B.6 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Clarified March 7, 2014. The text in Section 3.2 on eligibility of SOC and SPP Co-Investigators has been clarified to make it unambiguous that one month per year of support is the cut off. New text is in bold and deleted text is struckthrough. Step-1 Proposals are due 03/14/2014, and Step-2 Proposals are due05/01/2014.

NOTICE: The Strategic Capabilities element and the Sun-Climate Theme element will not be competed in ROSES-2014. Cross-Discipline Infrastructure proposals seeking support for workshops and conferences will also not be competed in ROSES-2014.

Proposal submission to all calls in Heliophysics is done by a two-step process, in which a Notice of Intent is replaced by a required Step-1 proposal. The Title and investigators cannot be changed between the Step-1 and Step-2 proposals. See Section 5 for details.

1. Scope of Program

1.1 Overview

The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed for the U.S. to effectively address those aspects of Heliophysics science that may affect life and society. LWS Science solicits proposals for fundamental science that will lead to a physics-based understanding of the integral system linking the Sun to the Solar System, including the impact on the heliosphere, planetary magnetospheres, and ionospheres. The program's objectives can be achieved by data analysis, theory, and modeling, and the development of tools and methods (e.g., software for data handling). LWS Science is a crosscutting initiative that addresses the following LWS strategic goals (in no priority order):

1. To deliver the understanding and modeling required for useful prediction of the variable solar particulate and radiative environment at the Earth, Moon, Mars, and throughout the solar system;
2. 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;
3. To deliver the understanding and modeling required for effective forecasting/specification of magnetospheric radiation and plasma environments; and
4. To deliver understanding and predictive models of upper atmospheric and ionospheric responses to changes in solar electromagnetic radiation and to coupling above and below.

These strategic goals, which are expounded on further at the LWS website (http://lwstrt.gsfc.nasa.gov/), provide the basis for the selection of topics for this solicitation. The primary goal of the LWS Program is to make progress in understanding the complex Heliophysics system, focusing on the fundamental science of the most critical interconnections.

As a result of its defining studies and recommendations, the LWS Science program has defined a strategy with three program elements, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs.

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

- The latest *TR&T Steering Committee Team Report* (http://lwstrt.gsfc.nasa.gov/trt_steeringcom.htm);
- 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 Strategic Capabilities

NOTICE: The Strategic Capabilities element will not be competed this year. In its previous guise as "Living With a Star Targeted Research and Technology: NASA/NSF Partnership for Collaborative Space Weather Modeling," it is fully subscribed this year with awards from ROSES-2011 and will not be recompeted until ROSES-2015 at the earliest.

3 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.

The 2013 LWS Steering Committee report formulated long-term targeted areas of System Science, requiring cross-disciplinary collaboration, for predictive development, termed “Strategic Science Areas (SSA).” An imperative in the development of SSA goals is making a stronger link between the scientific community of LWS and user/operational communities that can directly benefit from LWS scientific developments, with the intention that, upon team selection, the LWS Program Officer will contact relevant modeling centers to identify liaisons to appropriate user/operational communities. Two of the Steering Committee’s suggested topics are adopted for solicitation in ROSES-2014.

The Targeted Investigations element this year consists of three (3) Focused Science Topics (FSTs), and a call for “Physics of the Inner Heliosphere,” preparing for the launch of the future LWS missions Solar Orbiter (SOC) and Solar Probe Plus (SPP); there will not be a separate Science Analysis for the Solar Dynamics Observatory (SDO) solicited this year. The standalone Sun-Climate Theme of previous years has been subsumed into the FSTs.

3.1. Focused Science Topics

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

1) Prediction of the Interplanetary Magnetic Field Vector Bz at 1AU
2) Physics-based methods to predict connectivity of SEP sources to points in the inner heliosphere, tested by location, timing, and longitudinal separation of SEPs
3) Ion-Neutral Interactions in the Topside Ionosphere

Detailed descriptions of each follow on page B.6-4, below.

NASA desires a balance of research investigation techniques for each Topic, including theory, modeling, data analysis, observations, and simulations. Starting in 2013, proposals could be individual proposals that would form part of a team or Targeted Science Teams (TSTs) that form *prior* to selection under a single PI and submit a single TST proposal that attacks the focus science topic.

Individual proposals. Any individual proposal does not need to include all techniques. Given the submission of proposals of adequate number and merit, up to eight selections will be made for each Focused Science Topic. 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 the team research efforts the expected duration of FST awards is four years. One of the PIs will serve as the Team Leader for the Focused Science Topic for which he/she proposed, and 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 in their proposal describing how they would lead the team effort. Up to one extra page in 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. See Instructions for LWS Focus Team Members and Leaders at (http://lwstrt.gsfc.nasa.gov/trt_focusteams.htm) for full details of responsibilities.

Targeted Science Teams (TSTs). In order to be selected, the TST will necessarily have all the expertise required to attack the specified Science Target. The Team Leader, the PI, will again be preselected and will necessarily be a likely, effective leader in order for the proposal to be selected. A key aspect of the TST approach is that the expertise required for a particular Target will be specified in advance by the LWS program as part of the Target description. One of the main criteria for evaluating TST proposals will be the extent to which individual members of the Team satisfy the expertise requirement. This will encourage the TSTs to be strongly interdisciplinary and to involve the best people in the field, rather than simply co-located groups.

Proposers may propose to address any of the FSTs listed by means of a TST. Two extra pages are permitted in the central Science-Technical-Management section of TST proposals. A proposal with an annual budget in excess of $300k will implicitly be taken to be a TST proposal and will be evaluated accordingly. All of the FST compliance and relevance requirements are still valid and mandatory when proposing as a TST.

3.1.1 Prediction of the Interplanetary Magnetic Field Vector Bz at 1 AU

Target Description:

It is timely to reissue this 2007 FST, given the new opportunities that the STEREO spacecraft can (*i*) offer observations and model input on the topic; and (*ii*) suffer the consequences of major Coronal Mass Ejections (CMEs) themselves (e.g., the July 23, 2012 event)
There has been significant progress in recent years in our ability to observe CMEs from space. However, the net effect of CMEs on the geomagnetic field is a function of both CME speed and the embedded Interplanetary Magnetic Field (IMF) vector Bz. It would be valuable to the operations community if highly reliable forecasts were available of the vector Bz prior to the passage of the CME at 1 AU. Reliable forecasts of the Bx and By components are also desirable, but of secondary importance. A time series prediction of Bz is fundamentally important in the provision of space weather forecasts because:

• It allows for a prediction of the intensity of the ensuing geomagnetic storm
• It affords a much better-than-climatological prediction of the duration of the storm
• It would minimize false alarms

STEREO, SDO, and Hinode, individually, are delivering revolutionary new observations of the photospheric magnetic and velocity fields and of the coronal structures that give rise to CMEs. Further, when image data from two widely separated assets are combined, three-dimensional reconstructions become possible. As such, we are now capable of mounting a coordinated attack on the problem, using multiview imaging, *in situ*, and MHD modeling, to identify the characteristics of the magnetic field embedded in the CME ejecta.

Goals and measures of success:

The goal of this Focused Science Topic is to quantify accurately the polarity and magnitude of the IMF Bz for the next 12-24 hours. The prime measure of success for this work would be a good agreement in the time series of predicted and observed Bz values at 1 AU. An added bonus would be the ability to predict all three components of magnetic field, especially if either Bx or By are significantly larger than Bz. A second bonus feature would be the ability for predictions inside 1 AU, e.g., at Mercury (MESSENGER) or future missions (e.g., Solar Orbiter, Solar Probe Plus, Sunjammer).

Types of solicited investigations:

It is expected that the focus team will include, but certainly not be limited to, the following types of investigations:
• Observational and theoretical/modeling investigations relating to identification of characteristics of Bz (Bx, By) that relate to real-time photospheric magnetograms, and perhaps sub-surface flows from ground and space-based observations;
• Observational and theoretical/modeling investigations relating to identification of characteristics of the inner heliosphere that affect the magnetic field topology – specifically, Bz (Bx, By) at 1 AU;

- Multiview 3D imaging reconstructions;
- Observational and theoretical/modeling investigations of CMEs to include the embedded magnetic field vector Bz (Bx, By)

Focus on Predictability and Interactions with User and Operational Communities:

This FST aims to achieve understanding and to quantify the predictability of the interplanetary magnetic field vector in ejecta at 1 AU. An important component of the FST is to demonstrate relevance to user needs (for example, NASA/CCMC and/or NOAA/SWPC). Individual proposals should identify how they will contribute to the FST and aid with development to the point of a predictive capability.

3.1.2 Physics-based methods to predict connectivity of SEP sources to points in the inner heliosphere, tested by location, timing, and longitudinal separation of SEPs

Target Description:

Solar Energetic Particle (SEP) events increase radiation hazards throughout the solar system and adversely impact our space- and ground-based assets. The significant gaps in our understanding of the connectivity of SEP events to their source locations back at the Sun are impediments to achieving the goals of the Strategic Science Area (SSA): "Physics-based Solar Energetic Particle Forecasting Capability." This realization has come about because of recent combined STEREO and ACE measurements that show that many SEP events extend over much larger ranges of longitude than previously estimated. For example, in January and March of 2012, when ACE, STEREO-A, and STEREO-B were nearly equally spaced around the Sun, instruments on all three spacecraft observed intensity increases from individual SEP events. This is well beyond the expectation of broad longitudinal extent that arises from CME size, solar magnetic field configuration, or cross-field transport in interplanetary space. Small 3He-rich events have also been found to sometimes extend over much broader longitudinal extent than expected. The surprising longitudinal extent of these events shows that basic features of SEP acceleration and transport are not included in the standard picture. Therefore, even if a dangerous active region is recognized as likely to produce a major event, an essential question is whether/when those particles will connect to points of interest in the heliosphere, such as at Earth. This information is crucial for forecasting the onset of prompt events, increasing the time period of all-clear forecasts, and quantifying uncertainty.

Goals and Measures of success:

The goal of this topic is to combine theoretical studies, numerical modeling, remote, and *in situ* observations in order to identify the mechanism(s) that result in SEP events with extremely large extents in longitude. The measure of success and criterion for selection is a proposal’s impact in bringing observations, models, or theories that can lead to an understanding of the longitudinal extent and timing of the SEP intensity increases and contributing to an overall FST goal of quantifying the predictability of SEP longitude extent. Ideally, the FST would produce a model or model(s) that predict the longitudinal spread of SEPs, with statistical quantification of the uncertainty.

Types of Investigations:

Proposals that contribute to our basic understanding of the longitudinal extent of SEP events using observations, theory and modeling are encouraged, and could include:

- Theories and models for global acceleration events such as large CME-associated shocks; models with the ability to predict the evolution of shocks in the inner heliosphere that are inferred from remote sensing close to the Sun and *in situ* measurements at Mercury's orbit and beyond, requiring the characterization of coronal and solar wind properties into ~5-10 Rs where ICME shocks are inferred to form.
- Theories and models for particle access to a broad range of interplanetary magnetic field lines.
- Global models of the coronal/heliospheric magnetic field that predict the field line connectivity of sources at the Sun to points in the heliosphere.
- *In situ* observations of energetic particle arrival times, composition, and spectra for events covering large longitude ranges.
- Remote sensing of accelerating events at the Sun and in the inner heliosphere that constrain the acceleration, e.g., the range of magnetic field lines intercepted by a CME associated with particle acceleration.
- Timing studies that relate radio bursts, CME heights, etc., to the rising intensity profile of the SEPs.
- Models/observations that provide a better understanding of the initial phases of CMEs and how they couple into a range of SEP opening angles into the heliosphere.

Focus on Predictability and Interactions with User and Operational Communities:

The SSA "Physics-based Solar Energetic Particle Forecasting Capability" requires a new level of understanding of the connectivity of SEP events to their source locations back at the Sun. This FST aims to achieve this understanding and to quantify the predictability of SEP longitudinal extent. 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 to the point of a predictive capability.

3.1.3 Ion-Neutral Interactions in the Topside Ionosphere

Target Description:

The topside ionosphere and its dynamics during storms is a poorly understood domain that has a major influence on developing a predictive capability for TEC. We solicit investigations to elucidate the dynamics governing ion-neutral interactions in the topside ionosphere and exosphere during geomagnetic storms, to the point of being able to represent these interactions accurately in numerical models. The specific question being solicited is how topside ion and neutral density and composition vary during geomagnetic storms and how these topside variations affect TEC during storms. To the extent this variation is controlled by the preceding quiet time background, quiet time variability in the topside is also of interest. Since TEC is a sum of both topside and bottomside density, but the physics governing these regions is distinct, for this investigation it is important to identify those conditions where storm-time TEC is most affected by topside variation. The distinct physics of the plasmasphere, although a region that is also important for predictive TEC capabilities, is of less specific interest in this solicitation.

Goals and Measures of success:

The primary goal of this FST is to elucidate the photochemistry and dynamics governing ion-neutral interactions in the topside ionosphere and exosphere, particularly during geomagnetic storms. This goal hinges on the empirical quantification of key upper atmospheric state parameters simultaneously, along with their incorporation into assimilative models. Data acquisition must fuse data from both ground- and space-based platforms using multiple observing modalities, and existing techniques to estimate fundamental state parameters from these observables must be further developed for widespread applicability. The improved understanding of storm-time ion-neutral coupling would derive from data-driven assessment of the validity of physics-based model assumptions, such as nonlinear feedback mechanisms. This assessment would also yield an identification of causal influences on storm-time responses.

A primary measure of success rests on numerical model capability to reproduce real-time behavior of key observables, which would imply that both the parameter estimation techniques and the understanding of physical coupling processes are valid. A secondary metric is the accuracy of models in reproducing historical climatologies of key observables. Specifically, models should be able to reproduce morphologies associated with storm-time and day-to-day variability of TEC, airglow emission brightness, or species abundance ratios.

Types of Investigations:

- Observation and interpretation of the topside component of TEC during quiet and disturbed conditions.
- Observations relevant to topside chemistry and ion-neutral interactions, such as observations of magnetospheric energetic neutral atom fluxes, which are the product of exospheric and plasmaspheric chemistry, and UV and optical airglow emission data acquired from NASA TIMED, ground-based photometer networks (constraining [H]) and the future GOLD mission.
- Observations of solar radiation flux data, e.g., from TIMED-SEE or SDO-EVE, and the airglow from emission production, that constrains [O] and [He] densities.
- Statistical fusion of [O]/[N2] abundance ratio data (derived from NASA TIMED and elsewhere) with ground-based neutral wind and O airglow emission measurements to resolve chemical and dynamical influences on storm-time responses of the topside.
- Development of inverse theoretical techniques that fuse multiple observing modalities to better estimate atmospheric state parameters.
- Observations and models of topside drivers, such as neutral winds and electric fields.
- First-principles models of topside composition and densities of ions and neutral species.

Focus on Predictability and Interactions with User and Operational Communities:

We solicit proposals with a focus on topside composition and density that make a convincing case that their investigations will lead to improved predictive capability of TEC during geomagnetic storms. Investigations should address the following Strategic Science Area of the LWS TR&T program: "Physics-based TEC Forecasting Capability." Proposers should identify how they will contribute to this Focused Science Team and aid with development of a predictive capability for TEC. Reference to existing modeling and forecasting capabilities is useful.

Successful investigation teams are expected to provide yearly reports on how they are addressing objectives of the over-arching SSA. Elements of a successful team may include:

1) Assessments of current capabilities regarding forecasts and modeling of topside TEC variation during storms, as a function of latitude, longitude, and local time.
2) Observational capabilities that increase scientific understanding or that can be used to develop empirically-based, forecast-oriented models.
3) Scientific understanding of the factors that most affect topside TEC variation during storms, which may include the relative roles of neutral dynamics, versus chemical recombination and loss, versus other transport processes. Specific investigations that elucidate the roles of these competing processes will improve forecast capabilities via modeling, and are therefore important to include in the team.

Proposals for full teams or for team membership are solicited that discuss these suggested areas or other areas that the proposer can argue are critical to the predictive goals of this topic.

3.2 Physics of the inner Heliosphere

The LWS Science element *Physics of the Inner Heliosphere* challenges proposers to prepare for the upcoming launches of Solar Orbiter and Solar Probe Plus to develop a better physical understanding of the connection between coronal and heliospheric structure, both in time and space, relating the properties of coronal heating, magnetic topology, composition and fluctuation characteristics in the corona to their observational signature below 40 solar radii. It is also timely to develop theories and models that can be tested against the unprecedented cadence and spatial resolution of the instrument complement of Solar Orbiter and Solar Probe Plus.

This element is *not* a Focused Science Topic; there is no expected FST team contribution for awards, and the maximum duration of awards resulting from this element are for three years only. However, proposals will be judged for compliance based on their (demonstrated) relevance to the Solar Orbiter and Solar Probe Plus missions. It is anticipated that selected PIs will collaborate and share their models and results with each other and the missions' Science Investigations.

The heliosphere is created by the solar wind, a supersonic flow of plasma that carries the Sun's magnetic field at speed ranging from below 400 km/s to 700 km/s. The fastest solar wind (>700 km/s) is primarily associated with large regions of predominantly unipolar magnetic field – coronal holes, confined, at solar minimum, to the polar regions of the Sun. The slow solar wind

(~400 km/s), on the other hand, is usually confined within a band associated with the heliospheric current sheet that separates the two polarities. One of the most important results of the Ulysses mission was to observe and characterize the large scale structures associated with the heliospheric current sheet; high and low speed streams; the embedded magnetic field; through solar minimum, solar maximum, and the most recent extended minimum.

Ulysses' showed that there is a dramatic difference between the ion compositions of these two types of wind streams. Fast solar wind is characterized by ionic charge states that are indicative of relatively cool conditions in the corona. The slow wind exhibits ionic charge states indicative of hotter conditions in the corona and also has an elemental composition that is fractionated with respect to the photosphere, favoring ions with low first-ionization-potential (FIP), a phenomenon not strongly observed in the fast wind. Ulysses and Helios measurements also showed that the turbulent fluctuation amplitude and characteristics as well as particle distribution functions change according to solar wind type.

Types of Investigations:

- Preparing for the upcoming launch of Solar Orbiter and Solar Probe Plus by developing self-consistent models of solar wind and magnetic field structure inside 40 Rs that are consistent with solar data and associated solar observations: these can be local, time-dependent, up to global, stationary, but should provide specific observable tests.
    - Can solar wind models be updated to include solar observations (e.g., magnetic, spectroscopic or dynamic properties) using the wealth of solar (SOHO/ STEREO/ SDO) and *in situ* data (Ulysses/ Wind/ ACE/ MESSENGER) and/or empirical models that can relate to and interpret the spatial or temporal variations in the solar wind to specific coronal structures and/or events?
    - Where does the fast/slow solar wind differentiation and geographical boundary occur?
    - Where does the Heliospheric Current Sheet form and what is its structure in the inner heliosphere?
    - What are the signatures (compositional, distribution function, fluctuation characteristics) of different coronal structures and how do they evolve into different solar wind types?

- Solar observations (e.g. magnetic, spectroscopic or dynamic properties) using the wealth of solar (SOHO/ STEREO/ SDO) and *in situ* data (Ulysses/ Wind/ ACE/ MESSENGER) and/or empirical models that can relate to and interpret the spatial or temporal variations in the solar wind to specific coronal structures and/or events.
    - How finely can one map solar wind observations back to the Sun, for example, what happens to polar plumes, rays and fine structure in coronal holes in the solar wind? Where and how do fast wind microstreams and their associated characteristics form?
    - The evolution of active regions, coronal holes, and filament channels is known to be related so how does this influence heliospheric structure and how is it related to the origin of the slow wind? Transient winds have been associated with active regions and low-latitude coronal hole formation: what are the signatures (thermodynamic, composition, fluctuations) associated with boundary winds?
    - Just as helmet streamers are thought to evolve into the heliospheric current sheet, so pseudostreamers are thought to separate open regions on the Sun of the same polarities.

Are there generic features associated with pseudostreamer (speed, composition, fluctuations) or do they depend on coronal location?
    - Is there an intrinsically unsteady, time-dependent contribution to the solar wind at all scales (is there a cutoff to coronal mass ejection size and duration)?

- To develop tools and methods that will enhance the science return of the Solar Probe Plus and Solar Orbiter missions.
    - Tracers, aliases, or proxies extending the SPP observations;
    - Development of analysis frameworks to handle potential breakdown of standard analysis assumptions, e.g., the Taylor hypothesis or incompressible turbulence, inside 40 Rs.

- Develop observables from SPP inside 40 Rs will distinguish various possible sources of heliospheric structures. Joint/synergistic SPP and SO observations establishing a plasma history from the Sun's corona into the interplanetary medium, allowing understanding of its characteristics.

- Develop models with the ability to predict the evolution of shocks in the inner heliosphere that are inferred from remote sensing close to the Sun and *in situ* measurements at Mercury's orbit and beyond, requiring the characterization of coronal and solar wind properties into ~5-10 Rs where ICME shocks are inferred to form.

This proposal opportunity is open to all interested parties, *except* the Principal Investigators of SOC and SPP Science Investigations and named Co-Investigators receiving Phase A-D salary support from NASA at more than one month per year (0.08 FTE). ~~Such~~ **Eligible** investigators should draw explicit attention to their mission contributions in the "Current and Pending support" section. **[Clarified March 7, 2014]**

Since there is no expected FST team contribution for awards, and with the launch of Solar Orbiter scheduled for 2017, the maximum duration of awards resulting from this element are for three years only. However, it is anticipated that selected PIs will collaborate and share their models and results with each other and the missions' Science Investigations, and, as such, proposals should include sufficient travel funds in their proposed budgets to cover one meeting per year to be held in the vicinity of Greenbelt or Laurel, Maryland. Proposals will be judged for compliance based to their (demonstrated) relevance to the Solar Orbiter and Solar Probe Plus missions.

4. <u>Strategic Capabilities</u>

NOTICE: The Cross-Discipline Infrastructure Building element will not be competed this year. Proposals seeking support for workshops and conferences will not be recompeted until ROSES-2015 at the earliest.

5. Submission and Evaluation Process

5.1 Step-1 Proposals

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*).

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 an Authorized Organizational Representative (AOR) of the PI's institution. No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a full Step-2 proposal. Full proposals must contain the same scientific goals proposed in the Step-1 proposal. The Step-1 proposal title, Principal Investigator, and all Co-investigators, collaborators and consultants cannot be adjusted between the Step-1 and Step-2 proposals. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later, but all compliant Step-1 proposals are eligible to submit Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied confidentially by the PI through the NASA Science URL http://science.nasa.gov/researchers/suggested-reviewers when submitting a Step-1 proposal.

5.1.1 Step-1 Proposal Format

The Step-1 proposal is restricted to one page in length. It should include the following information:

- A description of the 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" (or relevance to the Solar Orbiter/ Solar Probe Plus missions)

The NSPIRES system for proposal submission requires a very brief summary to be entered into the "Proposal Summary" field and it requires a "Proposal Attachment," which should be the Step-1 proposal. Proposals will be checked to ensure that the text is compliant with the program element indicated (i.e., relevant to only the specified topics, with "Proposed Contributions" addressed).

5.2. Step-2 Proposals

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, Principal Investigator, and all team members must be the same as those in the Step-1 proposal. Step-2 proposals must contain the same goals proposed 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.

5.2.1 Step-2 Proposal Format

Guidelines for submitting Step-2 full proposals are specified in the *NASA Guidebook for Proposers*. The criterion for relevance includes relevance to one of the three Focused Science Topics (sections 3.1.1–3.1.3) or relevance to the Solar Orbiter/Solar Probe Plus missions as an essential requirement for selection. As such, NASA has instituted a compliance check as follows:

In order to be compliant to this ROSES element, each FST or TST Step-2 proposal submitted must contain a section, which 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. 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.

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."

5.2.2 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements in Section IV (b) ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* may be rejected without review.

Compliant proposals will be evaluated according to the criteria specified in section C.2 of the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance to the NASA's objectives and those of the FST, which includes cost realism/reasonableness.

For Focus Science Topics described in section 3.1, in addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion for relevance specifically includes the following factor:

- 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 will result in the proposal being judged noncompliant, and the proposal will not be reviewed. See section 3.1 for more details.

Relevance is dependent on the particular Focus Science Topic. Each proposal must demonstrate that the investigation is appropriate for the FST selected. This criterion will be strictly enforced.

The "Proposed Contributions" section is not required for proposals submitted to section 3.2, Physics of the Inner Heliosphere. However, such proposals will be judged for compliance based on their (demonstrated) relevance to the Solar Orbiter and Solar Probe Plus missions.

6. 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).

7. Summary of Key Information

Expected annual program budget for new awards	~ $3.2 M
Number of new awards pending adequate proposals of merit	~ 25
Maximum duration of awards	Focused Science Topics: 4 years Physics of the Inner Heliosphere: 3 years
Due date for Step-1 proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Date for start of investigation	No earlier than October 1, 2014.
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, two extra pages are permitted for a whole-team TST proposals; see also Chapter 2 of the *NASA Guidebook for Proposers*
File size limit for the proposal	10MB
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan; see Table 1 of ROSES and the reference therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
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 Section 3.3 of 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	NNH14ZDA001N-LWS
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