

National Aeronautics and
Space Administration



April 20, 2020

SMD/Heliophysics Division

Dr. Margaret Kivelson
Chair, Space Studies Board
National Academies of Science, Engineering, and Medicine
500 5th Street NW
Washington, DC 20001

Dear Dr. Kivelson,

I would like to express my sincere appreciation for the Committee's report, Progress Toward Implementation of the 2013 Decadal Survey for Solar and Space Physics: A Midterm Assessment. NASA appreciates the Committee's comprehensive review which will ultimately help inform NASA science during the remainder of this decadal period. I would also like to express our gratitude and congratulations to Drs. Robyn Millan and Thomas Woods, the Committee's co-chairs; the volunteer members; and the National Academies staff for their diligent support of this effort.

I have reviewed the findings and recommendations of the report, and I am pleased to convey NASA's responses to them. In general, our existing planning appears, by and large, well-aligned with the report's recommendations. Please do not hesitate to contact Dr. Michael New with any questions about NASA's response. He can be reached at (202) 358-1766 or michael.h.new@nasa.gov.

Sincerely,

Thomas H. Zurbuchen, PhD
Associate Administrator,
Science Mission Directorate

CC:

Space Studies Board/C. Hartman

- D. Smith
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- N. Fox

NASA Response to Progress Toward Implementation of the 2013 Decadal Survey for Solar and Space Physics A Midterm Assessment

Decadal Survey Research Goals and Recommendations

Recommendation 3.1: NASA and NSF should continue to use the DRIVE framework within their Research and Analysis programs. As the program elements that are part of DRIVE continue to evolve, they should remain visible and continue to be tracked in a transparent manner.

Response: NASA concurs with this recommendation and with the recognition of the importance of the Research and Analysis (R&A) program. NASA began using the decadal survey DRIVE recommendations to reframe the R&A programs in 2013 and, as the budget allowed, to develop and add new programs (e.g., DRIVE Centers in 2018, HSO Connect in 2019). As R&A programs continue to evolve, NASA will continue to use the DRIVE framework in a visible and transparent manner.

Recommendation 3.2: In consideration of developments and emerging opportunities since the 2013 solar and space physics decadal survey was published, and to optimize the science value of the agencies' programs for the remaining years of the current decadal survey interval,

1. [Not a recommendation for NASA]
2. [Not a recommendation for NASA]
3. [Not a recommendation for NASA]
4. NASA and NSF should maximize the scientific return from large and complex data sets by supporting (1) training opportunities on modern statistical and computational techniques; (2) science platforms to store, retrieve, and process data using common standards; (3) funding opportunities for interdisciplinary collaboration; and (4) supporting the development of open-source software. These four components should be considered alongside experimental hardware in the planning and budgeting of instrumentation.
5. NASA should find ways to increase solar and space physics community participation in strategic missions and enhance the diversity of mission teams. The Planetary Science Division's Participating Scientist program is a model that could be considered to achieve this goal.
6. NASA and NSF should strengthen their mutual coordination of ground-based and space-based observations, to include NASA investment in ground-based measurements that support their missions, and coordination of NSF ground-based facilities in support of NASA missions, including suborbital campaigns.
7. Both NASA and NSF should create inter-divisional funding opportunities that support science areas that bridge established divisional boundaries at the agencies. Specific examples of science areas include outer heliosphere, Sun-as-a-star, and star-exoplanet couplings. Progress will require collaboration between divisions at each agency to create inter-divisional programs.

Response: For clarity, each subpart of this recommendation is addressed separately.

Recommendation 3.2.4. NASA concurs with the spirit of this recommendation. For clarity, each subpart of this recommendation is addressed separately.

1. NASA does support training opportunities on a project-specific basis, but would defer to NSF for general training opportunities for the larger scientific community.
2. NASA supports the Solar Data Analysis Center (SDAC), the Space Physics Data Facility (SPDF), and the Community Coordinated Modeling Center to store and retrieve mission, modeling, and other data. SDAC and SPDF maintain common standards for archived data (FITS, CDF, and netCDF), CCMC has a common standard for model outputs (Kameleon), and both standards can be described with the SPASE metadata standard. NASA is currently engaging in internal discussions about these projects matching the Agency's current and projected future strategic needs. These discussions are expected to end in a plan to realign these projects in order to utilize modern techniques and capabilities for large and complex data sets.
3. NASA currently supports and intends to continue supporting interdisciplinary collaborations within NASA and between NASA and its partner agencies. NASA, NSF, and NOAA have been joint-soliciting the Research to Operations program (2018-2020). NASA solicited the DRIVE Science Centers (2018), consulting with NSF on the program design, and the Heliophysics System Observatory Connect program (2019); in both solicitations, the role of enabling interdisciplinary science was clearly identified. NASA has interdisciplinary, cross-Divisional programs that support the study of exoplanets and the science of planetary habitability. These efforts have been well-received by internal and external stakeholders, and NASA intends to continue their support; further, NASA continues to explore possibilities for additional interdisciplinary-emphasizing activities, and is currently reviewing community feedback on inter-Divisional research gaps as part of that effort.
4. NASA has been conducting internal discussions on policies related to these topics, and appreciates the National Academies' 2018 reports on open science and on open source software. Ahead of any larger NASA policy changes, NASA's Heliophysics Data Environment Enhancements program (H-DEE; 2018-2020) solicited proposals to advance the goal of a robust, vital, and coordinated Python environment. NASA currently intends to continue that support and is considering other programs where similar targeted support would be effective. Outside of those focused programs, NASA's Research Opportunities in Space and Earth Sciences 2020 (ROSES-2020) began the multi-year implementation of the National Academies' 2018 report "Best Practices for a Future Open Code Policy for NASA", requiring that new software produced in any award be released under an open source license. Further, ROSES-2020 also included two interdivisional program elements to support 1) the conversion of legacy code to modern code to be released under an open source license, and 2) the improvement and maintenance of open source software tools, libraries, and frameworks.

Recommendation 3.2.5. NASA concurs with this recommendation, and recognizes the importance of a diverse mission team and the benefit of community participation in strategic missions.

NASA includes in all recent mission solicitation (e.g., MIDEX 2019) support for diverse and inclusive teams, and the expectation that those values will be reflected in community groups, including mission and instrument teams. Further, the MIDEX 2019 solicitation encouraged proposers to include career development opportunities (e.g., deputies for key personnel) on mission proposals in order help develop the next generation of mission leaders.

NASA's Science Mission Directorate has used Participating Scientist, Interdisciplinary Scientist, and Guest Investigator/Scientist programs to increase participation in science teams in previous and current missions; for example, in 2017, the Heliophysics Division partnered with the Planetary Science Division to solicit Participating Scientists for the Juno mission. These increases of the mission science team ensure that it has the necessary skills and expertise to optimize the mission's science return. For future Heliophysics Division missions, NASA will explore the most effective ways to expand the mission teams, as budgets permit.

Recommendation 3.2.6. NASA concurs with the recommendation for improved inter-agency coordination of observations and partially concurs with NASA support of ground-based observations. NASA greatly appreciates NSF's support of ground-based assets that provide observations coincident with those from space-based assets. This coordination enhances the science return from both sets of observations, and inter-agency communication is an important part of that process. Lastly, within the scope of specific missions, NASA has supported ground-based observations that are beyond the observatories' normal operations; for example, the Heliophysics System Observatory Data Support program (2019) funded ground-based observations that would complement Parker Solar Probe.

Recommendation 3.2.7. NASA concurs with this recommendation, and does currently fund cross-Division programs that support science areas that bridge the established Division boundaries. The Juno Participating Scientist Program (2017) was jointly solicited by the Planetary Science and Heliophysics Divisions. The Heliophysics Division also joins with other Divisions in the on-going Exoplanet Research Program and Habitable Worlds program. These efforts have been well-received by internal and external stakeholders, and NASA intends to continue their support. Regarding potential additional efforts, NASA solicited community feedback on inter-Divisional research gaps and is reviewing those results at the time of this response.

Recommendation 3.3: The committee encourages NASA to continue to work toward the goals set out by the decadal survey for Explorer missions. In order to maintain a 3-year (or ideally faster) launch frequency of Explorers, the committee recommends that NASA develop a more efficient management environment and an improved contract/grant structure, both to reduce mission cost and to shorten the interval from AO to launch. In this context, NASA should (1) adopt new procedures to facilitate a more cost-efficient implementation of smaller

satellites and instruments using disruptive small-sat technology and (2) continue to strive towards reduced launch costs—for example, through ride sharing.

Response: NASA concurs with this recommendation’s points (1) and (2), and has been continuing, initiating, and refining such procedures within NASA Science Mission Directorate (SMD) and Heliophysics Division (HPD).

To address the cost-efficient implementation of small-satellite technologies, NASA has been working internally on optimizing the solicitation and management of those missions. These efforts include, but are not limited to:

1. In 2018, SMD issued a policy to enable rideshare on SMD-sponsored launches with excess performance. Based on lessons learned regarding to the rideshare integration process, SMD updated the policy in 2019. NASA is attentive for future lessons learned and will update the policy as needed.
2. To best leverage the expertise and insight from the science and technical community, NASA SMD and HPD co-chaired the Access2Space Workshop (2020) to solicit input on the creation and management of a small-spacecraft payload pipeline for NASA ESPA-class missions. Two of the major topics included 1) science instrument types and configurations conducive to development small science missions, and 2) programmatic barriers that may hinder small payload development. NASA is currently reviewing the results from that workshop at the time of this response, but expects to use effective outputs to inform future mission-related discussions and solicitations.

In parallel with these and other actions, NASA has proactively been supporting the development of innovative small-satellite technologies as well as soliciting and selecting missions leveraging those technologies. In order to mature technologies for later inclusion in Explorer missions, the HPD research program funds the development and flight of these technologies in the Heliophysics Flight Opportunities for Research and Technology (H-FORT) and the Heliophysics Technology and Instrument Development for Science (H-TIDeS) programs. Within its current mission competitions, NASA is proud of recent mission selections that are enabled by these innovative technologies, including, but not limited to, SunRISE (Heliophysics Explorers MO 2017), PUNCH (Heliophysics SMEX 2017), and EscaPADE (SIMPLEX 2017, solicited by NASA Planetary Science Division and selected by Heliophysics Division).

NASA strives for reducing launch costs through the launch service procurement process managed by the Launch Services Program (Kennedy Space Center) and through policies and solicitations managed by NASA SMD and HPD.

1. In October 2018, SMD instituted a policy to enable rideshare on SMD-sponsored launches with excess performance. In 2019, the policy was updated to integrate rideshare integration as part of the launch service procurement process for SMD primary payloads. Any excess capacity on these launches can be leveraged by SMD-sponsored payloads or, absent those, payloads sponsored by other NASA Mission Directorates, other U.S. Government Agencies, or NASA international partners.
2. SMD is in the process of standing up a Rideshare Office to more efficiently and effectively execute rideshare opportunities for the Directorate. Based on strategic planning and following the successful management of rideshare on the IMAP mission,

SMD selected HPD to lead that Office. This Office will develop an implementation plan of the new SMD Rideshare policy and foster the dissemination of information to the SMD Divisions, NASA Centers, and the community as a whole.

3. NASA has issued solicitations focused on rideshare missions. To leverage the excess capacity anticipated on an IMAP launch vehicle, NASA solicited potential-rideshare science and technology missions. SIMPLEX 2017 solicited only proposals that would launch as rideshare payloads (EscaPADE and Janus proposed to launch with the Psyche mission; Trailblazer, managed by the SMD Lunar Discovery and Exploration Program, is planned for accommodation on the IMAP launch vehicle).
4. Outside of the procurement process, NASA is looking at implementing rideshare on the next Heliophysics Explorers launch.

Recommendation 3.4: NASA should take the steps necessary to prepare for the release an Announcement of Opportunity for a DYNAMIC-like mission.

Response: NASA agrees with the compelling nature of the DYNAMIC science goals remaining unaddressed after the selection of ICON, GOLD, and AWE. Further, NASA recognizes their synergies with the Geospace Dynamics Constellation mission science objectives, their importance to national security interests, and their contribution to the advancement of space weather research. The Heliophysics Division supports this recommendation, but the timing of release for a DYNAMIC-like mission AO will be dependent upon available budget.

Recommendation 3.5: In order to proceed toward meeting the top-level decadal survey Living With a Star mission recommendation, NASA should take the steps necessary to define a specific mission architecture formulation and implementation scheme for the Geospace Dynamics Constellation within the next 3 years.

Response: NASA concurs with this recommendation. Further, NASA agrees on the importance of the Geospace Dynamics Constellation (GDC) mission as a stand-alone mission and as a mission that has strong synergies with the DYNAMIC mission concept recommended for the Solar Terrestrial Probes program. After the Heliophysics Advisory Committee delivered the GDC Science and Technology Definition Team (STDT) Final Report in October 2019, NASA directed the NASA Goddard Space Flight Center Living With a Star Program Office to stand up a GDC Pre-Project Study Team. This team has been charged to use the GDC STDT report to conduct the Pre-Formulation activities remaining to be done, including but not limited to: refinement of mission-level science requirements; exploration of alternative mission architectures, including development cost and schedule; and development of the necessary project management products. These activities are those necessary for the Pre-Project Study Team's completion of a Mission Concept Review, the first major mission lifecycle review. NASA expects this Project Pre-Formulation phase to be completed in late summer 2020.

Decadal Survey Applications Goals and Recommendations

Recommendation 4.1: In order to make efficient progress on the high-level goals in the National Space Weather Action Plan, NASA should initiate an implementation roadmap for space-weather science and for capability transfer between research and operations (research-to-operations and operations-to-research) in collaboration with the National Science Foundation's Geosciences (GEO) and Mathematical and Physical Sciences (MPS) directorates and their research communities. This document should identify and prioritize the science focus areas and the associated essential observables and data-driven space-environmental models that are critical to "significantly advance understanding and enable improved characterization and prediction of space weather" as part of the overall national space weather enterprise as well as for NASA's internal needs related to the exploration of space.

Response: NASA concurs with this recommendation's call for a strategic roadmap and is currently developing such a document. NASA expects completion in time for the next decadal survey.

As part of that strategic planning, NASA is in the initial stages of a science and observation gap analysis consistent with its role in the national and international space weather enterprise (expected completion in late 2020). Other aspects of that strategic planning will be informed by the National Academies of Sciences, Engineering, and Medicine workshop "Space Weather Operations and Research Infrastructure" and any follow-on activities.

Further, NASA is actively collaborating with NSF, NOAA, and other partners to efficiently and effectively make progress on the implementation of all sub-objectives in Section 2.0 of the National Space Weather Strategy and Action Plan. Specifically, NASA is currently working with other agencies to implement Objectives 2.1 ("Identify and Ensure Baseline Observational Capabilities") and 2.7 ("Improve Observations and Modeling for Characterization and Forecasting").

Heliophysics Career Enhancements

Recommendation 5.1: NASA, NSF, and NOAA should develop strategic plans for the heliophysics community with goals and metrics to improve the diversity of race, gender, age, and country of origin. The next decadal survey should include a State of the Profession Panel, similar to the Astro2020 decadal survey. The State of the Profession Panel should have in advance the demographics / diversity survey data recommended in this report's Recommendation 6.2.

Response: NASA concurs with the spirit of this recommendation. Fulfilling NASA's mission requires that the Agency monitor the Nation's relevant expertise and any structural issues that may degrade it. NASA has been initiating activities to address potential and realized issues in

that expertise; these efforts include but are not limited to dual anonymous peer reviews, mission PI development programs (e.g., PI Launchpad, mission design school, AO-encouraged training/mentorship opportunities), clearly stated policies on discrimination and harassment in solicitations (e.g., mission AOs), and codes of conduct at NASA-support workshops, conferences and symposia.

The 2013 solar and space physics decadal survey did address education and workforce issues; in addition to the currently on-going astronomy and astrophysics decadal survey, the planetary science and astrobiology decadal survey has also been charged to examine the state of the profession. NASA expects that the next solar and space physics decadal survey will likewise examine the state of the profession, and NASA intends to ask the Space Studies Board's Committee on Solar and Space Physics to provide input as to what data and/or analysis that NASA could provide to support that effort.

Preparing for the Next Heliophysics Decadal Survey

Recommendation 6.1: NASA and NSF should implement and fund advanced planning for the next decadal survey that involves the community in strategic planning of the next decade science challenges, science goals, and related high-priority measurements, and that also considers stretch goals (ambitious objectives that might extend past the next decade). NASA and NSF could request the Space Studies Board's Committee on Solar and Space Physics (SSB-CSSP) to evaluate options for implementing this planning for the next decadal survey.

Response: NASA concurs with the recommendation. NASA, NSF, and NOAA will host a pre-decadal survey community workshop that focuses on a short-, medium-, and long-term science strategy. NASA expects that a result of this workshop will be a discussion of the science objectives necessary to enable significant progress in the next decade and beyond.

Some of these science objectives would require the implementation of new missions. Before the planetary science and astrophysics decadal surveys, NASA did support the study of mission concepts. NASA is currently examining the benefits of that approach and considering the most effective way to support the development of mission concepts that would help execute the science strategy emerging from the community workshop.

Recommendation 6.2: NASA Heliophysics Division should conduct a demographics / diversity survey before the next heliophysics decadal survey to understand how the community's demographics have evolved and to assess whether progress has occurred in enhancing diversity in the community (see also this report's Recommendation 5.1). Thereafter, to benefit all of the space science disciplines within NASA's Science Mission Directorate (SMD) and to inform decadal survey planning across SMD, NASA at the SMD level should conduct this demographics / diversity survey on a 5-year cadence with clear identification of science areas relevant for each science division.

Response: NASA concurs with the spirit of this recommendation, but is addressing implementation other than as recommended. NASA Science Mission Directorate is requesting a major study by the National Academies of Science, Engineering, and Medicine on diversity

and inclusion in competed space missions. One proposed task for that study is comparing the past and current proposer pool to the demographics of the NASA science community, the larger U.S. science community, and the U.S. national population. NASA expects that the study may engage with experts to conduct a broad demographic survey of the NASA Division-specific communities. NASA expects that future survey activities would be informed by the results of this study.

Recommendation 6.3: NASA, NSF, and NOAA, the anticipated principal sponsors of the next solar and space physics decadal survey, should work together to develop an integrated statement of task that reflects the research and application needs for each agency and across the federal government. To address the evolving needs for science-driven strategic plans, the agency sponsors should ensure the following items are included as tasks for the next decadal survey committee:

- Definition of distinct science goals and implementation strategies for NASA's Solar Terrestrial Probes and Living With a Star programs,
- Evaluation of strategic plans with nominal (baseline) budget and optimal (best-case) budget,
- Inclusion of decision rules for guiding implementation of recommendations, and
- Identification of enabling technology needed in the coming decade to support longer-term stretch goals.

Response: For clarity, each subpart of this recommendation is responded to separately.

Recommendation 6.3(a). NASA agrees that it is important for programs to have distinct science goals and implementation plans, and is currently conducting internal discussions to distinguish the scopes and boundaries of the Solar Terrestrial Probes and Living With a Star programs. These discussions are based upon the referenced need for a scientific basis that is able to evolve with the Heliophysics Division's, the Agency's, and the Nation's needs. NASA's intention is to produce a plan for those programs, after which NASA would seek comments and input from the science community. A final plan for the two programs would then be published in time for the next decadal survey.

Recommendation 6.3(b). NASA does not agree that Agency-defined budgets would provide a benefit to the decadal survey. NASA seeks the input of National Academy of Sciences for a strategy that prioritizes the investigations and investments required to make long-term scientific progress. Agency-defined budgets would unduly confine the decadal survey committee's recommendations to those perceived as low risk. The decadal survey should present an ambitious but realistic strategy to address compelling scientific challenges and an honest assessment of the budgetary resources necessary for NASA to rise to meet them.

Recommendation 6.3(c). NASA concurs with the recommendation for the inclusion of decision rules in the decadal statement of task. The National Academies of Science's report *The Space Science Decadal Surveys: Lessons Learned and Best Practices* clearly addressed how strategic decision rules are able to guide programmatic

priorities in the case of a future situation not aligning with the decadal survey's expectations.

Recommendation 6.3(d). NASA concurs with the recommendation. NASA expects for the next decadal survey committee to address short-, medium-, and long-term science goals, and would request that committee to explicitly address enabling-technology needs.