B.6 LIVING WITH A STAR TARGETED RESEARCH AND TECHNOLOGY

Amended November 14, 2011. This version of Appendix B.6: Living With a Star Targeted Research and Technology replaces, in its entirety, the draft version that was released with the ROSES-2011. The due dates have changed. Notices of Intent to propose are due December 15, 2011. Proposals are due February 24, 2012. Award start dates are required to be October 1, 2012.

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 United States to effectively address those aspects of Heliophysics science that may affect life and society. The LWS Targeted Research and Technology (TR&T) program element solicits proposals leading 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 TR&T 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). TR&T is a crosscutting initiative that addresses the following LWS strategic goals (in no priority order):

1. Solar energetic particles and galactic cosmic rays pose major radiation hazards for space hardware and astronauts. Penetrating particle radiation adversely affects aircraft avionics and potentially the health of airline crews and passengers on polar flights. Communication and navigation systems are directly affected by impulsive changes in the solar particle and electromagnetic output leading to re-routed polar flights and GPS outages. In support of NASA's vision for space exploration and the national communication, navigation, and transportation infrastructure, the TR&T program needs 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. One of the major challenges facing humanity is global climate change. In order to gauge the response of the terrestrial climate system to natural and anthropogenic forcings, NASA through the TR&T program and Earth Science Division, in conjunction with other national agencies such as NOAA and NSF, needs 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. National infrastructures are increasingly dependent on satellites orbiting Earth. With increasing miniaturization these systems are ever more sensitive to variations in the near-Earth space environment. To protect these assets, the TR&T program needs to deliver the understanding and modeling required for effective forecasting/specification of magnetospheric radiation and plasma environments.

4. The upper atmosphere and ionosphere is central to a host of space weather effects, including anomalous satellite drag, GPS position error, radio blackouts, radar clutter, and geomagnetically induced currents. In order to mitigate space weather's impact on life and society, NASA through the TR&T program, in conjunction with other national agencies such as NSF and DoD, needs 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 provided the basis for the selection of focused science topics for this solicitation. The primary goal of the LWS Program is to make progress in understanding this complex system, focusing on the most critical interconnections.

The *Final Report of the LWS TR&T Science Definition Team (SDT)* (December 2003), located on the LWS TR&T homepage at http://lws-trt.gsfc.nasa.gov/trt_resources.htm, identified TR&T as a systematic, goal-oriented research program. The TR&T component of the LWS Program provides the theory, modeling, and data analysis necessary to enable an integrated system-wide picture of Heliophysics science with emphasis on societal relevance.

Significant progress toward quantitative understanding and predictive capability with respect to these problems will require large-scale, integrated modeling activities. Recognizing the need for activities that would be broader and more sustained than those that can be supported by a traditional NASA grants program, the *Final Report of the LWS TR&T Science Definition Team* recommended that "…large modeling activities that address coupling across traditional science domains in the Sun-Earth chain specifically be included as strategic capabilities." The TR&T SDT also recommended the formation of a TR&T Steering Committee in order to update periodically the designated strategic capabilities for future solicitations. The most recent report of this Steering Committee is available on the LWS TR&T homepage at http://lws-trt.gsfc.nasa.gov.

As a result of these studies and recommendations, the LWS TR&T 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 in the following documents:

- The Sun Earth Connection LWS web site (http://lws.gsfc.nasa.gov/);
- The LWS Science Architecture Team report to SECAS (http://lws.gsfc.nasa.gov/documents/sat/sat_report2.pdf);
- *The Sun-Earth Connection Roadmap Report* (http://sec.gsfc.nasa.gov/2009_Roadmap.pdf);
- The NRC Decadal Survey Report *The Sun to the Earth and Beyond* (http://www.nap.edu/books/0309089727/html/);
- *The Heliophysics Roadmap* (http://science.nasa.gov/media/medialibrary/2010/03/31/Heliophysics_Roadmap_2009_tagged-quads.pdf);

- *The TR&T Science Definition Team Report* (http://lws-trt.gsfc.nasa.gov/TRT_SDT_Report.pdf); and
- *The latest TR&T Steering Committee Team Report* (http://lws-trt.gsfc.nasa.gov/trt_steeringcom.htm).

1.2 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 TR&T program. First, the TR&T program must tackle large-scale problems that cross discipline and technique boundaries (e.g., data analysis, theory, modeling, etc.); and second, the TR&T program must identify how this new understanding will have a direct impact on life and society.

The Targeted Investigations program element is typically subdivided into the three components described below: (1) Focused Science Topics, (2) Sun-Climate Theme, (3) Tools & Methods. The maximum duration of these awards are 4 years, 3 years, and 2 years, respectively. Element (3) Tools & Methods will not be solicited this year. Read the following sections carefully; there are significant changes, especially as related to compliance.

Proposals will be judged non-compliant and will not be reviewed if the Evaluation Criteria found in section 2.2 and detailed in section 1.2.1 are not met.

Note that there is no Tools & Methods component this year

1.2.1. Focused Science Topics

A set of three Focused Science Topics has been chosen for this solicitation, which are listed below. The maximum duration of these awards is 4 years. NASA desires a balance of research investigation techniques for each Topic, including theory, modeling, data analysis, observations, and simulations. 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. 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 TR&T Focus Team Members and Leaders at (http://lws-trt.gsfc.nasa.gov/trt_focusteams.htm) for full details of responsibilities.

While the primary evaluation criteria remain unchanged (see *ROSES Summary of Solicitation*, Section V(a), and the *NASA Guidebook for Proposers*, Appendix C.2), the criterion for relevance includes relevance to one of the three Focused Science Topics (see a, b, and c below) as an essential requirement for selection within this component. As such, NASA has instituted a compliance check as follows:

In order to be compliant to this ROSES element, each proposal submitted must contain a section, 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 non-compliant, 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, and
- metrics and milestones for determining the successful progress and outcome of the proposed research.

Since each Focused Science Team has to produce a joint statement of work specifying its deliverables, success criteria, and milestones, the mandatory section described here can serve as a starting point for this SOW.

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." LWS further emphasizes that Focused Science Teams will be formed from individual proposals selected in a Focus Topic. Therefore, individual proposals do not need to tackle the whole problem, but can instead seek to solve a piece of the problem.

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

Focused Science Topic (a) Flare Dynamics in the Lower Solar Atmosphere

Target Description:
The lower solar atmosphere, in particular, the chromosphere, experiences during flares sudden changes in several basic physical parameters, such as opacity, collisionality, density, or plasma beta. Flares represent drastic impulsive perturbations of this complicated system, with interesting implications for particle acceleration, radiative transfer, and magnetic restructuring. The "impulsive phase" marks the epoch of most intense energy release and the main flare nonthermal effects, and coincides with the acceleration phase of the associated Coronal Mass Ejection (CME). The key process in the impulsive phase is the intense acceleration of non-thermal particles, recognized via the hard X-ray and gamma-ray bursts they produce.

As a part of this Focused Science Topic, the apparently connected phenomena of the CME launch, the white-light flare (as observed also in the total solar irradiance), and the newly recognized "sunquake" seismic signature in the solar interior may be tied together. Success in understanding the energy transformations and momentum balance of the impulsive phase should help substantially in characterizing the initial development of a CME and the global coronal processes associated with it

We now have major new observational and theoretical tools with the potential to make substantial progress in understanding this system. Previous studies have taken advantage of the stepwise changes in the photospheric line-of-sight magnetic field; which this FST will be able to extend to the full vector field from new observations (*Hinode* and *SDO*). The changes in the magnetic field at the time of the impulsive phase are expected to directly reflect the physical nature of the flare/CME instability, since they reveal the flow of energy from the field into particles, flows, and heating.

The complexity of this Focused Science Topic requires a multidisciplinary approach, incorporating modeling efforts at several levels (MHD, radiation transfer, plasma) as well as a diverse set of observational material that will require analysis by different specialists. The key observations from space include those from *RHESSI*, *Hinode*, and *SDO*. Success in understanding the energy transformations and momentum balance of the impulsive phase should help substantially in characterizing the initial development of a CME and the global coronal processes associated with it.

Goals and Measures of Success:

The goal of this Focused Science Team is to advance our understanding of the dynamics of the Lower Solar Atmosphere during flares by making:

- Progress in understanding the transport of energy and momentum into the interior from the solar atmosphere (sunquakes) during flares.
- Progress in understanding high-energy phenomena in the impulsive phase of a flare.
- Extensions of the photospheric field changes from the line-of-sight field to the full vector field.
- Progress in revising the standard thick-target model of the flare impulsive phase.

Types of Investigations:

- The characterization of sunquake signatures in terms of energy and momentum, and their relationship with the flare impulsive phase.
- The application of plasma-physics tools to the chromosphere, in which (for example) ion-neutral coupling may dominate the electrodynamics and Hall currents during flares.
- The analysis of footpoint emissions, relating hard X-rays and gamma rays with visible/UV continuum and EUV spectra, to understand energy transport.
- The observation and characterization of flare seismic waves in order to distinguish among different mechanisms for corona/interior coupling.
- The exploration of Alfven waves in the kinetic limit, in a dense, partially ionized medium, as a source of particle acceleration during flares.
- Investigations using the anomalous 511-keV line widths observed by *RHESSI*, i.e., positron annihilation, as probes of the density structure of the chromosphere and transition region.

Focused Science Topic (b) Interaction between the magnetotail and the inner magnetosphere and the impact of that interaction on the radiation belt environment

Target Description:

As plasma from the near-Earth magnetotail is transported inward to the inner magnetosphere, the plasma energizes and changes the structure and dynamics of the entire inner magnetosphere. For example, the resulting enhanced plasma pressures drive currents connecting to the ionosphere and severely distort the electric and magnetic fields of the entire inner magnetosphere. In turn, the altered magnetic fields and wave environment are key players in controlling the dramatic variability of the outer electron radiation belts. Therefore, understanding how plasma is energized and transported inward to the inner magnetosphere is one of the missing links in our ability to predict near-Earth space weather. Observations and models have demonstrated that plasma transport inward to the ring current region may occur through fine-scale instabilities rather than by a simple wide front of earthward plasma convection. Observations have demonstrated that O^+ can dominate the plasma pressure through non-adiabatic energization processes, the theory of which is now only understood within the limits of single particle theory. The responsible processes appear more complicated than previously thought in that they cannot be described, modeled or best understood by either MHD or kinetic (particle) phenomena alone – and the capability of modeling such a hybrid is still maturing. Major uncertainties remain about the exact nature of these processes: when they occur and when one process dominates over the other. Numerical modeling efforts that combine the ability to model the global magnetosphere with kinetic and particle models of the ring current and inner magnetosphere are expected to provide the useful tools for studying these processes. Global and in-situ observations by missions such as *IMAGE*, *TWINS*, *Cluster*, *THEMIS* and in particular *RBSP* offer data relevant to these investigations and can provide model validation.

Goals and Measures of Success:

The goal of this Focused Science Team is to advance our understanding of plasma acceleration and transport from the magnetotail to the inner magnetosphere by using observations and modeling. This effort builds upon existing numerical models and will utilize the observations made by several missions, but in particular the RBSP mission.

- Improvement in our understanding of plasma transport process;
- Development of detailed descriptions of the nonlinear interaction between low-energy plasma transport, the ring current and its impact on the outer radiation belt;
- Continued improvement of coupled numerical models of the inner and outer magnetosphere.

Types of investigations:

- Global and multi-point observations to characterize and investigate the energization and transport processes that lead to enhanced particle pressure in the inner magnetosphere.
- Studies of potential plasma processes responsible for the relevant plasma transport inward to the inner magnetosphere.

- Studies of how plasma energization and transport impact the dynamics in the inner magnetosphere including
    - how the dynamics of the ring current affects the structure of the magnetic and electric fields,
    - how the wave environment of the inner magnetosphere is altered, and
    - how the dynamics of the outer radiation belts are affected by the processes above.
- Investigations on how the state of the inner magnetospheric, e.g. structure of the ring current and convection electric field, affect the evolution of the magnetotail.

Focused Science Topic (c) Atmosphere-Ionosphere Coupling During Stratospheric Sudden Warmings

Target Description:

Over the last three years our understanding of the relationship between the neutral atmosphere and ionosphere has been dramatically altered due to research focused on Sudden Stratospheric Warmings (SSW). SSW represent a compelling manifestation of the complex coupling of the troposphere-stratosphere-mesosphere-ionosphere system. SSW events are large-scale, well-defined, long-lasting phenomena, with predictable short term (several day) behavior and post-event duration. Recent studies suggest that a SSW couples all atmospheric layers from the ground to the thermosphere and from the poles to the equator, and leads to significant perturbation in ionospheric electron density in excess of 50% from the mean state. Understanding the forcing mechanisms for SSW events, including wave-wave interactions in the neutral atmosphere and neutral/plasma coupling has the potential to significantly improve understanding of the drivers of ionospheric variability, and improve forecasting of ionospheric space weather.

While the occurrence of the initial SSW forcing is predictable, the subsequent effects of the forcing across the entire atmosphere-ionosphere system are not understood. Disturbances in the lower and middle atmosphere appear related to planetary wave anomalies, their coupling to upper atmospheric layers as well as the combined roles of planetary waves, atmospheric tides, and gravity waves are less clear. Not much is known about the characteristics of nonlinear wave-wave interactions, which require careful analysis to deduce from observational data. A full understanding of SSW coupling into the ionosphere requires studies that bring together simultaneous observations in a variety of neutral and ionosphere parameters and models that fully account for neutral/plasma coupling and dynamics. Other uncertainties to be resolved are the degree of influence on SSW events from solar variability and solar proton fluxes, and the links that SSW processes may have on the modification of planetary wave propagation in the stratosphere, mesosphere, and ionosphere.

Large space-based data sets (observations from EOS, TIMED SABER, Aura MLS, COSMIC, C/NOFS, NCEP and EMCWF global stratospheric maps), along with ground-based data sets (lidars, MF and meteor radars in the MLT region, incoherent scatter radars, magnetometers, GPS TEC maps) are available to address the problem in a mesoscale format. Comprehensive modeling tools (WACCM, NOGAPS, WAM) can be forced with assimilated troposphere and stratosphere data to recreate SSW events and analyze mesospheric-thermospheric responses.

Coupled whole atmosphere models can be used to interpret the observations and assess impacts of driving processes on the MLT region and ionosphere.

Goals and Measures of Success:

The goal of this Focused Science Topic is to advance our understanding of the dynamical coupling processes between the middle and upper atmospheres in both a theoretical and quantitative manner, and to lay the groundwork for future predictive capabilities in space weather and ionospheric variability through the study of SSW events. Success of this team will be measured by:

- Improved understanding of dynamo processes and energy transport from the lower atmosphere into geospace and from geospace to the lower atmosphere during SSW events.
- Characterization of spatio-temporal variations in wave activity associated with SSW events (planetary waves, atmospheric tides, gravity waves). Determination of the tidal modes modulated during SSW events (solar/lunar, migrating/non-migrating, diurnal/semidiurnal/terdiurnal), planetary and gravity wave fluxes.
- Improved theoretical and observational understanding of key factors affecting the efficiency of the atmosphere-ionosphere coupling (e.g. amplitudes of planetary waves, changes in zonal mean flow) responsible for SSW events.
- Improved theoretical and observational understanding of the relative impacts of gravity waves and planetary waves in driving the atmospheric and ionospheric response to planetary waves originating in the stratosphere during SSW events.
- Characterization of electrodynamic and ionospheric signatures associated with SSW and improved understanding of key mechanisms responsible for these signatures.

Types of Investigations:

- Observational investigations of planetary wave activity, tidal activity, and gravity wave activity in the stratosphere-mesosphere-ionosphere before, during, and after SSW.
- Observational investigations of changes in the dynamics in the stratosphere, mesosphere, and upper thermosphere and electrodynamics in the ionosphere-thermosphere system (e.g., electric field) associated with SSW.
- Modeling studies of interactions during SSW between planetary waves, tides, and gravity waves, planetary waves and zonal mean flow, and their effects on the ionosphere; effects of solar variability on the ionosphere-thermosphere response to these dynamical drivers of lower and middle atmospheric origin.
- Observational and modeling studies of the temporal development of the mesospheric and ionospheric response to SSW and recovery from SSW.

1.2.2 <u>The Sun-Climate Theme</u>

The LWS Sun-Climate strategic objective is to "*deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales.*" The new Sun-Climate Theme is established to address this objective. The maximum duration of these awards is 3 years. This theme represents a new opportunity to foster cross-disciplinary investigations of connections between solar forcing and climate. Particular emphasis is placed on coupling of the upper and lower atmosphere and the processes responsible for transmitting solar variations to the Earth's surface where they can affect regional climate. Only investigations of sun-climate issues will be considered compliant with this theme; climate investigations that are not directly relevant to solar forcing are not being solicited. Atmospheric responses on time scales of seasons to millennia are of primary interest.

Rather than aiming science contributions at a focused science team, proposers will submit individual investigations that must explicitly describe how the proposed work will lead to progress in achieving the prioritized goal quoted above. Contributions from a solar and upper atmosphere perspective will likely be on equal footing with those from a lower atmosphere climate dynamics and chemistry perspective. Exchange among diverse research foci within the Sun-Climate Theme is expected to grow through regular meetings (initially once a year), and individual collaborations are strongly encouraged.

Thematic Description: Proposals submitted to the new Sun-Climate Theme will target processes by which solar influence particulate forcing can impact the Earth's climate. Solar activity variations clearly influence the upper atmosphere, but signals diminish toward the surface. Nevertheless, in some locations climate-related parameters such as the historical surface temperature or moisture records exhibit variations that appear to be related to the solar cycle. Two key issues must be addressed to make progress in quantifying the solar contribution to climate variability and change: (1) Observed decadal to centennial-scale climate signals throughout the atmosphere and at the surface must be categorized as either systematically related to solar activity changes or as spurious because of internal climate system variations on similar time scales. (2) The emphasis of solar impact studies in climate research must be broadened beyond mean radiative forcing to include both direct and indirect atmospheric impacts of spectral irradiance and particle precipitation variations over the full range of spatial and temporal scales.

The intent of this Sun-Climate Theme is to initiate cross-disciplinary research that will develop a more solid mechanistic understanding of pathways by which solar variability affects the various levels of the atmosphere, and how these effects are communicated toward the troposphere and surface where they modulate global and regional climate. It also targets the pathways by which ongoing climate change influences the atmospheric response to solar forcing, both directly and via upward coupling. Investigations that identify these processes and analyze variations over a wide range of time scales are necessary to reconcile observations and understanding of the natural modulation of climate by the Sun, and to delineate the Sun's role in regional climate variability and current climate change. This information is crucial for testing climate models that are used for regional climate change prediction. Thus, this program component solicits investigations that seek to define and quantify the solar-induced changes in a "whole atmosphere" approach, emphasizing downward and upward coupling between the upper and lower atmosphere.

Objectives and Metrics: The overall objective is to predict the climate response to solar variability (in many different forms) on regional as well as global scales. Metrics will be gauged for a number of tasks: (1) Identifying and quantifying the relevant pathways by which solar forcing causes variability in climate parameters such as atmospheric temperature, circulation, and wave activity over a broad range of time scales; (2) Isolating the regional and global climate response to variations in these pathways with data that have enough sample (record length); (3) Assessing the sensitivity of these pathways to long-term change in the troposphere and atmospheric composition; (4) Incorporating solar forcing effects into coupled chemistry climate models (CCMs) to produce verifiable simulations of these effects on atmospheric processes; (5) Testing and improving the predictive capabilities of the CCMs and Earth System Models with regard to solar-induced forcing. Also of interest is identifying the minimum specifications of vertical extent, resolution and process complexity that a lower atmosphere model would need in order to adequately simulate solar effects on surface climate and variability.

It is expected that numerical modeling, theory, data analysis and assimilation investigations will contribute to the Sun-Climate Theme, with studies addressing seasonal to millennial time scales. The following topics are examples of relevant areas of investigation; these are meant only to be illustrative, and are not all-inclusive:

- Quantify wintertime constituent transport from the thermosphere to the stratosphere, and any subsequent effects on the troposphere, to investigate the influence on these processes of solar particle variability.
- Improved understanding of dynamo processes and solar theory as it relates to long-term climate evolution and change.
- Interpreting cosmic nuclide data in terms of solar activity including accurate estimates of the history of Earth's magnetic field.
- Cyclic and secular changes in Sun-like stars: implications for solar variability and climate change.
- Quantify stratospheric ozone variations caused by solar irradiance variability, and the impacts of these variations on atmospheric circulation patterns.
- Explore the sensitivity of planetary-wave propagation and of large-scale circulation processes, such as the Brewer Dobson circulation, to solar variability.
- Develop and apply statistical procedures to climate data in order to quantify solar-variability signals on various time scales, tying these signals to radiative, chemical or dynamical processes.
- Determine what regional climate variability is systematically influenced by solar variability.
- Develop an assimilation of meteorological data from the troposphere up to the lower thermosphere to identify the impact of solar variations.
- Investigate the sensitivity of inter-hemispheric coupling to wave activity variations induced by solar variability.
- Evaluate the spectral detail necessary for proper treatment of the radiative and photochemical response to solar spectral variability.
- Identify the dominant processes by which galactic cosmic rays can influence climate, including impacts on cloud condensation nuclei and thus cloud cover and cloud radiative forcing as well as impacts on the global atmospheric electric circuit.
- Assess the influence of climate change on any of the above.

Note that this theme is not soliciting proposals for the development of solar irradiance proxies, unless they are specifically focused on improving the treatment of atmospheric coupling.

Furthermore, this theme does not address day-to-day weather variability, unless it is connected to longer-term changes in tropospheric and stratospheric climate.

1.3 Cross-Discipline Infrastructure Building Programs

One of the major challenges facing the LWS Program is the development of a research community that can cross traditional discipline boundaries and attack the system-wide problems that are central to understanding and modeling the Sun-Solar System connection. In order to address this challenge, proposals to this LWS TR&T program may include one or more of the following infrastructure-building elements: cross-disciplinary workshops, summer schools, and postdoctoral fellowships programs. Most of these activities will be supported through formal proposals to the TR&T program as part of the regular proposal cycle. In all cases, two extra pages will be allowed to the page limit for the science/technical/management section of the proposal (see Section 3 below) for each of these activities.

(a) Support of LWS Workshops/Campaigns: Given the goals of the Infrastructure Building Program, there are several guidelines that successful requests for workshop/ campaign support must satisfy:

- The workshop must address a science or technology topic that is both timely and important to the goals of the LWS program.
- Workshops must focus on comparing and validating tools that have already been developed. Examples of possible workshops include 1) predicting all clear forecasting, 2) comparison of helioseismic techniques, and 3) velocity estimation methods.
- Other workshop topics must be cross-disciplinary in nature and bring together researchers from different disciplines encompassed by the LWS program.
- Although there are no restrictions as to where the workshop will be held, preference should be given to locations that are convenient and cost-effective for LWS researchers and students.
- Workshops that encourage the training of new researchers in LWS system science are strongly encouraged.
- Workshops that leverage funding from other institutions and agencies are strongly encouraged.

(b) Support of LWS Summer Schools for early career scientists: The details of the summer school (e.g., format, location, duration, etc.) are left to the proposer to define. However, proposals should provide convincing evidence concerning the breadth of the topics to be considered, the means to be taken to assure participation by recognized research/ education authorities, and any institutional support that may be forthcoming.

(c) Management of Postdoctoral Fellowship Programs: The details of the fellowship program format are left to the proposer to define. The goals and objectives of the program, topic areas to be covered, and specific program details should be outlined by the proposer, providing evidence of past successes.

2. Programmatic Information

2.1 Types and duration of investigations

This program element contains two components described in section 1.2: (1) Focused Science Topics, and (2) Sun-Climate Theme. The maximum duration of these awards are 4 years, and 3 years, respectively. In addition there are Cross-Discipline Infrastructure Building Programs described in section 1.3. The duration of these awards are 1 to 5 years.

Read the preceding sections carefully; there are significant changes this year, especially as related to compliance. Proposals may be judged non-compliant and not be reviewed if certain criteria are not met. Highlights are listed below.

2.2 Evaluation Criteria

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance, and cost realism and reasonableness.

For Focus Science Topics (only) described in section 1.2.1, 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 non-compliant, and the proposal will not be reviewed. See section 1.2.1 for more details.

For the Sun-Climate Theme component, described in section 1.2.2, and the Cross-Discipline Infrastructure Building Program described in section 1.3, there are no additional the evaluation criteria, other than those given in the *NASA Guidebook for Proposers*.

3. Summary of Key Information

Expected annual program budget for new awards	~ $3 M/Yr
Number of new awards pending adequate proposals of merit	~ 25
Maximum duration of awards	Sun-Climate Theme: 3 years Focused Science Topics: 4 years Cross-Discipline Infrastructure: 1-5 years
Supplemental EPO Eligibility	Yes, for awards >1 year; see Appendices E.5 and E.6
Due date for Notice of Intent to propose (NOI)	**December 15, 2011**
Due date for proposals	**February 24, 2012**

Date for start of investigation	October 1, 2012 (Required).
Page limit for the central Science-Technical-Management section of proposal	15 pp; extra page permitted for proposals to be Team Leader of Focused Science see also Chapter 2 of the *2011 NASA Guidebook for Proposers*
File size limit for the proposal	10MB; this limit applies to the combined size of all PDF files that are uploaded for a single proposal.
Relevance	This program is relevant to the Heliophysics strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 and the references 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 *2011 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 *2011 NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal 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	NNH11ZDA001N-LWSTRT
NASA point of contact concerning this program	Dr. Madhulika Guhathakurta Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1992 E-mail: lws.trt@nasa.gov