

B.6 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Amended October 20, 2017. The text (primarily in Section 7) has been changed to clarify the expected structure and content of program-specific material within the proposal. The requirement to address potential contribution to the Focused Science Team effort is described in Section 7.2.2. Please note that the proposer's response to this requirement will be provided in a 4000-character text box on the NSPIRES cover page not in the 15-page main body of the proposal. Section 7.2.3 explains how the evaluation criteria explicitly include assessment of the potential contribution to the Focused Science Team effort. In addition, it is noted (in Section 7.2) that proposers are expected to provide mail-in reviews for one to three proposals to this program element. The Data Use policy for the LWS Element in ROSES 2017 is described in Section 1.1, and small changes have been made in Section 2.1, including estimates of the anticipated number of awards and average award size.

The Step-1 Proposals are now due December 5, 2017 and Step-2 Proposals are due February 6, 2018. New text is in bold and deleted text is struck through.

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 Focused 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. See section 7 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).

1.1 Data Use in the Living With a Star Program

This program element has policies on the use of data in proposals that expand upon and supersede those given in [B.1 Heliophysics Research Program Overview](#).

For successful completion of the proposed project, proposals to this program may only use data that is in a publicly available archive at least 30 days prior to the Step-2 deadline (see Section 7.2.3). This applies to both space-based and ground-based observations, as well as any data products derived from them. Any questions about whether a data set qualifies as publicly available must be submitted to the program element's point of contact at least 10 days before the Step-1 deadline.

After an award is made, projects may incorporate new data that becomes available, provided that their use does not alter the goals and objectives of the selected proposal. Any changes in the data used must be described in the annual progress report submitted by the Principal Investigator.

While the inclusion of useful ground-based observations is allowed, proposals are expected to incorporate space-based observations. Further, the evaluation process will include the consideration of the presence and importance of space-

based or ground-based observations in the proposals (see Section 7.2.3). Regardless of the type of data that would be utilized in the proposed study, space-based, ground-based, or some combination, the proposal must clearly demonstrate why the proposed data set or data sets are sufficient to address the proposed goals and objectives.

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:

- 1) Understanding the Onset of Major Solar Eruptions (described in section 3);
- 2) Toward a Systems Approach to Energetic Particle Acceleration and Transport on the Sun and in the Heliosphere (described in section 4);
- 3) Ion Circulation and Effects on the Magnetosphere and Magnetosphere - Ionosphere Coupling (described in section 5);
- 4) 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 Focused Science Topic. However, such TSTs will not be permitted in ROSES-2017 **and the FST teams will be formed from the selected individual proposals based on panel evaluations and programmatic considerations.** ~~Instead,~~ LWS Science will ~~adopt~~ **pursue** 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 have annual budgets in the range of **\$185K - \$225K** ~~\$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~~ **NASA anticipates** forming teams of ~~5-6~~ **4-6** selections for topics (2) and (4) and teams of ~~4-5~~ **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. **Starting with the LWS selections in ROSES-2016 and continuing with ROSES 2017, successful teams will participate in a Kickoff Workshop where all selected teams will meet and develop work plans for the anticipated period of performance, generally 4 years, based on the requirements of the FST and the composition of the selected team.**

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 **responsiveness** 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 **must** ~~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 **responsiveness** ~~relevance~~ to user needs (for example, NASA/SRAG or NOAA/SWPC). Individual proposals **must** ~~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, **and** 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, **but are not limited to**:

- 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 **responsiveness** ~~relevance~~ to user needs. Individual proposals **must** ~~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 FST 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 ROSES [Summary of Solicitation](#) Section IV.b.vii).

In addition to the general requirements and restrictions (e.g., in Table 1 of the [ROSES Summary of Solicitation](#) and in [Heliophysics Research Program Overview](#)) this program element has specific compliance constraints for both format (e.g., Sections 7.1.1 and 7.2.1) and content, e.g., involving data (see Sections 1.1 and 7.2.3). These compliance rules ensure fairness and are enforced strictly by the Heliophysics Division. Proposals that are deemed non-compliant will typically be returned without review or, if not caught until during or after the review, will typically be declined despite any merits that may have been found by peer review.

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 Focused **Science** Team Effort" (**see Section 7.2.2 for the material to be summarized**).

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 Step-2 Proposals

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 noncompliance letter are not eligible to submit a Step-2 proposal.

Proposers are expected to provide mail-in reviews for one to three proposals in this competition. Much of the science expertise lies in the PI/Co-I community, because, increasingly, nearly the entire Heliophysics community proposes. In order to maintain a high caliber review process, it is important to get the additional mail-in reviews to cover all proposals fairly.

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.

~~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 Focused Science Topics, the evaluation for relevance is dependent on the particular Focused 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 Focused Science 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.~~

7.2.2 Step-2 Required Additional Section on Proposed Contribution to the Focused Science Team Effort

Proposals to this program element must address the proposed contribution to the Focused Science Team effort, which is now one of the evaluation criteria (see Section 7.2.3). This text will be provided by proposers in a 4000-character plain text box on the NSPIRES cover page, rather than in the text of the proposal, so it does not count against the 15-page limit for the Scientific/Technical/Management section of the proposal. Failure to complete this section will result in the proposal being judged noncompliant, and the proposal may be returned without review. This section must address the following three topics:

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

The discussion in this section must describe how the proposed project would fulfill the FST goals. Proposals that identify Types of Investigation(s) listed in Sections 3 through 6 above (see Sections 3.3, 4.3, 5.3, or 6.3) must describe how the proposal addresses those investigations. For proposals that include Types of Investigations not listed in the FST description, the discussion must summarize those proposed investigations and describe how they would meet the Focused Science Topic goals.

Although Living With a Star program elements in previous ROSES announcements required this discussion in the 15-page main body of the proposal (the Scientific/Technical/Management section), this section has now been moved to the proposal front matter. No discussion of these topics is

expected in the 15-page main body and any such discussion in the main body will not be considered in the evaluation of the Potential Contribution to the Focused Science Team Effort.

This section in the front matter will only be used in the evaluation of the Potential Contribution to the Focused Science Team Effort criterion. No discussion in this section will be considered in the evaluation of Intrinsic Merit or Cost Reasonableness.

7.2.3 Step-2 Evaluation Criteria

Compliant proposals will be evaluated according to three criteria: (1) Intrinsic Merit, (2) Potential Contribution to the Focused Science Team Effort, and (3) Cost Reasonableness. The Intrinsic Merit and Cost criteria will be evaluated primarily as specified in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. The Relevance criterion, as described in the *NASA Guidebook for Proposers* will be evaluated as part of Potential Contribution to the Focused Science Team (Section 7.2.2) and, based on this evaluation, any proposal that would contribute to an FST objective is, by definition, relevant to this program element.

The Intrinsic Merit evaluation will include consideration of the proposal's response to the FST's specific requirements outlined in the FST descriptions (see Sections 3 through 6 above). This includes 1) scientific and technical scope (described under Target Description in the FST section), 2) Goals and Measures of Success, 3) Types of Investigation, and, if required by the FST, 4) Focus on Enabling Predictability and Interaction with User Communities

The evaluation of Intrinsic Merit will consider only information contained within the 15-page main body of the proposal (the Scientific/Technical/Management section). Most proposals are expected to describe a complete scientific study (i.e. clearly identified science questions and a project that achieves closure on those questions); however, this program element also accepts proposals that lack a complete scientific study but do describe a project that would enable or enhance the FST's activities (e.g. develop a data set, implement a model). Regardless of the project, all proposals must identify science questions responsive to the FST's goals that the proposed work would address.

As part of the review process, the evaluation will include the determination of whether the proposal violates the restrictions in Section 1.1, including the use of data not in a publicly available archive 30 days before the Step-2 deadline. Non-compliant proposals will face the consequences described in Section 7.

The evaluation of the Potential Contribution to the Focused Science Team Effort will only consider the three topics specified in Section 7.2.2: 1) relevance of the proposal to the scientific objectives of the FST, 2) potential contributions of the proposed effort to the FST's effort, and 3) metrics and milestones for determining the successful progress and outcome of the proposed research. This evaluation will be based on only the discussion contained within the 4000-character text box on the NSPIRES cover page; no discussion of these topics is expected in the 15-

page main body and any such discussion in the main body will not be considered in the evaluation of the Potential Contribution to the Focused Science Team Effort.

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	~\$4.1 3.75 M
Number of new awards pending adequate proposals of merit	~ 18 – 22 15 – 20
Maximum duration of awards	Focused Science Topics: 4 years
Due date for Step-1 proposals	See Tables 2 and 3 in the <i>ROSES Summary of Solicitation</i> .
Due date for Step-2 proposals	See Tables 2 and 3 in the <i>ROSES Summary of Solicitation</i> .
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 <i>NASA Guidebook for Proposers</i>
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to the FSTs in this program element are, by definition, relevant to NASA. See Section 7.2.3 regarding evaluation criteria.
General information and overview of this solicitation	See the <i>ROSES Summary of Solicitation</i> .
Detailed instructions for the preparation and submission of proposals	See the <i>NASA Guidebook for Proposers</i> 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 <i>ROSES Summary of Solicitation</i> and the <i>NASA Guidebook for Proposers</i> .
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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