NASA’s STEREO Mission
(Solar TErrestrial Relations Observatory)

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Outline

• Intro to STEREO
  – Orbit
  – Goals
  – Instruments

• Operational
  – Beacon mode status

• Recent results
  – Far Side Observations
  – Multi-spacecraft CME analysis
STEREO A & B orbits

Video at http://svs.gsfc.nasa.gov/vis/a010000/a010700/a010718/index.html
Goals

• Understand the causes and mechanisms of CME initiation
• Characterize the propagation of CMEs through the heliosphere
• Discover the mechanisms and sites of energetic particle acceleration in the low corona and the interplanetary medium
• Develop a 3D, time-dependent model of the magnetic topology, temperature, density, and velocity structure of the ambient solar wind
Scientific Instruments

- S/WAVES - broad frequency response radio detection of Type II, III bursts
- PLASTIC – solar wind plasma and suprathermal ion composition measurements
- IMPACT – energetic electrons and ions, magnetic field
- SECCHI - EUV, coronagraphs and heliospheric imagers (surface to 1.5 AU)
Two Data Streams

• Full Science Data – full resolution science data downloaded via Deep Space Network about 2 days after observations.

• Real Time Space Weather Beacon Data - low data rate, for Space Weather prediction. In partnership with NOAA SWPC.
Beacon Data Products

- SECCHI images reduced to 256 x 256 pixels and highly compressed
- Subsampled solar wind and energetic particle data (PLASTIC, IMPACT)
- Subsampled RF data from S/WAVES

http://stereo.gsfc.nasa.gov/beacon/
Beacon Higher Level Data Products

- Full Sun maps (STEREO+ SDO)

- J-Maps
Beacon Mode

Beacon mode

• Low rate (currently 633 bps). Will soon be switching to more efficient encoding method that will allow us to continue with current data rate for rest of the mission

• Informal antenna partners
  – Arranged in partnership with NOAA SWPC
  – Currently: Bochum and Kiel, Germany (radio amateurs), Toulouse, France (CNES), Koganei, Japan (NIISC)
Need more beacon stations in Americas, Pacific, Asia

Need 10 meter or larger antennas – X band
Uses in SWPC Forecasting

• **Active Regions**: provides view of far side of Sun & active region evolution there.

• **CMEs**: STEREO & SOHO used to determine velocity, direction, and width of CMEs used as input to the Enlil model.

• **CIRs**: STEREO-B used to provide warning on high speed streams from coronal holes.

• **SEPs**: situational awareness of energetic particles.

• **Future Missions**: STEREO test bed for what capabilities would be most useful in future heliospheric space weather spacecraft.
Enlil model run for Aug. 1, 2010 CME
Lagrange Points – Monitor at L5?
Full Solar System Space Weather

April 29, 2011
Far-side of the Sun

[Image of the Sun's far-side]

304 Å, STEREO A & B SECCHI/EUVI

Comparison & Calibration of Far-side Images

STEREO A & B SECCHI/EUVI

Reconstruction using SDO/HMI and GONG

Video at http://svs.gsfc.nasa.gov/vis/a010000/a010700/a010718/index.html
April 3, 2010 CME

Ying Liu, SSL, UC Berkeley
Modeling the April 2010 CME

Shock Fronts and Solar Energetic Particles

Rouillard et al. (2011)
The April 3, 2010 CME: Shock and SEPs

Rouillard et al. (2011)
The April 3, 2010 CME: Magnetic Field

SEPs over large longitude ranges

August 18, 2010 multispacecraft SEP event
Aug 1 – 20, 2010

## DSN Nominal Telemetry Rates for Full Resolution Data

<table>
<thead>
<tr>
<th>Telemetry (kps)</th>
<th>STEREO A Start Date</th>
<th>STEREO B Start Date</th>
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<tr>
<td>720</td>
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<td>2007/01/22</td>
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<td>120</td>
<td>2012/11/04</td>
<td>2013/05/03</td>
</tr>
</tbody>
</table>

+ Higher rate passes with 70 meter stations as available