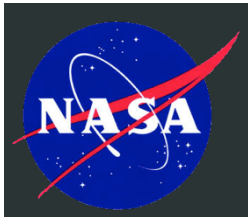



Space Weather Forecasting for NASA Robotic Missions

Alexandra Wold & Zach Waldron, American University
Community Coordinated Modeling Center & Space Weather Research Center

Outline

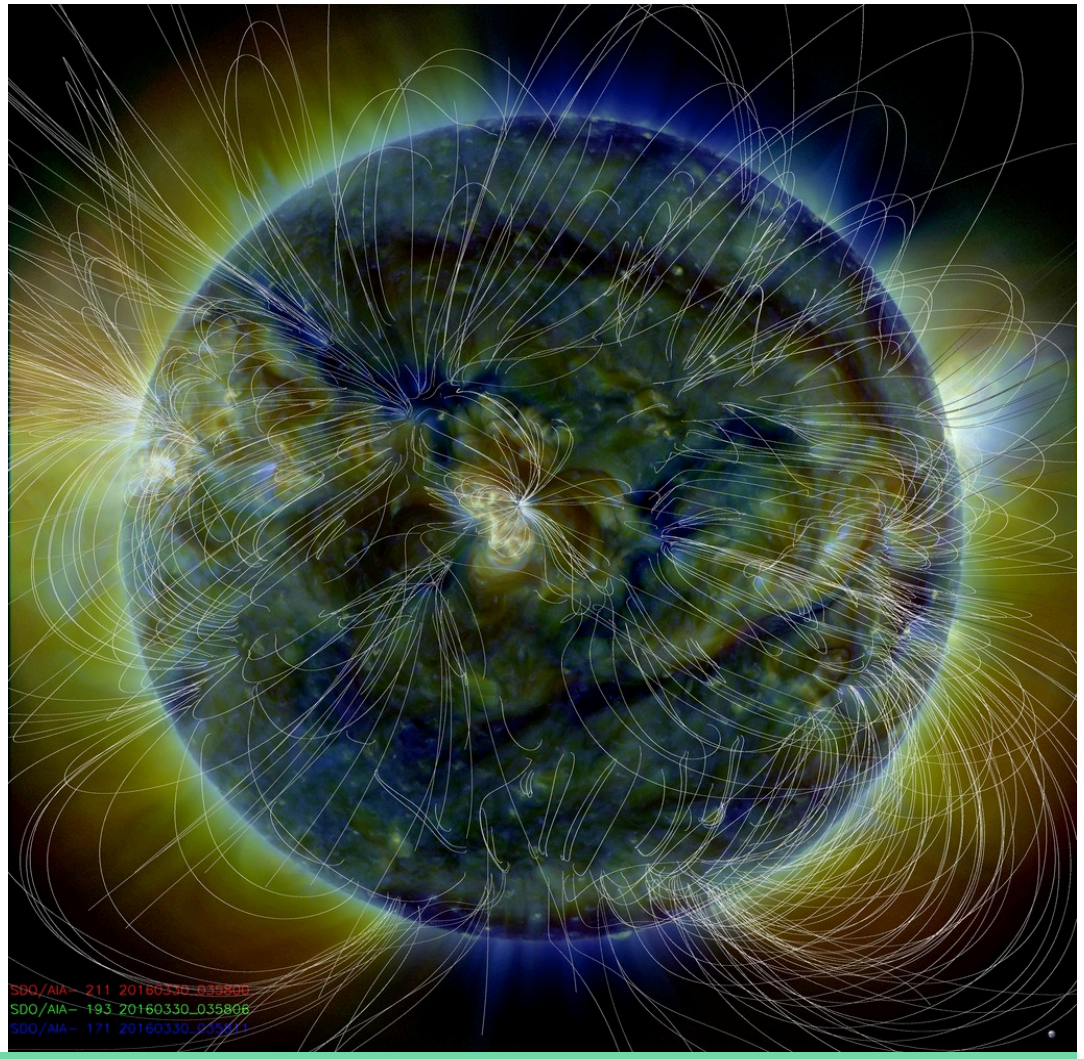
How we became space weather forecasters

Why we forecast

Forecasting tools

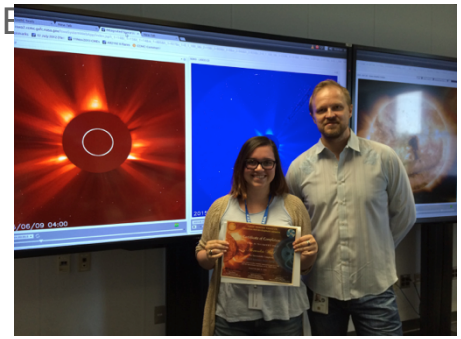
Event demo

Questions



Alex's Forecasting Journey

- Why I chose an internship in space weather forecasting
- How I was trained
  - Space Weather Research, Education and Development Initiative (REDI) E
  - Working at Goddard Space Flight Center

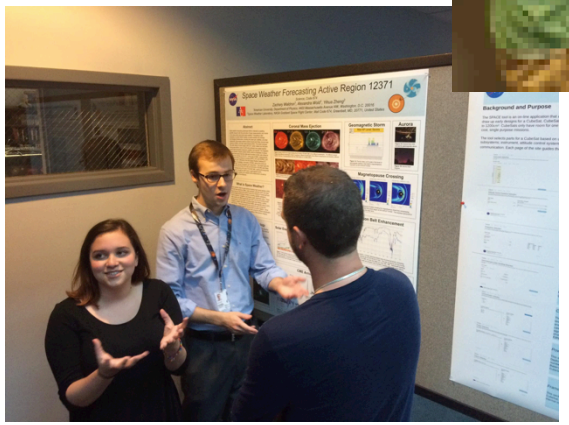


- What I do now
  - Remote forecasting
  - Space weather research

- The future
  - Training new forecasters
  - Continued research
  - Graduate School

Zach's Forecasting Journey

- How I got here...
- Forecasting Training Summer 2015
  - REDI Bootcamp
  - Summer as Goddard Intern
- What I do now
  - Part time weekly forecaster
- Future
  - Nuclear Physics Research- Mainz, Germany
  - Continue Forecasting
  - Graduate School

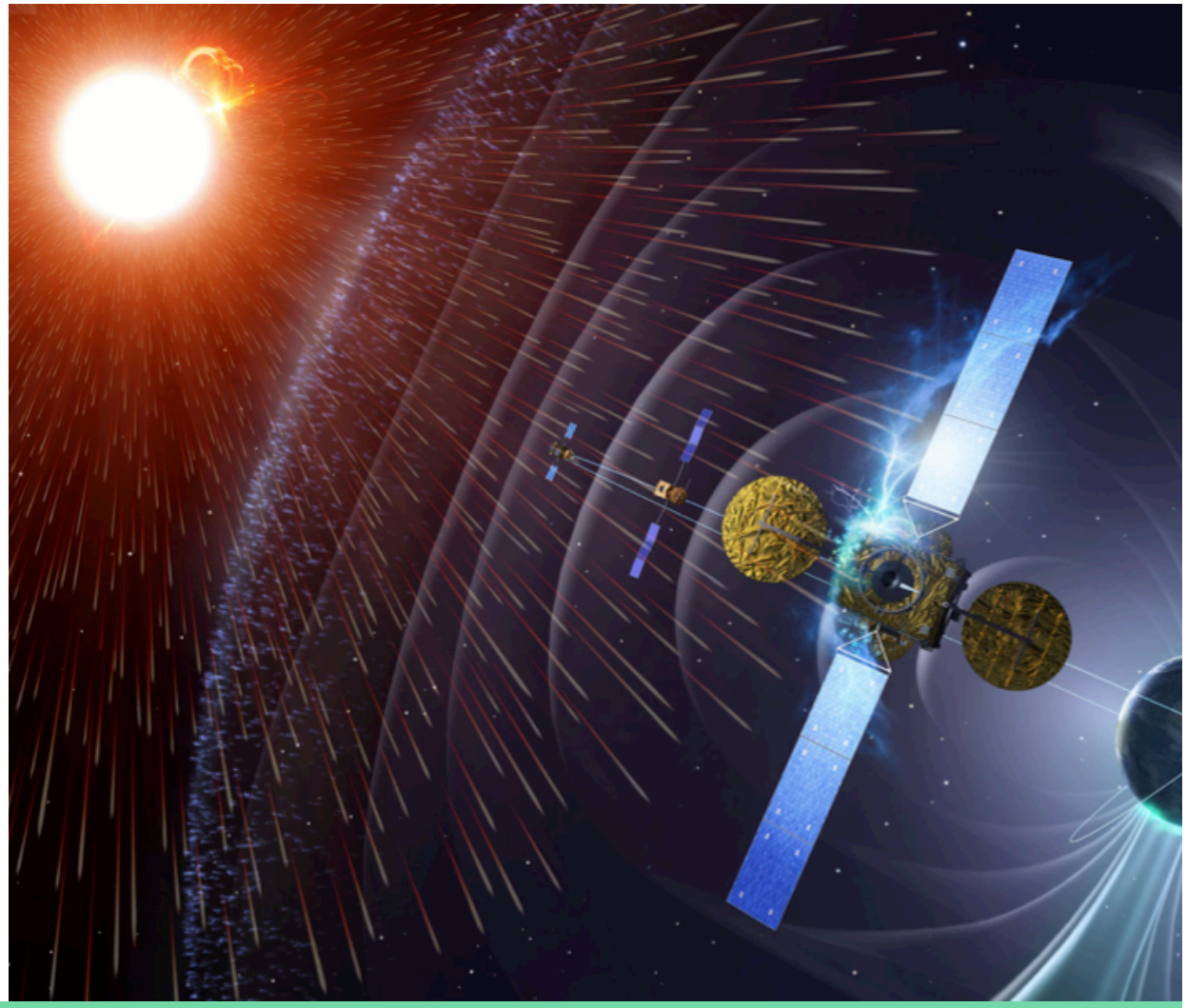


Why We Forecast the Space Weather

To assist with NASA's scientific research

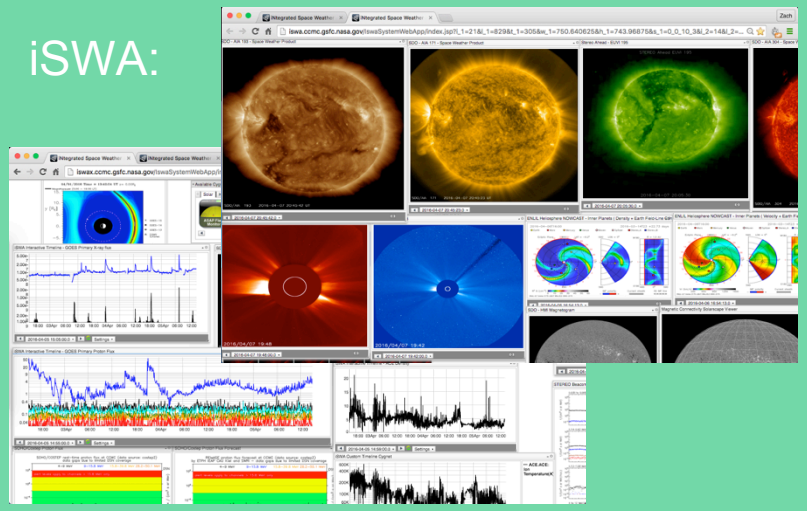
Protect NASA's robotic missions assets

Learn interactively

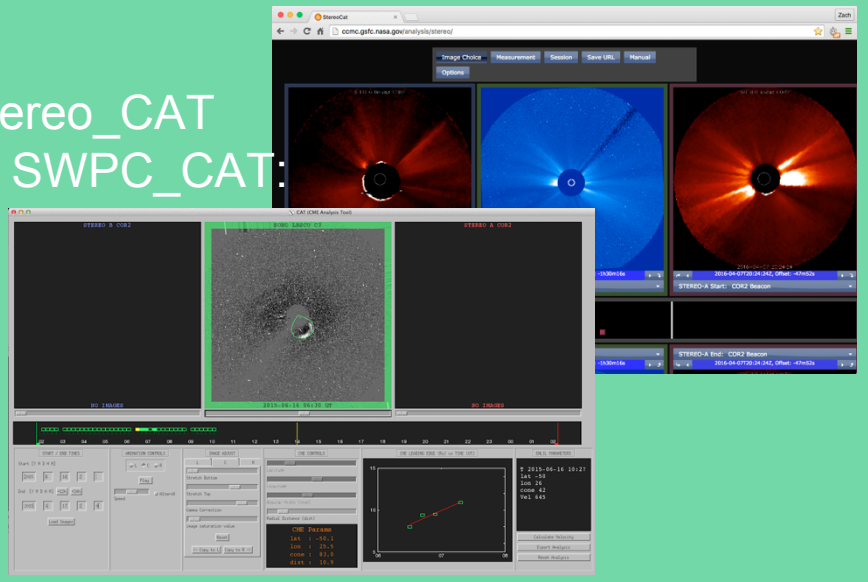


How We Forecast

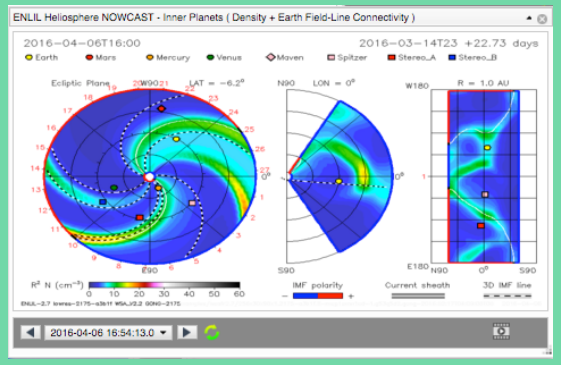
iSWA:



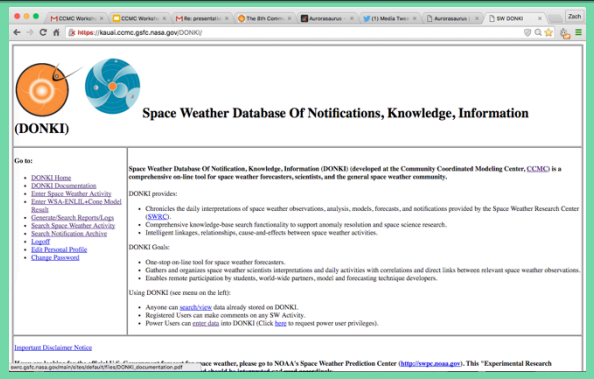
Stereo_CAT & SWPC_CAT:



WSA-ENLIL Cone Models:



DONKI:



Solar Flare	2015-06-22 17:39	GOES15: SEM/XRS 1.0-8.0	2015-06-22T18:23Z	2015-06-22T18:51Z	M6.5	N13W05	12371	2015-06-22T18:36:00-CME-001 Long=3.0, Lat=14.0, Speed=1155.0, Type=O, Half Width=45.0, Time 21.5=2015-06-22T21:10Z WSA-ENLIL+Cone result: Result 1 (2.0 AU)

Solar Energetic Particle	2015-06-21 20:35	GOES13: SEM/EPS >10 MeV	2015-06-21T01:02:00-FLR-001 FLR Type: M2.0 2015-06-21T02:06:00-FLR-001 FLR Type: M2.6 2015-06-21T02:48:00-CME-001 2015-06-21T09:38:00-FLR-001 FLR Type: M3.8 2015-06-21T15:40:00-IPS-001 2015-06-21T18:10:00-FLR-001 FLR Type: M1.1

More events in DONKI

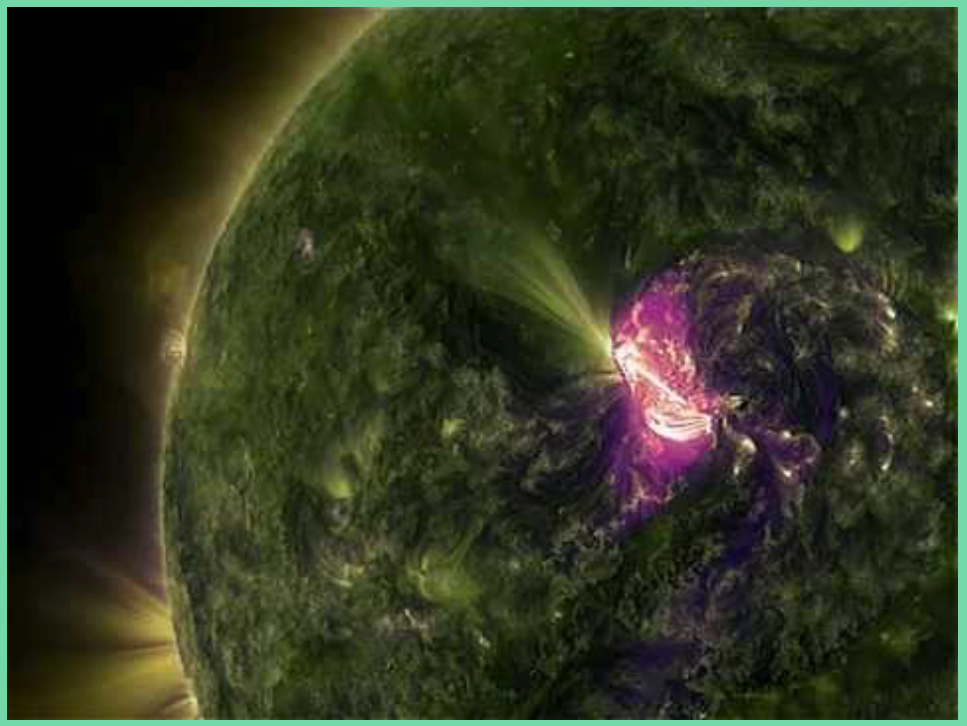
Interplanetary Shock	2015-06-12 12:19	Earth	ACE: MAG	ACE: MAG ACE: SWEPAM	2015-06-09T20:00:00-CME-001

Geomagnetic Storm	2015-06-22 18:00		NOAA Kp: 8 (2015-06-22T21:00Z) NOAA Kp: 8 (2015-06-22T21:00Z) NOAA Kp: 7 (2015-06-23T03:00Z) NOAA Kp: 8 (2015-06-23T06:00Z) NOAA Kp: 6 (2015-06-23T09:00Z) NOAA Kp: 6 (2015-06-23T15:00Z)	2015-06-21T02:48:00-CME-001 2015-06-22T17:59:00-IPS-001

Event Type	Event Time (UT)	Associated Instrument	All Detecting Instruments	Directly Linked Event(s)
High Speed Stream	2015-06-08 00:16	ACE: SWEPAM	ACE: SWEPAM ACE: MAG	2015-06-08T06:00:00-GST-001 NOAA Kp: 6 (2015-06-08T09:00Z) 2015-06-10T13:09:00-MPC-001

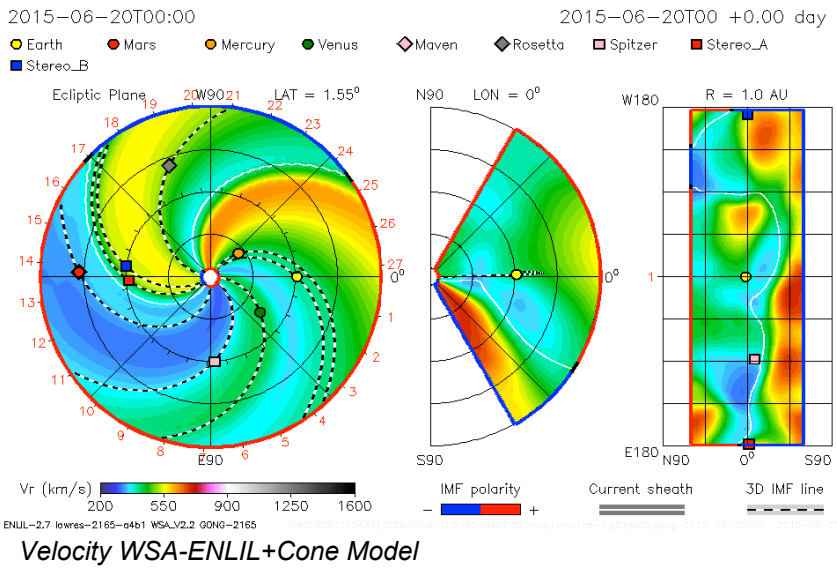
Event Demo

Two solar flares and an associated eruption on June 21, 2015 catalyzed a chain of events that culminated in an intense geomagnetic storm the next day.



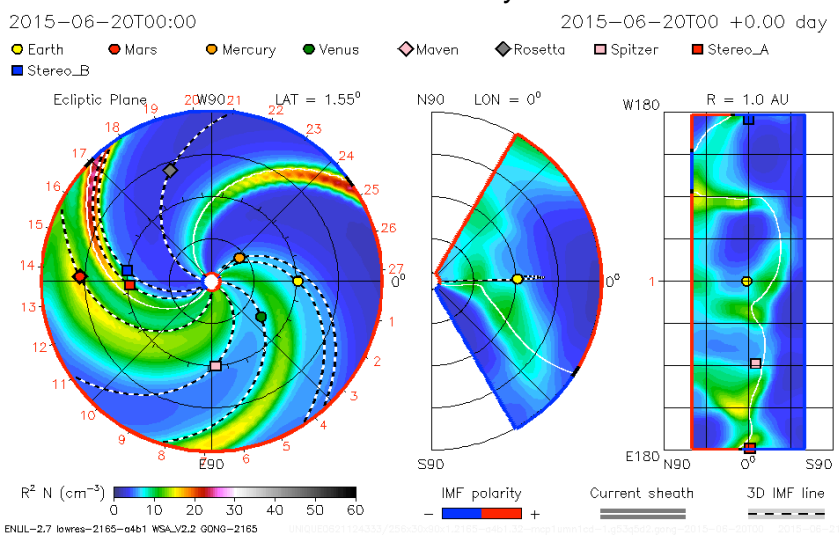
From the Solar Dynamics Observatory (SDO)

Modeling the CME

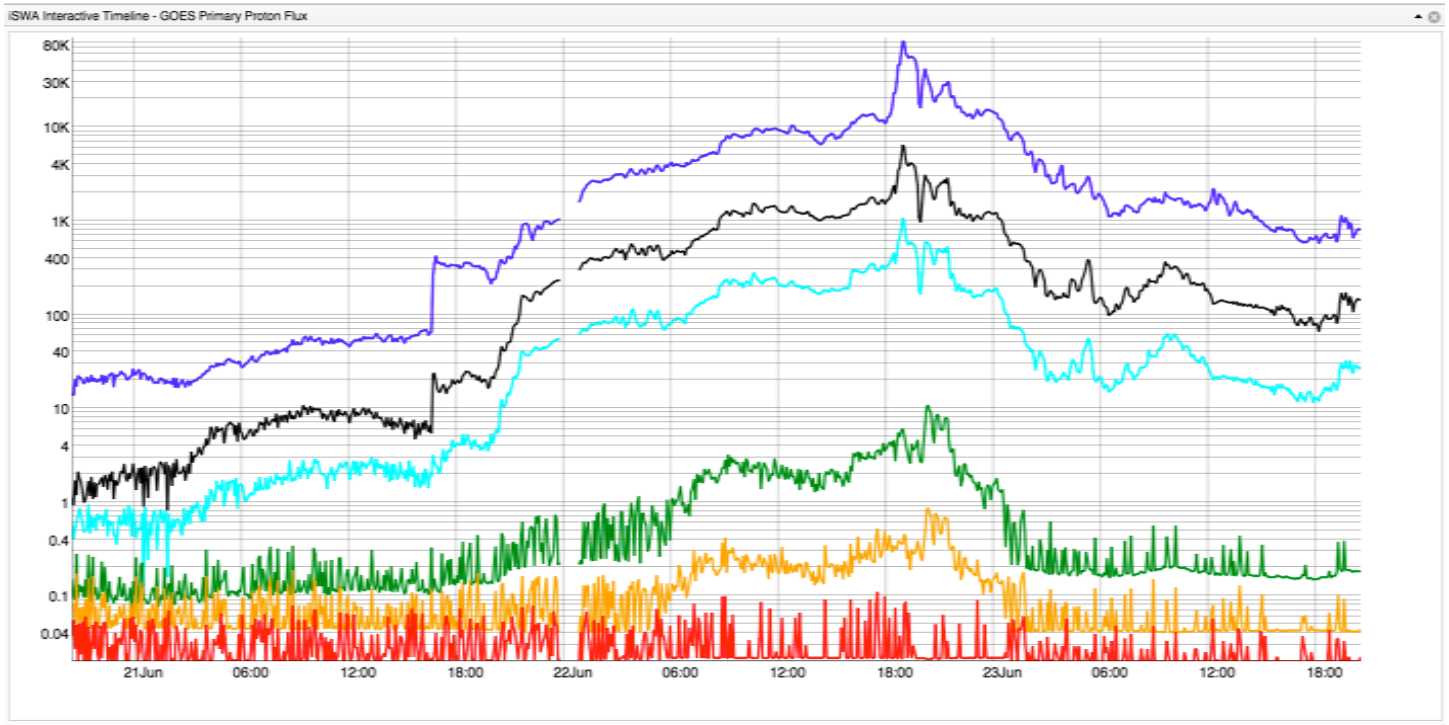


Velocity WSA-ENLIL+Cone Model

Density WSA-ENLIL+Cone Model

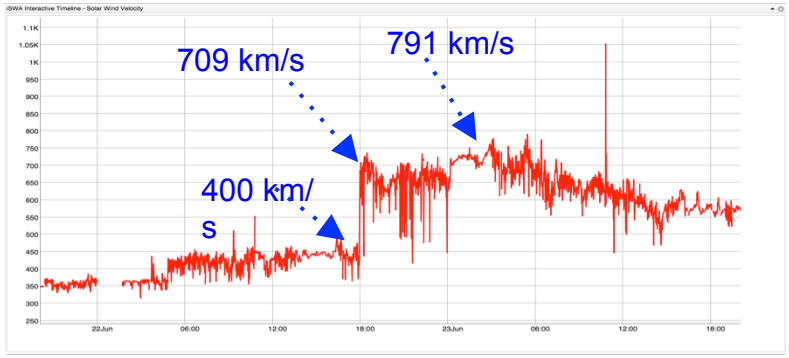


Arrival of Solar Energetic Particles

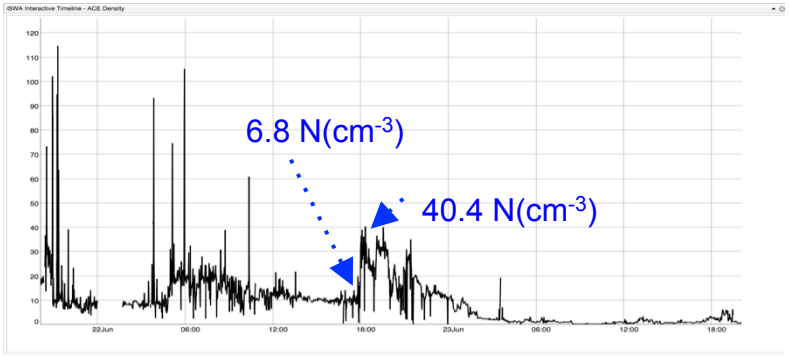


GOES primary proton flux showing 2015-06-21T20:35Z SEP event with the >10 MeV proton flux (cyan) exceeding the 10 pfu threshold.

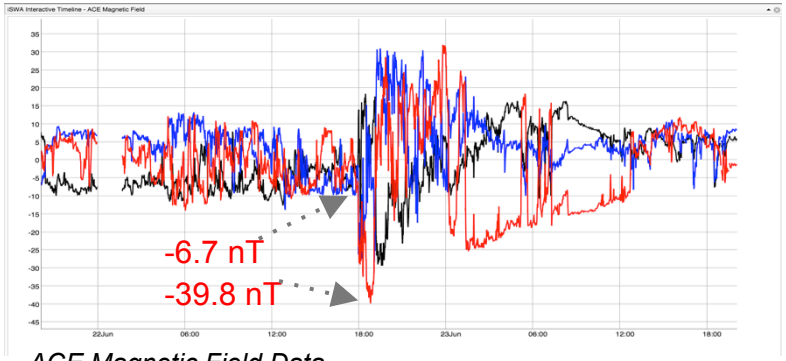
Arrival of CME



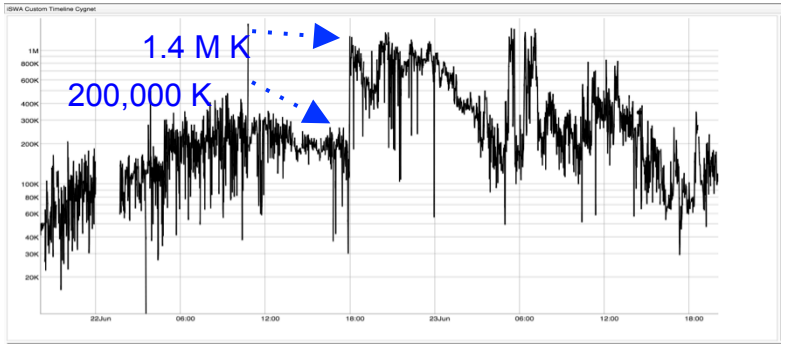
ACE Velocity Data



ACE Temperature Data

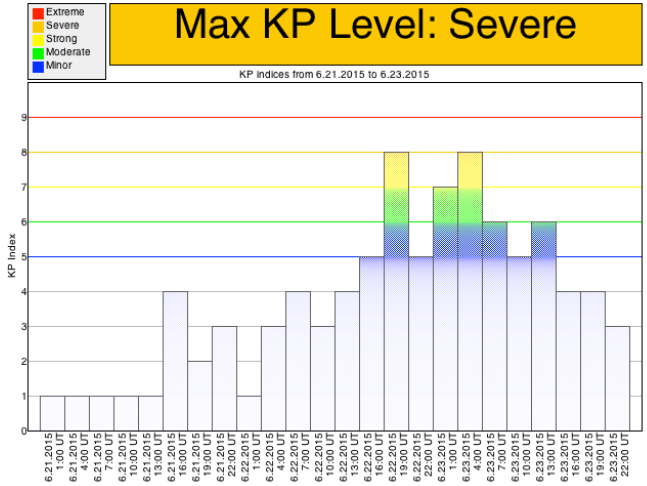


ACE Magnetic Field Data

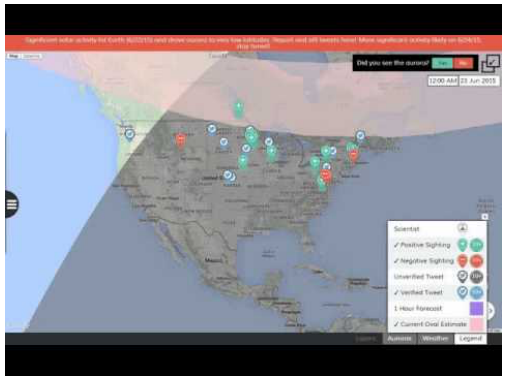


ACE Density Data

Geomagnetic Storm

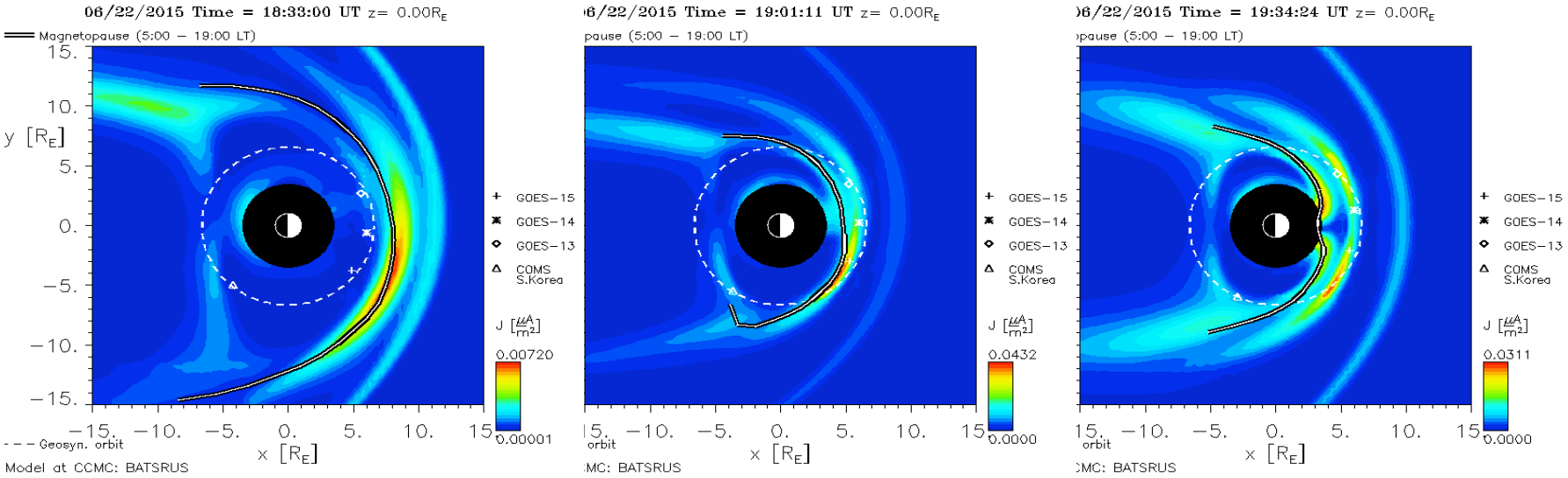


The Kp index, a 0-9 scale of the level of geomagnetic activity in the Earth's magnetosphere, reached 8 at 2015-06-22T18:00Z.



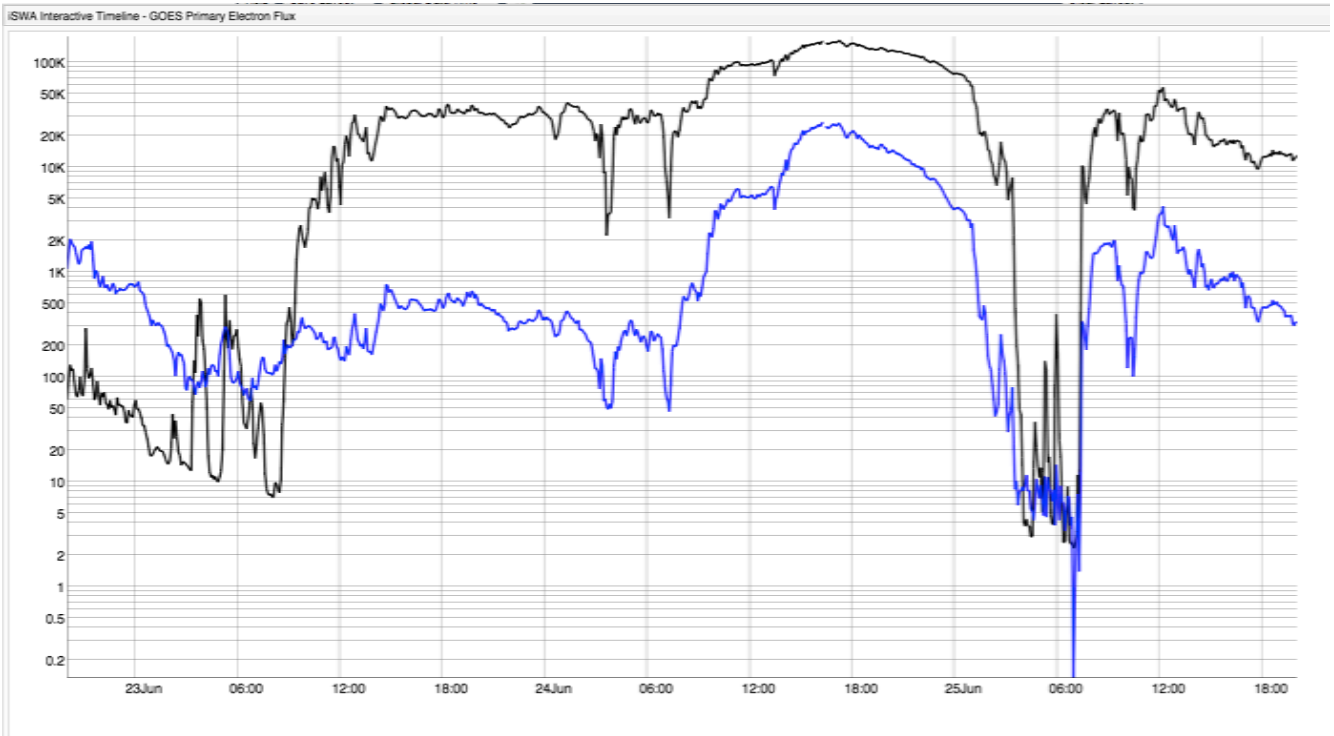
Aurorasaurus

Compression of the Earth's Magnetosphere



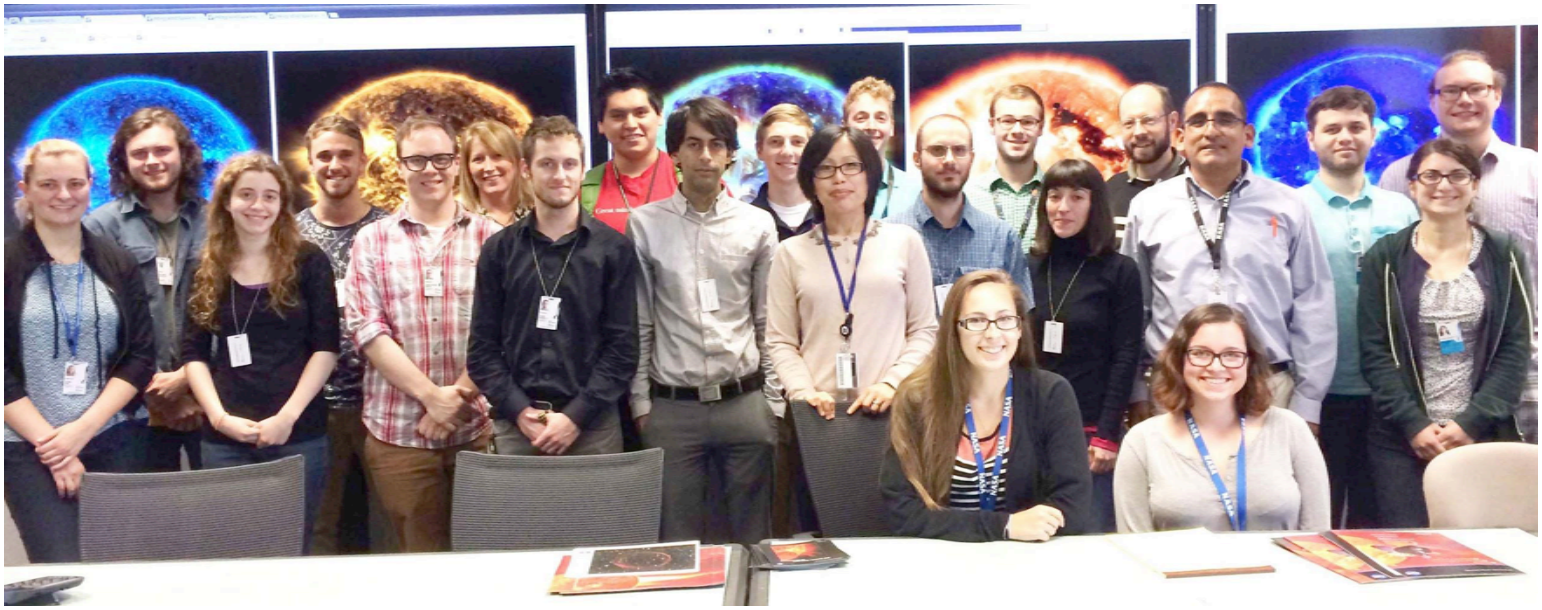
SWMF Magnetopause Position

Radiation Belt Enhancement



The GOES > 0.8 MeV electrons (black) were at enhanced levels, exceeding the threshold of 100,000 pfu at 2015-06-22T17:59Z.

Reflections...



Thank You!