Living With a Star
Architecture Committee


California Institute of Technology, University of Colorado, Southwest Research Institute, Ball Aerospace, Johns Hopkins Applied Physics Laboratory, University of Michigan, Goddard Space Flight Center
LWS Objectives

• Understand how the Sun varies and what drives solar variability
• Understand how the Earth and planetary systems respond to dynamic external and internal drivers
• Understand how and in what ways dynamic space environments affect human and robotic exploration activities
HQ is re-evaluating the LWS mission line

Current missions
• Solar Dynamics Observatory
• Space Environment Testbed
• Parker Solar Probe
• Solar Orbiter Collaboration

Upcoming missions
• Heliophysics Environmental & Radiation Measurement Experiment Suite (HERMES)
• Geospace Dynamics Coupling (GDC)
LWS Architecture Committee

- HPD formed a 10-member committee to:
  - assess the current state of the mission aspect of the LWS program
  - propose a future LWS program mission architecture
  - not reviewing the TR&T program
- Scheduled time with JHUAPL and GSFC to perform a few mission concept studies
Strategic Science Areas (SSAs)

I. Origins and Variability of Global Solar Processes
II. Solar Eruptive and Transient Heliospheric Phenomena
III. Acceleration and Transport of Energetic Particles in the Heliosphere
IV. Variability of the Geomagnetic Environment
V. Dynamics of the Global Ionosphere and Plasmasphere
VI. Ionospheric Irregularities
VII. Composition and Energetics of the Neutral Upper Atmosphere
VIII. Radiation and Particle Environment from Near Earth to Deep Space
IX. Solar Impacts on Climate
X. Stellar Impacts on Planetary Habitability

• https://lwstrt.gsfc.nasa.gov/strategic-science-areas-ssas
Focused Mission Topics (FMTs)

Process

• Examine the SSAs and formulate related Science Objectives
• Identify the Phenomena to be examined
• Determine the Physical Quantities to be measured
• Suggest Sample Implementations
• Identify needed Technological/Modeling Development

FMTs

• Combined set of science objectives (*LWS, not STP*)
• Implementation strategies
Activities

Community input
- Aug-Sep 2021, web form on SSA-related Science Objectives
  - Measurement strategy, physical parameters, required measurements, envisioned implementation
- LWS Townhall, Jan 2022
  - Update
  - Feedback at event and via email

Formulated 12 FMTs
- NASA/GSFC MDL has studied 4
- APL ACE has studied 2 and orbits for 1
- 2 based on HMCS studies
- 3 described as best we could
- Not prioritized, but identified synergies between FMTs and existing/future missions
<table>
<thead>
<tr>
<th>FMT</th>
<th>Study Name</th>
<th>Generic Name</th>
<th>Center</th>
<th>Primary Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SELOS</td>
<td>Sun Earth Observing System</td>
<td>MDL</td>
<td>Solar-Heliospheric</td>
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<tr>
<td>2</td>
<td>HELIX</td>
<td>Inner Heliospheric Constellation</td>
<td>ACE Lab</td>
<td>Solar-Heliospheric</td>
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<td>3</td>
<td>4pi</td>
<td>3D Sun &amp; Heliosphere</td>
<td>HMCS-based</td>
<td>Solar-Heliospheric</td>
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<tr>
<td>4</td>
<td>GOS</td>
<td>Plasma Irregularity</td>
<td>MDL</td>
<td>Geospace</td>
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<tr>
<td>5</td>
<td>MagCon</td>
<td>Multipoint magnetosphere</td>
<td>HMCS-based</td>
<td>Geospace</td>
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<tr>
<td>6</td>
<td>WEBER</td>
<td>Magnetospheric imaging</td>
<td>MDL</td>
<td>Geospace</td>
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<tr>
<td>7</td>
<td>MAVRIC-D</td>
<td>Thermospheric density and composition</td>
<td>MDL</td>
<td>Geospace</td>
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<tr>
<td>8</td>
<td>Plasmasphere</td>
<td>Plasmasphere</td>
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<td>Geospace</td>
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<tr>
<td>9</td>
<td>CREO</td>
<td>Inner magnetosphere &amp; Radiation Belts</td>
<td>ACE Lab</td>
<td>Geospace</td>
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<td>SICLEx</td>
<td>Space Climate</td>
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<td>Solar-Geospace-Earth</td>
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<td>11</td>
<td>Earth-as-Exo</td>
<td>Earth-as-ExoPlanet</td>
<td>---</td>
<td>Geospace-Astrophysics</td>
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<tr>
<td>12</td>
<td>PeriGeospace</td>
<td>PeriGeospace Observing System</td>
<td>ACE-orbit</td>
<td>Solar-Heliospheric-Geospace</td>
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</tbody>
</table>
Solar-Heliospheric FMTs
Combination FMTs
Mapping FMTs to SSAs

- Every FMT connects to at least one SSA
  - Typically there are multitude of connections (primary/secondary)
- Every science objective of SSA has an FMT addressing it
Mapping FMTs to SSAs

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### SSA: Origins and Variability of Global Solar Roentgen Emissions

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### SSA: Dynamics of the Global Ionosphere and Thermosphere

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### SSA: Solar and Magnetic Impacts on the Electric Ionosphere

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### SSA: Solar Variability of the Geoelectric/Geomagnetic Phenomena

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**Mapping FMTs to SSA**

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### SSA - Origins and Variability of Global Solar Processes

<table>
<thead>
<tr>
<th>SSA-I: Origins and Variability of Global Solar Processes</th>
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<tbody>
<tr>
<td><strong>Science Objective</strong></td>
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<tr>
<td>Determine the characteristics of convective flows and meridional circulation at all latitudes and depths down to the tachocline, the location and strength of the toroidal magnetic flux belts, and characterize the strength, structure, and evolution of the solar fields to enable predictive models of solar cycle magnitudes and phases.</td>
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<tr>
<th>SSA-II: Dynamics of the Global Magnetic Phenomena</th>
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<tbody>
<tr>
<td><strong>Science Objective</strong></td>
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<tr>
<td>Determine the signatures of imminent active region emergence in surface and sub-surface flow and magnetic field structures. Understand the origin of active region formation in terms of sub-surface flows as a function of depth. Determine the global coronal connectivity of active regions and the mechanisms that lead to their eventual decay.</td>
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<tr>
<th>SSA-III: Variability of the Solar Geophysical Environment</th>
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<td><strong>Science Objective</strong></td>
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<td>Determine how chromospheric and coronal magnetic field dynamics and energy inputs from the convection zone/photosphere create solar variability.</td>
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**What is the solar wind and/or magnetopause in formation needed to develop (basis of model) magnetic reconnection models? What is the impact of substorms on the ICME?**

**What solar wind, magnetosphere/ionosphere processes and variables (e.g., low-latitude solar wind) are most relevant to the solar wind/magnetosphere?**

**How does the variability of the solar-wind magnetosphere change over different solar cycles?**

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**How do solar-wind/magnetosphere processes and variables (e.g., low-latitude solar wind) affect the solar-wind magnetosphere?**

**How does the variability of the solar-wind magnetosphere change over different solar cycles?**

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Additional Comments

- Many of the FMTs have ‘augmentations’ to allow more science coverage
- To realize maximum science return
  - Need support for data analysis and modeling
- Did not address ground-based assets
- Technology developments identified
  - Constellations, Data downlink, Onboard processing, Smallsat/Cubesat capabilities
- Not full concept studies (trade study level)
Report Status

• Draft being assembled this week (and last)
• Revision by committee next week (May 9-13)
• Review by external committee (May 14-25)
• Final revision by committee (May 26-31)
• Submission to NASA (May 31)