APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

B.1 HELIOPHYSICS RESEARCH PROGRAM OVERVIEW

1. Overview

NASA's heliophysics strategic objective is to understand the Sun and its interactions with the Earth and the solar system, including space weather. In this framework, the Heliophysics Research Program is guided by goals defined in the *NASA 2014 Science Plan* (available at https://science.nasa.gov/about-us/science-strategy) and the *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society* (www.nap.edu/catalog.php?record_id=13060) and its purpose is to enable achieving these goals, which are:

1. Determine the origins of the Sun's activity and predict the variations in the space environment;
2. Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs;
3. Determine the interaction of the Sun with the solar system and the interstellar medium;
4. Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

The Heliophysics Research Program seeks to understand phenomena, on a broad range of spatial and temporal scales, the fundamental processes that drive them, how these processes combine to create space weather events, and to enable a capability for predicting future space weather events. In concert with the other NASA science divisions (Planetary Science, Astrophysics, and Earth Science), the program shares responsibility for learning about the Earth, our solar system, the universe, and their interrelationships.

The program supports investigations of the Sun, including processes taking place throughout the solar interior and atmosphere and the evolution and cyclic activity of the Sun. It supports investigations of the origin and behavior of the solar wind, transient structures, energetic particles, and magnetic fields in the heliosphere and their interaction with the Earth and other planets, as well as with the interstellar medium. The program supports investigations of the physics of magnetospheres, including fundamental interactions of plasmas and particles with fields and waves, and coupling to the solar wind and ionospheres. It supports the physics of the terrestrial mesosphere, thermosphere, ionosphere, including the coupling of these phenomena to the lower atmosphere and magnetosphere.
The program elements are as follows:

- B.2 Heliophysics Supporting Research (H-SR)
- B.3 Heliophysics Technology and Instrument Development for Science (H-TIDeS)
- B.4 Heliophysics Guest Investigators (H-GI/Open)

- B.5 Heliophysics Grand Challenges Research – Theory, Modeling and Simulations (H-GCR/TMS)
- B.6 Heliophysics Living With a Star Science (H-LWS)
- B.7 Heliophysics Data Environment Enhancements (H-DEE)
- B.8 Heliophysics Guest Investigators – Magnetospheric Multiscale (MMS) Opportunity (H-GI/MMS)
- B.9 Heliophysics Grand Challenges Research – Science Centers (H-GCR/SC)

It is the overall purpose of each of the program elements to contribute as effectively and directly as possible to the achievement of the NASA Heliophysics strategic objective. Priority for selection is given to those proposals that most clearly demonstrate the potential for such contributions.

1.1 Data Management

All proposals to Appendix B will have to address data management. For all programs, but B.7 H-DEE, proposers must present a data management plan (DMP), or an explanation of why one is not necessary given the nature of the work proposed, by responding to the compulsory NSPIRES cover page question about the DMP. The kinds of proposals that require a data management plan on the cover pages are described in the NASA Plan for increasing access to results of Federally funded research and in the Service and Advice for Research and Analysis (SARA) Frequently Asked Questions (FAQs) about Data Management Plans (DMPs). For proposers to B.7 H-DEE, the minimum DMP requirement is superseded by instructions in the program element that place more detailed descriptions into the body of the Scientific/Technical/Management section of proposals. See, Section 2 of B.7 H-DEE.

1.2 Data Eligibility

NASA spacecraft mission data to be used in proposed work must be available in the Solar Data Analysis Center (SDAC), Space Physics Data Facility (SPDF), or an equivalent, publicly accessible archive at least 30 days prior to the full proposal submission deadline, unless otherwise specified in the program call. This is applicable to ROSES-2017 Heliophysics elements B.2 (H-SR), B.4 (H-GI Open), B.6 (H-LWS), B.8 (H-GI/MMS), and B.9 (H-GCR/SC).

1.3 Two-Step Process and Duplication

Proposal submission to all elements in Heliophysics will continue using a two-step process, in which a Step-1 proposal is required. The title, science goals, and investigators cannot be changed between the Step-1 and Step-2 proposals. All Heliophysics programs will continue reviewing Step-1 proposals for compliance and will require a description that is limited to the 4000 character text box on the NSPIRES cover page that includes (1) the science goals and objectives, and (2) the proposed methodology. The Encourage/Discourage evaluation of Step-1 proposals will not be in effect in ROSES-2017. All compliant proposals submitted to these calls will be invited to submit a Step-2 proposal. Proposers to H-GI and H-SR are limited to one Step-1

proposal per Principal Investigator (PI) per program element, i.e., they can submit one and only one proposal as PI to each.

Proposers may not submit Step-2 proposals for the same or essentially the same work to more than one program element concurrently. This covers all program elements in Appendix B and also all cross-divisional ROSES program elements (Appendix E) supported by the Heliophysics Division. This prohibition is active for a particular submitted proposal until the PI is notified through NSPIRES that the proposal was declined or until the proposal is withdrawn. The prohibition on duplicate proposals applies across ROSES years as well (e.g., a duplicate of a pending ROSES-2016 proposal may not be submitted in response to ROSES-2017).

If a second proposal is submitted while a duplicate proposal is still pending in another program element, only the first proposal will be evaluated; the duplicate proposal may not be evaluated or considered and may be returned without review.

2. Recent Trends in Proposal Selection Rates

The Heliophysics research budget that supports analysis of Heliophysics System Observatory (HSO) data is competed through ROSES and continues to experience high demand through increased numbers of proposals submitted by the community. As a result, the success rate of proposals submitted to the ROSES portfolio that Heliophysics offers has declined (Figure 1) in the period of ROSES-2007 to ROSES-2013 and has stabilized since at a low level. A contributing cause of this trend is Heliophysics research funding not keeping up with inflation.

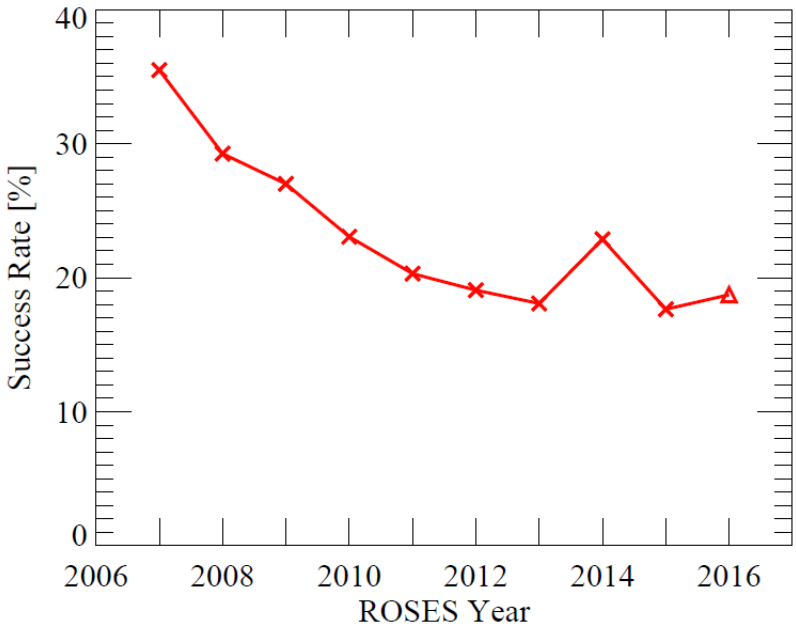

Figure 1 shows the selection rates over the ROSES years 2007-2015 and an initial estimate for ROSES-2016.

At the time of writing, complete data on submissions for ROSES-2016 is not available, but initial indications are that proposal submission numbers are not declining as compared to the rates seen in the ROSES-2013 through ROSES-2015 solicitations. Possible causes for continuing high submission rates are sustained success rates under 25% since ROSES-2010.

The Encourage/Discourage approach, i.e., peer review of three-page Step-1 proposals, for H-GI and H-SR program elements in ROSES-2014 and ROSES-2015 has been analyzed and found not to be as meaningful and effective as hoped for in identifying proposals with insufficient scientific merit. It, therefore, has been discontinued.

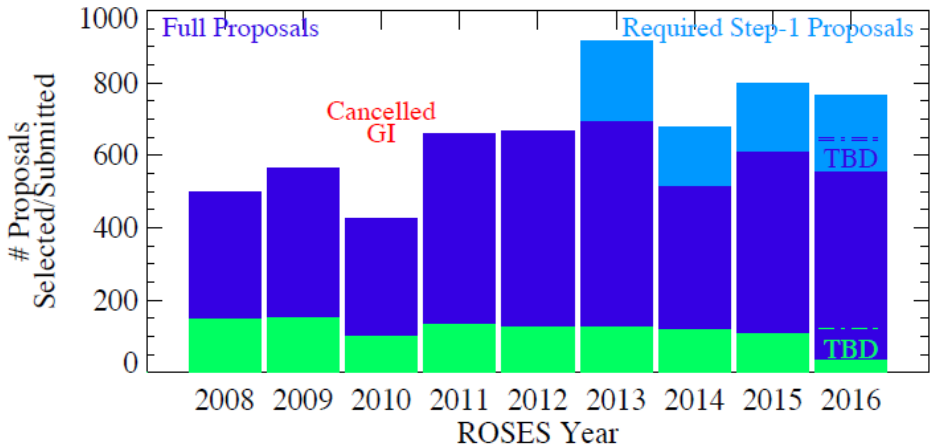

Figure 2 shows Step-1 and full proposals submitted by ROSES year along with selections, where available. In the bar chart, green indicates the awards, dark blue shows Step-2 proposals, and light blue shows the Step-1 proposals.

Beginning in ROSES-2016, the H-SR program scope has been expanded, requiring higher levels of commitment of the PI (or science lead) to funded projects than before with the goal of increasing the science return. This approach is continued in ROSES-2017. While it was observed that this larger scope led to a reduction of proposal submissions, due to a larger cost per proposal the H-SR success rate is expected to be slightly lower in ROSES-2016 than it was in ROSES-2015.

On a positive note, the outlook for success rates in ROSES-2017, which competes Fiscal Year 2018 funds, is expected to improve from the full implementation of the 2013 Decadal Survey "Diversify, Realize, Integrate, Venture, and Educate" (DRIVE) initiative. The Heliophysics Division is committed to strengthening the Heliophysics Research Program.

3. Program Elements

A brief description of each program element offered in the Heliophysics Research Program is given below. Note that the program elements underwent major restructuring between ROSES-2012 and ROSES-2013. The ROSES-2013 structure is generally maintained in ROSES-2017. Please note also that there are opportunities added this

year (B.8, B.9). The intent of the following summaries is to give the prospective proposer some insight into the element's purpose within the context of the overall program structure. Detailed descriptions of each element are to be found in Program Elements B.2 through B.9.

Heliophysics Supporting Research (H-SR):

In order to increase the science return from funded investigations and to avoid duplication and overlap of proposal opportunities, in particular between H-GI and H-SR, a larger scope, introduced in ROSES-2016, will be maintained also in ROSES-2017. Heliophysics SR awards are research investigations that employ a variety of techniques, including theory, numerical simulation, modeling, analysis, and interpretation of space data. This increased scope of investigations must be of sufficient breadth as to require approximately one full time equivalent (FTE) per year to achieve successful completion of the project. As a result, the anticipated average award size has been increased, as well. The investigations that will be of highest priority to the H-SR program will be those that use data from current or historical NASA spacecraft, together with theory and/or numerical simulation to address one of the four Heliophysics Decadal Survey goals. Proposals focused on non-NASA data are now allowed. However, such proposals must demonstrate that the proposed work is necessary to make a significant contribution to addressing one or more Decadal Survey questions. Moreover, all data used must be in a publicly accessible archive at least 30 days before the Step-2 submission deadline.

H-SR supports investigations of the solar interior, solar photosphere, solar chromosphere, transition region, and corona; particle acceleration, transport, modulation in the heliosphere, heliospheric plasma processes, turbulence, waves, composition, interplanetary coronal mass ejections/magnetic clouds and of the outer heliosphere and the interstellar boundary; solar wind – magnetosphere coupling, dayside outer magnetosphere, inner magnetosphere, magnetosphere-ionosphere coupling and magnetotail; ionosphere – atmosphere coupling, neutral atmosphere and solar output-ionosphere/atmosphere coupling; and other planetary magnetospheres. The Heliophysics Supporting Research program is described in Program Element B.2.

Heliophysics Technology and Instrument Development for Science (H-TIDeS):

The H-TIDeS program solicits proposals for technology and instrument development investigations that are relevant to NASA scientific goals in Heliophysics. The H-TIDeS program seeks to investigate key Heliophysics science questions by addressing the best possible (i) science and/or technology investigations that can be carried out with instruments flown on suborbital sounding rockets, stratospheric balloons, International Space Station (ISS), CubeSats, or other flights of opportunity; (ii) state-of-the-art instrument technology development for instruments that may be proposed as candidate experiments for future space flight opportunities; and (iii) laboratory research.

The H-TIDeS program element has three separate components:

Low Cost Access to Space (LCAS) investigations may be science investigations in and of themselves or proof-of-concept experiments for techniques/detectors that enable new Heliophysics science. LCAS includes rides on research balloons, sounding rockets, the

ISS, airborne platforms, commercial reusable suborbital rockets, CubeSats, and other flights of opportunity. LCAS investigations that launch into space in order to return scientific data are expected to make direct contributions to the science of Heliophysics.

Instrument and Technology Development (ITD) investigations have as their objective the development of instrument technologies that show promise for use in scientific investigations on future Heliophysics science missions, including the development of laboratory instrument prototypes, but not of flight hardware. Instrument development proposals are not necessarily expected to apply the results of their efforts to science questions within the time period of the proposed effort. They must, however, demonstrate that there is a (are) specific scientific problem(s), for which the development is a necessary precursor.

The Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) subelement supports studies that probe fundamental physical processes and produce chemical, spectroscopic, plasma, and nuclear measurements that support spacecraft measurements and atmospheric models.

The Heliophysics Technology and Instrument Development for Science program with subelements Low-Cost Access to Space (LCAS), Instrument and Technology Development (ITD), and Laboratory Nuclear, Atomic and Plasma Physics (LNAPP) are described in Program Element B.3.

Heliophysics Guest Investigators (H-GI/OPEN and MMS-GI):

The Heliophysics Guest Investigators (H-GI) program was strongly endorsed by the 2013 Decadal Survey. This program is offered for investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory. The focus of the solicited research continuously evolves to ensure that the most important questions identified for recently launched Heliophysics missions are addressed and that high-value data products of currently operating missions of the HSO are created to enable significant advances in Heliophysics science. There are two distinct opportunities in ROSES-2017:

The Heliophysics Guest Investigators open program (H-GI/OPEN) is described in Program Element B.4. Proposals using Magnetosphere Multiscale (MMS) mission observations as primary emphasis are excluded from this program element.

The Heliophysics Guest Investigators MMS Special Opportunity (MMS-GI) is described in Program Element B.8. Proposals that focus on the analysis of MMS observations should be submitted to this Special Opportunity. The MMS observations were publicly released in early 2016, and the prime phase of the mission ends September 1, 2017.

Heliophysics Grand Challenges Research (H-GCR/TMS and H-GCR/SC):

Another program that was strongly supported in the Decadal Survey is the Heliophysics Grand Challenges Research program. As recommended, the goals of this program are specifically designed to support investigations of complex problems that fall within the general realm of Heliophysics and whose full resolution has remained elusive. Work on such problems has traditionally been carried out by independent research groups that employ observational, theoretical, and modeling-based approaches. Increasingly, major

advances in the field are taking place as a result of the close interactions among observers, theorists, and modelers. Thus, a coherent attack on the most challenging broad problems requires the efforts of a synergistically interacting group of multidisciplinary teams led by a single Principal Investigator, so as to enable deep and transformative science. The H-GCR program is open for proposals in ROSES-2017. One program element is planned: Heliophysics Science Centers (SC). The Theory, Modeling, and Simulations (TMS) element is not solicited in ROSES-2017 as it currently is fully subscribed.The Heliophysics Grand Challenges Research Science Centers program element (H-GCR/SC) will be offered for the first time as part of the ROSES-2017. The particulars of this program will be described in an amendment later in this ROSES year (see Program Element B.9).

Heliophysics LWS Science (H-LWS):

The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed to effectively address those aspects of Heliophysics science that affect life and society. To ensure this, the Heliophysics LWS Science program solicits proposals for Focus Teams which coordinate large-scale investigations that cross discipline and technique boundaries, leading to an understanding of the system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. A primary goal of NASA's LWS Program is the development of first-principles-based models for the coupled Sun-Earth and Sun-Solar System, similar in spirit to the first-principles models for the lower terrestrial atmosphere. Such models can act as tools for science investigations, as prototypes and test beds for prediction and specification capabilities, as frameworks for linking disparate data sets at vantage points throughout the Sun-Solar System, and as strategic planning aids to enable exploration of outer space and testing new mission concepts. The development of these models is generally conducted in terms of Strategic Capabilities, but this component of the LWS program will not be solicited in ROSES-2017. The details of the Living With a Star Science program for ROSES-2017 are described in Program Element B.6.

Heliophysics Data Environment Enhancements (H-DEE):

The goal of the H-DEE program is to enable breakthrough research in Heliophysics by providing both a state of the art data environment and necessary supporting infrastructure to maximize the scientific return of the NASA missions. It is essential that observations be properly recorded, analyzed, released to the general public, documented, and rapidly turned into scientific results. These studies are carried out in support of the Heliophysics strategic goals and subgoals in NASA's 2014 Strategic Plan and Chapter 4.1 of the *NASA 2014 Science Plan*. The recommended priorities of the Heliophysics community are also discussed in the *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society*. Note particularly the sections dealing with the "DRIVE" initiative, more specifically "R" and "I," and the discussion in Appendix B.

The H-DEE program encompasses the data environment needs throughout Heliophysics, including Solar, Heliospheric, and Geospace Sciences (Magnetosphere and Ionosphere/Thermosphere/Mesosphere [ITM]).

As part of a mission-oriented agency, the Heliophysics Research Program seeks to fund those efforts that directly impact NASA missions or interpretation of their data. Therefore, investigations that are judged to be more appropriate for submission to other Federal agencies, even if of considerable merit, will not be given high priority for funding through this solicitation. In turn, the "Infrastructure" subelement of the former "H-IDEE" program has been dropped.

Proposers should take into account the special needs driven by the increasing complexity of missions, the associated increasing complexity and volume of data, and the need for innovative and enabling technologies. For proposers to B.7 H-DEE there will be no NSPIRES cover page question about a data management plan. This is superseded by instructions in the program element that place more detailed descriptions into the body of the Scientific/Technical/ Management section of proposals. See Sections 2. of B.7 H-DEE.

The Heliophysics Data Environment Enhancement program is described in Program Element B.7.