NASA LWS Program and Research to Operations

Janet Kozyra (LWS Science Lead)
Jeff Morrill (LWS Program Scientist)
Elsayed Talaat (Chief Scientist)
Heliophysics Division, NASA HQ

SEESAW Workshop

5-8 September 2017
Some Heliophysics Division News

Steve Clarke on detail to OSTP as of end of July

New faces: Janet Kozyra (recently joined NASA from NSF) Jared Leisner (joined from NASA Planetary Science Div)

Seeking a Heliophysics Division Director – IPA Position

- NASA is looking for an experienced science leader to serve as Heliophysics Division Director under an Intergovernmental Personnel Act (IPA) appointment. You can find more information on this open position here: https://science.nasa.gov/about-us/job-opportunities.

- Response on or before October 13, 2017
Voyager 40th Anniversary
20 Aug 2017
40th Anniversary of Voyager
Smithsonian Air & Space Museum, Sept 5

What design strategies enabled Voyager to survive?
Three elements:

1) Learned from Pioneer about the severity of the space environment -> Added shielding & redesigned some components

2) Simpler design, 63kB memory, 1/240,000th of the computing power in your smartphone

3) Redundancy and automation:
   - “Two-string” redundancy for its critical systems
   - Voyager could sense the state that it was in, and turn something off if there was a problem.
   - Also one of 1st probes to have “back up” mission installed. Carried on even without ground commands.

William Shatner sent message to Voyager

We offer friendship across the stars. You are not alone. #MessageToVoyager

--Suzanne Dodd, project manager, Voyager
Moon's shadow moving across North America as seen by EPIC on DISCOVR.

Credit: NASA EPIC Team

Credits

Innermost image: NASA/SDO.
Ground-based eclipse image: Jay Pasachoff, Ron Dantowitz, Christian Lockwood and the Williams College Eclipse Expedition/NSF/National Geographic
Outer image: ESA/NASA/SDO
### HPD ROSES16 Status

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>STEP 1 PROPOSALS (Due Date)</th>
<th>STEP 2 PROPOSALS (Due Date)</th>
<th>AWARDS (Expected)</th>
<th>YEAR 1 ($M)</th>
<th>~ % Success Rate</th>
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<tbody>
<tr>
<td>B.2 H-SR</td>
<td>235</td>
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Success rate = \# proposals funded / \# STEP 2 proposals received
## DRIVE implemented in FY18 President’s Budget

<table>
<thead>
<tr>
<th>$M</th>
<th>FY16</th>
<th>FY17</th>
<th>FY18</th>
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+$41M +$24M
Living With A Star (LWS)

Objectives are to understand (and model):

• The variable sources of mass and energy from our Star
• The associated reactions of heliospheric and geospace regions and
• The implications for life and habitability at the Earth and beyond.

Elements:

• strategic missions
• targeted research
• technology development
• space environment testbed
• flight opportunity
• partnerships with other agencies/nations.
Largely line up with SWAP Benchmark topics. Synergisms expected in results:

1. Induced geo-electric fields
2. Ionizing radiation
3. Ionospheric disturbances
4. Solar radio bursts
5. Upper atmospheric expansion

SWAP Benchmark Steps:
1. Phase 1 benchmarks – close to completed
2. Assessment report of gaps submitted
3. Process for Phase 2 benchmarks – under discussion
LWS Focus Science Topics Related to Each Strategic Science Area (2004 - upcoming 2017)

- Solar Outputs
- 2017 LWS Institute
- 2016 LWS Institute
- 2015 LWS Institute
- GICs
- Satellite Drag
- SEPs
- Scintillations
- TEC
- Ionizing Radiation
- Sun/Climate

Number of Focus Science Topics

Strategic Science Area SSA

Solicited 2017
2004-2016

Note: Some FSTs fall under multiple SSAs. There are 4 separate FSTs in 2017.
A typical award may include:

- Two 5-day meetings for up to 15 team members including: travel, catering, meeting room and audiovisual costs (Please note that UCAR cannot support travel for federal employees).

- A ½ day team meeting at either AGU or AMS including meeting room rental and audiovisual.

- Teleconferencing using Go-to-Meeting or Ready Talk

- Publication costs

2015: Principles in relation to the effects of geomagnetically induced currents (GICs) during CME-driven geomagnetic disturbances (GMDs)

2016: Now-casts of atmospheric drag for LEO spacecraft

2017: Now-casts of radiation storms (proton events) at energy levels that could create a radiation hazard for aircrew and passengers

2017/18: Two new institutes will be solicited
ROSES – H-LWS 2016

- ROSES 2016 LWS FSTs developed incorporating inputs from previous Steering Committee reports and informed by SWAP science priorities.
- Proposals were due November 2016.
- A total of 63 Step-2 proposals were received by NSPIRES.
- Three FST Teams (20 proposals) were selected.
- Kickoff Workshop planned
  — All new FST teams will meet and develop comprehensive work plans for team member activities.
  — Goal is to have teams produce a clear set of targets and plan of action at the outset of the FST.
<table>
<thead>
<tr>
<th>PI/Institution</th>
<th>Investigation Title</th>
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<tr>
<td>DeForest/SWRI</td>
<td>FRAN: Fluxon Rapid Assimilative Nowcasting</td>
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<tr>
<td>Schuck/GSFC</td>
<td>Developing Vector Magnetic Maps from SDO/HMI that can Drive Space Weather Models</td>
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<tr>
<td>Leake/GSFC</td>
<td>Implementing and Evaluating a Vector-Magnetogram-Driven Magnetohydrodynamic Model of the Magnetic Field in the Low Solar Atmosphere</td>
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<td>Sokolov/U Mich.</td>
<td>Matching EUV observations to a flare model with self-consistent energy release</td>
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<tr>
<td>Gibson/UCAR</td>
<td>Plasmoid Instabilities and Supra-Arcade Downflows: Validating Theory and Simulation with Observations</td>
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<tr>
<td>Warren/NRL</td>
<td>Data-driven Simulations of Active Region Evolution and CME Initiation-SOLR</td>
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<tr>
<td>Jackson/UCSD</td>
<td>Dynamics of solar flares: synthesis of NASA space data with microwave imaging spectroscopy from EOVSA</td>
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<tr>
<td>Gopalswamy/GSFC</td>
<td>The Global State of the Solar Atmosphere and Inner Heliosphere during Cycles 23 and 24</td>
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<td>Denton/SSI</td>
<td>Characterizing the Earth’s Radiation Environment: A Flux Model of the Inner Magnetosphere</td>
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<td>Tenishev/UMich</td>
<td>Effect of solar variability on the geospace radiation environment</td>
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<td>Tobiska/SET</td>
<td>RADiation environment using ARMAS data in the NAIRAS model (RADIUS)</td>
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<tr>
<td>Ukhorskiy/JHU APL</td>
<td>Data-constrained predictive model of radiation belt dynamics</td>
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<td>Glocer/GSFC</td>
<td>Predicting radiation variability in Earth’s magnetosphere</td>
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<td>Elkington/LASP, CU</td>
<td>Effects of advective and diffuse transport of trapped energetic particles in radiation belt models</td>
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<td>Understanding the Impacts of Dynamic Drivers on Global Storm-time Ionosphere-Thermosphere (IT) System</td>
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<td>Lu/UCAR</td>
<td>Global Ionospheric Electrodynamics and Its Influence on the Thermosphere</td>
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<td>Fang/UCO</td>
<td>Quantifying the variability of equatorial electrodynamics during disturbed geomagnetic conditions using first-principle models</td>
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<tr>
<td>Raeder/UNH</td>
<td>Storm Enhanced Density, Tongues of Ionization, and Sub Auroral Polarization Streams</td>
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<tr>
<td>Sazykin/UT Dallas</td>
<td>Ionospheric Storm-Time Electrodynamics: Coupling Across Latitudes and Magnetospheric Imprint</td>
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<tr>
<td>CROWLEY/ASTRA</td>
<td>Ionospheric Electrodynamics – A Quantitative Characterization</td>
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</tbody>
</table>
FST Development and Selection Process (ROSES 2017)

Community Input → LWS Steering Committee → Heliophysics Advisory Committee → NASA HPD → Selected 4 FSTs

60 inputs → 15 FSTs → Ranked FST List

Past FSTs (5-6 years)

1) Understanding The Onset of Major Solar Eruptions
2) Toward a Systems Approach to Energetic Particle Acceleration and Transport on the Sun and in the Heliosphere
3) Ion Circulation and Effects on the Magnetosphere and MI-Coupling
4) Understanding Physical Processes in the Magnetosphere & Ionosphere Thermosphere / Mesosphere System During Extreme Events
ROSES 2017 LWS Step-1 and Step-2 submissions delayed until after the ROSES 2016 selections.
— Delay in part due to delay in announcement of NASA budget.

Revised ROSES 2017 LWS Amendment to be announced shortly. Four chosen FST topics not altered. Changes:
— Location of the “Relevance Discussion” & it’s evaluation
— Clarification of the data usage for LWS FST studies.

Target dates
— Step-1 late September/early October
— Step-2 late November/early December

Should still be able to access any previous STEP-1 work done on the NSPIRES web site.
LWS Steering Committee reconstituted as the LWS Analysis Group (LPAG).

- Interdisciplinary forum for soliciting & coordinating community input in support of LWS objectives
- Two LPAG Co-Chairs and an LPAG Executive Committee (EC) – organize meetings, collect & summarize community input, prepare reports to HPD Director
- The full LPAG consists of all members of the community who participate in the open meetings.
- NSF, NOAA ex officio members; adding DOD
- DCL soliciting candidates for the LPAG will be out shortly

Core LWS Science activities continue:

- ROSES – 2017, … LWS FST calls
- ROSES – 201X LWS Strategic Capabilities (with NSF)

Partnerships:

- Joint NSF-NASA – Computational Aspects of Space Weather
- Space weather focused aspects of Heliophysics Science Centers

Seeking to enable Space Weather-oriented opportunities:

- R2O & O2R tools, SBIR’s, Space Weather-oriented tech development
**R2O Concept of Operations**

**Fundamental Research**
- Targeted Modeling Research and Development
  - LWS Focus Science Teams
  - LWS Strategic Capabilities

**Policy Frameworks**
- NSF-NASA MOU
- NOAA-NASA MOU

**Operational Models**
- CCMC
- SWPC (& 557th Weather Wing)

**International Contributions/Partnerships**
- Access to best models, implements int’l metrics, leverages expertise & access to information, rapid implementation & testing, access portal to simulation results & observations
- RFI closed 9/5 ~20+ responses
- Planned start FY18

**Recent Collaborations**
- Most recently Europe (L5), Japan (NGSPM), Korea (SW model, rocket), India (L1, SW modeling)

**Major Initiatives**
- NSF-NASA “Computational Aspects of Space Weather”
  - 3-Year Grants (FY18-20)
  - ~$2M/YR from LWS Science

- Tri-agency O2R pilot in development
  - Approved 18 May

- NSF-NASA - "Computational Aspects of Space Weather"
  - 3-Year Grants (FY18-20)
  - ~$2M/YR from LWS Science

- Planned start FY18

- Joint R2O modeling. Approved 18 May

- Final language under review.
Thank you.
**L5 Mission - Europe**

**PARKING SPACE-WEATHER PROBES**
The European Space Agency hopes to place its new probe at the gravitationally stable Lagrange point 5 (L5), where it will have a different view of the Sun compared with probes at the more populated spot, L1.

A probe at L5 can see the surface region of the Sun that will spin to face Earth in 4-5 days.

**Next Generation Solar Physics Mission (NGSPM)**
- Agreement among NASA, JAXA and ESA for the study of a possible multilateral solar physics mission concept.

**Aditya - L1 First Indian mission to study the Sun**
- launch during 2019 – 2020 timeframe
- 6 experiments
- observations of Sun's Photosphere (soft and hard X-ray), Chromosphere (UV) and corona (Visible and NIR). In addition, particle payloads will study the particle flux emanating from the Sun and reaching the L1 orbit, and the magnetometer payload will measure the variation in magnetic field strength at the halo orbit around L1.
NASA-NSF Partnership for Collaborative Space Weather Modeling

**Solar Interior**
- Magnetohydrodynamics (MHD)
- Emerging magnetic flux
- Subsurface flow maps
- Far-side imaging (helioseismology)
- Magnetic flux transport

**Photosphere & Chromosphere**
- Magnetic field
- Solar energetic particles (SEPs)
- Flares/coronal mass ejections (CMEs)
- Coronal holes/solar wind
- Radio bursts
- X-ray/extreme ultraviolet emissions

**Heliosphere**
- Interplanetary magnetic field (IMF)
- Solar wind
- Shocks/SEPs
- CMEs

**Magnetosphere**
- IMF
- Magnetic storms/substorms
- Auroral zones/ring currents
- Polar cap potential
- Radiation belts
- South Atlantic Anomaly

**Thermosphere & Ionosphere**
- Plasma bubbles/equatorial anomalies
- Scintillation/density fluctuation
- Neutral winds
- Traveling ionospheric disturbances
- Ultraviolet heating
- Ion chemistry
- Bulk ionosphere

Integrated Global-Sun Model of Magnetic Flux Emergence and Transport
- Nagi N. Mansour
  NASA Ames Research Center

The Coronal Global Evolutionary Model (CGEM)
- George Fisher
  University of California Berkeley

A Modular Capability for Community Modeling of Flares, CMEs and Their Interplanetary Impacts
- Spiro Antiochos
  NASA Goddard Space Flight Center

Integrated Real-Time Modeling System for Heliospheric Space Weather Forecasting
- Dusan Odstrcil
  NASA Goddard Space Flight Center

Corona-Solar Wind Energetic Particle Acceleration (C-SWEPA) Modules
- Nathan Schwandron
  University of New Hampshire

Integration of Extended MHD and Kinetic Effects in Global Magnetosphere Models
- Amitava Bhattacharjee
  Princeton University

Medium Range Thermosphere Ionosphere Storm Forecasts
- Anthony Mannucci
  Jet Propulsion Laboratory

A First-Principles-Based Data Assimilation System for the Global Ionosphere-Thermosphere-Electrodynamics
- Robert Schunk
  Utah State University
On May 31, the Solar Probe Plus was renamed the Parker Solar Probe in honor of the discovery of the solar wind by Eugene Parker. During the ceremony he received the NASA Distinguished Public Service Award.