B.6 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: The Strategic Capabilities and Cross-Discipline Infrastructure Building components are not being competed in ROSES-2017.

Proposal submission to all calls in Heliophysics will be done by a two-step process, in which a Notice of Intent is replaced by a required Step-1 proposal. The proposal title, science goals and objectives, and investigators cannot be changed between the Step-1 and Step-2 proposals. See section 7 for details.

Targeted Science Team proposals, whereby a single large proposal covers the entire breadth of a Focus Science Topic, will not be permitted in ROSES-2017.

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process. See subsection 7.2.1 for details.

1. Introduction

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS program is to provide a scientific understanding of the system, almost to the point of predictability, of the space weather conditions at Earth and the interplanetary medium, as well as the Sun-climate connection.

The LWS program objectives are based on these goals and are as follows:

1. Understand solar variability and its effects on the space and Earth environments with an ultimate goal of a reliable predictive capability of solar variability and response.
2. Obtain scientific knowledge relevant to mitigation or accommodation of undesirable effects of solar variability on humans and human technology on the ground and in space.
3. Understand how solar variability affects hardware performance and operations in space.

The LWS Program seeks to make progress in understanding the complex Heliophysics system, focusing on the fundamental science of the most critical interconnections. Further information on the LWS Program can be found at the updated LWS website (http://lwstrt.gsfc.nasa.gov/). The LWS Science program maintains a strategy with three components, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs. Because Strategic Capabilities and Cross-Disciplinary Infrastructure Building programs are fully subscribed, only the Targeted Investigations will be competed in this announcement.

Further background material concerning relevant research objectives can be found on the LWS website, and in the following documents:

- The LWS *10-Year Vision Beyond 2015 Report* (http://lwstrt.gsfc.nasa.gov/images/pdf/LWS_10YrVision_Oct2015_Final.pdf)
- The National Research Council Decadal Survey Report *Solar and Space Physics: A Science for a Technological Society* (http://www.nap.edu/openbook.php?record_id=13060).

2. Scope of Program Element - Targeted Investigations

The stated goal of LWS, that of achieving an understanding of those aspects of the Sun-Solar System that have direct impact on life and society, poses two great challenges for the LWS program. First, the program must tackle large-scale problems that cross discipline and technique boundaries (e.g., data analysis, theory, modeling, etc.); and second, the program must identify how this new understanding will have a direct impact on life and society. Over time, the Targeted Investigations provide advances in scientific understanding to address these challenges.

The Targeted Investigations component this year consists of four Focused Science Topics (FSTs).

2.1 Focused Science Topics

The Focused Science Topics (FST) permitted as the objectives for proposals this year are as follows:

- Understanding The Onset of Major Solar Eruptions (described in section 3);
- Toward a Systems Approach to Energetic Particle Acceleration and Transport on the Sun and in the Heliosphere (described in section 4);
- Ion Circulation and Effects on the Magnetosphere and Magnetosphere - Ionosphere Coupling (described in section 5);
- Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System During Extreme Events (described in section 6).

Detailed descriptions of each FST are listed below. NASA desires a balance of research investigation techniques for each topic, including theory, modeling, data analysis, observations, and simulations. In 2013 and 2014, proposals could be individual proposals that would form part of a team or Targeted Science Teams (TSTs) that form prior to submission under a single Principal Investigator (PI) and submit a single TST proposal that attacks the entire breadth of the Focus Science Topic. However, such TSTs will not be permitted in ROSES-2017. Instead, LWS Science will adopt one of the recommendations in Chapter 10 of the 2013 Heliophysics Decadal Survey that NASA "work toward doubling the size of Individual-Principal-Investigator grants."

Given the strategic nature of LWS, and the fact that strategically feasible tasks require sufficient investment, it is anticipated that FST proposals will be in the range of $200k – $250k. (This includes fully encumbered Civil Servant labor, where appropriate.) It is left to individual PIs to decide whether a strategically feasible award size could be achieved by increased collaborative efforts, greater FTE of investigators, or a mix of the two. PIs should be cognizant, however, that verification of the level of effort versus the actual work proposed will be part of the review panel process. Given the submission of proposals of adequate number and merit and investigative techniques, up to six selections will be made for each Focused Science Topic. We anticipate forming teams of 4-6 selections for topics 2) and 4) and teams of 3-4 selections for topics 1) and 3) due to the more focused nature of the latter two topics. The expected duration of FST awards is four years.

Once selected, these investigators will form a team in order to coordinate their research programs. Due to the collaborations that will arise from coordination of these team research efforts, one of the PIs will serve as the Team Leader for the Focused Science Topic for which he/she proposed. This PI will receive supplemental funding, as necessary, to support costs associated with these duties after the selection process is completed. Proposers are encouraged to propose to act as a Team Leader and, if they do so, should include a brief section at the end of their proposal describing how they would lead the team effort. Up to one extra page of the proposal is allowed for this proposed effort. All proposers for Focused Science Topics should include sufficient travel funds in their proposed budgets to cover two team meetings per year to be held on the U.S. coast furthest from their home institutions. This assumes that one meeting per year will be held in conjunction with a major U.S. scientific meeting.

3. Understanding the Onset of Major Solar Eruptions

3.1 Target Description

The LWS program has the overarching goal to achieve a quantitative understanding of how the Sun influences the Earth's environment. A key aspect of understanding this interaction is the ability to quantitatively describe – and ultimately predict - the occurrence of major solar eruptions. This topic is essential to nearly all of the LWS Strategic Science Areas (SSAs). For example, Solar Energetic Particle (SEP) events (SSA-3) generated by flares and Coronal Mass Ejections (SSA-0) increase radiation hazards throughout the solar system and adversely impact our space- and ground-based assets (SSA-1). The initial particles can arrive in minutes to hours after an eruption on the Sun.

A key difficulty in achieving the goals of SSA-3 (probabilistic prediction of the spectral intensity of SEP events, and increased time periods for all-clear forecasts) is forecasting the likelihood of a major eruption from active region(s) on the Sun, hours to days prior to the event. Present-day forecasts are empirical. For example, NOAA/SWPC currently relies on qualitative assessments of sunspot groups to produce a 24, 48, and 72 hour forecasts. There are statistical methods that could potentially improve these forecasts based on characterization of prior flaring, surface solar magnetic field properties derived from magnetograms, etc. However, even such techniques typically have little theoretical or modeling insight incorporated into their methodologies.

There has been significant theoretical, modeling and observational work on the eruptive properties of solar magnetic fields, as evidenced by previous LWS Focused Science Teams (FSTs). However, it appears we are still many years away from an entirely first principles approach for predicting major eruptions. The goal of this FST is to directly combine insights from theory, modeling, and observations to improve probabilistic forecasts of major solar eruptions required by the user community.

3.2 Goals and Measures of Success

The goal of this science topic will be to obtain a quantitative understanding of the signatures which indicate the imminent occurrence of a major solar eruption, such as magnetic flux emergence, the interaction of the emerging flux with existing structures, and the degree of non-potentiality in the atmosphere. This requires studies of local and global-scale phenomena as ably demonstrated by the observations of the Solar Dynamics Observatory over the past six years. Measures of success would be:

- The ability to integrate numerical and observational studies across the breadth of temporal and spatial scales to better understand major eruptions.
- The ability to differentiate between minor and major storm eruptions.
- The ability to robustly determine "all-clear" periods for major eruptions.
- Production of critical derived data products such as Poynting flux, helicity flux injection, and free energy build up from the observables with appropriate estimates of uncertainties.
- Identification of comprehensive, consistent, robust extrapolation methods involving magnetic field measurements in photosphere, chromosphere and corona to identify degrees of non-potentiality and the timescales on which it develops.
- The ability to predict the location, timing, and initial velocity of major solar eruptions.

All studies must consider data and model uncertainty and how the sources of error impact the results.

3.3 Types of investigations

Investigations may include, but are not limited to:

- Observational, theoretical, empirical, statistical and/or modeling studies that identify signatures of stability and/or imminent eruption triggering and onset.
- Studies that use these signatures to provide probabilistic forecasts of major solar eruptions that examine
  - the processes by which the emergence of magnetic flux energizes pre-eruptive active regions and / or triggers eruptions.
  - the flux of magnetic energy stored, entering, or leaving solar active regions, and study how this relates to the triggering of eruptions.
- Studies that identify signatures of stability and/or imminent eruption by examining
  - magnetic reconnection onset or other destabilization mechanisms, as related to eruption onset, throughout the solar atmosphere and across the broad range of scales presented therein.
  - inferred/measured quantities such as free magnetic energy, non-potentiality, helicity flux injection, and Poynting flux injection to the likelihood of a major event.

3.4 Focus on Enabling Predictability and Interaction with User Communities

An important aspect of the FST is to demonstrate relevance to user needs, especially when designating storm onset, assessing all-clear periods, or differentiating between minor and major solar events. For example, an end user of this FST would be the operational group at NOAA/SWPC. Individual proposals should identify how they will contribute to the FST and improve understanding of major event onset and the physical properties of those events that can eventually be transitioned to user/operational models.

4. Toward a Systems Approach to Energetic Particle Acceleration and Transport on the Sun and in the Heliosphere

4.1 Target Description

The Radiation Environment Strategic Science Area (SSA-6) and the Geomagnetic Variability Strategic Science Area (SSA-1) outline broad needs for advancing the characterization of the science of the radiation environment in a varying environment. The radiation environment between the troposphere and outer magnetosphere can change rapidly due to varying galactic cosmic ray (GCR) and solar energetic particle (SEP) influx. This environment can also be affected by solar wind pressure effects due to high-speed streams (HSS), coronal mass ejections (CME), and periods of southward interplanetary magnetic field (IMF). The GCR background is typically variable on the timescale of days with a long-term trend that changes slowly and is modulated by the solar IMF varying with the approximate eleven-year solar cycle. The SEP environment can be highly time variable, with impulsive, order of magnitude changes associated with solar eruptive events occurring in a matter of seconds to minutes. HSS, CME, and solar wind pressure increases cause changes to the radiation belt environment on a scale of tens of minutes to days with the probability of occurrence of these events being dependent on the solar cycle. Together, the effect of these phenomena on the Earth's Magnetosphere–Ionosphere–Thermosphere (M-I-T) system, create the "weather" of the radiation environment.

Recent observations and modeling developments have permitted substantial progress in understanding the drivers and responses of the radiation environment. However, the variability and prediction potential of the coupled systems describing this radiation environment are not yet well quantified and this remains a long-term community research goal. First principles and empirically based models, combined with new data streams, are needed to achieve substantial progress toward future predictability. In the near-term, there is great value in comparing existing models and observational data sets for validation, leading to an ability to conduct ensemble modeling so as to characterize uncertainty in the radiation environment.

4.2 Goals and Measures of Success

The goal of this FST is to take a systems approach to understanding the acceleration and transport of solar energetic particles. The investigations addressing this FST will, as a whole, use a systems approach to integrate investigations covering the different acceleration regions of SEPs from active regions to the corona and through the heliosphere. These include the need to:

- develop a detailed observational understanding of the properties of the source regions of solar energetic particles;
- understand the composition and evolution of solar energetic particle populations in time and space;
- identify the mechanisms by which impulsive energetic particle events or gradual events of large angular extent occur;
- understand the relative roles of flares and CMEs in producing energetic particles as well as the underlying acceleration mechanisms;
- understand the origin and distribution of seed particles;
- develop advanced systems-based models of the production and transport of solar energetic particles as precursors to predictive capabilities.

Investigations based on observational, theoretical, and/or modeling initiatives are expected to show clearly how they contribute to a broader understanding of the coupled physical processes that underpin the production and transport of solar energetic particles. Observational investigations should show how new methods or techniques will yield insights into the production and transport of energetic particles, and/or how they will lead to data or data products that may be assimilated by models. Theoretical investigations should lead to an understanding of the comparative importance of the coupled physical processes that contribute to the acceleration and transport of solar energetic particles. Modeling efforts should leverage progress in observations and theory to demonstrably improve our understanding of the timing, origin, and properties of solar energetic particles and their potential for affecting the near-Earth environment.

All studies must consider data and model uncertainty and how the sources of error impact the results.

4.3 Types of Investigations

Types of investigations appropriate for this focused topic include (but are not limited to):

- Determination of the relative importance of various particle acceleration mechanisms (e.g., magnetic reconnection, turbulence, and shocks), and particle transport mechanisms, in different physical scenarios.
- Comparative studies of particle populations on the Sun inferred from their electromagnetic radiations and/or those detected *in situ*.
- Determination of the origin and distribution of seed populations of SEPS, and investigation of the relative importance of contributions to the seed populations of SEPs, such as flare-accelerated particles escaping the Sun and/or relics of a previous CME.
- Investigation of CME evolution and shock formation/evolution and/or flare initiation and evolution in order to determine conditions leading to acceleration of SEPs.
- Investigation of the relative roles of flares and CME-driven shocks in the acceleration of energetic particles, as well as temporally and spatially extended gamma-ray events.
- Determination of the distribution of spectral and isotopic characteristics of SEPs, and characterization of the underlying causes for the distinction between highly impulsive and gradual SEP events.

4.4 Focus on Enabling Predictability and Interaction with User Communities

An important component of the FST is to demonstrate relevance to user needs (for example, NASA/SRAG or NOAA/SWPC). Individual proposals should identify how they will contribute to the FST and aid with development of a predictive capability.

5. Ion Circulation and Effects on the Magnetosphere and Magnetosphere - Ionosphere Coupling

5.1 Target Description

Accurate knowledge and understanding of the magnetospheric composition is critical for understanding the space environment. Heavy ions of ionospheric origin become a substantial constituent of the ring current and plasma sheet during storms. In large storms O+ can even dominate the ring current energy density. Heavy ions therefore play a key role in the electrical currents and magnetic field structure of the entire inner magnetosphere. Heavy ions also affect the radiation belt population by controlling the growth and interaction of radiation belt particles with EMIC waves. O+ may also affect the global Solar Wind – Magnetosphere coupling by quenching dayside reconnection rates as well as global magnetospheric convection, and on the night side affecting location and recurrence of reconnection and associated instabilities. Thus the heavy ion composition, and in particular O+, plays an important role in understanding geomagnetic variability (SSA-1) and the radiation environment (SSA-6).

Understanding and modeling of the magnetospheric composition and all of the associated feedback mechanisms is an extremely challenging task, and an important issue for space weather models. While some progress has been achieved in understanding how O+ is energized and transported from the central plasma sheet to the ring current, there is a gap in our understanding of the source and transport mechanisms in the ionosphere and to the magnetosphere largely as a result of the complex interplay between the solar wind, magnetospheric activity and the ionosphere. Mechanisms include transport of ionospheric material from mid- to high-latitudes, potentially through the cusp region and polar cap, cusp outflow stimulated by precipitation and poynting flux (in turn stimulated by solar wind variability), outflow from the auroral regions, outflow directly from subauroral latitudes leading to the warm plasmaspheric cloak.

This topic focuses on how and when ions, and in particular O+, are supplied from the ionosphere to the magnetosphere and where it becomes available for energization. Newly available data from the Van Allen Probes and MMS satellites as well as older data sets such as Cluster and DMSP sampling both inner and outer magnetosphere, and covering eV to MeV energies provides an unprecedented opportunity to determine the accumulation and energization processes of O+ ions throughout the magnetosphere during geomagnetic storms. A number of other currently-operating spacecraft, as well as new missions soon to launch, support these topics as well, forming a comprehensive suite of observations that can support studies of conductivity, as well as (in many cases) interhemispheric effects. In addition, global models and computational capabilities have reached the level of maturity allowing users to take full advantage of the available data.

5.2 Goals and Measures of Success

The goal of this FST is to understand how heavy ions, and in particular O+ ions, are energized and transported from the ionosphere to the magnetosphere where they become available for further energization up to ring current energies.

Proposals to this FST should aim to determine heavy ion characteristics in the magnetosphere across a wide range of L-shells/geomagnetic latitudes, including the inner magnetosphere that will allow one to identify and differentiate various ionospheric source regions, such as plasmaspheric cloak, auroral outflow, and cusp outflow; identification of what controls heavy ion characteristics in the ionosphere and magnetosphere; and identification of the important sources and transport processes including through wave-particle interactions.

All studies must consider data and model uncertainty and how the sources of error impact the results.

5.3 Types of Investigations

As there is currently an FST which is dedicated to a portion of this topic considering how O+ is energized and transported through the transition region from the plasma sheet to the ring current, proposed investigations should focus on other aspects of the heavy ion circulation throughout the magnetosphere while being aware of, incorporate, and work with the currently funded FST. Suggested types of investigations include:

- Data analysis seeking to characterize ionospheric and magnetospheric processes that directly or indirectly are critical for the supply of O+ to the magnetosphere. This includes their dependence on solar and solar wind drivers, seasonal changes, and magnetospheric drivers including wave-particle interactions.
- Data analysis that seeks to characterize the spatial and temporal distribution of O+ in the inner magnetosphere to the outer magnetosphere.
- Modeling seeking to understand and confirm the physical mechanisms that directly or indirectly are critical for the supply of O+ to the magnetosphere.

5.4 Focus on Enabling Predictability and Interaction with User Communities

An important component of the FST is to demonstrate relevance to user needs. Individual proposals should identify how they will contribute to the FST and improve magnetic data that can eventually be used in user/operational mode.

6. Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System during Extreme Events

6.1 Target Description

Detailed observations of heliospheric processes during superstorms are rather limited, and statistics is sparse. Superstorms are unusually strong storms where the Dst index reaches below 300 nT and even below 500 nT in extremely rare circumstances.

Evidence that geomagnetic storms can potentially be much stronger than that observed during the space age comes from historical observations of the solar storm in 1859, known as the Carrington event, and recent observations of the very powerful Coronal Mass Ejections (CME) that occurred in July 2012, that largely missed the Earth. Understanding the effects of superstorms and the strongest (e.g., 1 in 100 years) space weather events is a key component of the National Space Weather Action Plan. Such an understanding is required to develop mitigation strategies for worst case Geomagnetically Induced Currents (GIC), spacecraft charging, communication outages and navigation error scenarios. Understanding the coupling processes that occur under extreme conditions presents a challenge, as these processes may be very different than those under the more typical conditions for which existing physics-based models were developed. Saturation processes or nonlinear responses of the systems during extreme driving may preclude extending empirical parameterizations to the more extreme values for drivers that occur during such events. Using available observations of superstorms and historical records of extreme events, this FST will conduct focused investigations of key physical processes needed to extend modeling capabilities to the conditions that occur during extreme events. This proposed topic is relevant to nearly all of the Strategic Science Areas (SSAs).

6.2 Goals and Measures of Success

The goal of this focused topic is to identify the key physical processes that differentiate superstorms from more typical storms by using any and all available observations of superstorms and historical records of extreme events, so that modeling capabilities can be accurately extended to extreme events. The efforts of this FTS will be targeted at filling critical gaps in our understanding of the Magnetosphere-Ionosphere/Thermosphere/Mesosphere System dynamics that occur during extreme events. This FST will improve our ability to model superstorms and Carrington-type storms and improve our ability to predict the consequences of the extreme events. The advances made by this FST may feed into a future long-term strategic capability topic on the integrated magnetospheric response to superstorms. Successful investigations will provide quantifiable evidence of progress toward accurate simulation of extreme Space Weather events and their effects in the Magnetosphere-Ionosphere/Thermosphere/Mesosphere System.

All studies must consider data and model uncertainty and how the sources of error impact the results.

6.3 Types of Investigations

Types of investigations appropriate for this focused topic include (but are not limited to):

- Theoretical and modeling studies focused on understanding the physics of solar wind-magnetosphere interaction changes from normal times to superstorms/extreme events (e.g. boundaries, currents, properties of plasma populations, etc).
- Multipoint and multi-instrument observations of superstorms.
- Studies concerning the response of currents, radiation belt particle fluxes, and magnetospheric electric and magnetic fields to extreme driving.

- Quantifying the limitations of current models in simulating responses (e.g., saturation effects, balance between currents and plasma, topology, etc.).
- Development of the data-driven models and analysis of the response of the Magnetosphere-Ionosphere/Thermosphere/Mesosphere System to extreme driving.
- Development and validation of simulations that can accurately represent the extreme responses that occur in the magnetosphere and ionosphere during superstorms and Carrington-type storms.
- Application of the extreme value theory to understand the extreme behavior of heliophysics systems and making predictions.

7. Submission and Evaluation Process

To streamline the proposal process (submission, evaluation, and administration), this program uses a two-step proposal submission process (see the overall description of a two-step process in the *Summary of Solicitation* Section IV.(b)vii).

7.1 Step-1 Proposals

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program element.

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). The Step-1 proposal must be submitted by the organization’s Authorized Organizational Representative (AOR). No budget or other uploaded files are required. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Step-1 proposals will be checked for compliance, but they will not be evaluated. The Step-1 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) cannot be changed between the Step-1 and Step-2 proposals. The expected format and evaluation criteria are described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal.

7.1.1 Step-1 Proposal Format

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. It should include the following information:

- A description of the science goals and objectives to be addressed by the proposal.
- A brief description of the methodology to be used to address the goals and objectives.
- A brief description of "Proposed Contributions to the Focus Team Effort."

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is required or permitted for Step-1 proposal submission. All information for the proposal summary will be entered within the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. Proposers will be notified by email when they are able to submit their Step-2 proposals.

7.2 <u>Step-2 Proposals</u>

Proposers should refer to the "Instructions for Submitting a Step-2 Proposal" under "Other Documents" on the NSPIRES page for this program element. A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). The Step-2 proposal must be submitted by the organization Authorized Organizational Representative (AOR). A budget and other specified information is required. The Step-2 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the Step-1 proposal.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that have received a noncompliant letter are not eligible to submit a Step-2 proposal.

7.2.1 Step-2 Proposal Format

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

- The Scientific/Technical/Management section must not exceed the length specified in this Program Element (See Section 9 below).
- Margins: no less than 1 inch on all sides.
- Page Size: the PDF must be set for a standard US letter page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per horizontal inch, including spaces. Proposers may not adjust the character spacing or otherwise condense a font from its default appearance.
- Line spacing: Font and line spacing settings must produce text that contains, on average, no more than 5.5 lines per vertical inch. Proposers may not adjust line spacing settings for a selected font below single spaced.
- Figure captions: Captions must follow the same font and spacing rules as the main text.
- Figures and tables: For text in figures and tables, font and spacing rules listed above do not apply, but all text must be judged to be legible to reviewers without magnification above 100%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

Guidelines for submitting Step-2 full proposals, other than those listed above, are specified in the *NASA Guidebook for Proposers*. The Guidelines above supersede those found in the Guidebook. The criterion for relevance includes relevance to one of the Focused Science Topics in Section 2 and is an essential requirement for selection. As such, NASA has instituted a compliance check as described below.

In order to be compliant with this ROSES program element, each FST Step-2 proposal submitted must contain a section that must be entitled "Proposed Contributions to the Focus Team Effort" and identified in the proposal's table of contents. Failure to include this section will result in the proposal being judged noncompliant, and the proposal will be returned without review. This section must include the following three items:

- The relevance of the proposal to the scientific objectives of the Focused Topic.
- The potential contributions (e.g., data sets, simulation results, understanding of physical mechanisms, etc.) from the proposed effort to the Focused Science Team's effort.
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

7.2.2 Step-2 Evaluation Criteria

Compliant proposals will be evaluated according to the criteria specified in Section VI(a) of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. These criteria are (1) intrinsic scientific/technical merit and (2) work effort realism/reasonableness. In addition, the relevance of the proposed science goals and objectives to those of the FST will be evaluated.

Work effort realism/reasonableness includes assessing the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out in the proposal work plan. The *NASA Guidebook for Proposers* states, "NASA strongly encourages PIs to specify only the most critically important personnel to aid in the execution of their proposals."

For Focus Science Topics, the evaluation for relevance is dependent on the particular Focus Science Topic. Each proposal must demonstrate that the investigation is appropriate for the FST selected. This will be strictly enforced. In addition, each proposal submitted must contain a section, entitled "Proposed Contributions to the Focus Team Effort" and it must be identified in the proposal's table of contents. Failure to include this section may result in the proposal being returned without review.

8. Award Types

The Heliophysics LWS Science program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA centers. This call will not award contracts, as it is not appropriate for the nature of the work. Please also see the *ROSES Summary of Solicitation,* Section II (a).

9. Summary of Key Information

Expected annual program budget for new awards	~$3.75 M
Number of new awards pending adequate proposals of merit	~15-20
Maximum duration of awards	Focused Science Topics: 4 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	No earlier than 6 months after the Step-2 proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; one extra page permitted for proposals to be Team Leader of a Focused Science Topic; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. Responses to the FSTs must also show relevance to the specific FST described in section 3.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH17ZDA001N-LWS
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