LIVING WITH A STAR – STEERING COMMITTEE 2014

LWS Steering Committee Members:

- Nathan Schwadron, UNH (Chair)
- Tony Mannucci, JPL (Co-Chair)
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- Amitava Bhattacharjee, Princeton
- Tamas Gombosi, UMichigan
- Nat Gopalswamy, NASA/GSFC
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- Jon Linker, PSI
- Peter Pilewiske, U. Colorado
- Antti Pulkkinen, NASA/GSFC
- Harlan Spence, UNH
- Kent Tobiska, Utah State University/SET
- Daniel Weimer, Virgina Tech
- Paul Withers, BU

Liaisons to TR&T SC:

- Mario Bisi, Rutherford Appleton Laboratory
- Masha Kuznetsova, CCMC
- Kent Miller, AFOSR
- Terese Morretto, NSF
- Terry Onsager, NOAA
- Ilia Roussev, NSF
- Rodney Vierick, NOAA

LWS Program Ex Officio:

- Madhulika Guhathakurta, NASA/HQ
- Bob Leamon, NASA/HQ

TASKS OF THE STEERING GROUP

- Provide a yearly report with new Focus Topics
- Provide a top-level 10 year vision for the LWS program

LWS COMMUNITY PRIORITIES

Enabling discovery (Chapter 1) & Addressing Societal Needs (Chapter 3)

- LWS is central to the decadal survey's strategy: achieve scientific results that will be useful to society

"Given adequate resources, the research community should be able to leverage advances in computing capability to develop the predictive models required to specify the extended space environment in order to protect society and advance growing aspirations for the use of space."

"Solar and Space Physics: A Science *for* a Technological Society"

WHAT ARE WE TRYING TO ACHIEVE?

Examples of Long-term Strategic Science Areas

- **Physics-based Geomagnetic Forecasting Capability**

  Enable1-3 day (long lead-time) and 15-30 min (short lead-time) predictions of pending extreme fluctuations in geomagnetic field

- **Physics-based Satellite Drag Forecasting Capability**

  Enable specification of the global neutral density in the thermosphere and its variations over time

- **Physics-based Solar Energetic Particle Forecasting Capability**

  Probabilistic prediction of the intensity of SEP events, and increased time periods for all-clear forecasting capability with higher confidence level

- **Physics-based TEC Forecasting Capability**

  Enable specification of the global ion density in the ionosphere and plasmasphere and its variations over time under varying geomagnetic conditions, with variable lead times (~1 hour or ~1-3 days)

- **Physics-based Scintillation Forecasting Capability**

  Enable prediction of scintillation occurrence utilizing limited sources of available data and ascertain how radio signals are degraded by ionospheric irregularities

- **Physics-based Radiation Environment Forecasting Capability**

  Enable predictive capability for the radiation environment and its effective dose as well as dose rates based on GCR, SEP, cutoff rigidity, atmosphere density, and gamma-ray/X-ray inpu

Clarification: Strategic Science Areas versus Focused Science Topics

- Strategic Science Areas have a direct connection to the user community
- SSAs are longer-term goal within which several Focused Science Topics are applicable
- Focused Science Topics improve scientific understanding of key areas that are relevant to predictability

WHERE IS THE MISSING PHYSICS (1/2)

- Interdisciplinary areas with varying levels of model & physics development
- "Missing physics" can be a major factor limiting predictive accuracy

  Example: Solar Energetic Particles

  - Incorporation of Plasma Environment
    - Realistic Corona
    - CMEs
    - Solar Wind
  - Seed populations
  - Ambient Waves and Self-Generated Waves

→ Realization of global models through inner heliosphere with predictive capability

WHERE IS THE MISSING PHYSICS (2/2)

- Example: Thermosphere & Ionosphere
  - Ion-neutral coupling between ionosphere and thermosphere
  - Magnetosphere-ionosphere coupling
  - Ability to predict disturbances in solar wind
  - Coupling across scales
    - Magnetospheric drivers
    - Lower atmosphere drivers (small scale gravity waves * planetary waves)

→ *Realization of global models with physical couplings and predictive capability*

HOW DO WE FILL IN THE PHYSICS TO DEVELOP PREDICTABILITY?

- Chicken and egg problem
  - Need to develop initial models and validation to know what you don't know
  - Need to incorporate the physics in models
- Validation is absolutely essential
- In all areas, we need to go deeper into the physics to achieve predictability
- We need to validate multiple physical processes simultaneously
- The physics crosses the boundaries we arbitrarily define
  - Requires an interdisciplinary approach!
- Remain focused on the LWS goals
  - Architecture of LWS critical
  - *Structure of LWS has served us well over the last decade → build on the foundations of LWS*

HOW DO WE DEVELOP THE LWS ARCHITECTURE?

- LWS MOWG has been essential over the last decade
- Foundation of the LWS Program: Targeted science topics and strategic capabilities (models)
  - LWS Architecture Report led by Glenn Mason
  - Initial LWS Science TR&T Definition led by Gosling
  - LWS Project Office
- Next step in LWS Architecture under formulation by Steering Committee
- Focus on Strategic Science Areas with Goal of Enabling Predictability

INTERACTION WITH USER COMMUNITIES

- FST, SC and TST teams partner with members of key space weather centers (e.g., CCMC, NASA/SRAG, and NOAA/SWPC)
  - facilitate better interaction with user communities
  - deliverables that best serve user needs
- Upon team selection, NASA/HQ will contact relevant modeling centers to identify liaisons to appropriate user communities.
- CCMC could play major role
  - Testing and validation experience
  - Cultivating end-to-end models

EXAMPLES OF FST TOPICS IN 2013 REPORT

- Physics-based Predictive Capability Development for Geomagnetically Induced Current (GIC) Events
- Physics-based predictive capability development for changes in the composition of the thermosphere during extreme events
- Physics-based Predictive Capabilities for Solar Eruptions
- Physics-based methods to predict connectivity of SEP sources to points in the inner heliosphere, tested by location, timing, and longitudinal separation of SEPs
- Ion-Neutral Interactions in the Topside Ionosphere
- Radio Scintillation Prediction in Mid-latitude Ionosphere
- Physics-based predictive capability development for the radiation environment from the lower atmosphere to beyond the upper atmosphere during quiet and storm conditions

TAKE AWAYS

- LWS Fundamentally Rooted in the Science and Goals Laid out by the SSP Decadal Survey
- LWS Architecture critical to achieving strategic goals
  - Complement HPS Roadmap and SSP Decadal Survey
  - Builds on LWS foundation created over last decade
- Strategic Science Areas
  - Long-term goals for predictive capability development
  - Increased awareness of user-community needs