Space Weather with NASA's Van Allen Probes

Nicola Fox, JHU/APL
Mona Kessel, NASA HQ

Contributions by
Geoff Reeves, Michelle Weiss

See also *The Radiation Belt Storm Probes and Space Weather* by Kessel et al., Space Sci Rev DOI 10.1007/s11214-012-9953-6

Van Allen Space Weather Data

Space weather data is being generated and broadcast from the spacecraft 24/7 when not sending science data. The mission targets one part of the space weather chain: the very high energy electrons and ions magnetically trapped within Earth's radiation belts. The understanding gained by the Van Allen probes will enable us to better predict the response of the radiation belts to solar storms in the future, and thereby protect space assets in the near-Earth environment.

Outline

- Mission and Instrument Overview
- Capabilities for generating and broadcasting space weather data
- Ground stations collecting the data
- Data products
- Users/models that will incorporate the data into test-beds for radiation belt nowcasting and forecasting

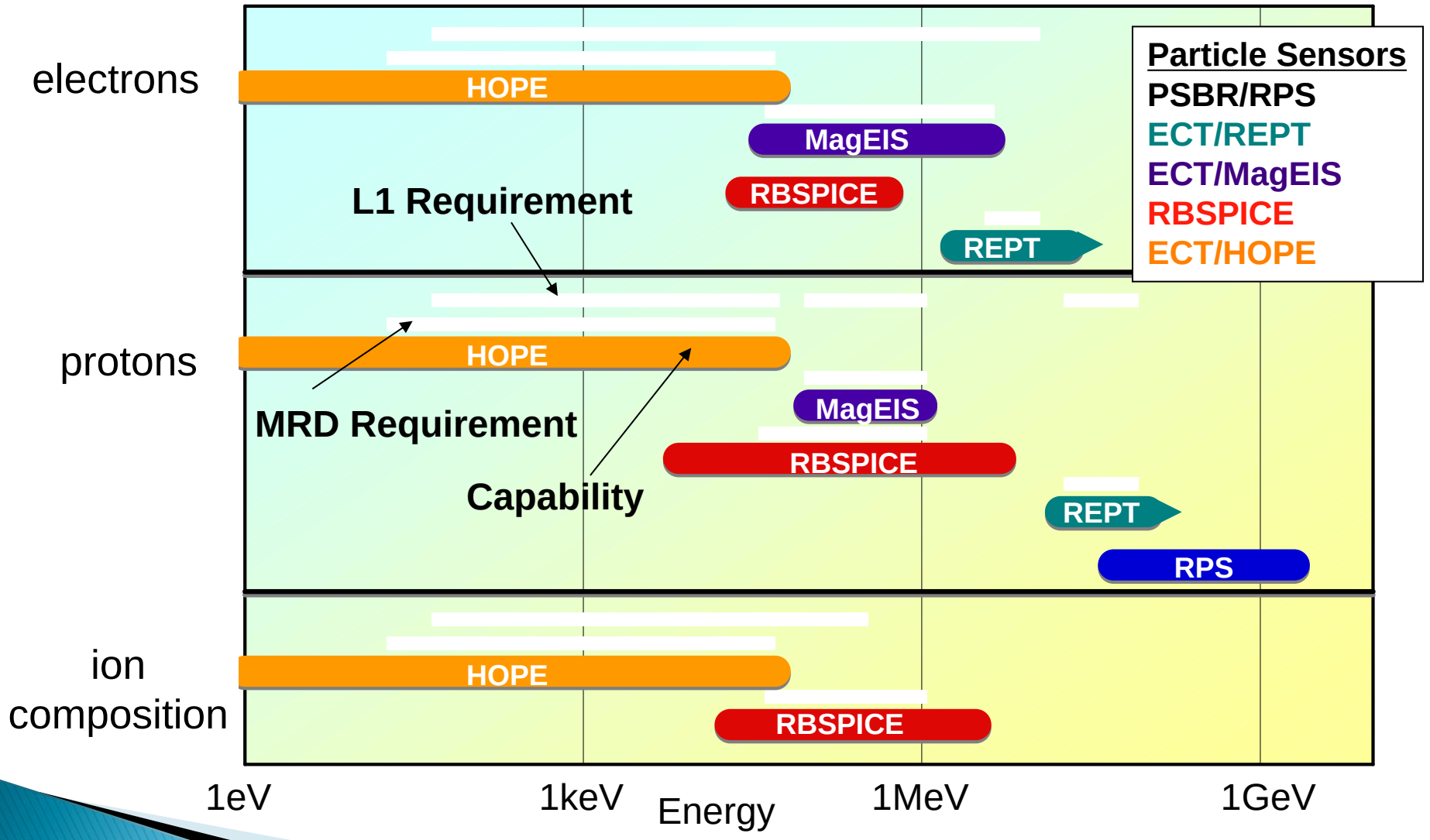
Van Allen Mission Facts

Second Living With a Star Mission
Launch August 30, 2012
Perigee: ~700 km altitude
Apogee ~5.5 Re geocentric altitude
Inclination ~10 degrees
Sun pointing, spin stabilized
Duration 2 years (+? expendables)

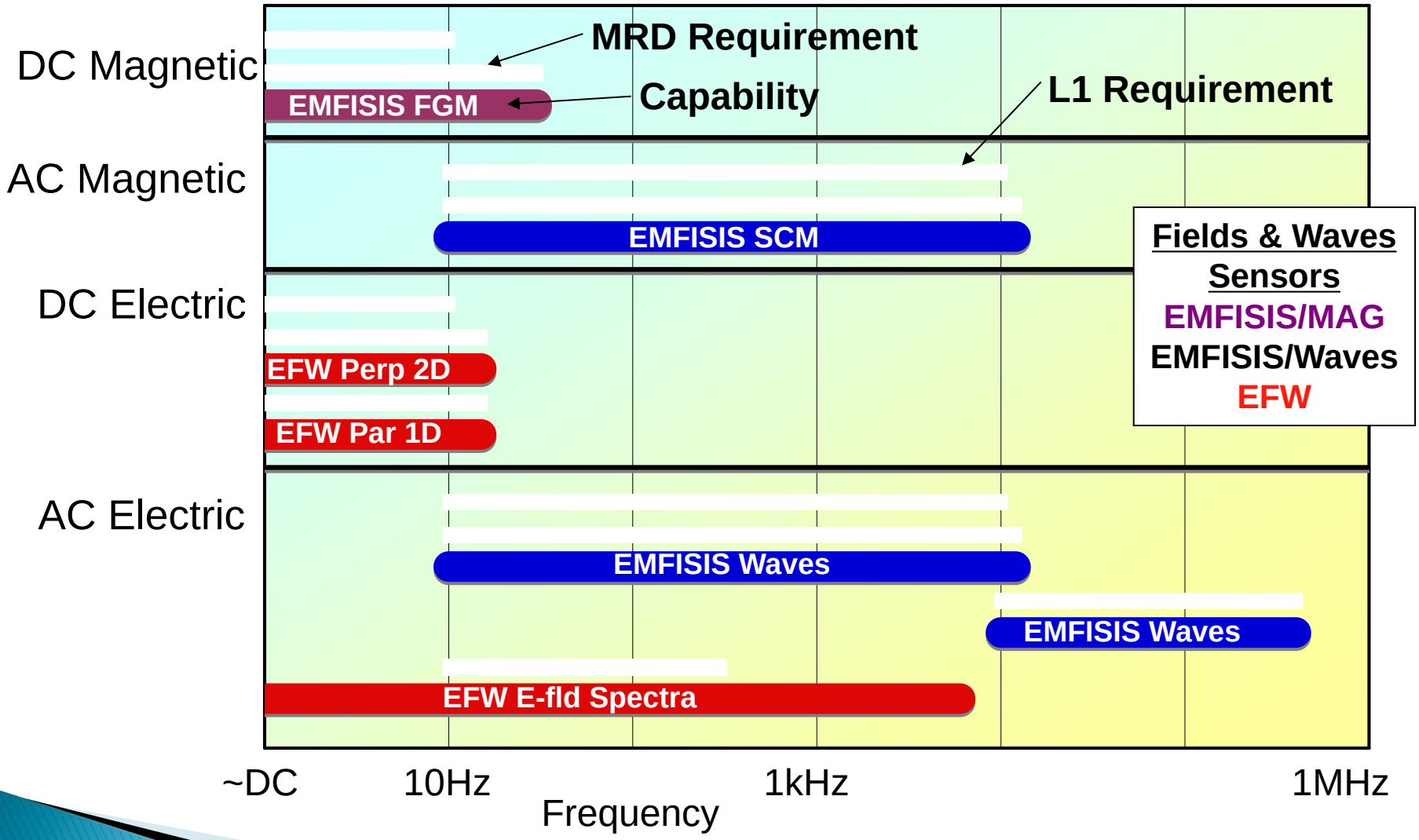
Mission Overview

Provides understanding, ***ideally to the point of predictability,*** of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun.

RBSP has unusually comprehensive particle instrument measurement capabilities

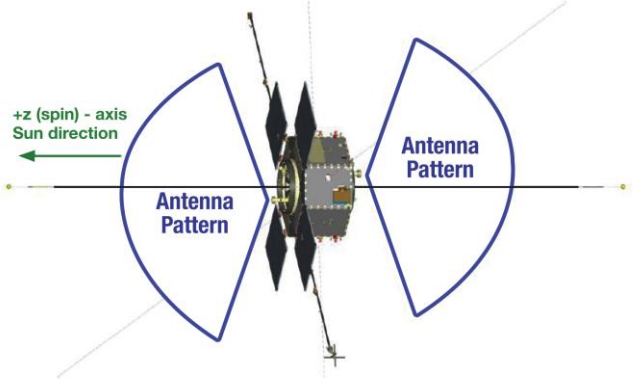


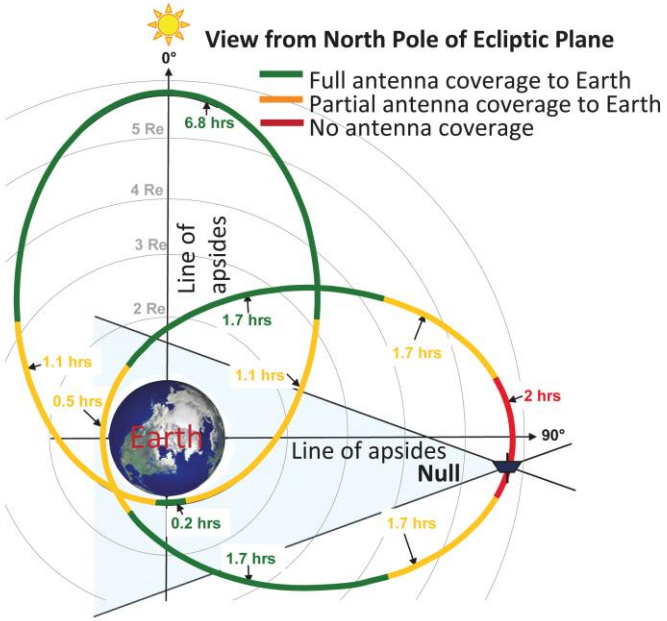
RBSP has unusually comprehensive fields instrument measurement capabilities



Capabilities for generating and broadcasting space weather data

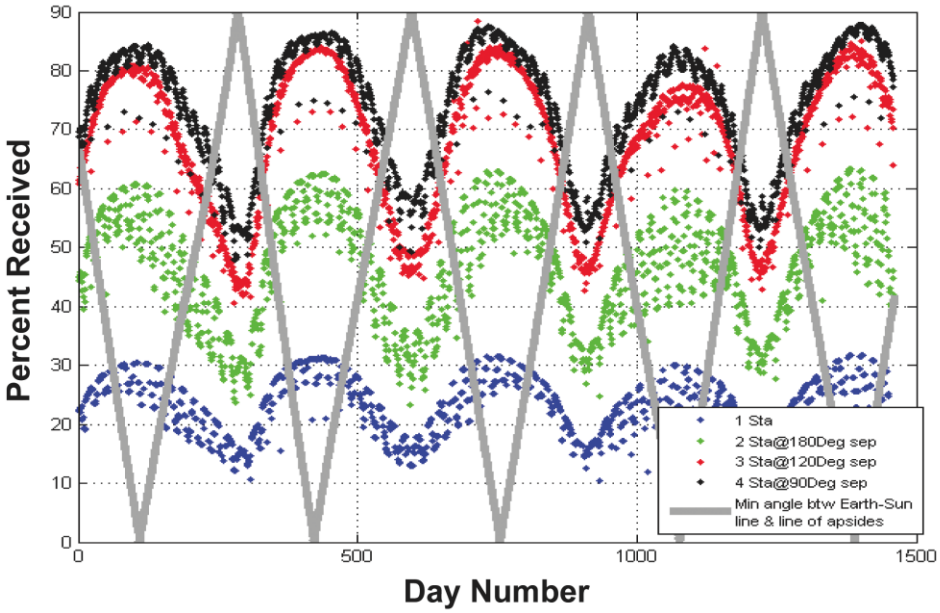
- Each satellite's sw broadcast ~21.5 hr/dy.
- Each instrument has a sw product.
- The 2 RF antennas are aligned with the spacecraft spin- and anti-spin-axes, coverage of ~140°.
- Both antennas are always active, only one has line-of-sight to Earth at any given time.
- Different regions of the orbit have communications downlinks that are robust, variable, or impossible.
- Stations near equator have best year-around coverage.





Space Weather Data Coverage

- Multiple stations at diverse longitudes can maximize potential spacecraft contact duration as a function of the number of ground stations.
- Agreements in place with 2 ground stations (spacecraft A)
  - KASI – Korea Astronomy and Space Science Institute – specially built for RBSP
  - Czech Republic
- Discussions underway with other sites
  - Alaska, Brazil, Argentina, South Africa, Australia, Japan, Taiwan



KASI Scheduled Contacts

From 2013/04/02 12:48:38 to 2013/04/02 21:00:38

From 2013/04/02 12:45:00 to 2013/04/02 21:06:08

Total download: 3.55Mb

Actual Streamed Data

From 2013/04/02 00:00:00 to 2013/04/02 02:51:01

From 2013/04/02 12:50:22 to 2013/04/02 20:58:04

From 2013/04/02 22:11:48 to 2013/04/02 23:59:58

Radiation Belt Storm Probes (RBSP) Web Site

http://rbspsdp.jhuapl.edu/data.php

Oracle Meetings Travel LANL DREAM AGU NASA Reeves LWS RBSP Bibliography Dropbox MobileMe

Radiation Belt Storm Probes Mission

Exploring the Extremes of Space Weather

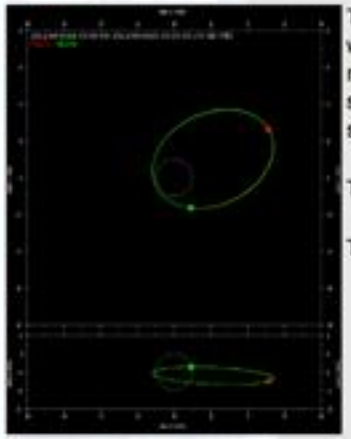
HOME | MISSION | SPACECRAFT | SCIENCE | DATA | NEWS CENTER | EDUCATION | GALLERY

- OVERVIEW
- DATA POLICY
- SPACE WEATHER
- DATA PRODUCTS
- COLLABORATION TOOLS
- MODELS
- ANCILLARY DATA
- INSTRUMENT SOC LINKS
- LINKS TO VIRTUAL OBSERVATORIES
- MEETINGS

Science Data Portal - Home

Welcome to the RBSP Science Data Portal.

The RBSP Science Data Portal provides a common point of entry of specific interest to the RBSP community. The portal provides ancillary services, tools, data and links that benefit the RBSP project. Consistent with NASA policy, all RBSP observations and software will be fully accessible to the research community.



The two RBSP spacecraft will be placed in unusual and highly elliptical orbits which will provide data from the non-traditional orbit locations - operational mointoring satellites are usually at or near geosynchonous orbit. For 3-D specification models, these altitude-varying profiles will provide greater sampling of Earth's radiation environment.

To see the RBSP spacecraft orbits, click here

To access the RBSP position calculator, click here

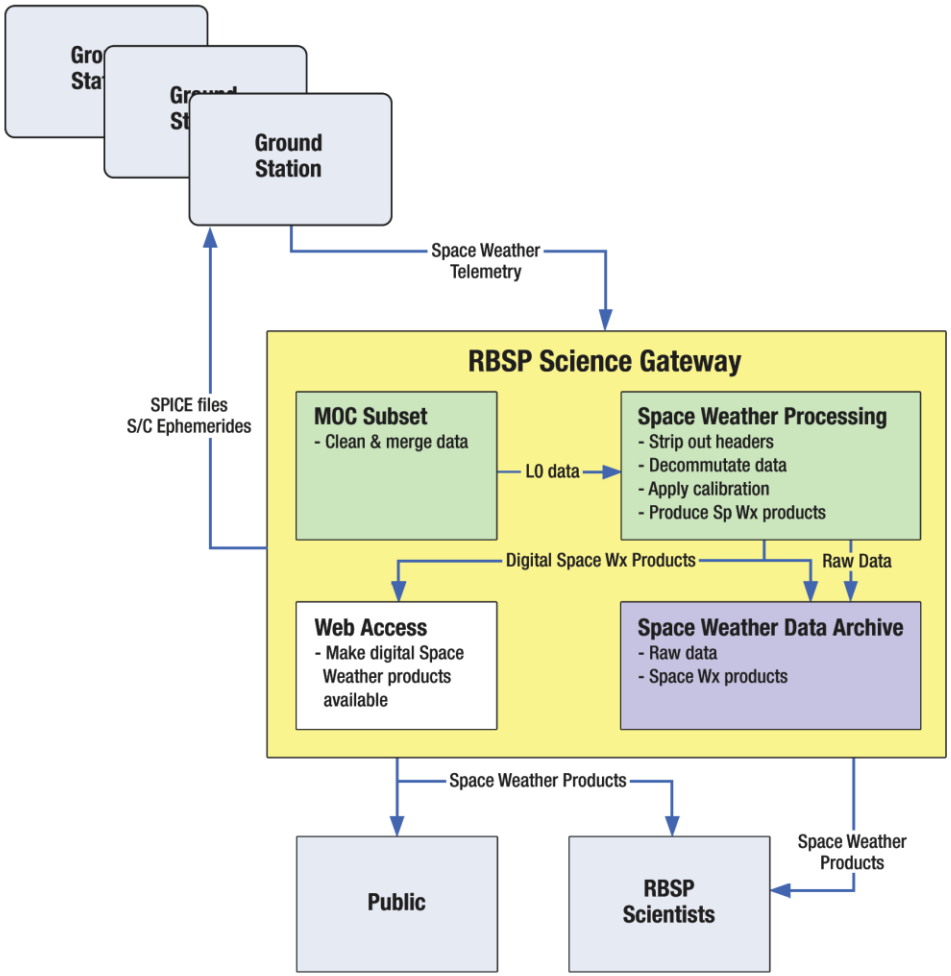
http://athena.jhuapl.edu

NASA APL

Last modified: 4/25/11
Editor: JHU/APL Webmaster
JHU/APL Official: Ms. K. Beisser
+ Contact JHU/APL

Space Weather Data Acquisition and Processing Plan

- Processing uses legacy APL MOC (Mission Operations Center) software developed for the STEREO mission and LRO/Chandrayaan.
- MOC retrieves data from external ground stations, strips out the headers, clean and merge Level 0 data, store raw data in a telemetry archive.
- SW processing system retrieves data from archive, decommutates and applies calibration algorithms to generate sw data products for all of the instruments.



Space Weather Data Products

- Space Weather data products are a subset of full science data
- Processing algorithms are provided by science teams
- Full science data will include gap-filling SW data

					#bits/ component	Data Product Report Rate (bps):
Magnetic Field						
1 vector sample per 5 spins x 3 components					16	0.80
Electric Field						
1 vector sample per 5 spins x 3 components					16	0.80
ULF Wave Power						
1 vector magnetic field sample per 6 secs x 3 components					16	8.00
Plasma Density						
1 spacecraft potential value (+250 V) per 5 spins					12	0.20
Particle Count Rates (electrons & protons)						
energy bin centered at or near:	~bin width:	per # spins	# angles per quarter spin	#az angles		
25 eV	50 eV	5	1	1	12	0.40
300 eV	100 eV	5	5	1	12	2.00
1 keV	5 keV	5	1	1	12	0.40
30keV	10 keV	5	5	1	12	2.00
70 keV	30 keV	5	5	1	12	2.00
150 keV	50 keV	5	1	1	12	0.40
300 keV	100 keV	5	5	2	12	4.00
600 keV	200 keV	5	1	2	12	0.80
1 MeV	1 MeV	5	5	2	12	4.00
3 MeV	2 MeV	5	1	1	12	0.40
>10 MeV*	n/a	5	5	1	12	1.00
>50 MeV*	n/a	5	1	1	12	0.20
>400 MeV*	n/a	5	5	1	12	1.00

NOTES:

Spin rate (s)= 12

*no electrons reported above 10MeV

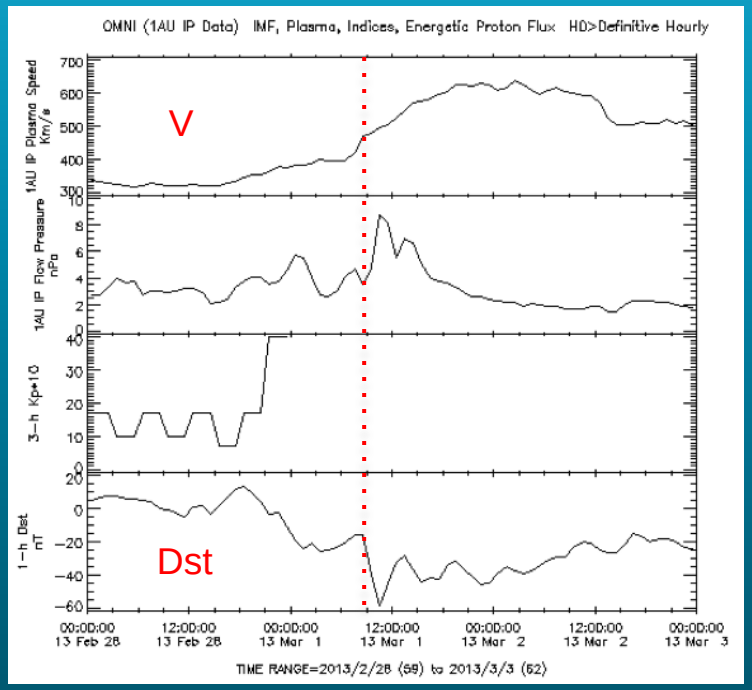
TOTAL DATA PRODUCT REPORT RATE: **28.40**

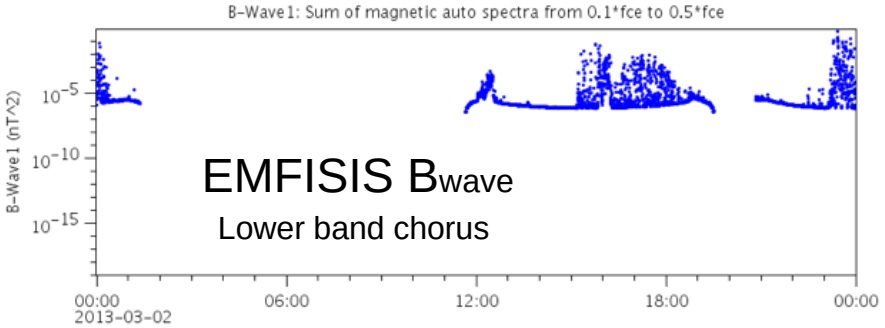
Van Allen Space Weather Data

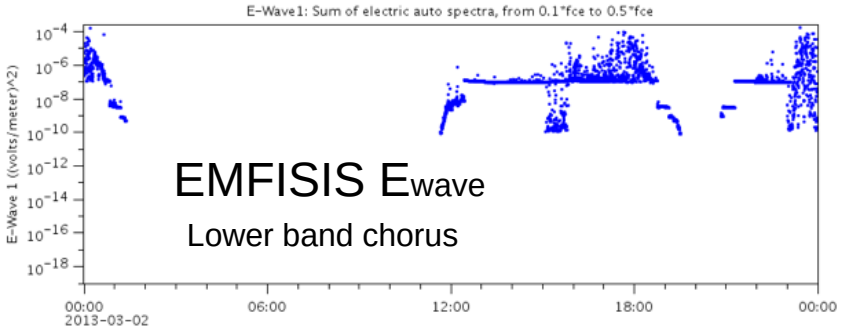
show increase in high energy particles and fields

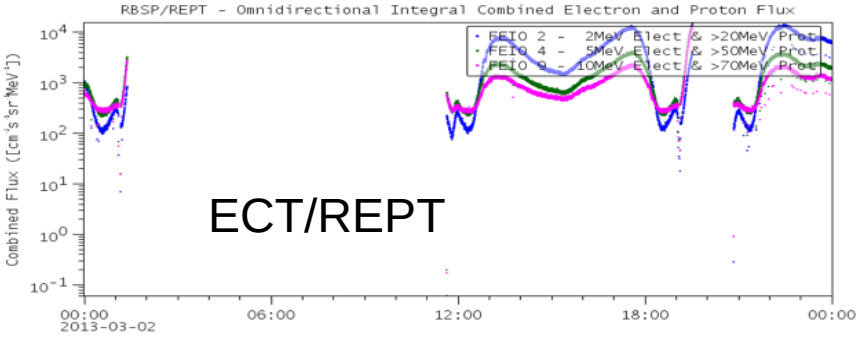
due to impact of high speed solar wind stream

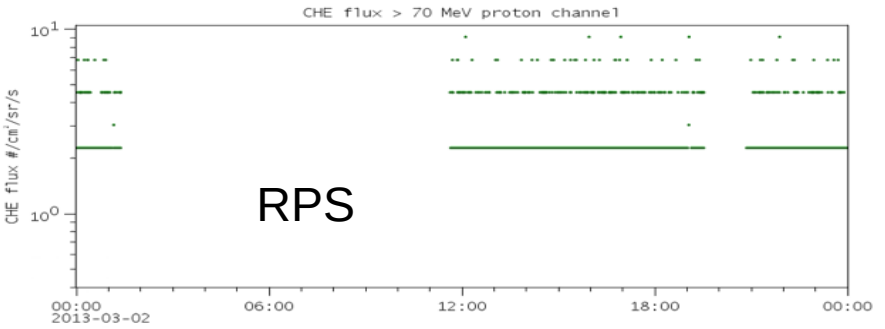
High Speed Stream with increase in Dst











Users/models incorporating data for radiation belt nowcasting and forecasting

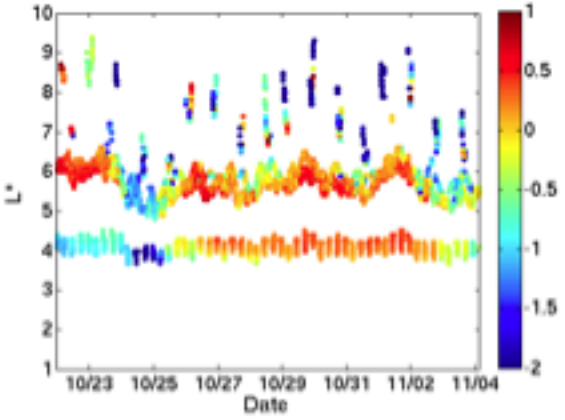
CCMC Space Weather Research Center
will run model

NOAA Space Weather Prediction Center
will host model output

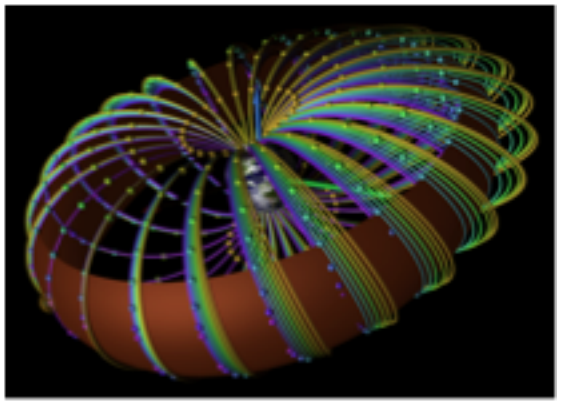
One application

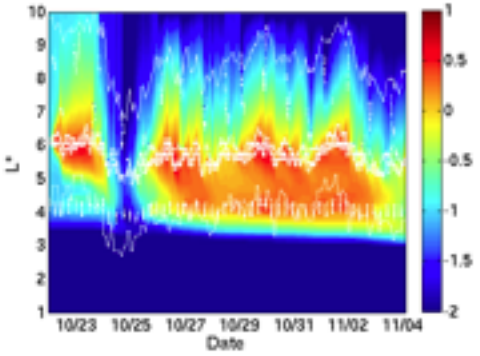
Radiation Belt Data Assimilation

Sparse and/or Heterogeneous Observations



Complex Physical System

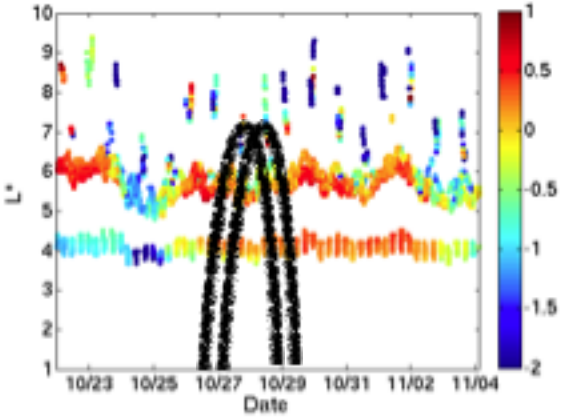




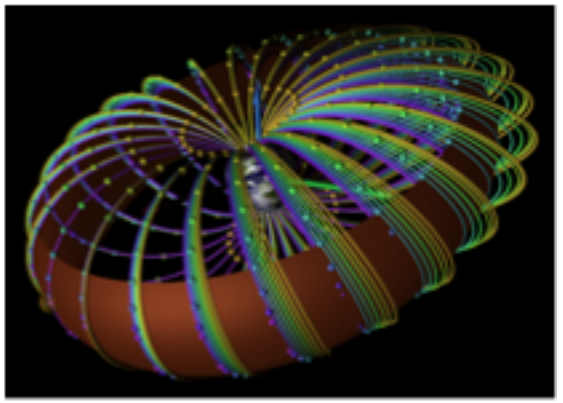
Output: Global specification or forecast of the state of the Radiation Belts

Radiation Belt Data Assimilation

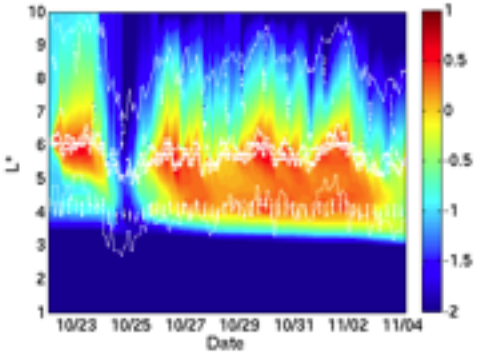
Sparse and/or Heterogeneous Observations



Complex Physical System



Van Allen data will be much less sparse



Concluding Remarks

- The Van Allen probes will continuously broadcast space weather data, except during prime science download and maneuvers. These data were selected to monitor the state of the radiation belts and will be incorporated into models such as DREAM that could lead to better space weather forecasts.
- Currently two international partners have agreed to download this data and make it available for space weather data products. NASA is actively pursuing other ground station partners to fill in data gaps.
- The Van Allen probes have been designed to operate throughout the worst conditions expected in the hazardous radiation belt environment. The mission is poised to significantly enhance our understanding of radiation belt dynamics with changing solar wind conditions.
- The Van Allen probes will enable the prediction of extreme and dynamic space conditions, and will provide the understanding needed to design satellites to survive in space for future missions.