



**Michael W. Liemohn** • Professor

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Dr. Nicola Fox, Heliophysics Division Director  
National Aeronautics and Space Administration  
Heliophysics Division  
300 E Street, SW  
Washington, DC 20546-0001

Dear Dr. Fox:

The Heliophysics Advisory Committee (HPAC), an advisory committee to the Heliophysics Division (HPD) of the National Aeronautics and Space Administration (NASA), convened on 18 December through 20 December 2018 at NASA Headquarters (HQ). The undersigned served as Chair for the meeting with the support of Dr. Janet Kozyra, HPAC Designated Federal Officer (DFO), of NASA-HPD.

All HPAC members participated. Those in attendance at NASA HQ were Vassilis Angelopoulos (University of California, Los Angeles), Paul Cassak (West Virginia University), Darko Filipi (Adcole Maryland Aerospace), Larisa Goncharenko (Massachusetts Institute of Technology (MIT) Haystack Observatory), George Ho (Johns Hopkins University Applied Physics Laboratory), Lynn Kistler (University of New Hampshire), James Klimchuk (NASA Goddard Space Flight Center), Tomoko Matsuo (University of Colorado at Boulder), Mari Paz Miralles (Harvard-Smithsonian Center for Astrophysics), and Cora Randall (University of Colorado, Boulder). William Matthaeus (University of Delaware) attended via telecon. This letter summarizes the meeting outcomes.

The meeting opened with you providing an HPD science and technology overview and a lengthy discussion about HPD activities with you and the other HQ personnel present. One of the first items mentioned were staffing changes in HPD, including your appointment. We would like to give a special thank you to Ms. Margaret Luce, who served as Acting Division Director in 2017 and 2018. Our congratulatory remarks on this are as follows:

Ms. Luce, your recognition throughout the space science community may render this note quite unnecessary. Nevertheless, the Heliophysics Advisory Committee will add our gratitude and praise for your fantastic job as acting director of NASA's Heliophysics division. As fellow researchers, we have a keen appreciation for your contributions to humankind's endeavor to grasp the Sun and its interactions with Earth and the solar system. From the spectacular departure of Voyager from the Solar System to the more mundane but essential management of the

division's budget, your guidance of the Heliophysics division is marked by notable accomplishments. The record-smashing launch of Parker Solar Probe is perhaps the pinnacle of your term. The range of your work spans far and wide, from Earth, to the Sun, and beyond. We thoroughly appreciate your diverse contributions as well as your interactions with this committee. We wish you the very best in your future endeavors and look forward eagerly to our future collaborations.

HPAC was glad to hear that the HPD had so many mission successes since our last meeting. We are glad to hear that the Ionospheric Connections (ICON) Explorer satellite was delivered on time and on budget, and look forward to its successful launch. HPAC also was pleased to hear about HPD's effort to maintain a high and reliable cadence for upcoming mission Announcements of Opportunity (AOs), including the timeline for the upcoming Medium Explorer (MIDEX) AO release. Our finding on HPD flight projects is as follows:

HPAC would like to laud NASA's Heliophysics Division (HPD) for a number of recent actions and activities. We commend HPD for (1) maintaining contact with the Voyager spacecraft and supporting the operations team to monitor these spacecraft that have now left the solar system; (2) the successful launch of Parker Solar Probe and the record-breaking pass of this spacecraft through its first perihelion, breaking a number of spacecraft records in the process; (3) the new NASA-USGS partnership to complete the US magnetotelluric survey to infer Earth's subsurface electric conductivity, an important input for space weather applications; (4) the proposed plan for the HTIDES-LCAS program to split mission proposals by suborbital and orbital rather than by cost caps; and (5) successful efforts on public outreach, especially concerning outreach surrounding the launch of Parker Solar Probe.

HPAC was delighted to hear that DRIVE funding has been fully implemented, up to \$175M in FY19. We are especially glad to hear that R&A program element success rates are approaching or above 30%. We also applaud the new structure in leadership and management of the R&A program within HPD. Our two findings on this are as follows:

#### Research and Analysis Program

HPAC is very pleased by the attention that HPD has given to the research and analysis (R&A) program. We are especially happy with the increased funding that has come about through full implementation of DRIVE. We recommend that this good news be actively advertised to the heliophysics community, which has become demoralized by the steady decrease in inflation-adjusted R&A funding over the past decade and a half. We request that detailed budget numbers (current budget and increment) be provided on the different R&A program elements, especially the long-standing core programs of SR, GI, and LWS. We also request information on how the increased funding has translated into proposal success rates,

both overall and as a function of proposal grade. We applaud the decision to create a new HPD position dedicated to R&A, which indicates a strong commitment to the vital role that R&A plays in maximizing the science return from the large investment in missions.

#### Space Weather Efforts

HPD is, very appropriately, increasing its activities in space weather research. As it does so, it must remain cognizant that its role is to provide the scientific understanding that forms the underpinnings of accurate space weather specification and prediction. Close interaction with the operational community is crucial in this regard. However, HPD should avoid drifting into activities that are purely operational and not research based. HPAC is delighted by our new director's comments to the effect of "science is the foundation of everything we do."

HPAC was pleased to hear about the numerous international collaborations that HPD has established and continues to foster and grow. HPAC has a few recommendations about this issue, as follows:

HPAC encourages HPD to continue to build connections with international partners to strengthen the scientific yield of NASA missions. For instance, HPD will benefit from engaging in more direct interactions with ESA Earth Observation to enable synergistic collaborations between NASA and ESA for the ionosphere-thermosphere (IT) science community. Recent Earth Observation mission examples include Swarm, GOCE and Earth Explorer candidate mission Daedalus. The IT community's scientific interests often fall in between the areas administered by ESA's Earth Observation and Space Science directorates, and the two ESA directorates operate independently with limited coordination.

HPAC then heard from you about a new initiative, the "Whole Helio" Campaign, coordinating observations across not only HPD but also other SMD divisions to maximize scientific return from the perihelion passes of PSP. HPAC commends you for launching this campaign and strongly supports it. Our finding on this campaign is as follows:

HPAC congratulates HPD for conceiving and supporting the "Whole Heliosphere and Planetary Interactions" campaign initiative that will promote coordination of the whole heliosphere system science. This is a unique opportunity for connected, interdisciplinary research, potentially involving several NASA SMD divisions as well as participation by other agencies. These campaigns will coordinate PI-led team observations centered on perihelion passes of the Parker Solar Probe, in concert with other helio/astrophysical and planetary space, suborbital, and ground-based observational assets, complemented by theory and modeling efforts. The campaigns will enable characterization of specific structures in transit

throughout interplanetary space, along with activity in the space environments and atmospheres of Earth and other planets. Workshops after the campaigns will foster multidisciplinary collaboration and planning of future campaigns.

HPAC heard from you about SMD's commitment to rideshare opportunities. HPAC thinks this is fantastic opportunity for expanding HPD science and fully supports this endeavor. This includes HPD participation in the Lunar Gateway project and utilization of commercial assets for HPD investigations. Our recommendation on this issue is as follows:

HPAC applauds HPD efforts to provide innovative rideshare opportunities (e.g., commercial launch providers and via the lunar gateway) in order to maximize access to space. We note that the NASA Earth Science Division and National Science Foundation are working with commercial small-satellite constellation operators that are beginning to provide observational data of value to the HPD. We recommend that HPD:

- 1) investigate implementing mission concept development programs similar to those in other NASA divisions (e.g., PSD) and DoD (e.g., Space Experiment Review Board) through regular ROSES calls for mission studies that can be made readily available to take advantage of these rideshare opportunities in a timely fashion;
- 2) investigate innovative ways to explore non-traditional options (i.e., commercial providers) of obtaining science-quality observational data.

Finally, HPAC heard from you about the HelioConnects website ([bit.ly/SubmitHelioScience](http://bit.ly/SubmitHelioScience)) for collecting and disseminating scientific results from NASA-funded researchers and those using NASA mission data and modeling resources. This is an excellent way to promote the exciting findings of our discipline to the general public.

During lunch, HPAC heard a presentation from Dr. Mary Voytek of NASA HQ on the "Idea Lab for Astrobiology" that took place this past year. We were impressed with its success at generating innovative and creative project ideas for this topic. We were also intrigued by the process of how it was conducted, including the initial selection of participants and the involvement of facilitators throughout the meeting week.

After lunch, Dr. Michael New of HQ briefed HPAC on his assessment of gender representation in both missions and R&A programs across SMD, and the actions that SMD has been taking to address disparities found from this analysis. HPAC highly commends Dr. New for undertaking this assessment and is very pleased to see the numerous new initiatives that SMD is starting to enhance equity in proposer demographics. Our detailed response to this is as follows:

HPAC applauds the efforts of NASA SMD to quantify diversity metrics in proposal submissions and grant awards, and to promote an inclusive grants program. In particular, we recognize the need to provide adequate training and resources to potential PIs, and strongly support the implementation of

a PI incubator program (see also below). In addition, we recommend that HPD investigate hosting regular proposal writing workshops, consider mission design workshops similar to JPL's planetary summer school program but for HPD science, and investigate the feasibility of a faculty development funding opportunity analogous to (or in collaboration with) the NSF GEO FDSS program. We also recommend that HPD collect HPD-specific diversity metrics to identify division-specific issues on diversity.

To promote inclusivity in the PI incubator program, HPAC recommends that the workshops be open to scientists at all stages of their careers. Specific attention might be given to graduate students, since research suggests that people from underrepresented groups are more likely to withdraw from the field before reaching mid-career. Offering PI incubator opportunities to graduate students might therefore help to diversify the PI pipeline. We further recommend that the PI incubator include leadership training for hardware projects on various platforms (e.g., balloons, rockets, cubesats, satellites), as well as for large science teams (not necessarily hardware-based). Ideally the PI incubator program would be self-perpetuating, in that successful participants would later serve as mentors. We recommend that HPD investigate institutional teaming strategies that might facilitate training of people from institutions that are not involved in hardware projects.

At the end of the first day, HPAC heard from Dr. Jeff Hayes on data management and computing issues. We are pleased to hear that the high-end computing (HEC) resources available to HPD researchers will dramatically increase this year. It is good news to hear that the unused allocations were down from the year before, and we highly applaud Dr. Hayes' active monitoring of accounts and steps to encourage researchers to fully utilize their allocations. HPAC enjoyed its lively discussion with Dr. Hayes and we thank him for his time with us.

HPAC had a lengthy discussion with Dr. New and Dr. Hayes about the R&A program, especially the inclusion of a call within the next Heliophysics Data Environment Enhancement program element solicitation for converting research codes to open source platforms. An additional topic that arose was the HPD's commitment to model verification, validation, and assessment of models' performance. Our recommendation on this is as follows:

HPAC notes the lack of resources for comprehensive assessment of existing models that require the following: a) level-3 gridded observational data products for input, assimilation and validation of physics-based models for a wide range of conditions; b) human, computing and data storage resources to generate and store massive amounts of models' outputs; c) coordination of effort between data and model output providers that are funded by different agencies; and d)

sustained effort to examine performance of different models as they evolve.

The lack of support translates into unrealistic expectations within the community about the strengths and weaknesses of existing models (a.k.a. pretty-picture syndrome) and will hinder R2O transition to improve space weather forecasting capabilities. We ask for more information from HPD about its planned approach in addressing this problem.

The second day began with a briefing from Dr. Jim Spann on the Senior Review (SR) process. He had two specific issues about the SR process for which he solicited input from HPAC. The first is the possibility of allowing changes to the Level 1 operating requirements involving spacecraft operations, telemetry, and data processing. Right now, the expectation is that these continue as originally implemented in the Prime Mission phase of the project; the issue for us to consider is the allowance to alter these requirements in later years. HPAC agrees with this change. Our finding on this is as follows:

We support the suggestion that missions in extended phases be required to reassess their level 1 (prime mission) operational requirements on a cadence commensurate with the Senior Review. This likely already happens for missions whose new Prioritized Science Goals (PSGs) and/or changing mission parameters (e.g., orbit) demand new operational requirements. In addition, some missions have already streamlined their operational requirements to maximize science return. But there might be other missions for which new PSGs can be accomplished, and data set continuity can be achieved, with less stringent operational requirements. Changing the operations of such missions could result in cost savings, so reassessing operational requirements periodically is warranted. We caution, however, that changing operational parameters can be costly in its own right, both because of direct operational transition costs and costs of retrieving and validating data under different operational conditions. Thus we recommend that the reassessment of operational requirements be undertaken at a cursory level for the purposes of the Senior Review proposals, and only pursued in depth if there are indications that substantial cost savings would be likely.

The second issue that Dr. Spann discussed with HPAC is in regard to the length of the Prime Mission. Often mission teams enter their first Senior Review cycle while they are just "hitting their stride" on full exploration of their initial data. The SR process asks them to propose new Prioritized Science Goals for continuing their mission into extended phase. This is often a difficult burden for most missions. The issue for us to consider is lengthening the Prime Mission of flagship missions to 5 years and Explorer missions to 3 years. HPAC disagrees with this suggestion, but offers an alternative solution to the problem. Our response is as follows:

HPAC was asked to comment on whether the prime mission phases of individual missions should be extended unilaterally and across-the-board by NASA/HQ to allow for successful missions to continue producing good science at the time when they may have reached peak productivity. The HPAC warns against creating such a requirement, or even endorsing a prime mission duration longer than what is necessary to meet the proposed and approved baseline mission objectives, as this would impact negatively the mission implementation cost, with a ripple effect on the entire HPD line of missions. Rather, HPAC recommends adjustment of the SR review process to recognize the potential for unique and increased scientific value of successfully implemented missions that are requesting a first extended phase. HPAC recommends that missions in their first round of the SR cycle not be required to develop a set of new Prioritized Science Goals (although missions may still choose to strengthen their case in a competitive review environment). However, in recognition of the value of the SR for reviewing data dissemination and community participation, HPAC recommends that such missions are still subject to the rest of the standard rules and budgetary constraints of the SR process.

HPAC then heard from the co-chairs of the Living With a Star (LWS) Program Analysis Group (LPAG), Drs. Mark Linton and Anthea Coster. We congratulate LPAG on a successful completion of their task at drafting options for LWS to consider as Focused Science Topics and Strategic Capabilities. Our finding on this is as follows:

HPAC appreciates the significant community engagement that the Living with a Star (LWS) Program Analysis Group used in gathering information for the LWS focused science topics, and is pleased to see that the same process is planned for reassessing the Strategic Science Areas (SSAs) next year. While the current SSAs cover a wide range of space weather impacts, some topics are absent, and it is appropriate to reassess them periodically.

The penultimate report to HPAC was a status briefing about the Geospace Dynamics Constellation (GDC) Science and Technology Definition Team (STDT) from Jared Leisner and the STDT co-chairs, Drs. Allison Jaynes and Aaron Ridley. We were updated with the progress made so far, and are pleased with the schedule laid out by the co-chairs to achieve success within their committee timeline, and commend the co-chairs in their strong leadership of this process. HPAC looks forward to seeing the final STDT report in April of 2019. We have two findings on this issue. The first is a recommendation to conduct a feasibility study soon after receipt of the STDT report, as follows:

HPAC applauds the prioritization strategy of the GDC STDT science objectives, which provides NASA flexibility in the execution of the mission. However, HPAC is worried about a potentially inordinate cost implied by the GDC STDT study goals, which is a consequence of new

FACA regulations that expressly prohibits discussions of implementation strategies in that forum. The rather open-ended science objectives, even if prioritized, without consideration of the technical implementation strategies, has the potential to exceed the intended budget for this type of mission. Without an intermediate study, between the current GDC STDT study report due in April 2019 and the development by NASA/HQ of an actionable mission formulation strategy with well-defined science goals, measurement strategy, and clear technical requirements, the unintended consequence of the aforementioned FACA rules may be mission cost that is unaffordable or will result in programmatic delays in other HPD programs.

HPAC recommends that NASA conduct a technical feasibility study of the range of prioritized science options proposed by the STDT, before executing a mission formulation plan. In the interest of time, the HPAC recommends that NASA follow closely the orbital design strategies outlined in the STDT report. Since FACA rules prohibit the inclusion of instrumentation options in the STDT report, HPAC recommends that NASA solicit community input on instrumentation options for the feasibility study. HPAC further recommends that NASA assemble the technical team to conduct the study quickly after the STDT report is official, such that the technical feasibility study is both comprehensive and does not delay the GDC mission execution.

The second is a request to seek out partners in NSF to coordinate ground-based observations that will highly complement the GDC measurements and significantly augment the scientific return from the mission:

HPAC recommends that HPD to coordinate closely with NSF to make ground-based observing systems an integral component of the GDC mission concept. Because of the nature of IT system that is exposed to changing conditions of both space and terrestrial weather, closure of GDC scientific objectives would benefit from continuous monitoring of the region from ground to provide the contextual information of the IT system upon which magnetospheric inputs impinge. This coordinated simultaneous investigation of the region will help entice the entire IT community to rally behind the GDC mission concept, as many of the IT community members develop, operate and work with various types of distributed ground-based instrumentations. Past mission examples include THEMIS, which has successfully incorporated a network of ground-based all-sky imagers as part of the mission observing system from its very inception. Another example is a ground-based instrumentation suite, including SuperDARN and Sondrestromfjord ISR, which complemented measurements from Geotail, Wind, Polar, SoHO, and Cluster, as part of the International Solar-Terrestrial Physics (ISTP) Science Initiative.

The final presentation heard by HPAC was from Dr. Art Charo of the National Academy of Sciences on the preparation for the Midterm Report on the Decadal Survey in Solar and Space Physics. It was an engaging discussion and we had some verbal feedback directly to Dr. Charo during his time with the committee. We are looking forward to the progress of the assembled group and to their eventual report.

HPAC welcomes NASA Heliophysics Division requests for elaboration or clarification regarding any of these findings and recommendations from the committee.

In conclusion, HPAC thanks HPD and all others involved for convening this committee meeting and the extensive discussions we had with HQ staff. We would like to especially thank Ms. Ana Wilson, Ms. Vanessa Patrick, and Dr. Janet Kozyra for their organization efforts to make this meeting run so smoothly.

Sincerely yours,



Michael W. Liemohn

Cc: Margaret Luce, HPD Deputy Director  
Janet Kozyra, HPAC Designated Federal Officer  
Meenakshi Wadhwa, Chair, NASA Advisory Committee - Science Committee [NAC-SC]  
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