NASA Living with a Star Program Analysis Group (LPAG)

Executive Committee (EC) Co-Chairs:
Anthea Coster (MIT Haystack Observatory)
Mark Linton (Naval Research Laboratory, NRL)
EC Members:
Joe Borovsky (Space Science Institute)
Richard Collins (University of Alaska)
Seebany Datta-Barua (Illinois Institute of Technology)
Matina Gkioulidou (JHU / APL)
Fan Guo (Los Alamos National Laboratory)
Jorg-Micha Jahn (Southwest Research Institute)
Enrico Landi (University of Michigan)
John Leibacher (National Solar Observatory)
Sabrina Savage (NASA / MSFC)
Brian Walsh (Boston University)

See website at
https://lwstrt.gsfc.nasa.gov/lpag

Living with a Star LPAG, continued

Liaison Members:
Charles N. Arge, *NASA GSFC*
Barbara Giles, *NASA GSFC*
Terry Onsager, *NOAA*
Vyacheslav Lukin, *NSF*
S. Irfan Azeem, *NSF*
Ghee Fry, *NASA MSFC*
Ekaterina M. Verner, *NASA HQ*
James Spann, *NASA MSFC*
Maria Kuznetsova, *NASA GSFC*
Simon Plunkett, *NASA HQ*

LWS Program Ex Officio:
Jeff Morrill, LWS Program Scientist (NASA HQ)
Janet Kozyra, LWS Science Lead (NASA HQ)
Shing Fung, LWS Website Manager (NASA GSFC)

2018 Charge from NASA Headquarters to LPAG Executive Committee

- Solicit community input for science topics; use this input to develop new Focused Science Topics (FSTs) for consideration by NASA for ROSES 2019 and beyond.
- Discuss the upcoming opportunity for Strategic Capabilities.
- Discuss methods for evaluating progress by FSTs in advancing LWS goals.

Development of LWS Focused Science Topics

- Solicited community input to TR&T science topics (5/7 – 7/2).
  46 distinct community inputs submitted.

- Four LPAG town halls held at conferences during summer of 2018:
  at TESS, SHINE, GEM, and CEDAR.

- July 2018: Executive Committee drafted 21 topic write-ups from these community inputs, as well as from previous, as-yet uncompeted TR&T topics, at first LPAG meeting

- Solicited community comment on these draft topics (9/7 – 10/19).

- October 2018: Executive Committee finalized 22 topic write-ups at second LPAG meeting (note - one topic was split into two).

Titles for 20 Focused Science Topics, Plus Two "Other" Topics

- Understanding the Impact of Thermospheric Structure and Dynamics on Orbital Drag
- Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere
- Pathways of Cold Plasma through the Magnetosphere
- Understanding the Variability of the ITM System Due to Tides, Planetary Waves, Gravity Waves, and Traveling Ionospheric Disturbances
- The Variable Radiation Environment in the Dynamical Solar and Heliospheric System
- The Origin and Consequences of Suprathermal Particles that Seed Solar Energetic Particles

Titles for 20 Focused Science Topics, Plus Two "Other" Topics

- Connecting Thermospheric Composition and Space Weather
- Understanding Ionospheric Conductivity and Its Variability
- Modeling and Validation of Ionospheric Irregularities and Scintillations
- Fast Reconnection Onset
- Extreme Solar Events – Probabilistic Forecasting and Physical Understanding
- Connecting Auroral Phenomena with Magnetospheric Phenomena

Titles for 20 Focused Science Topics, Plus Two "Other" Topics

- Understanding Space Weather Effects and Developing Mitigation Strategies for Human Deep Space Flight
- Solar Photospheric Magnetic Fields
- Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes
- Coupling of Solar Wind Plasma and Energy into the Geospace System
- Combining Models and Observations to Study CME Plasma Energetics in the Inner Corona

Titles for 20 Focused Science Topics, Plus Two "Other" Topics

- Atmospheric Evolution and Loss to Space in the Presence of a Star
- Sun-Climate: Long Term Variability and Predictability of the Solar-Driven Earth System
- Hemispherical Asymmetries in Magnetosphere-Ionosphere-Thermosphere Coupling Processes: Fundamental Causes and Myriad Manifestations
- Data Science and Analytics (Tools and Methods Topic)
- Correcting or Mitigating Artifacts in HMI Photospheric Magnetic Fields
  (likely outside scope of TR&T – possible HGI or Tools and Methods?)

Discussion of
LWS Strategic Science Areas:

Strategic Science Areas (SSAs) for LWS Targeted Research and Technology (TR&T) program articulated in the LWS Ten Year Vision from 2015:

Physics–Based Understanding to Enable Forecasting of
- **SSA-0:** Solar electromagnetic, energetic particle, and plasma outputs driving the solar system environment and inputs to Earth's atmosphere
- **SSA-1:** Geomagnetic Variability
- **SSA-2:** Satellite Drag
- **SSA-3:** Solar Energetic Particles
- **SSA-4:** Total Electron Content (TEC)
- **SSA-5:** Ionospheric Scintillation
- **SSA-6:** Radiation Environment

Discussion of Strategic Science Areas

Based on community input, two Focused Science Topics were drafted that highlighted a need for updates to the SSAs. Proposed updates are as follows:

For the FST “Understanding Space Weather Effects and Developing Mitigation Strategies for Human Deep Space Flight,” it is suggested that SSA-6 be updated to extend beyond low earth orbit:

- SSA-6, Physics-based Radiation Forecasting Capability for Spacecraft, Aviation, and Human Space Flight from the Near-Earth to the Deep Space Environment

For the FST “Atmospheric Evolution and Loss to Space in the Presence of a Star,” it is suggested that a new SSA be drafted. An initial version of this is available in the report as:

- A proposal for a new Strategic Science Area (SSA-7) for the Living With A Star Program - The Heliophysics of Planetary Habitability

Review: Strategic Capabilities

- Delivers a model that is essential for making progress toward the ultimate goal of forecasting and specifying the coupled Sun-Earth system.
- Model can serve as a prototype for operational capability; must use actual data as input and produce useful output.
- Delivers a tool with broad, cross-disciplinary science applicability.
- Project provides easy access to the model, either directly by the developers or through a modeling center such as the Community Coordinated Modeling Center (CCMC).
- Targets Strategic Science Areas (SSAs; see LWS 10-Year Vision, 2015)

Discussion of Upcoming Strategic Capability Opportunity

The consensus of the LPAG Executive Committee was that it would be beneficial for the Strategic Capability to be open to all topics relevant to LWS goals (as for the 2012 call), subject to the founding guidelines for the Strategic Capability program (see previous slide).

Other priorities supported by the LPAG EC discussion:

- Transition to CCMC: That the proposals include an explicit plan for transition of the proposed capability to the Community Coordinated Modeling Center (CCMC), with milestones along the way, and that communication with the CCMC be established early in the project.

- Model Compatibility: For cases where the project develops output of one model for input into another, that the proposal includes a plan to ensure that the output is compatible with the required input.

Discussion of Upcoming Strategic Capability Opportunity

Other priorities supported by the LPAG EC discussion, continued:

- Robustness: That plans be specified in the proposal to ensure a certain level of robustness for the capability to be produced, namely, that error analysis, metrics, validation and/or sensitivity analysis be included. In addition, that the use of data for validation be encouraged.

- User Utility: That the proposal makes the case that it will develop and transition capabilities that will be useful to prospective users, and that are not already in CCMC, or that could add to the CCMC capabilities for doing ensemble model simulations.

- Training: That the proposals make a case that the proposed team contributes to the training of the next generation of researchers and model developers.

- Timely modeling advances to consider: Transition from steady state to time dependent; Improvement of boundary conditions; Data driving or assimilation.

Metrics for Evaluating Progress Towards Achieving LWS-TR&T Goals

The LPAG discussed ways to evaluate the progress made by FSTs in addressing NASA Heliophysics and LWS goals.

In particular, the discussion focused on how the LPAG could use information from past and ongoing FSTs as input for new FSTs.

The discussion also focused on ways to enable the flow of information from one FST to the next, and to identify results from one FST that would enable progress in a following one.

This discussion is ongoing, and will be continued at next year's LPAG meetings.

Metrics for Evaluating Progress Towards Achieving LWS-TR&T Goals

Primary conclusion - strong benefit if FST team leads prepared final reports to be posted on the LWS TR&T website, including:

Extended summary

- What was accomplished by the FST, both by the individual proposal units, and by the team as a whole? What scientific capabilities were added or improved?
- What are the next steps for this topic? What challenges and open questions arose which could not be addressed by this FST, and which would therefore be good challenges for future FSTs? What are the remaining gaps that need to be filled?
- What synergies emerged from the team dynamic?

Brief summary (~ 1 page) with bulletized lists of:

- Research highlights
- Remaining challenges and open questions
- Team dynamics

Possible Discussion Topics for 2019 LPAG:

- Revisit and review topic write-ups from 2016 and 2018 reports which have not yet been selected by NASA.
- Solicit community input on these remaining topics, as well as input for possible new topics.
- Revisit SSAs 0-6, and possible new SSA 7. Solicit community input on these SSAs.
- Continue discussion of metrics for evaluating progress towards achieving LWS-TR&T goals

Background Slides

2016 TR&T Committee Report: Focused Science Topics

- Mid-latitude and Equatorial Dynamics of the Ionosphere-Thermosphere System **(ROSES 2018)**
- Origins, Acceleration and Evolution of the Solar Wind **(ROSES 2018)**
- Ion Circulation and Effects on the Magnetosphere and Magnetosphere - Ionosphere Coupling **(ROSES 2017)**
- Toward a Systems Approach to Energetic Particle Acceleration and Transport on the Sun and in the Heliosphere **(ROSES 2017)**
- Coupling Between Different Plasma Populations by Means of Waves

2016 TSC Report: Focused Science Topics

- Probabilistic Forecasting and Physical Understanding of Extreme Events
- Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System During Extreme Events **(ROSES 2017)**
- Understanding the Impact of Thermospheric Structure and Dynamics on Orbital Drag
- Solar Magnetic Inputs to Coronal and Heliospheric Models
- Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures **(ROSES 2018)**

2016 TSC Report: Focused Science Topics

- Heliospheric and Magnetospheric Energetic Precipitation to the Atmosphere and Its Consequences
- Understanding The Onset of Major Solar Eruptions **(ROSES 2017)**
- Understanding Ionosphere-Thermosphere (IT) responses to high-latitude processes and Magnetospheric energy input
- Enabling Geospace System Science Through Imaging and Distributed Arrays
- Understanding Global-scale Solar Processes and their Implications for the Solar Interior **(ROSES 2018)**