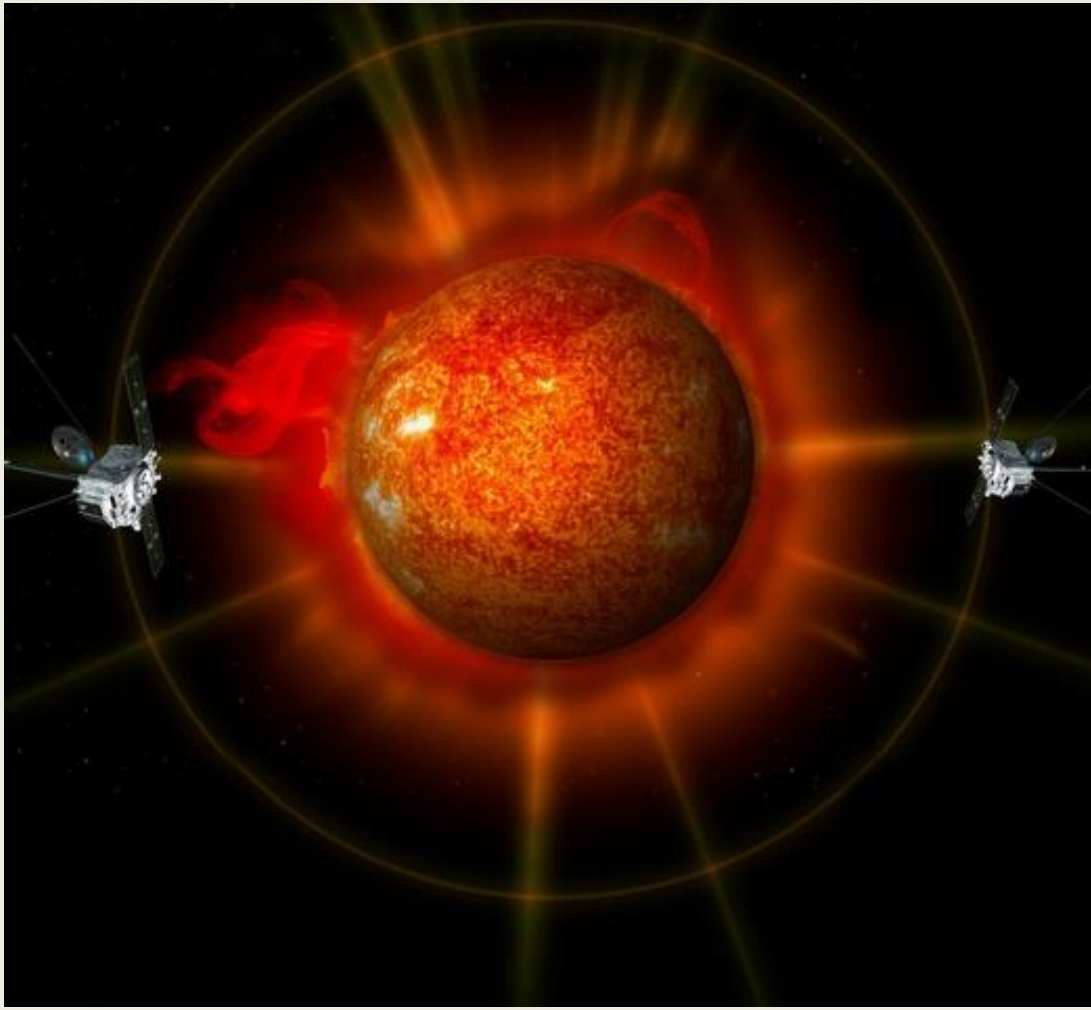
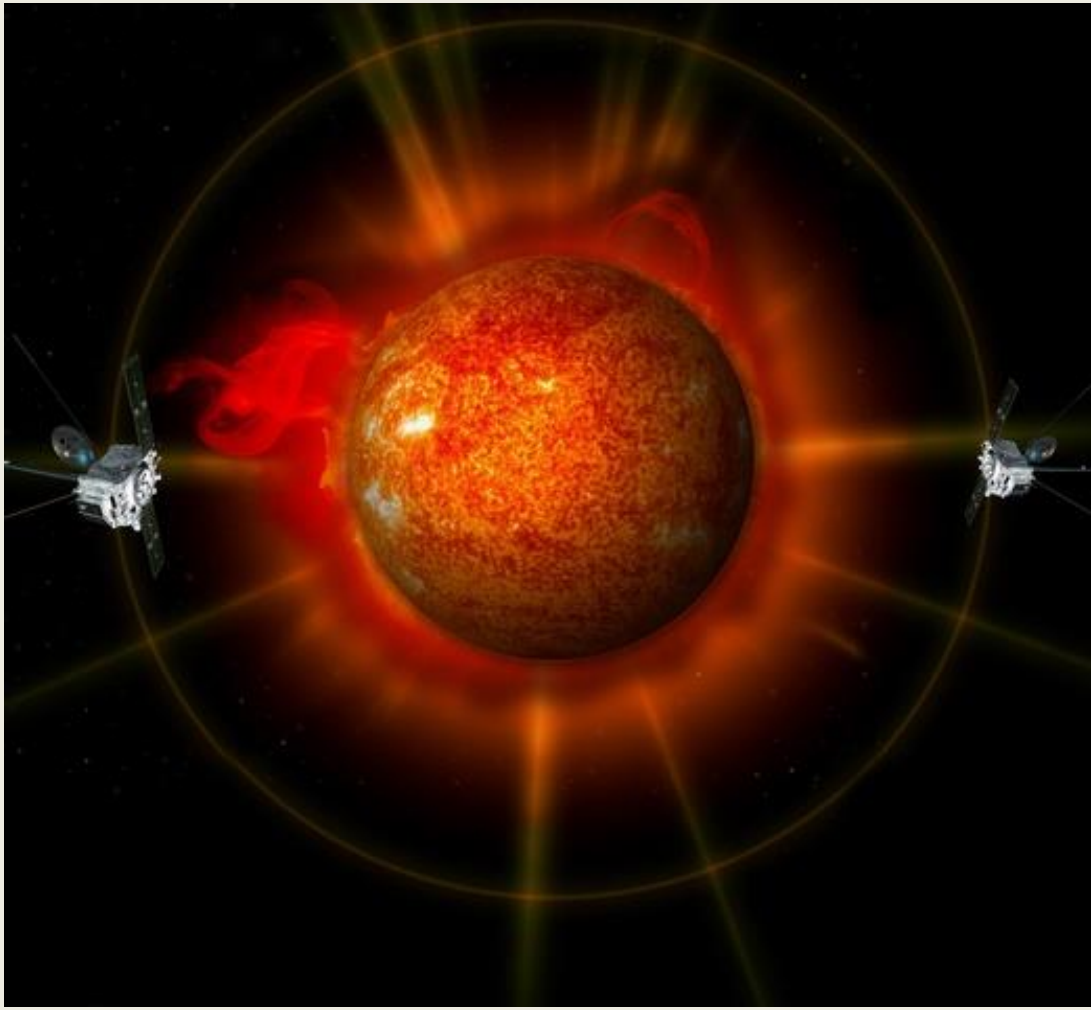
NASA's STEREO Mission
(Solar TErrestrial Relations Observatory)

T.A. Kucera,
W. T. Thompson, J.B. Gurman
NASA Goddard Space Flight Center

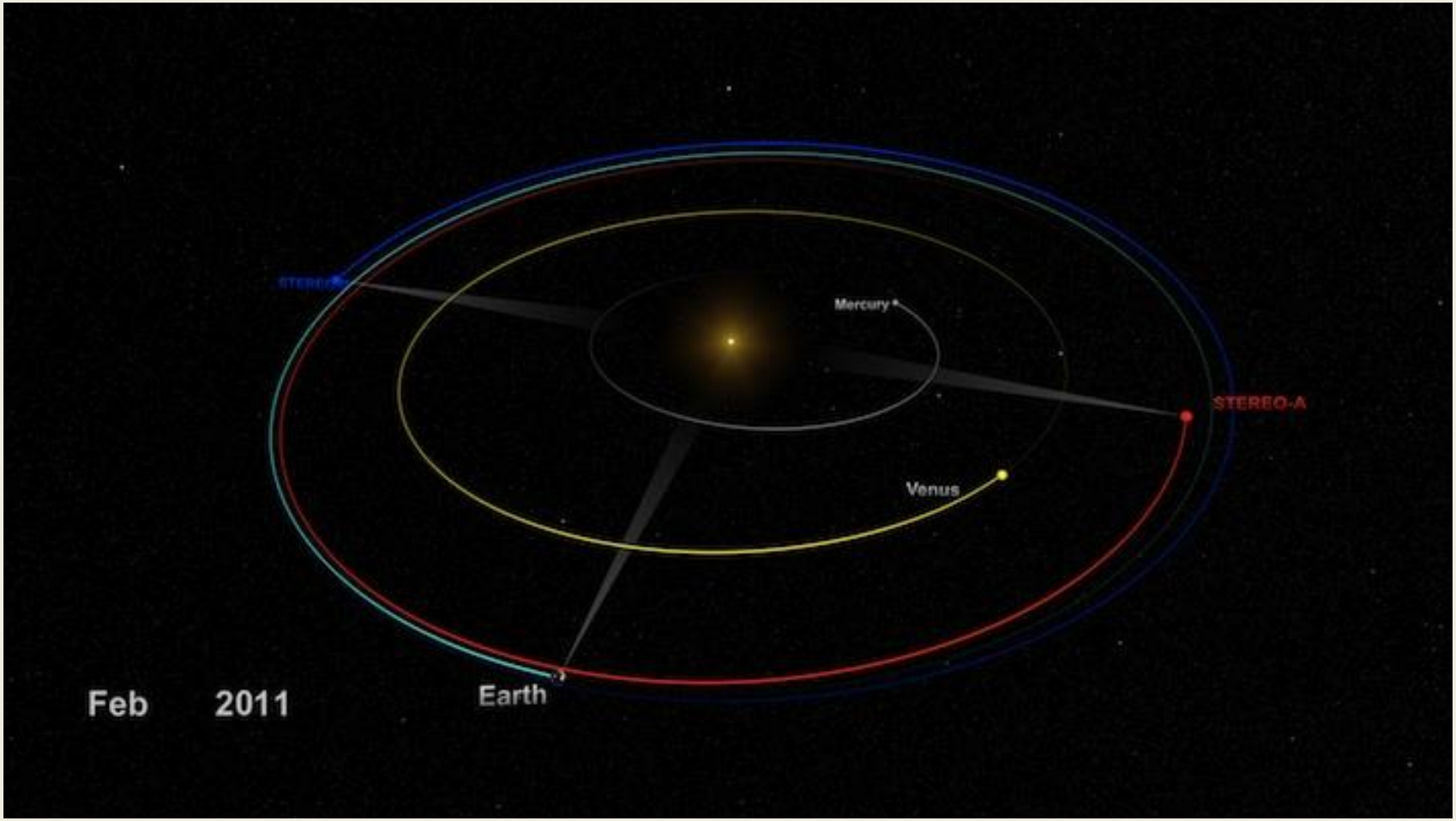


Outline

- 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

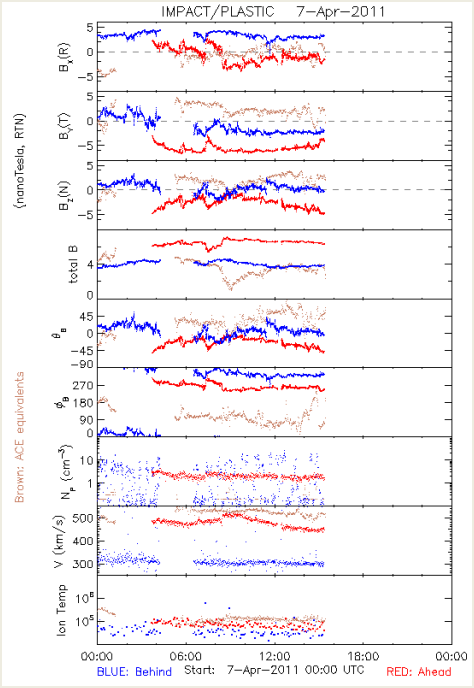
- S/WAVES - broad frequency response radio detection of Type II, III bursts
- PLASTIC – solar wind plasma and suprathermal ion composition measurements
- IMPACT – energetic electrons and ions, magnetic field
- SECCHI - EUV, coronagraphs and heliospheric imagers (surface to 1.5 AU)

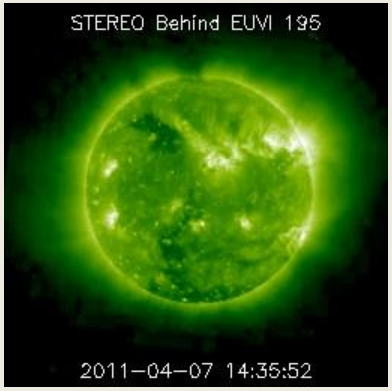
Two Data Streams

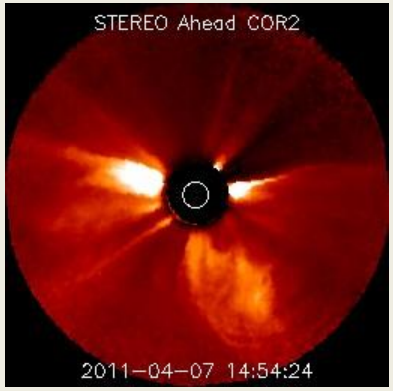
- Full Science Data – full resolution science data downloaded via Deep Space Network about 2 days after observations.
- Real Time Space Weather Beacon Data - low data rate, for Space Weather prediction. In partnership with NOAA SWPC.

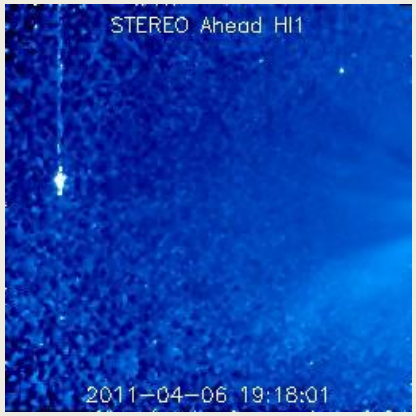
Beacon Data Products

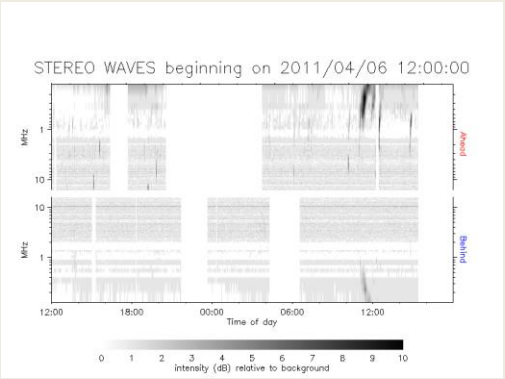
- SECCHI images reduced to 256 x 256 pixels and highly compressed
- Subsampled solar wind and energetic particle data (PLASTIC, IMPACT)
- Subsampled RF data from S/WAVES







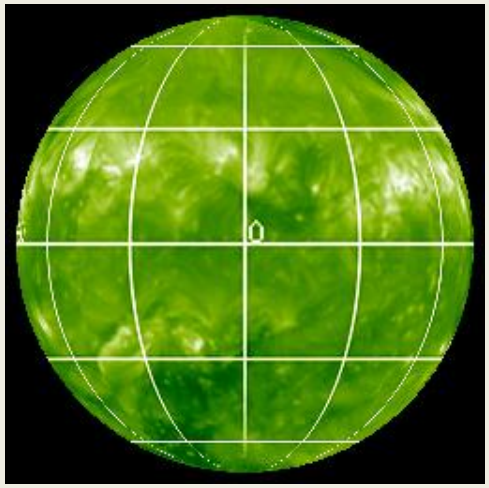


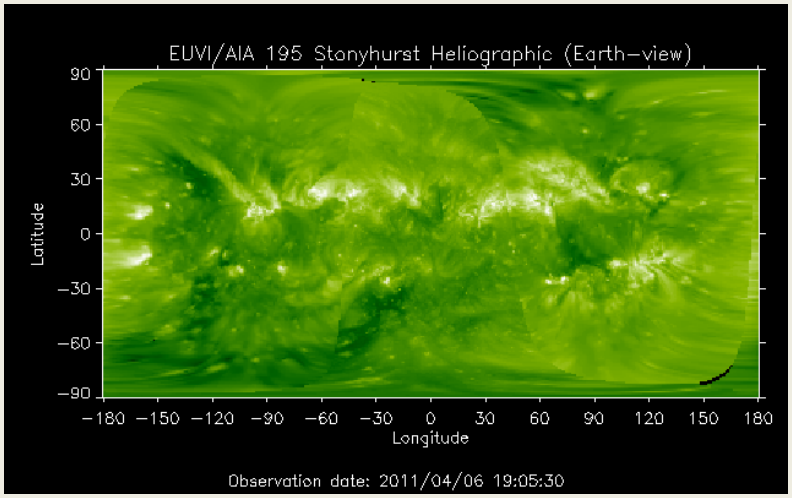


http://stereo.gsfc.nasa.gov/beacon/

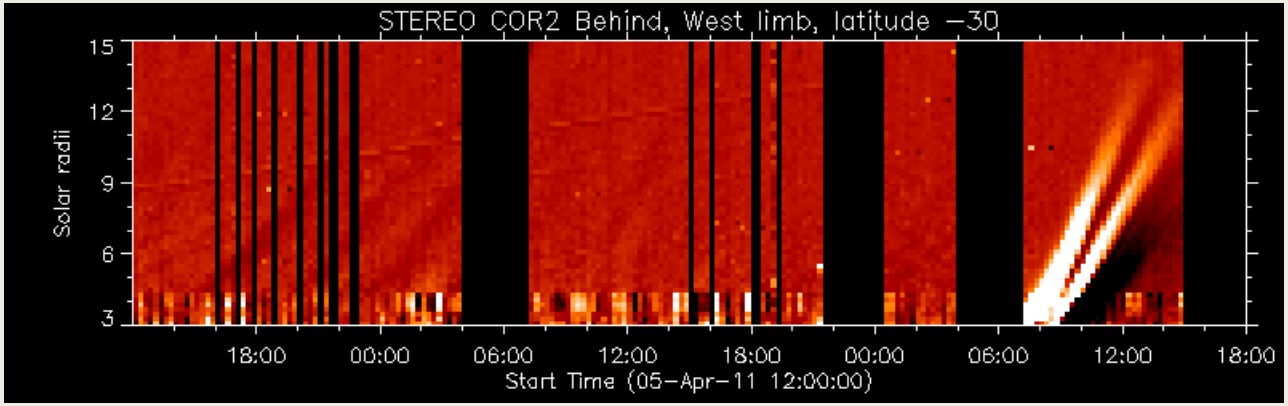
Beacon Higher Level Data Products

- 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)

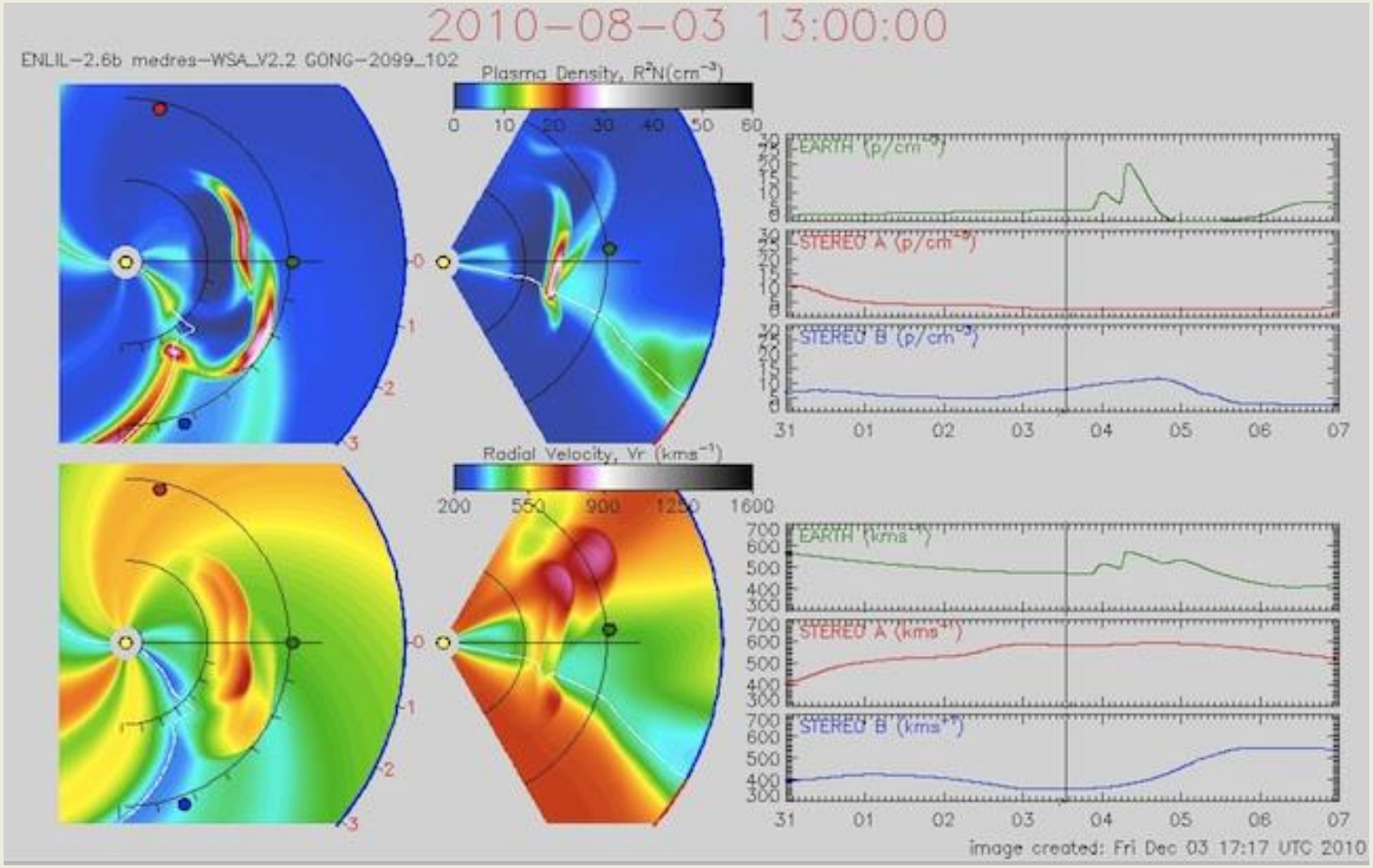
Need more beacon stations in Americas, Pacific, Asia

Need 10 meter or larger antennas – X band

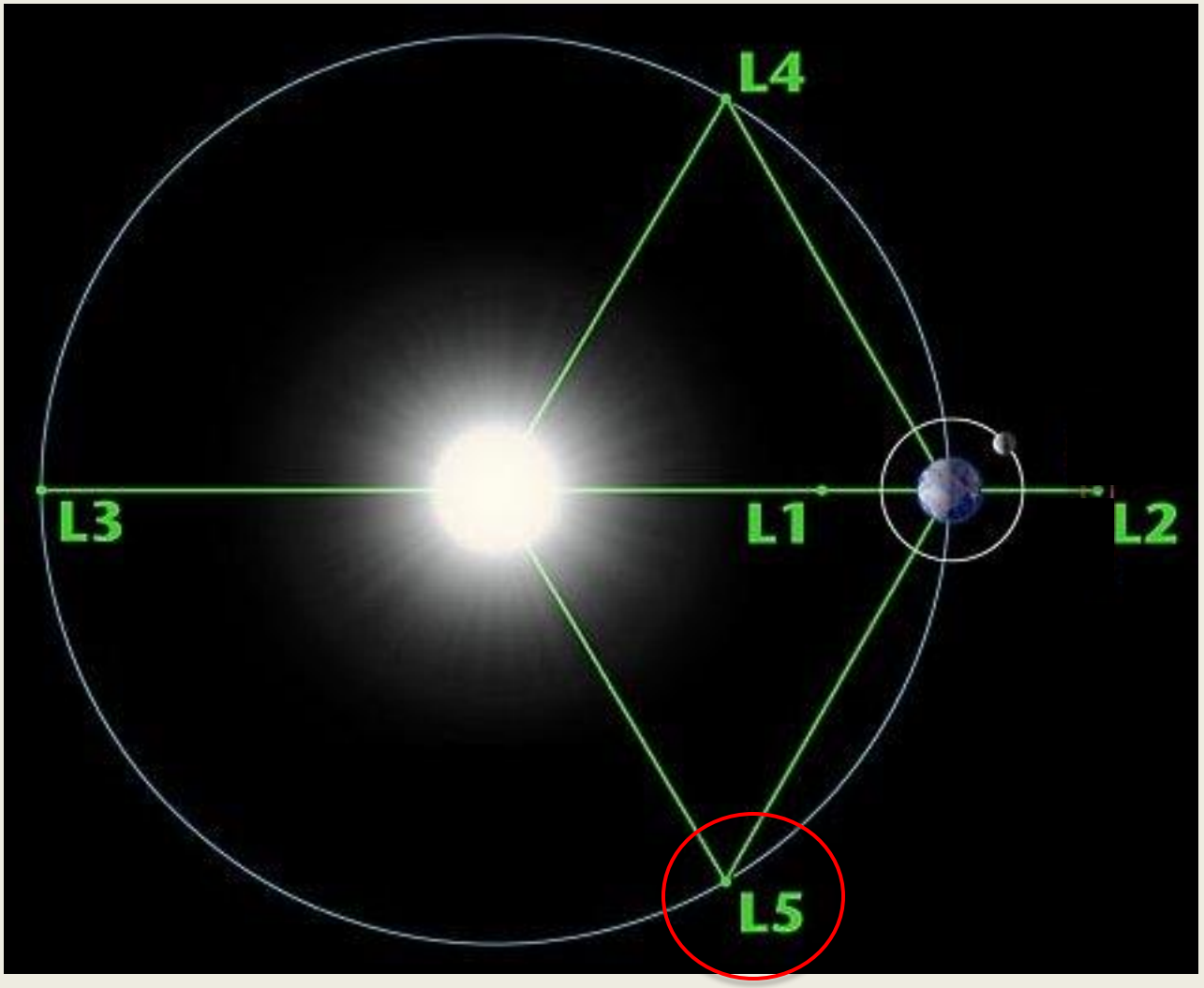
Uses in SWPC Forecasting

- **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.

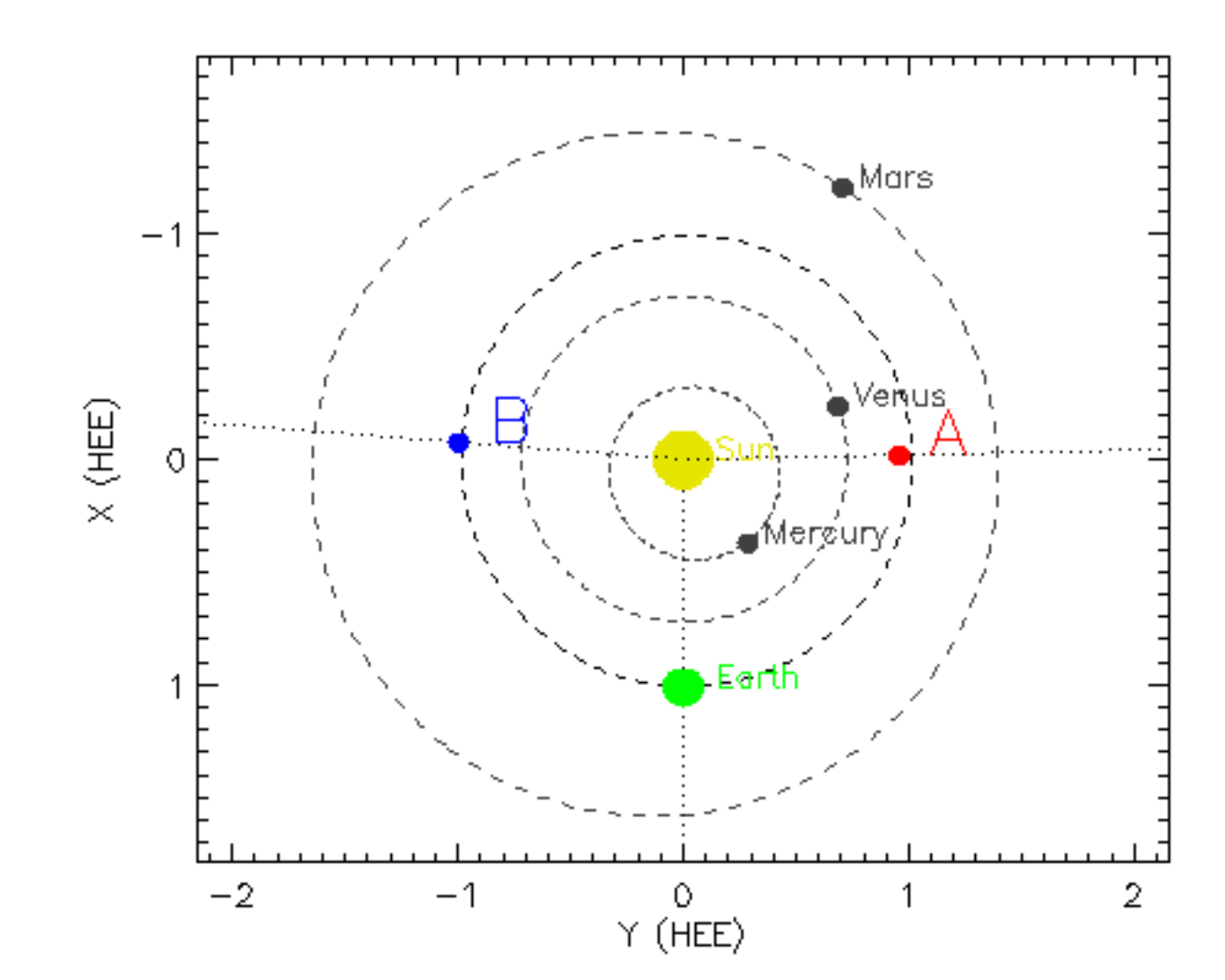
Enlil model run for Aug. 1, 2010 CME



Lagrange Points – Monitor at L5?

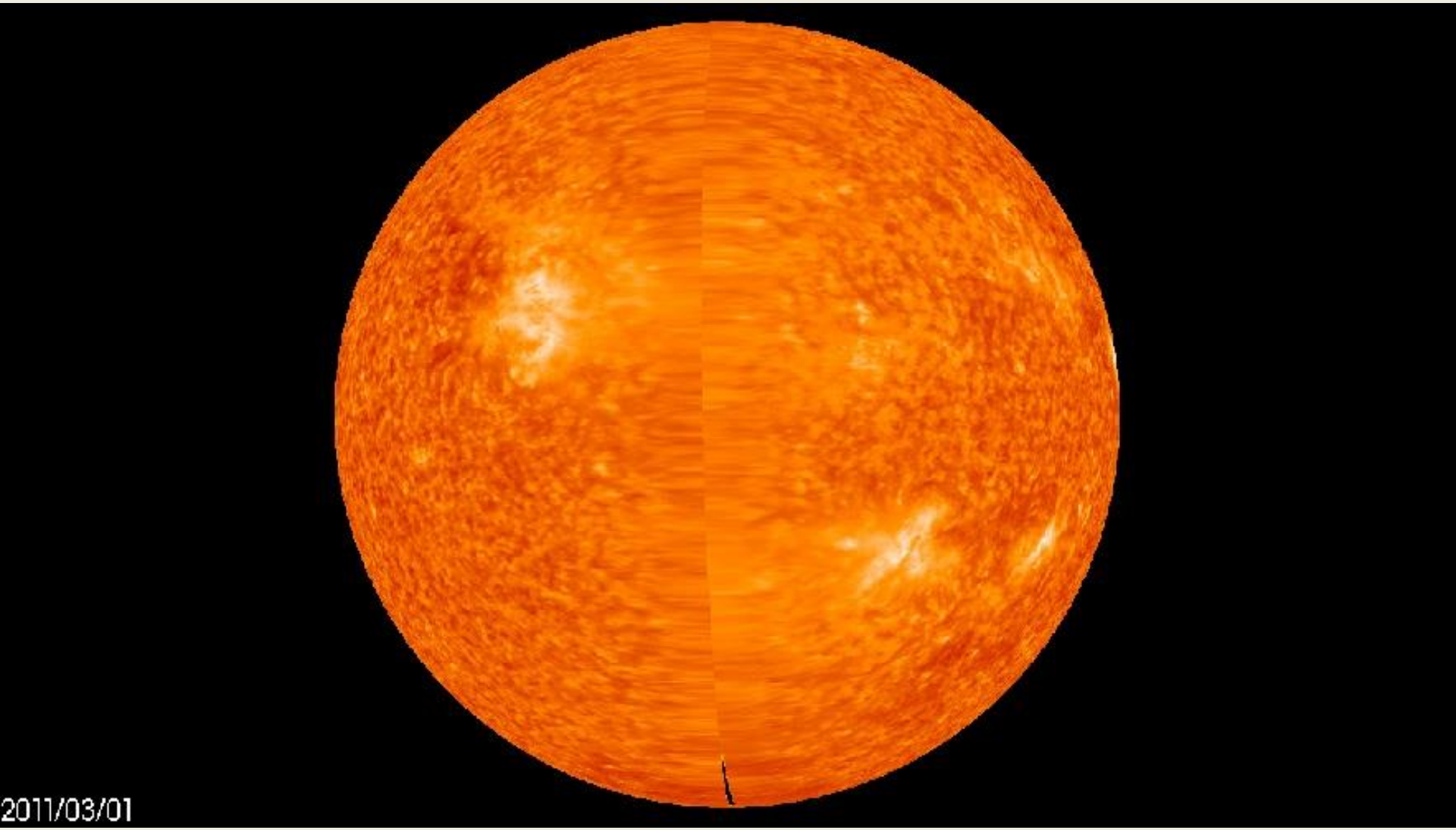


Full Solar System Space Weather



April 29, 2011

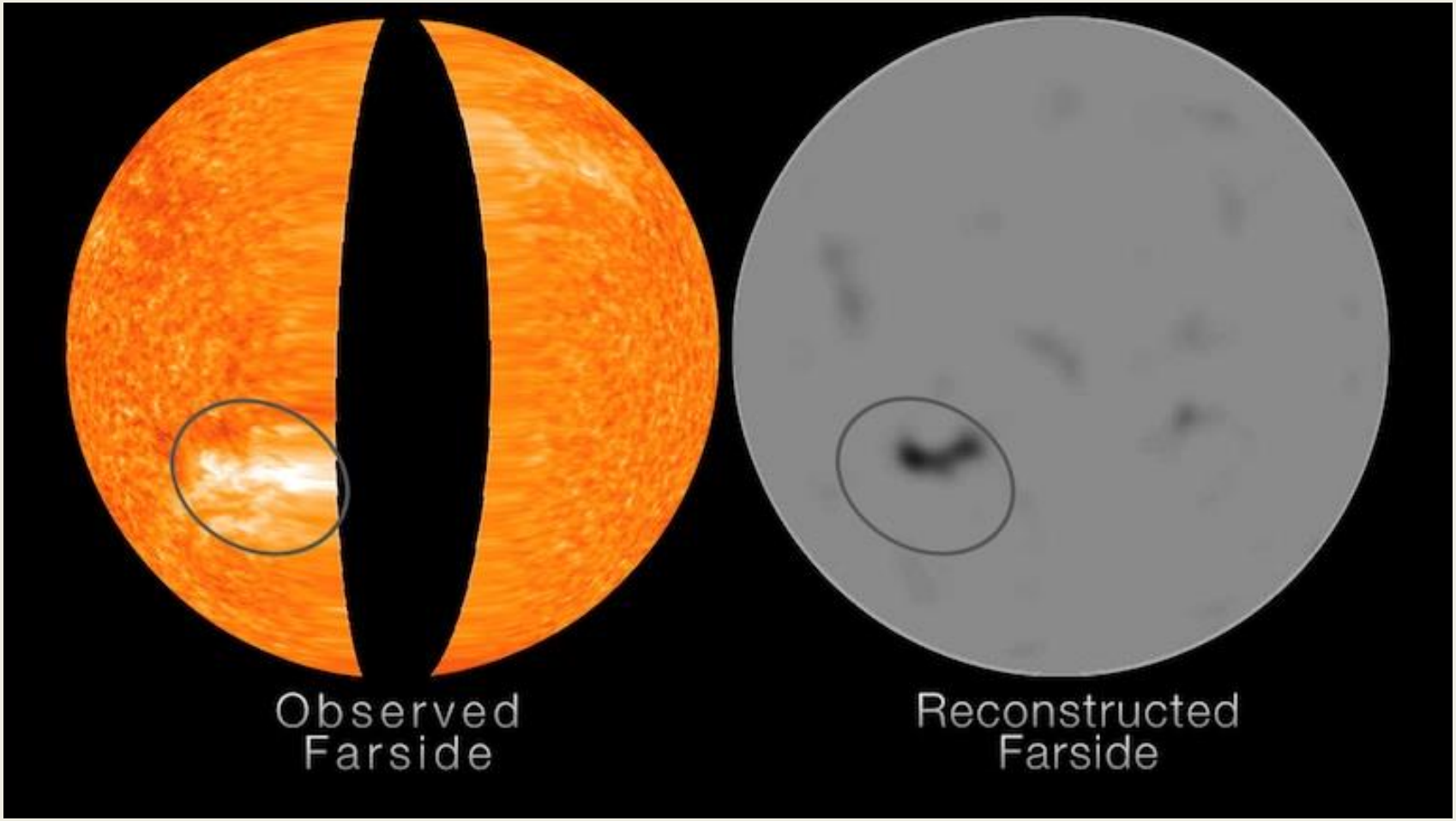
Far-side of the Sun



304 Å, STEREO A & B SECCHI/EUVI

Video at http://stereo.gsfc.nasa.gov/gallery/item.php?id=selects&iid=151

Comparison & Calibration of Far-side Images

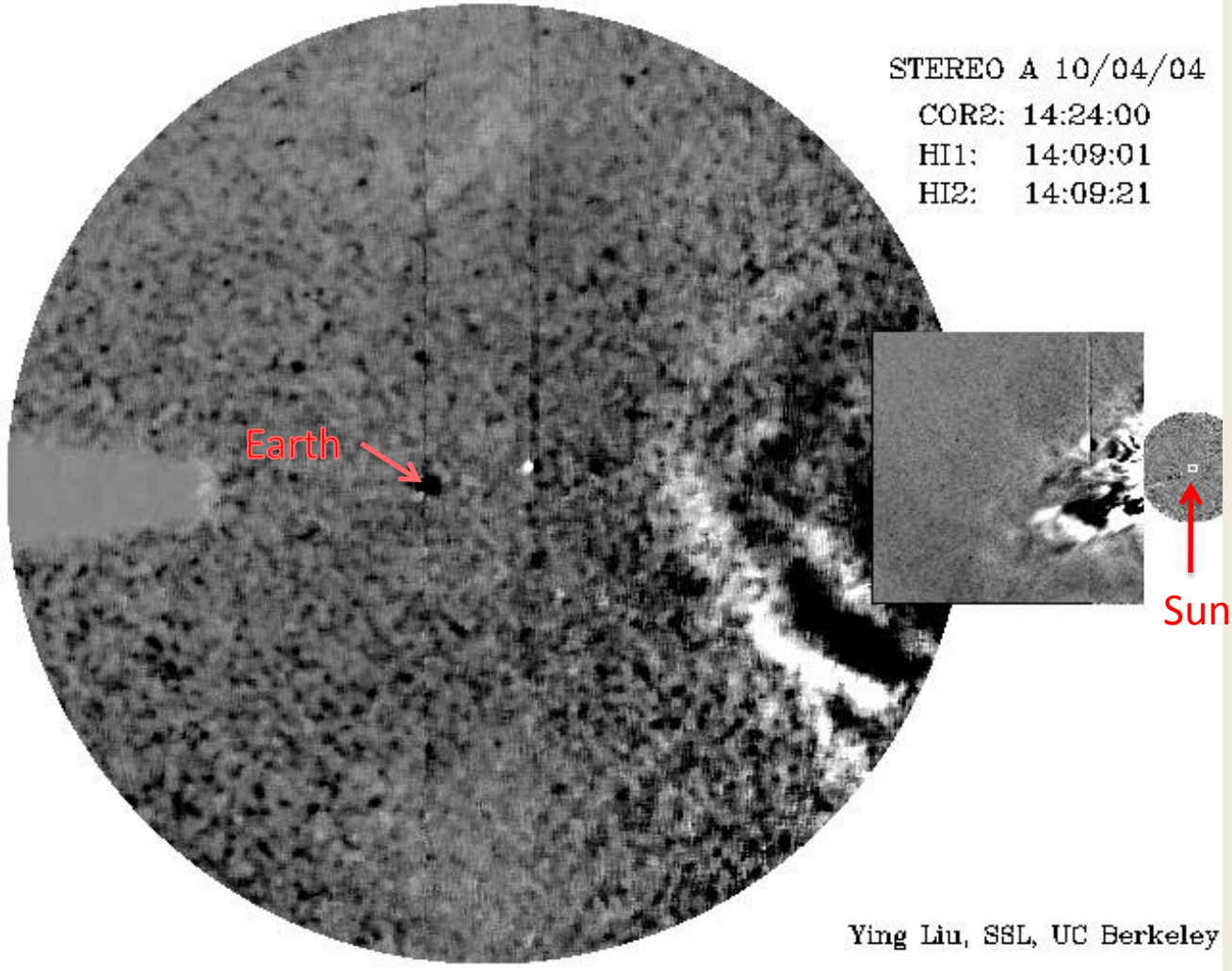


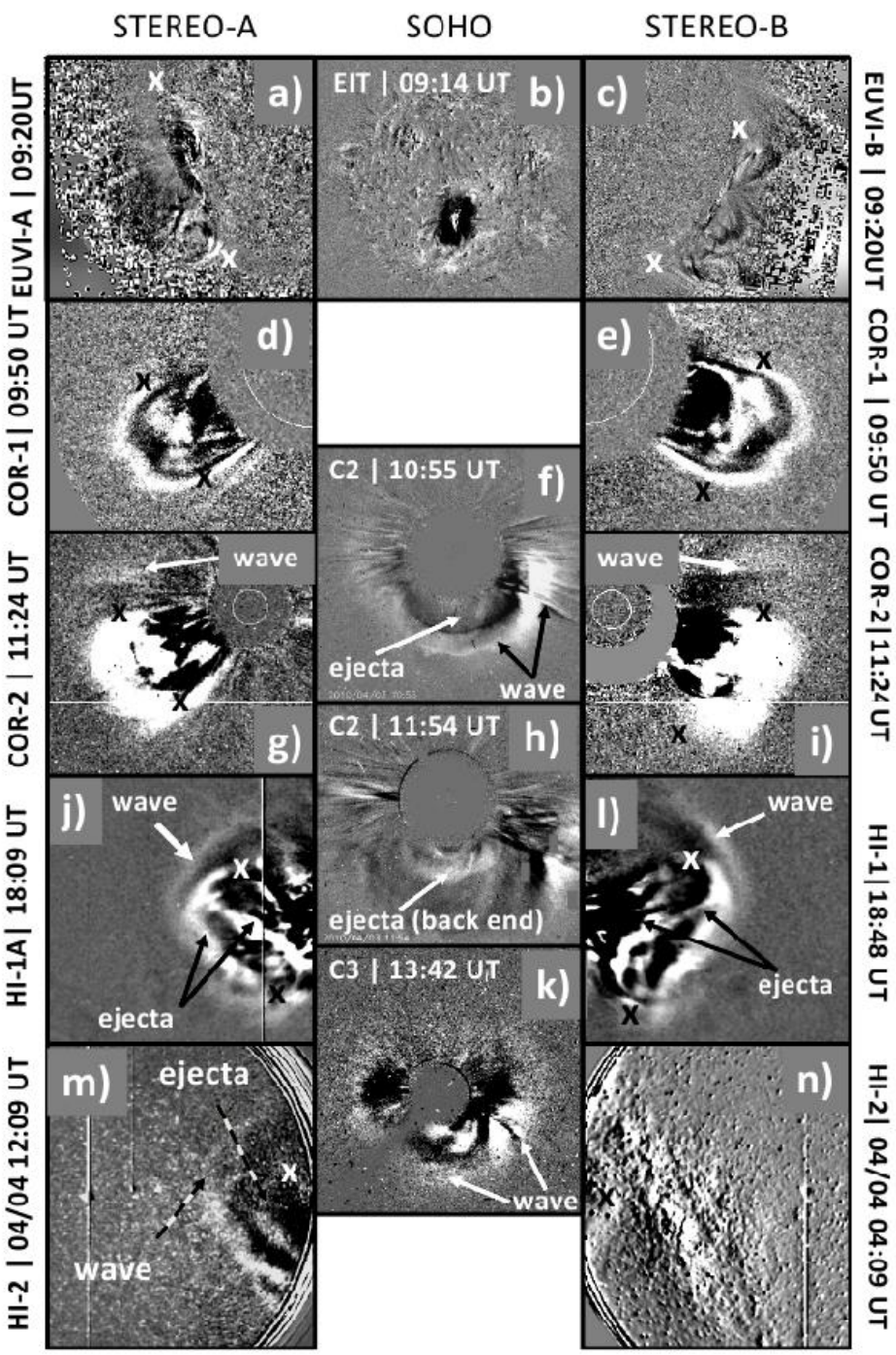
STEREO A & B SECCHI/EUVI

Reconstruction using SDO/HMI and GONG

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

April 3, 2010 CME



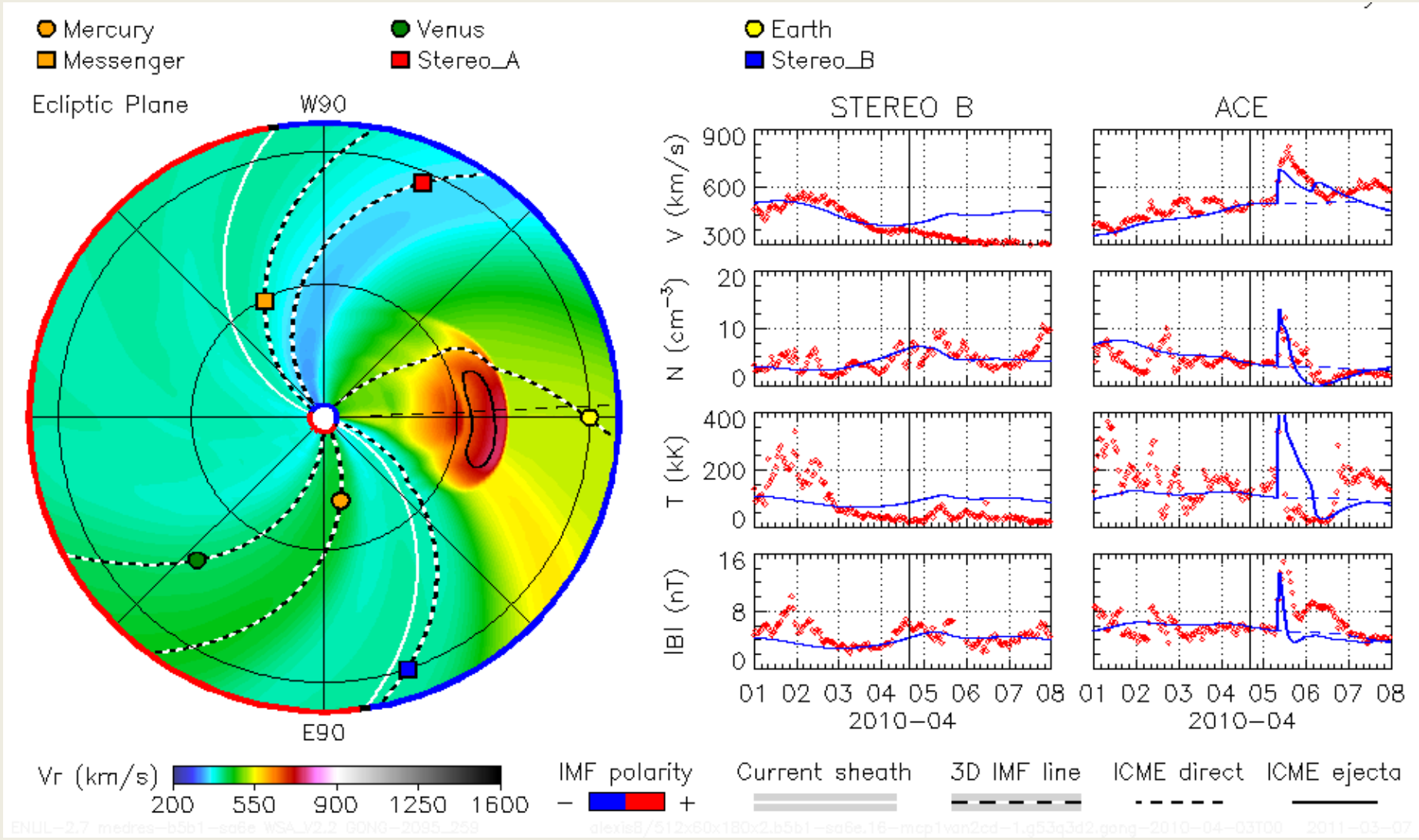


Modeling the April 2010 CME

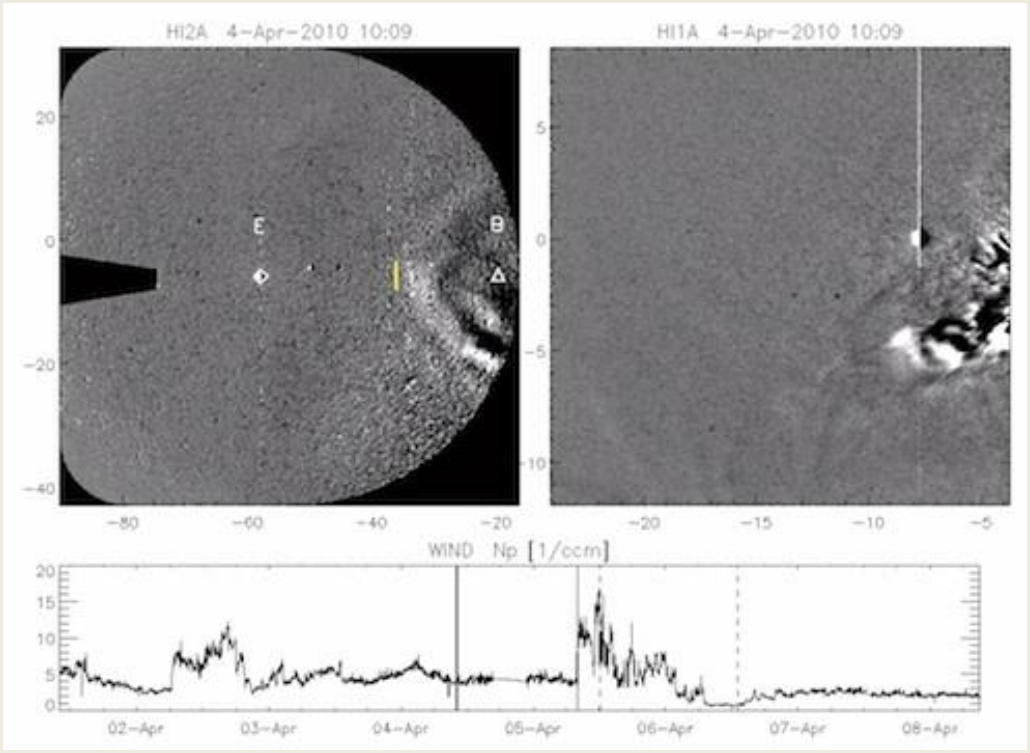
Shock Fronts and Solar Energetic Particles

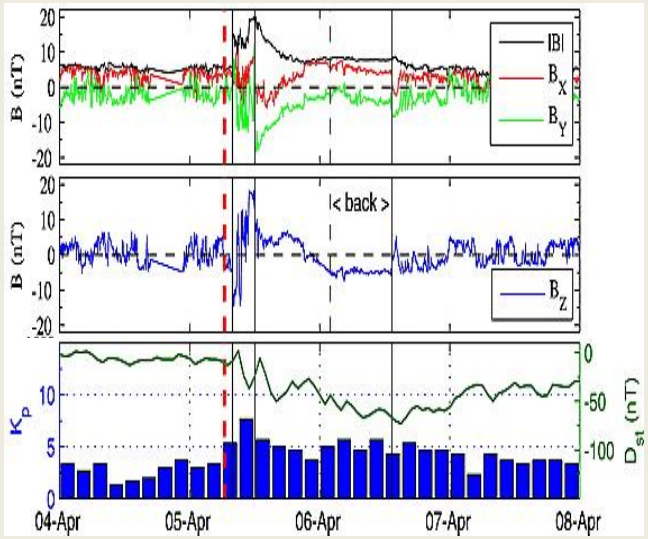
Rouillard et al. (2011)

The April 3, 2010 CME: Shock and SEPs



Rouillard et al. (2011)

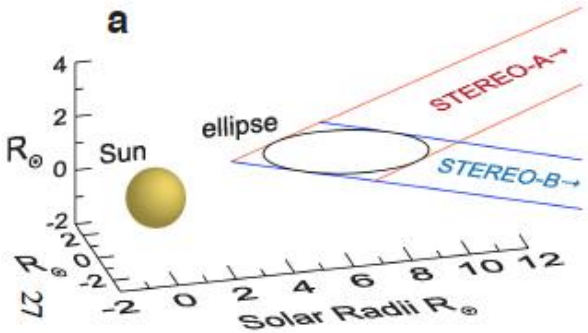


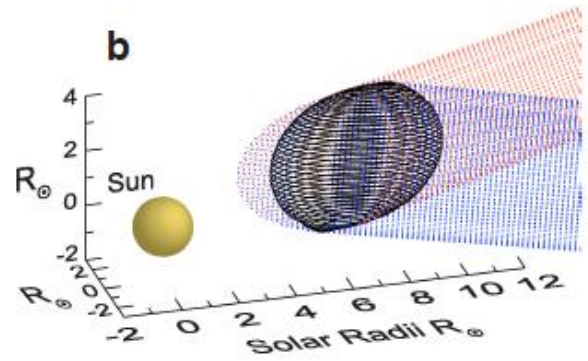


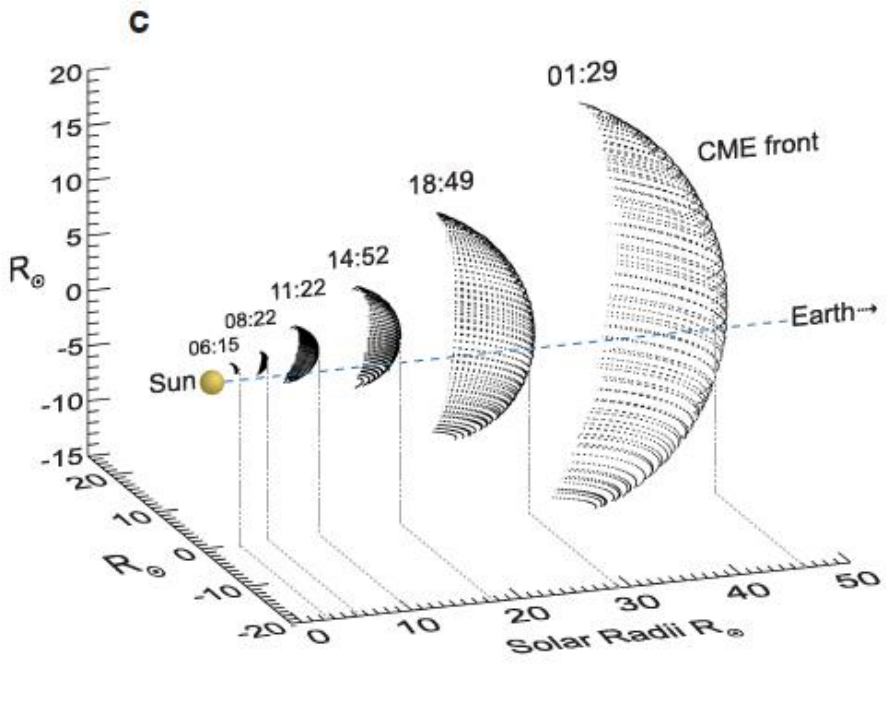
The April 3, 2010 CME: Magnetic Field

Möstl et al. 2010 video at http://www.agu.org/journals/gl/gl1024/2010GL045175/

CME Front Trajectory



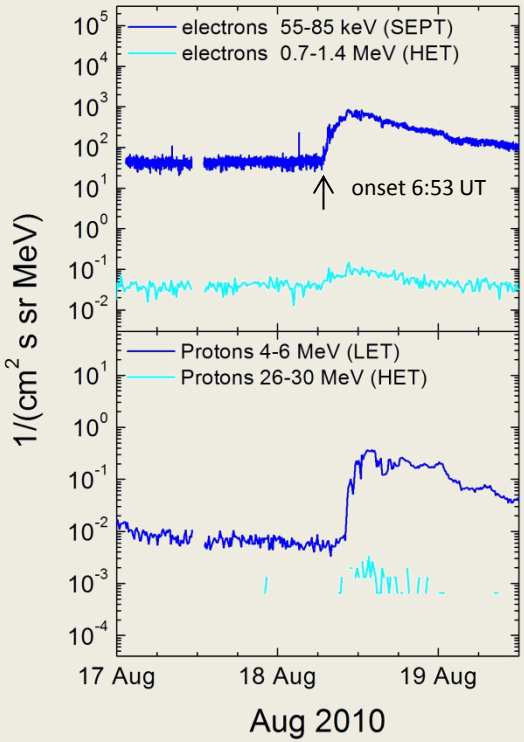


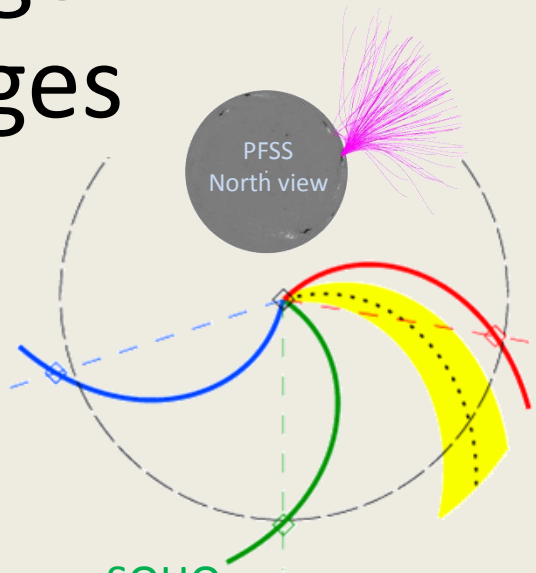


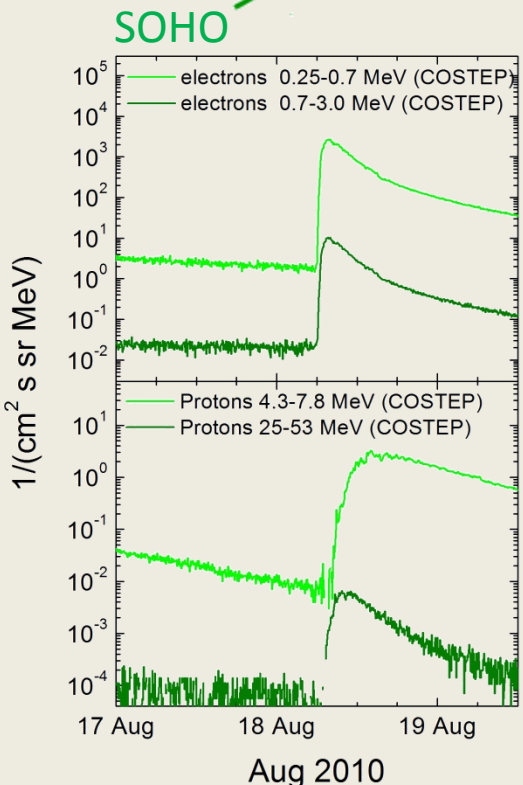
CME Dec. 12, 2008

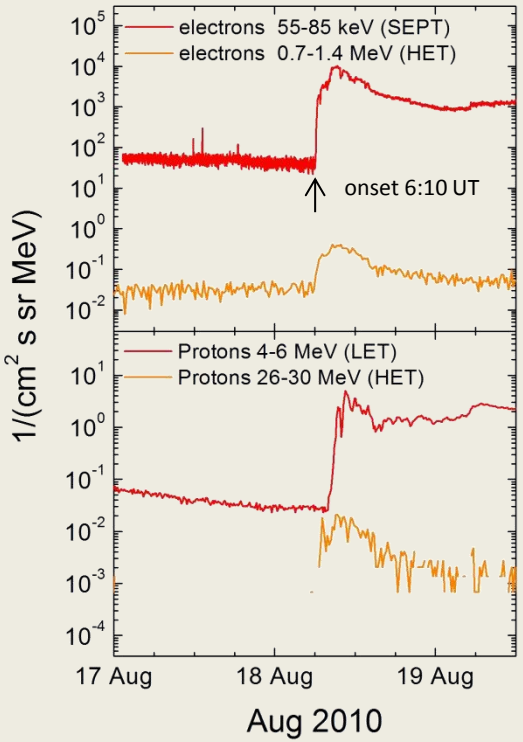
Byrne et al 2010

SEPs over large longitude ranges





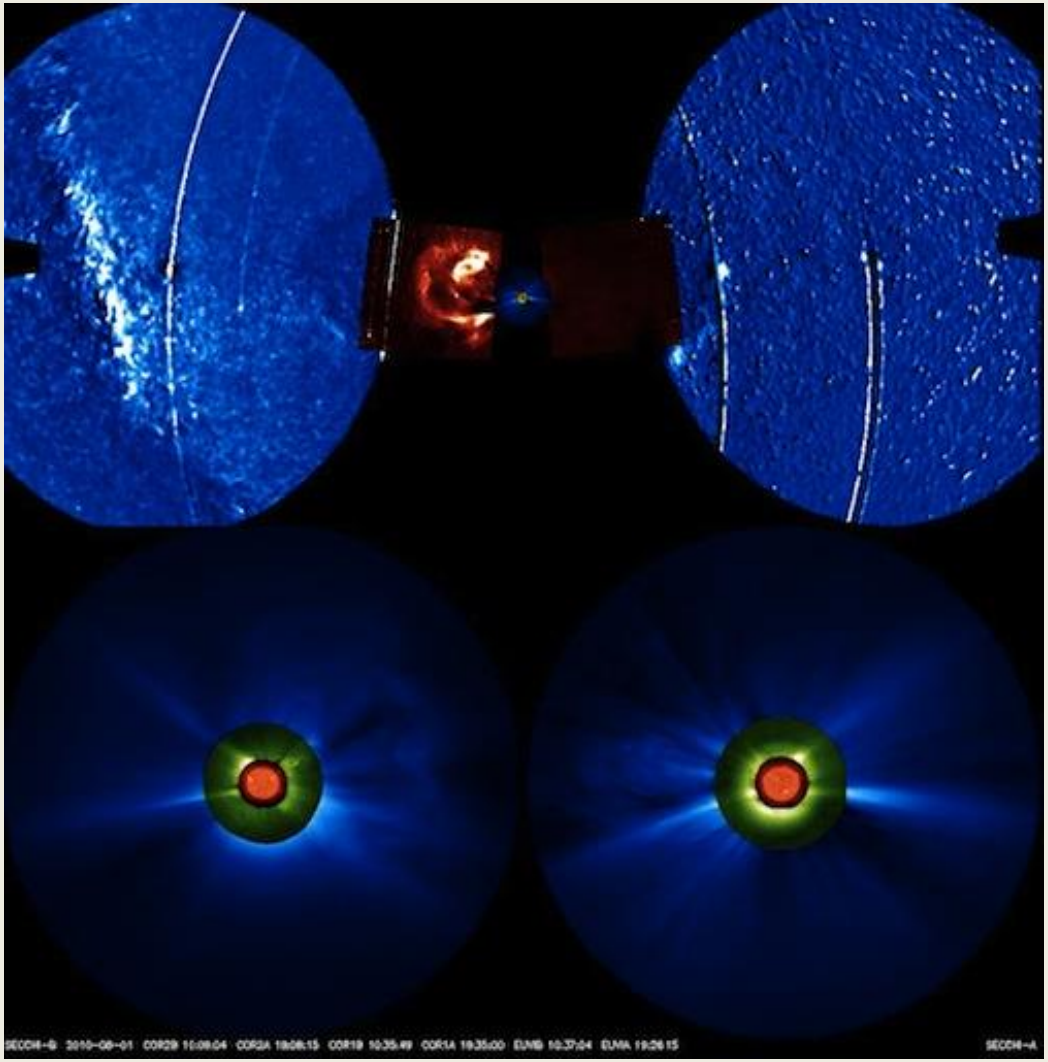




August 18, 2010 multi-spacecraft SEP event

Gómez-Herrero

Aug 1 – 20, 2010



STEREO/SECCHI, NRL

Video at http://stereo.gsfc.nasa.gov/gallery/item.php?id=selects&iid=145

DSN Nominal Telemetry Rates for Full Resolution Data

Telemetry (kps)	STEREO A Start Date	STEREO B Start Date
720	2007/01/22	2007/01/22
480	2008/09/15	2008/10/13
360	2009/09/08	2009/08/17
240	2009/12/07	2010/04/26
160	2011/07/15	2011/06/27
120	2012/11/04	2013/05/03

+ Higher rate passes with 70 meter stations as available