B.5 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Corrected August 18, 2023. The expected annual budget for new awards and the number of new awards listed in Section 9 have been updated based on current programmatic budget guidelines. New text is in bold and deleted text is struck through. The Step-2 proposal due date is unchanged at November 7, 2023.

Amended April 26, 2023. This amendment releases the final text for this program element, which had been listed as "TBD". Due to programmatic constraints, the Independent Investigations topic is not solicited this year. Step-1 proposals are due by August 15, 2023, and Step-2 proposals are due November 7, 2023.

In addition to and outside of the 15-page S/T/M section, Step-2 proposals must include: (1) a 2-page "Open Science and Data Management Plan" (OSDMP), see Section 5.3.1, (2) a 2-page statement of the Potential Contribution to the Focused Science Team Effort, see Section 5.3.2, and (3) up to 1 extra page is permitted for an optional section to be a Focused Science Team Leader, see Section 5.3.3.

All proposers are strongly encouraged to use the standard Heliophysics template for Current and Pending Support (for the PI and all Co-Is, regardless of time commitment) and to use the template for the Open Science Data Management Plan (OSDMP). Please see https://science.nasa.gov/researchers/templates-heliophysic-division-appendix-b-roses-proposals for more details.

1. Scope of Program

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the coupled Sun-Earth system that affect life and society. The overarching goal of the LWS Program is to provide advances in scientific understanding of this system that can lead to predictive capability of the space environment conditions at Earth, other planetary systems, and in the interplanetary medium. Every year the LWS Science program element solicits Focused Science Topics (FSTs) that address some part of this goal. This year's FSTs are described in Section 1.1 and Sections 2 - 4 below.

Specific LWS program goals are to:

1. Understand how the Sun varies and what drives solar variability.
2. Understand how the Earth and planetary systems respond to dynamic external and internal drivers.
3. Understand how and in what ways dynamic space environments affect human and robotic exploration activities.

Further information on the LWS Program goals and objectives can be found at the LWS website (http://lwstrt.gsfc.nasa.gov). Additional background material can also be found on the LWS website, and in the following documents:

- The LWS TR&T SDT Report
  https://lwstrt.gsfc.nasa.gov/images/pdf/TRT_SDT_Report.pdf
- The LWS 10-Year Vision Beyond 2015 Report
  http://lwstrt.gsfc.nasa.gov/images/pdf/LWS_10YrVision_Oct2015_Final.pdf
- The Revised Strategic Science Areas (SSAs)
  https://lwstrt.gsfc.nasa.gov/assets/docs/lpag/LPAG_EC_report_2019_12_31.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

LWS Science is a component of the Heliophysics Research Program and proposers interested in this program element should read ROSES-2023 B.1 The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Defaults for all ROSES elements are found in the *ROSES-2023 Summary of Solicitation* and for all NASA solicitations in the Guidebook for Proposers. The order of precedence is the following: This document (B.5) followed by B.1, followed by the ROSES *Summary of Solicitation*, and last the *Proposer's Guidebook*. Proposers should review all these resources to ensure compliance with Program requirements. See also Section I(g) of the *ROSES-2023 Summary of Solicitation* for a full discussion of order of precedence.

1.1 Solicited Investigations

To be responsive to this program element, proposed investigations must have objectives suitable for one of the three Focused Science Topics (FSTs) listed below:

- FST 1: Understanding Ionospheric Conductivity and its Variability (Section 2);
- FST 2: Synergistic View of the Global Magnetosphere (Section 3);
- FST 3: Evolution of Coronal Mass Ejections in the Corona and Inner Heliosphere (Section 4).

A general overview of FST investigations is given in Section 1.1.1. Sections 1.2 and 1.3 provide guidance on treatment of uncertainties and data use, respectively, for proposals submitted to any of this year's FSTs. Detailed descriptions of the science goals, objectives, and types of investigations for each FST are given in Sections 2 - 4.

1.1.1 *Focused Science Topic Investigations*

This program element seeks proposals involving a broad range of methodologies (e.g., data analysis, theory, modeling, etc.). To be successful, proposals submitted to one of the three FSTs listed above must identify science questions responsive to that FST's science goals and address them by the proposed work. Individual FST proposals are not required to be a comprehensive scientific study of the entire topic, but instead may address a specific aspect of the topic (e.g., develop a data set, analysis technique, or model) that would contribute to the FST goals and objectives.

For each FST, a Focused Science Team will be formed from the selected individual proposals that each address an aspect of the FST, and together cover the breadth of the FST. To foster the collaborations and coordinate these Focused Science Team research efforts, one of the selected PIs will serve as the Team Leader for the FST for which they proposed. The Team Leader will organize team meetings and will be responsible for producing a yearly report to the LWS Science program officer describing team activities and progress, in addition to the required annual progress report for their specific award. The other selected PIs will coordinate their research programs with their Team Leader.

To serve as a Team Leader, proposers should include a separate one-page section describing their qualifications, interest, and approaches to team leadership (see Section 5.3.3). Recommendations for selection of Team Leaders will be made by the LWS Science Program Officer and final selections will be made by the Heliophysics Division selecting official. Guidance for the team development process will be provided by the program officer after selection of the Team Leader.

Past experience has shown that Focused Science Teams usually need one year to organize team members, followed by another three years to make significant progress on the FST. Thus, the expected duration of FST awards is four (4) years. While proposals with shorter duration are allowed, proposers are encouraged to propose up to four (4) years to ensure maximum overlap between individual contributions to the team efforts.

All proposers to a specific FST must include sufficient travel funds in their budgets to cover two team meetings per year. To leverage travel costs, one meeting per year may be held in conjunction with a major U.S. scientific meeting. Successful teams will participate in a Kickoff Workshop where the selected team members will meet and develop work plans for the anticipated 4-year period of performance, based on the requirements of the FST and the composition of the selected team.

1.2 Treatment of Uncertainties

A critical element in enhancing understanding and developing predictive capabilities is the determination of whether the model or data products being developed are accurate and reliable. Consequently, a methodology for verification and validation of results, and quantification of uncertainty, is required as a key component of the proposed research. As mentioned below (Section 6), all proposals must address data and model uncertainty. This is also described in Section 2.13 of the *NASA Guidebook for Proposers*, which indicates that all proposals must address sources of error and uncertainties and what effect they may have on the robustness of potential results and conclusions.

1.3 Data Use in the LWS Program

This program element has policies on the use of data in proposals that expand upon and supersede those given in ROSES-2023 B.1 The Heliophysics Research Program Overview. Data and data products necessary for successful completion of the proposed project must be in a publicly available archive at no cost at least thirty (30) days prior to the Step-2 deadline. This applies to both space-based and ground-based observations, as well as any data products derived from them. This 30-day requirement does not apply to data products to be developed as part of a proposed study, only those existing in advance of Step-2 submission. Any questions about whether a data set or data product qualifies as publicly available must be submitted to the LWS Program Officer of the element at least ten (10) days before the Step-1 deadline.

After an award is made, projects may incorporate new data that become available at no cost in a public archive, provided that their use does not alter the goals and objectives of the selected proposal. Any planned changes in the data used must be described in the annual progress report submitted by the PI and approved by the LWS Program Officer.

While the inclusion of useful ground-based observations is allowed, proposals should incorporate relevant space-based observations within the proposed investigation through, e.g., data analysis, model initialization, model validation, or other means. Regardless of the data types used in the proposed study, the proposal must clearly demonstrate why the proposed data set or data sets are appropriate for addressing the proposed goals and objectives.

2. FST 1: Understanding Ionospheric Conductivity and its Variability

2.1 Target Description

Conductivity is an essential physical parameter for understanding how a planetary atmosphere interacts with variations in solar output. Due to coupling between the solar wind, the magnetosphere, ionosphere, and thermosphere, conductivity in the Earth's upper atmosphere is one of the most difficult heliophysical parameters to characterize and estimate. Variations in conductivity arise from several interconnected phenomena, including changing energy input from the Sun and solar wind, in the form of solar radiation, particle precipitation and Poynting flux, as well as dynamical processes that establish and maintain thermospheric composition and structure over a wide range of spatial and temporal scales. Conductivity cannot be directly observed but is instead determined through knowledge of both neutral and ionized components of the coupled ionosphere-thermosphere system. Variations in conductivity at high, middle, and low latitudes can form through a variety of energetic and dynamic processes such as auroral disturbances (including both large-scale and small-scale structures), ionospheric and thermospheric disturbances, and large-scale plasma transport arising from ion-neutral interactions.

Because of this inherent complexity, ionospheric conductivity and its variability are not well understood, particularly in the so-called atmosphere/space "transition region" between roughly 100-200 km altitude where ion-neutral collisional processes dominate. Most first-principles numerical models have embedded electrodynamics equations that require knowledge of the horizontal distribution of height-integrated conductivities and their variations to properly capture feedback processes between the ionosphere and magnetosphere. However, the vertical structure of the transition region conductivity in these models is not well constrained observationally due to lack of dedicated measurements, even though such constraints are critical for properly characterizing and understanding key energy exchange processes. There is now a recognized need for targeted investigations that integrate diverse data sets with state-of-the-art modeling to advance our understanding and prediction of ionospheric conductivity. Developing and validating realistic representations of ionospheric conductivity will address this gap and lead to improved predictive capabilities for ionospheric variations in response to a wide range of energetic inputs.

2.2 FST #1 Science Goals and Objectives

The science goal of this FST is to advance understanding of ionospheric conductivity variations throughout the ionosphere-thermosphere system, including the transition region, that can inform empirical models or first-principle physics-based models used to specify and/or predict ionospheric impacts of space weather that affect life and society. A key objective will be to contribute quantitative assessments of spatiotemporal variations in conductivity driven by processes such as, e.g., traveling ionospheric disturbances, thermospheric composition change, and high latitude energetic electron and ion precipitation. An additional objective of this FST is to assess the degree to which changes in ionospheric conductivity may affect the overall magnetosphere - ionosphere coupling during geomagnetic activity.

2.3 FST #1 Types of Investigations

FST #1 encourages the innovative use of data, theory, models and simulation, as well as the development of tools and analysis techniques, in combinations necessary to address the science goals. Proposals to this FST may leverage advances brought by observations from one or more NASA satellite missions focusing on different aspects of Ionosphere-Thermosphere (I-T) system behavior relevant for conductivity variations (e.g., ICON, GOLD, COSMIC, GNSS, CHAMP, DMSP/SUSSI, TIMED/GUVI, AMPERE) in addition to datasets from ground-based facilities such as Incoherent Scatter Radars (ISR), ionosonde, SuperDARN, SuperMAG, and others. Note that joint analysis methods are encouraged since some of these different space-based and ground-based assets can provide important cross-scale information. Proposed investigations that integrate traditionally disparate areas of I-T research to make progress on both qualitative and quantitative understanding of ionospheric conductivity and its variations are particularly encouraged.

Some types of investigations addressing the FST #1 goals and objectives listed in Section 2.2 may include, but are not limited to:

- Development of numerical methods and/or models to improve representation of ionospheric conductivity and impact on ionosphere-magnetosphere coupling processes;
- Improved particle precipitation description on the three-dimensional conductivity structure;
- Ionospheric processes across multiple scales producing conductivity variations beyond those driven by solar radiation and particle precipitation;
- Conductivity variability due to large scale plasma transport and its potential feedback on the thermosphere and other coupled systems (e.g., magnetosphere, lower atmosphere);
- Exploring the connection between ionospheric conductivity variations at high latitudes and response at lower latitudes for different geomagnetic conditions.

3. FST #2: Synergistic View of the Global Magnetosphere

3.1 Target Description

The global structure of the magnetosphere and its variability during geomagnetic storms and substorms is a function of many coupled processes involving different plasma populations (e.g., dayside vs. nightside, hot vs. cold plasma). Due to this complexity, research efforts expanding beyond the study of individual components or processes and consider the entire system are desired. Currently, our understanding of the global behavior of the magnetosphere storms and substorms is limited because the magnetosphere is sparsely sampled by *in situ* observations. This FST focuses on studies of the global magnetosphere capable of extracting system-level information and physical insight from innovative combinations of observations, data analysis, and numerical models of this complex region.

Some open questions to be addressed by this FST include: (1) What are the global storm/substorm distributions and time variations of magnetospheric electric currents, plasma pressure and density, and how well can they be reproduced with models and remote sensing measurements?; and (2) What new methodologies are available for combining global images of the magnetosphere, its global simulations, and empirical reconstructions obtained using modern machine learning methods?

For this FST, these questions may be addressed through investigations that employ multiple observational data sets, physical models, data assimilation, and/or machine learning tools. This FST seeks to build a team of researchers with a broad range of expertise in these areas to address these open questions and improve understanding of the magnetosphere as a global system in a concerted and synergistic fashion.

3.2 FST #2 Science Goals and Objectives

The overarching science goal is to advance our understanding of the impact of geomagnetic storms on the global magnetosphere through complex coupled processes such as magnetic reconnection, quasi-viscous interactions, plasma turbulence, shocks and interaction with neutrals. Specific objectives of this FST are to (1) describe and quantify global magnetospheric variability and reconfiguration during storms and substorms; (2) develop improved understanding and forecast capabilities of the global state of the ionosphere and its connection with the plasmasphere; and (3) develop predictive models of the dynamic radiation environment and spacecraft-charging environment based on the global structure of the magnetosphere.

3.3 FST #2 Types of Investigations

Proposals to this FST may include combinations of data analysis, data-model comparison, theory, and numerical simulation, including application of ML/AI tools and techniques. Available data sources include NASA missions or instruments (space-based or ground-based) focusing on different components of the coupled global magnetosphere-plasmasphere system (e.g., TWINS, GOES-R, GOLD, ICON, THEMIS, SuperMAG). Successful investigations will clearly describe the synergistic nature of the methodology, i.e., how the proposed investigation will use innovative methods to extract system-level information that advances physical understanding of global magnetospheric structure and can lead to improved prediction of its variability during storms and substorms.

Types of investigations addressing the FST #2 goals and objectives listed in Section 3.2 may include, but are not limited to:

- Combined analysis of multiple observations such as energetic neutral atom (ENA) emissions of ring current hot plasma, EUV plasmaspheric images, soft X-ray images, radio tomography, field-aligned current maps obtained from constellations of LEO spacecraft or ground-based radars, all-sky cameras, space-borne auroral imagers, and ground-based magnetometer networks;
- Global physical models to describe magnetospheric structure and evolution, linking solar wind perturbations to global changes in the magnetospheric structure and their ultimate space weather impacts, such as solar energetic particle fluxes, perturbations of the ionosphere and thermosphere, radiation belts, and geomagnetically induced currents; and
- Use of current and historical databases from *in situ* spacecraft observations and/or extended LEO observations to build innovative data-based specification and prediction capabilities for the global magnetosphere through, e.g., application of data assimilation or AI/ML tools and methods.

4. FST #3: Evolution of Coronal Mass Ejections in the Corona and Inner Heliosphere

4.1 Target Description

Fast coronal mass ejections (CMEs) are the major driver of the most intense space weather. There are now more coronal and inner heliospheric observations than ever before. Recent advances in observing CMEs with heliospheric imagers has narrowed the gap between studies focusing on remote observations in the corona vs. investigation of the *in situ* properties of CMEs. *In situ* observations from Parker Solar Probe (PSP) and Solar Orbiter (SO) close to the Sun, combined with simultaneous radio observations and wide-angle imaging of the inner heliosphere, help to close this gap. Upcoming missions are also expected to provide both speed and density information along with polarized imaging of the corona and heliosphere. Radio scintillation observations provide column density, the velocity in the plane-of-the-sky, and occasionally magnetic field and density information along the line-of-sight (using Faraday rotation and scintillation techniques), including the level of turbulence in the solar wind upstream of the transient. Global heliospheric models use synoptic photospheric magnetographic inputs to describe the 3-D magnetic field that is integral to solar wind flows and propagation of space weather events through the background fast and slow wind.

One-to-one mapping and tracking from solar observations to measurements at 1 AU is challenging due to the evolution of CMEs and the background solar wind that occurs over a wide range of scales. In addition to the tracking of solar wind features in remote sensing observations, the PSP and SO *in situ* magnetic field and composition measurements at intermediate distances between the Sun and 1 AU are critical for testing the tracking of CMEs, mapping, and determining the background source regions. This uniquely comprehensive collection of *in situ* and remote observations combined with modeling provides a wealth of information on CME evolution across scales but makes it challenging to synthesize and interpret all information.

A team approach is needed to determine how CME properties and their geo-effectiveness depend on solar conditions, initial state, propagation, and evolution through the corona and heliosphere. This FST is timely given the comprehensive *in situ*, imaging, and radio observations spanning the corona and inner heliosphere that have recently become available.

4.2 FST #3 Science Goals and Objectives

The overarching goal of this FST is to advance our understanding of CMEs, CME evolution, and space weather impact of CMEs as well as to improve heliospheric models, data analysis, and assimilation techniques, within 1 AU heliocentric scales. Objectives include determining how CME properties are affected on their journey through the corona and inner heliosphere as they interact with background structures and investigating the geoeffective potential of CMEs.

4.3 FST #3 Types of Investigations

This goal of the FST can be achieved through new science investigations combining modeling, remote and *in situ* data analysis, and the development of new tools and techniques, such as data assimilation as well as joint *in situ* and remote models. The use of Artificial Intelligence (AI) and/or Machine Learning (ML) is encouraged (but not required) in this FST.

Proposals to this FST may include data analysis, data-model comparison, simulations, theory and modeling methods. Available data sources include PSP, SO, STEREO, ACE, Wind, and ground-based radio scintillation observations. Some types of investigations addressing the FST #3 goals and objectives listed in Section 4.2 may include, but are not limited to:

- Modeling or simulation studies (including application of theory, data driven and data assimilative techniques) that successfully span multiple spatial scales and improve the understanding of CME evolution in the corona and inner heliosphere.
- Understanding the evolution of CMEs and their substructures as they transit the corona and inner heliosphere and interact with the background solar wind.
- Integration of new observations or new combinations of observations to extract additional physical information about the evolution of CMEs and their substructures as they transit the corona and inner heliosphere and interact with the background solar wind.
- Development of a capability that leads to improved forecasts of the space weather impact on the Earth system as a result of advances in understanding of CMEs and their evolution through the corona and inner heliosphere.

5. Submission Guidelines

Each PI, or the Science PI if applicable, may submit one and only one proposal to this program element. The PI (or Science PI) is required to commit at least 20% of their time per year to the investigation.

In addition to the general requirements and restrictions (e.g., in Table 1 of *ROSES-2023* and in B.1 Heliophysics Research Program Overview) this program element has specific compliance constraints for both format (see Sections 5.2.1 and 5.3.1) and content (see Sections 1.2, 1.3, and 5.3). Proposers must include an Open Science and Data Management Plan in a separate section immediately following the Scientific/Technical/Management portion of this proposal. Proposers are also strongly encouraged to use the standard Heliophysics template for Current and Pending Support for the PI and all Co-Is, regardless of time commitment. These compliance rules ensure fairness and are enforced strictly by the Heliophysics Division. Proposals that are deemed noncompliant will be returned without review or declined following review if violations are found during the evaluation process.

5.1 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a "binding" two-step proposal submission process described in Section IV(b)vii of the *ROSES-2023 Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Because potential reviewers are solicited based on the Step-1 proposal, investigators may not be added to the proposal team between the Step-1 and Step-2 proposals, unless prior approval is obtained from the LWS Program Officer. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal.

5.2 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date given in Tables 2 and 3 of *ROSES-2023*. The Step-1 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. No budget or other uploaded files are required. Step-1 proposals will be checked for compliance, but they will not be evaluated. Only proposers who submit a Step-1 proposal and who are invited are eligible to submit a Step-2 (full) proposal.

Submission of a Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal.

5.2.1 *Step-1 Proposal Format*

The Step-1 proposal is restricted to a 4,000-character Proposal Summary text box on the NSPIRES web interface cover pages. It must 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;
- For proposals submitted to a specific FST: A brief description of the relevance of the proposed study to the scientific objectives of the FST, and the potential contributions of the proposed study to the Focused Science Team's effort.

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be notified by NSPIRES whether they are invited to submit their Step-2 proposals. Proposers are strongly encouraged to provide names and contact information of up to 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 in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

5.2.2 *Step-1 Compliance Criteria*

Step-1 proposals may be declared noncompliant if they fail to meet the submission guidelines or if they are determined by the Program Officer to be outside the scope of either the LWS Science program or the specific FST topic selected by the proposer. PIs of noncompliant proposals will not be invited through NSPIRES to submit the associated Step-2 proposal and will be notified through NSPIRES to this effect.

5.3 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date given in Tables 2 and 3 of *ROSES-2023*. The Step-2 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. A budget and other specified information is required.

Only proposers who submit a Step-1 proposal and who are invited can submit a Step-2 (full) proposal. Proposers that have received a noncompliance letter in response to their Step-1 proposal are not eligible to submit a Step-2 proposal.

5.3.1 *Step-2 Proposal Format and Content*

All proposals submitted to ROSES must strictly conform to the formatting instructions specified in Section IV(b)ii of the *ROSES-2023 Summary of Solicitation* except where superseded by the requirements in this program element. Proposals that violate these instructions may be returned without review or declined following review if violations are found during the evaluation process.

Proposals are restricted to fifteen (15) pages for the Science/Technical/Management section.

Proposals must include an Open Science and Data Management Plan (OSDMP), as described in Section 1.6 of ROSES 2023 Appendix B.1, the Heliophysics Research Program Overview. The OSDMP must be placed in a separate section, not to exceed two (2) pages in length, titled "Open Science and Data Management Plan" immediately following the references and citations for the Science/Technical/Management section. The OSDMP does not count against the 15-page limit for the Science/Technical/Management section. Use of the OSDMP template is strongly encouraged. See https://science.nasa.gov/researchers/templates-heliophysic-division-appendix-b-roses-proposals.

5.3.2 *Required Additional Section in Step-2 Proposal: Potential Contribution to the Focused Science Team*

Proposals submitted to this program element must also address the proposed contribution to the Focused Science Team in a separate section, not to exceed two (2) pages in length, titled “Potential Contribution to the Focused Science Team Effort” immediately following the OSDMP section of the proposal. Formatting requirements for this section are the same as for the Science/Technical/Management section. This section on Potential Contribution does not count against the 15-page limit for the Science/Technical/Management section. Proposals that fail to address proposed contributions to the Focused Science Team may be declared noncompliant and will typically be returned without review or declined following review if the lack of this section is discovered during the evaluation process.

This Potential Contribution section must summarize the following three topics:

- The relevance of the proposed study to the scientific goals and objectives of the individual FST as outlined in Sections 2.2, 3.2, or 4.2;
- The potential contribution(s) of the proposed study to the broader Focused Science Team's effort;
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

This summary must describe the goals of the proposed project and why they are aligned with the FST goals outlined in Sections 2.2, 3.2, or 4.2. For proposals that address a Type of Investigation that is listed in Sections 2.3, 3.3, or 4.3, this summary must also describe briefly how the proposed investigation addresses one or several of those investigations.

In addition, all proposers are expected to provide a set of metrics that they will use to determine successful progress toward their proposed goals. Proposers must also provide a set of milestones that should indicate the anticipated timing of the major achievements over the course of the proposed study.

The review panel will only consider material in this section when the relevance of the proposal to the Focused Science Team effort is evaluated (see Section 6).

5.3.3 *Optional Additional Section in Step-2 Proposal: Proposed FST Team Leader Contribution*

Proposal PIs willing to serve as a Team Leader for a specific Focused Science Topic should describe the proposed team leader activities in a separate section, not to exceed one (1) page in length, entitled “Proposed Team Leader Contribution” (see Section 1.2). When included, this section should follow the section on “Potential Contribution to the Focused Science Team Effort” described in Section 5.3.2. This section on Team Leader Contribution does not count against the 15-page limit for the Science/Technical/ Management section.

5.3.4 *Step-2 Compliance*

Noncompliant Step-2 proposals will be returned without review or may be declined after review if the noncompliance is found during the evaluation process. Step-2 proposals may be declared noncompliant if:

- The title has substantially changed from that of the Step-1 proposal;
- Investigators have been added since the Step-1 proposal without prior approval of the Program Officer;
- The science goals and objectives have substantially changed from that of the Step-1 proposal;
- The proposal has the same (or essentially the same) team and objectives as a Step-2 (full) proposal currently submitted to or selected by another Heliophysics program in the ROSES-23 announcement;
- The proposal violates the restrictions in Section 1.3 regarding use of data; or

- The proposal violates the formatting instructions in Section 5.3.1.

6. Evaluation Guidelines

Compliant proposals will be evaluated according to three main criteria: (1) Intrinsic Merit, (2) Potential Contribution to the Focused Science Team Effort (Relevance), and (3) Cost Reasonableness. The open science and data management plan (OSDMP), described in Section 5.3.1 of this program element and Section 1.6 of B.1, the Heliophysics Research Program Overview, will be evaluated as part of Merit. Intrinsic Merit and Cost Reasonableness will be evaluated primarily as specified in the *ROSES-2023 Summary of Solicitation* and defined in the *NASA Guidebook for Proposers*, but Relevance is handled differently. Clarifications and additions specific to this program element are listed below.

The evaluation of intrinsic merit will include the following:

- Scientific Merit: Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now; and
- Technical Merit: Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Sources of error or uncertainties, and what effect they may have on the robustness of potential results or conclusions, will be evaluated as a methodology issue (intrinsic merit), and the review panel will assign a strength or weakness based on the treatment of these sources as presented in the proposal. Proposers are free to choose any appropriate method of uncertainty analysis or validation of results, but it must be clearly addressed in the body of the proposal. Proposals that fail to address uncertainty will be assigned a Major Weakness in the evaluation and may be considered unselectable.

Intrinsic Merit and Relevance will be evaluated separately. Based on the above two factors (Scientific and Technical Merit), the evaluation will consider the overall potential science impact and probable success of the investigation and an adjectival grade for Intrinsic Merit will be assigned.

The evaluation of the potential contribution to the Focused Science Team effort (Section 5.3.2) will serve as the Relevance evaluation and a separate adjectival grade for Relevance will be assigned.

The final adjectival grade assigned to the overall evaluation will be the lower of the two adjectival grades for Intrinsic Merit and Relevance.

Evaluation of Cost Reasonableness will include a comparison of the scope of the proposed study to the proposed resources (personnel-time allocated, necessary computer resources, etc.). The panel will provide feedback to SMD but will not assign a grade and this information will be considered by the Heliophysics selecting official during the selection process.

7. Award Types

It is anticipated that awards to non-governmental organizations will be grants or cooperative agreements, as appropriate, rather than contracts which would not be appropriate given the nature of the work solicited. See the ROSES Summary of Solicitation Section II(a) Funding and Award Policies for more information.

8. Available Funds

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 $180K - $250K per year. (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 time commitment of investigators, or a combination 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, merit, and range of investigative techniques, NASA anticipates forming teams of approximately 5 to 7 selections for each of the three FST topics. Team Leader activities should not be included in the proposal budget. The Team Leader will receive up to an additional $25,000 per year to support their leader activities, and the Team Leader's budget will be revised during final award negotiations.

9. Summary of Key Information

Expected annual program budget for new awards	~$**4M** ~~5M~~, see also Section 8, above.
Number of new awards pending adequate proposals of merit	~**16** ~~15~~, see also Section 8, above.
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
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 pages; up to 2 extra pages each for required separate sections describing the Open Science and Data Management Plan (5.3.1) and the Potential Contribution to the Focused Science Team Effort (5.3.2), and up to 1 extra page for an optional separate section for proposers to be a Focused Science Team Leader (see Section 5.3.3). See also Table 1 of *ROSES-2023* for the default components of a ROSES proposal.
Relevance	Proposals that are relevant to an FST are, by definition, relevant to NASA. See also Section 6.
General information and overview of this solicitation	See the *ROSES-2023 Summary of Solicitation*.

General requirements for content of proposals	See above and B.1 The Heliophysics Research Program Overview and Section IV and Table 1 of *ROSES-2023.*
Detailed instructions for the submission of proposals	See NSPIRES Online Help, Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
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	https://www.grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH23ZDA001N-LWS
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