Heliophysics System Science and Funding for Extended Missions

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I have served on the last three Heliophysics Senior Review (HSR) Panels, in 2005, 2008, and 2010. Based on those experiences, I am writing to offer some comments and recommendations for your consideration. Please note that I am writing you as an individual, and nothing that I say here should be imputed to my employer, which is another government agency. For the record, I note that I am not nor ever have been a member of a mission or instrument team. (Undoubtedly, this is why I keep getting tapped for the HSR.) However, throughout my career, a large part of my research has involved making use of data from heliophysics missions and has been funded by the Heliophysics GI, SR&T and LWS/TR&T programs.

This document is broken into two parts. As background, in Section 1, I briefly review findings and comments from the 2010 HSR. In Section 2, I offer four suggestions and recommendations on MO&DA funding for Heliophysics extended missions.

Section 1: Background: The 2010 Heliophysics Senior Review

The 2010 Heliophysics Senior Review differed from the last two senior reviews in important ways. In the previous HSRs, the mission teams were asked to submit both 'optimal' and 'in-guide' budgets. The former were designed to maximize the scientific impact of the mission while still recognizing the very tight fiscal constraints that NASA faces. Although the MO&DA budgets have never been sufficient to support all missions at the optimal level, it was the happy task of the HSR Panel to identify the missions that made the most compelling scientific cases for a higher budget.

In the 2010 HSR, circumstances were very different. First, mission teams were instructed to present only "minimal science" budgets. Second, the Senior Review Panel was informed of the need to cut the prospective MO&DA "minimal science" budget from $59.5M to $54.7M in FY11 and from $57.9M to $51.8M in FY12. (These numbers do not include the Heliophysics GI program, which also falls under the "MO&DA" line.) Moreover, due to the projections of reduced funding levels in future years and the impact of new missions moving from their prime mission phase to the extended mission budget, the latter will be under-funded, by the order of $5M per year in the out-years.

In assessing the value and costs of extended missions, the Panel noted several facts:

(a) Overall, the Panel found that the mission teams have been responsive to the call for "minimal science funding". In fact, in nearly all cases, the mission teams have been aggressive in reducing operating costs.

(b) The Panel found that NASA, in consultation with the science community, has done a good job in terminating satellites and/or instruments made obsolete by newer missions.

(c) The Panel found that the remaining missions in the Heliospheric System Observatory (HSO) are complementary, not duplicative. Each mission occupies a unique vantage point, in terms of either its instruments and/or orbits.

(d) The Panel rejected the notion that mature missions, well into their extended phase, are easy targets for cuts since these missions already have a large database in hand. This notion overlooks the growing power of the HSO, due to the addition of new missions, such as Hinode, IBEX, and SDO, and how the context provided by these new missions increases the potential value of new data from older instruments. The long baseline of existing instruments also has intrinsic value, in the light they shed upon phenomena with long timescales, which we are only beginning to understand. It is also short-sighted to assume that a mission can only make discoveries during its "prime" phase.

(e) In the opinion of the Panel, the Heliophysics MO&DA is already operating at inadequate levels of funding. These funding levels jeopardize HSD's ability to meet its objectives for Heliospheric System Science. These concerns are further aggravated by the instability in support for Helio GI, SRT, and LWS/TRT programs, which utilize the HSO datasets.

Section 2: Suggestions and Recommendations

1. The Priority of Heliophysics System Science

Heliophysics is an exciting part of NASA's science portfolio. Like our colleagues in NASA's other science divisions, we explore fundamental processes that challenge our ability to understand Nature. However, we also address challenges (like space weather and space climate) with direct implications for our Nation's economy and security. These two aspects of our research meet in the Heliophysics Division's commitment to Heliospheric System Science. System Science is larger than any single mission, and understanding the heliospheric system necessarily requires sampling this vast region of space at multiple locations and with an array of sensitive, robust instruments measuring a broad spectrum of physical quantities.

The Heliophysics System Observatory (HSO), the product of many years of effort and billions of dollars in investment, is our prime tool for advancing heliospheric system science. Given NASA's overall budget constraints, we must identify the most cost-effective way of doing system science. In particular, the marginal costs of operating of an existing mission are very small compared to costs of developing and launching a new mission. It may therefore be argued that the best way of leveraging previous investments and of addressing system-science objectives is to collect data from existing spacecraft and instruments until they fail or are rendered obsolete by a new mission.

Unfortunately, once a mission has completed its first 3-5 years of operation, NASA necessarily starts to perceive that mission as a liability, rather than an asset. This attitude is driven simply by pressure on the mission-operations budget. This attitude must be changed. Eventually every satellite will fail or be superseded by a new mission with better technology. But until that happens, our obligation to taxpayers should be to squeeze as much science out of every mission

as we can. NASA should explicitly recognize that our satellites have the ability to deliver unique and useful data for many years – 10, 15, maybe even 22 years! – and budget accordingly.

So here's the big question: given the Heliophysics Division budget of ~$600M, how is it decided that continued operation of existing missions is worth no more than $55M? Does this amount come from an effort to maximize the science return from the HSO? Or does the does the budget line for extended-mission operations come at the bottom of the HSD queue, garnering the remainders of whatever may be left after paying for new missions and other mandates? Given what I have seen in the Senior Reviews, I believe that the situation is the latter: the budget for the HSO and for extended missions is literally "what is left?"

Since Heliophysics has proven to be an observationally-driven science, the essential need for and inherent value of new missions is beyond question. Appropriately, new missions will always get the lion's share of the Heliophysics budget. Nevertheless, the Decadal Survey provides an opportunity to examine the larger question of the budgetary balance between extended-phase and new missions. In particular, when it comes to system science, should we 'put our money where our mouth is' and assert that funding adequate to exploit fully the HSO should be at the top of the Heliophysics priority queue?

Changing the order of priorities, and the balance between ongoing and new missions, are high-level questions. HQ officials rightfully argue that, at some level, their hands are tied by congressional mandates. It therefore requires congressional action to recognize the prime importance of adequate funding for extended-mission operations. The Decadal Survey is our best opportunity for conveying this message to Congress.

2. The Senior Review Process

Many people will undoubtedly blanche when they read about funding going on for 10-20 years. It is important to emphasize that we are not creating sinecures. Ongoing funding for extended missions must be limited and strictly controlled; it cannot in itself be allowed to become the primary source of income for individuals or institutions.

For these reasons, the Senior Review process, or something like it, must still play a critical role, in assessing the ongoing health of instruments and spacecraft, identifying redundancies with newer mission, and evaluating the extent to which the mission's data are still valuable to heliophysics research, as evidenced by peer-reviewed publications.
But once the Senior Review has given a positive judgment on these issues, NASA should be charged to find adequate resources to support the ongoing missions. This scenario is the exact opposite of what has happened in recent Senior Reviews, where the panel's primary duty has been to "find out what we can turn off with doing the least damage."

3. External Funding for Extended Missions

Here's an idea that might initially be rejected as outlandish or distasteful. But think about it:

NASA should explore sources of out-of-house funding for extended missions. In the 2010 Senior Review, 10 of the 13 reviewed missions had FY11 budget requests in the range of $1M-$5M per year. The aggregate cost is large. But just imagine: "The Google Voyager Interstellar Mission" or "The Microsoft Advance Composition Explorer".

Universities have sold "naming rights" for decades, and to many corporate entities, the amounts of money we are talking about are not large. For them, spending a few million dollars per year to be identified with these missions might be very appealing. After all, our science inspires the next generation of scientists and engineers who will develop and use their technology. Clearly the corporate support could not be used to fund work by civil servants. But universities and private corporations, where a lot of the MO&DA work gets done, could accept funding from private sources. Congressional action might be required to allow these arrangements. If that is so, an endorsement from the Decadal Survey would be the first step.

4. Relationship to Research and Analysis (R&A) Funding

Support for the operation of extended missions should not be allowed to become competition for research and analysis (R&A) funding. That has happened twice in recent years, in which the Heliophysics GI competition has been cancelled because of the squeezed MO&DA budget. It should be recognized that the extended-mission operations and research and analysis funding are inherently dependent on each other and complementary. We cannot do system science without the data from extended missions, and it certainly makes no sense to collect and archive data if no one is funded to do science with them.