Research and Analysis programs and for technology development.**