APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

B.1 HELIOPHYSICS RESEARCH PROGRAM OVERVIEW

1. Overview

NASA's Heliophysics Research Program supports research activities that address understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its interaction with the space environment of the Earth is a particular focus. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand how these processes combine to create space weather events, and to enable a capability for predicting future space weather events.

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, 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 also supports investigations of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles; and the physics of the terrestrial mesosphere, thermosphere, ionosphere, and auroras, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

The Heliophysics Research Program of 2012 represents a strategic commitment to system science — emphasizing the understanding of fundamental processes and interconnections across the traditional science disciplines. 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 documentation underlying the Heliophysics Research Program provides the needed background for proposals addressing its objectives. The science carried out must directly address NASA's Strategic Goal 2.2, to study the Sun and its interactions with the Earth and the Solar System (see Section I(a) and Table 1 in the *ROSES Summary of Solicitation*). In particular, proposals must address the more specific Science Outcomes (see Section I(a) and Table 1 in the *ROSES Summary of Solicitation*), which are to achieve:

- Progress in understanding the fundamental physical processes of the space environment—from the Sun to Earth, to other planets, and beyond to the interstellar medium;
- Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres; and
- Progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space.

A brief description of each program element offered in the Heliophysics Research Program is given below. The intent of these summaries is to give the prospective proposer insight into the element's purpose within the context of the overall program structure. Detailed descriptions of each element are to be found in Appendices B.2 through B.8.

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

2. Program Elements

Heliophysics Theory:
Theoretical investigations are funded as parts of a number of Heliophysics programs, but the Heliophysics Theory Program is the only Heliophysics program that is dedicated solely to theoretical efforts. It also differs from the theoretical investigations funded by other Heliophysics program elements in that it addresses only physical processes that have sufficient breadth and complexity to require the efforts of a critical mass of expertise. Theory Program awards are commensurately larger than typical SR&T awards. The Heliophysics Theory program, which is competed only once every three years, is fully subscribed for Fiscal Years 2011-2013 and will not be competed again until ROSES 2013. The Heliophysics Theory program element is described in Appendix B.2.

Supporting Research and Technology (SR&T):
The main function of SR&T awards is to support planning for future NASA mission. This element supports focused individual research tasks that employ a variety of research techniques, e.g., theory, numerical simulation, and modeling; analysis and interpretation of space data; development of new measurement concepts; laboratory measurements of atomic and plasma parameters, and laboratory simulations of Heliophysical phenomena. Geospace-related SR&T tasks are solicited as part of the Geospace Science element described in Appendix B.3, while solar and heliospheric-related SR&T tasks are solicited as part of the Solar and Heliospheric Science program element described in Appendix B.4.

Low Cost Access to Space (LCAS):
LCAS investigations have as their objective science investigations that require access to space as provided by sounding rockets, research balloons, the International Space Station, and/or CubeSats. LCAS investigations may be science investigations in and of themselves or proof -of-concept experiments for techniques/detectors that enable new Heliophysics science. Geospace-related LCAS investigations are solicited as part of the Geospace Science program element described in Appendix B.3, while solar and heliospheric-related LCAS investigations are solicited as part of the Solar and Heliospheric Science element described in Appendix B.4.

Instrument Development:
Instrument development 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 are specific scientific problem(s), for which the development is a necessary precursor. Geospace-related instrument development investigations are solicited as part of the Geospace Science program element described in Appendix B.3, while solar and heliospheric-related instrument development investigations are solicited as part of the Solar and Heliospheric Science element described in Appendix B.4.

Guest Investigators (GI):
Guest Investigators (GI) programs are intended to maximize the scientific output of currently operating Heliophysics missions through support of individual investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory. The focus of the selected research continuously evolves to ensure that the most important questions identified by the operating mission senior reviews are addressed. Geospace-related GI investigations are solicited as part of the Geospace Science program element described in Appendix B.3, while solar and heliospheric-related GI investigations are solicited as part of the Solar and Heliospheric Science element described in Appendix B.4.

LWS Targeted Research and Technology (TR&T):
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 TR&T 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 (terrestrial upper atmosphere?). In addition, TR&T supports the Sun-Climate objective whose goal is to deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales. Development of Tools and Methods that are needed to achieve the LWS goals are also supported. A draft version of the LWS TR&T program element is described in Appendix B.6 with the release of ROSES-2012. An amendment will subsequently provide the final text.

LWS Targeted Research and Technology (TR&T) Strategic Capability:
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 for enabling exploration of outer space and testing new mission concepts. Strategic Capabilities are the development and integration of such models for all the various components of this system. A draft version of the LWS Strategic Capability program element is described in Appendix B.7 with the release of ROSES-2012. An amendment will subsequently provide the final text.

Heliophysics Data Environment Enhancements:
Progress in space science is sparked by space observations. It is essential that observations be properly recorded, analyzed, released, documented, and rapidly turned into scientific results. Heliophysics Data Environment Enhancement investigations support and extend data services necessary for the conduct of heliophysics research. Holders of heliophysics data propose for small grants to continue resident archives of data from previously operating missions and to participate in one of the several virtual observatories either in existence or proposed. Aspects to be taken into account are 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. The data environment enhancement program element is described in Appendix B.8.