

中級編 1 : イベント解析miniワークショップ (地上観測+Van Allen Probes衛星のデータを用いて)

平成26年度国立極地研究所研究集会
「太陽-地球大気の地上多点観測データ総合解析ワークショップ」
2013年8月20日 於 国立極地研究所

ERGサイエンスセンターチーム
名古屋大学太陽地球環境研究所

Contents

2012年8月に打ち上げられたVan Allen Probes衛星の科学データを、SPEDASを用いて可視化・解析する手法について紹介します。ここでは、具体的なイベントとして SCOSTEP/VarSITIのキャンペーンイベントの一つである 2013年3月17日に起きた磁気嵐を対象とします。

- おしらせ
 - ERGWATについて
- セットアップ
 - Load procedures for Van Allen Probesをダウンロードする
 - » https://github.com/spedas-j/member_contrib/tree/master/rbsp_tool
- 解説と解析
 - VA Probes用のload proceduresの解説と実行 (EMFISIS, ECT/MagEIS, ECT/HOPE)
 - SPEDASによる太陽風/地磁気データのプロット
 - CEFを用いたVA Probesの軌道、地上観測との対応関係の確認 (CEFを使用)
 - ERG連携地上観測データ (SuperDARN、地磁気) の可視化、VA Probesデータとの比較

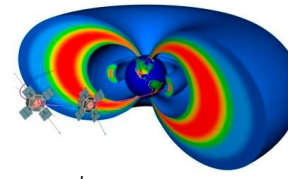
Load procedures to download

spedas-j on GitHub

[https://github.com/spedas-j/member_contrib/
tree/master/rbsp_tool](https://github.com/spedas-j/member_contrib/tree/master/rbsp_tool)

- » rbsp_load_emfisis_hfr.pro
- » rbsp_load_emfisis_wfr.pro
- » rbsp_load_ect_mageis.pro
- » rbsp_load_ect_hope.pro
- » rbsp_load_crib.pro

The Van Allen Probes



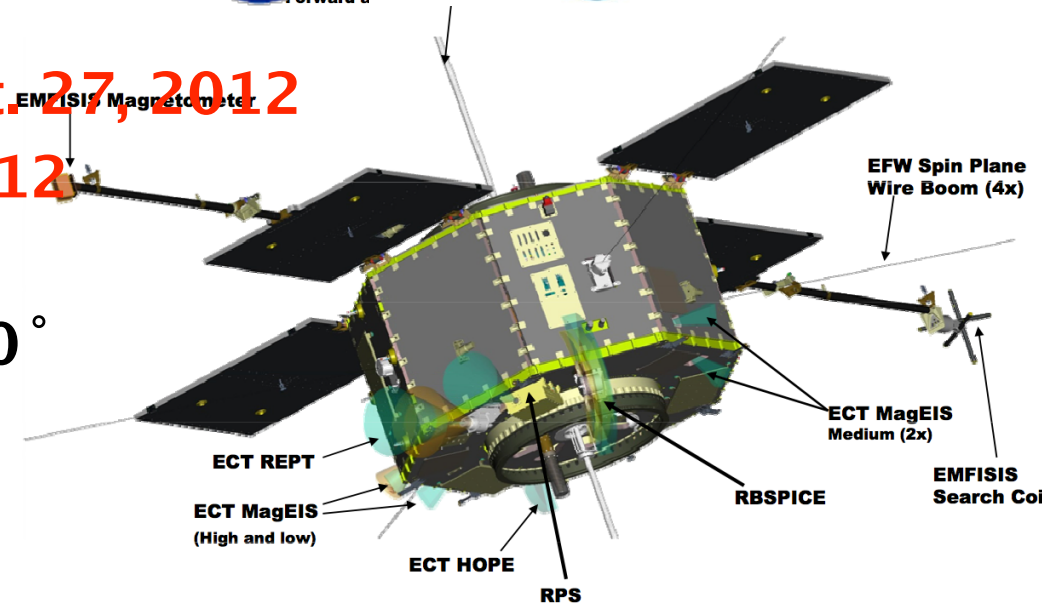
APL

Launch: 4:05 EDT on Aug. 30, 2012

Commissioning phase: through Oct. 27, 2012

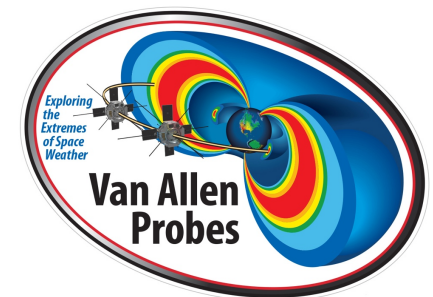
Science operation: after Oct. 27, 2012

- Orbit: ~600 km x 5.8 Re
- Inclination: ~10 deg., |MLAT| < 20°
- Lapping rate: 4 – 5 laps/year



More detail at

- <http://nasa.gov/rbsp>, <http://vanallenprobes.jhuapl.edu/index.php>, YouTube
- Agendas and presentations (incl. focused science topics & inter-mission collaborations) at SWG meetings available at the JHU/APL website.
- Instrument papers are available for FREE in Space Science Reviews.



The Van Allen Probes

Exploring Earth's Radiation Belts and the Extremes of Space Weather



HOME

MISSION

SPACECRAFT

SCIENCE

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GALLERY

INSTRUMENTS

[ECT](#)

[EMFISIS](#)

[EFW](#)

[RBSPICE](#)

[RPS](#)

Spacecraft Instruments

The Applied Physics Laboratory will build and operate the twin RBSP spacecraft for NASA's Living With a Star program.

The RBSP spacecraft will operate entirely within the radiation belts throughout their mission. When intense space weather occurs and the density and energy of particles within the belts increases, the probes will not have the luxury of going into a safe mode, as many other spacecraft must do during storms. The spacecraft engineers must therefore design probes and instruments that are "hardened" to continue working even in the harshest conditions.

The probes will carry a number of instruments and instrument suites to support five experiments that will address the mission's science objectives. Because it is vital that the two craft make identical measurements to observe changes in the radiation belts through both space and time, each probe will carry the following:

- [Energetic Particle, Composition, and Thermal Plasma Suite \(ECT\)](#)
Principal Investigator: H. Spence, University of New Hampshire
- [Electric and Magnetic Field Instrument Suite and Integrated Science \(EMFISIS\)](#)
Principal Investigator: C. Kletzing, University of Iowa, Iowa City
- [Electric Field and Waves Suite \(EFW\)](#)
Principal Investigator: J. Wygant, University of Minnesota, Minneapolis
- [Radiation Belt Storm Probes Ion Composition Experiment \(RBSPICE\)](#)
Principal Investigator: L. Lanzerotti, New Jersey Institute of Technology
- [Relativistic Proton Spectrometer \(RPS\)](#)
Principal Investigator: National Reconnaissance Office



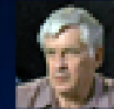
Craig Kletzing
EMFISIS



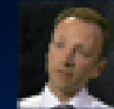
Harlan Spence
ECT



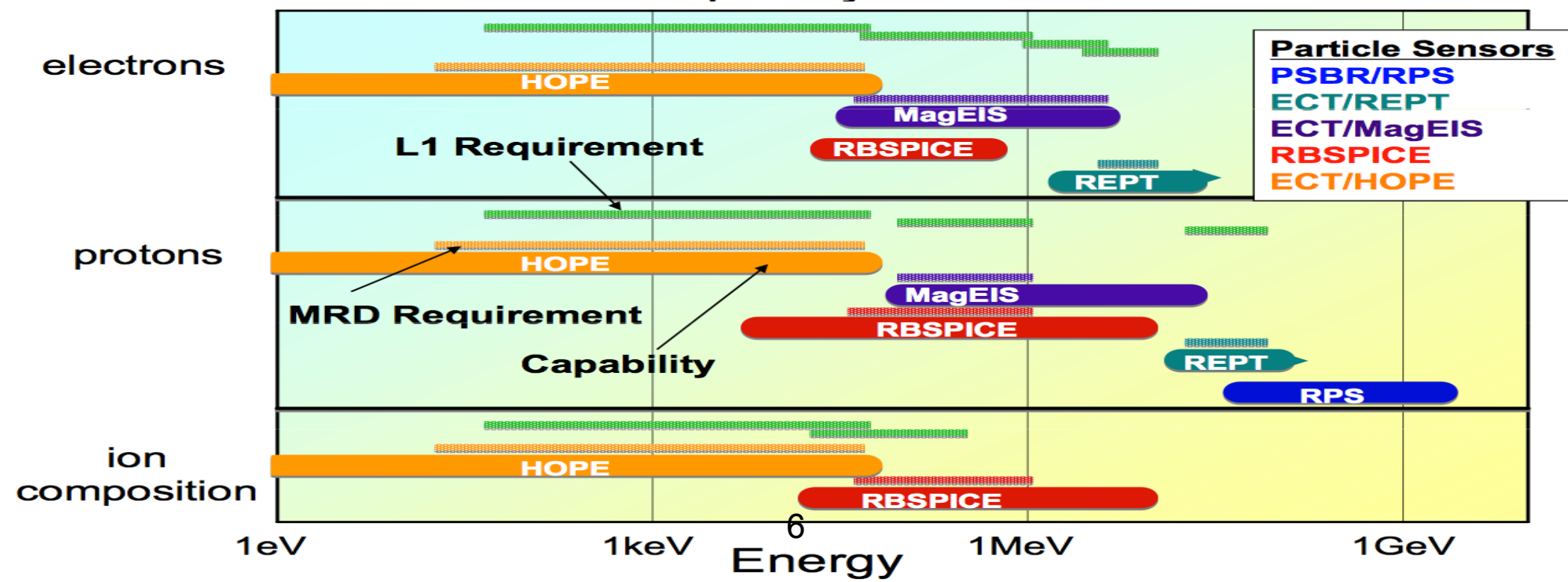
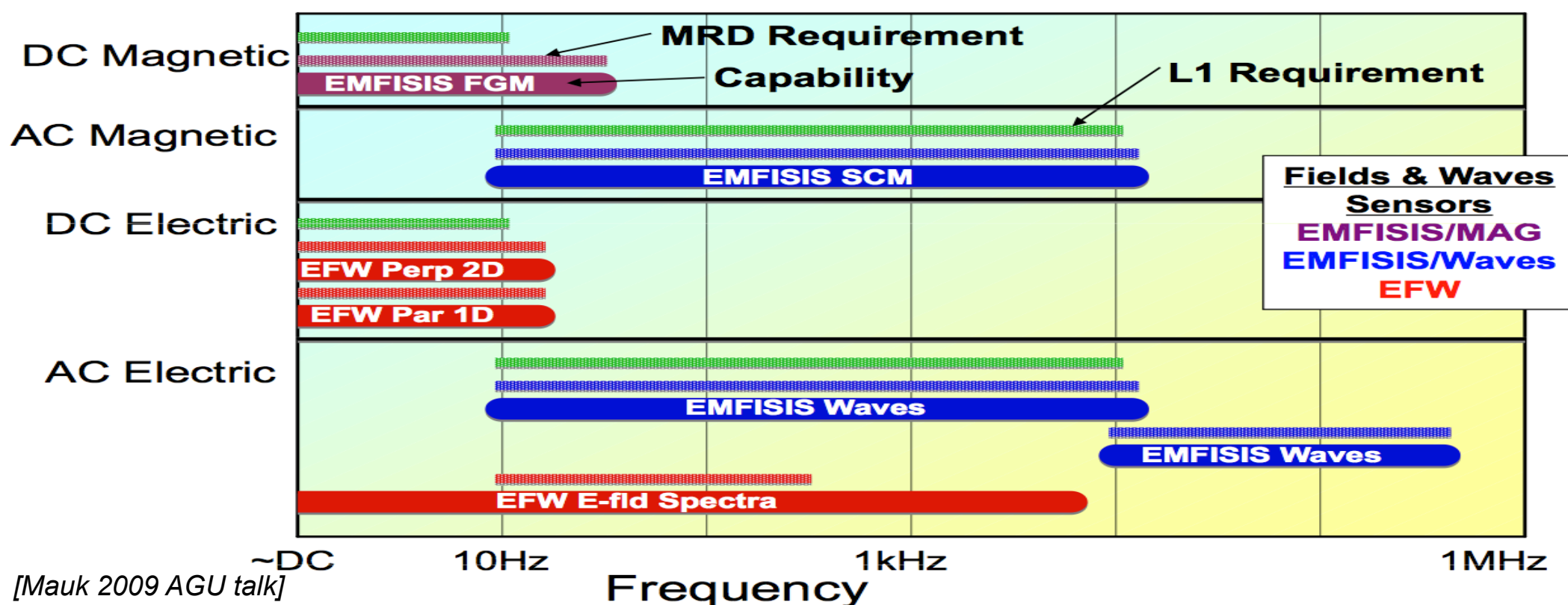
Louis Lanzerotti
RB-SPICE



John Wygant
EFW



Joe Mazur
RPS



DATA: Data Product Descriptions

| Data Level | ECT | EFW | EMFISIS | RBSPICE | RPS |
|------------|--|--|--|--|--|
| L0 | Raw Telemetry (Raw de-computed telemetry received from MOC) | Raw Telemetry (Raw de-computed telemetry received from MOC) | Raw Telemetry (Raw de-computed telemetry received from MOC) | Raw Telemetry (Raw de-computed telemetry received from MOC) | Raw Telemetry (Raw de-computed telemetry received from MOC) |
| L1 | Count Rates (Sorted time tagged instrument separated counts per second) | Time Tagged Raw waveform and spectral data (Expressed in spinning spacecraft coordinate system) | Time series and spectra (relative amplitudes); burst data Calibrated Magnetic Field values (Calibrated and corrected physical units) | Count Rates (Sorted time tagged instrument separated counts per second) | Energy/Photon deposits, singles and coincidence rates (Time tagged in UTC, magnetic field vector, minimal magnetic coordinates) |
| L2 | Calibrated Flux (Calibrated and corrected physical units) | Calibrated Waveform and Spectral Data (In despun spacecraft coordinate system and other relevant geophysical Systems) | Spectral Quantities (Calibrated and corrected physical units); Includes low frequency spectra from MAG B vector in UVW | Calibrated Flux (Calibrated and corrected physical units) | Flux versus Energy Spectrum |
| L3 | Pitch Angle and Moments (Pitch angle distributions and moments of the plasma distribution) | Calibrated Waveform and Spectral Data (with $V \times B$ subtraction for DC E-field estimate) | Magnetic wave parameters B vector in GSE, GSM, SM | Pitch Angle and Moments (Pitch angle distributions and moments of the plasma distribution) | Energy-pitch angle spectrum, equatorial pitch angle, and magnetic coordinates |
| L4 | Phase Space Density (PSD units in adiabatic coordinate space) | Global Electric Field Pattern | Wave propagation parameters (Spectral matrices, WNA, polarization, Poynting flux, etc) Electron densities | Phase Space Density (PSD units in adiabatic coordinate space) | Global Maps (flux versus E/K/Phi and PSD versus M/K/Phi) |

EMFISIS fluxgate magnetometer data (4 sec, 1 sec, and 64 Hz)

`rbsp_load_emfisis.pro` is available in the TDAS bleeding edge.

```
IDL> timespan, '2013-03-17', 1, /days
```

1-sec data in SM coordinates

```
IDL> rbsp_load_emfisis, level='I3', cadence='1sec',  
coord='sm', probe='b'
```

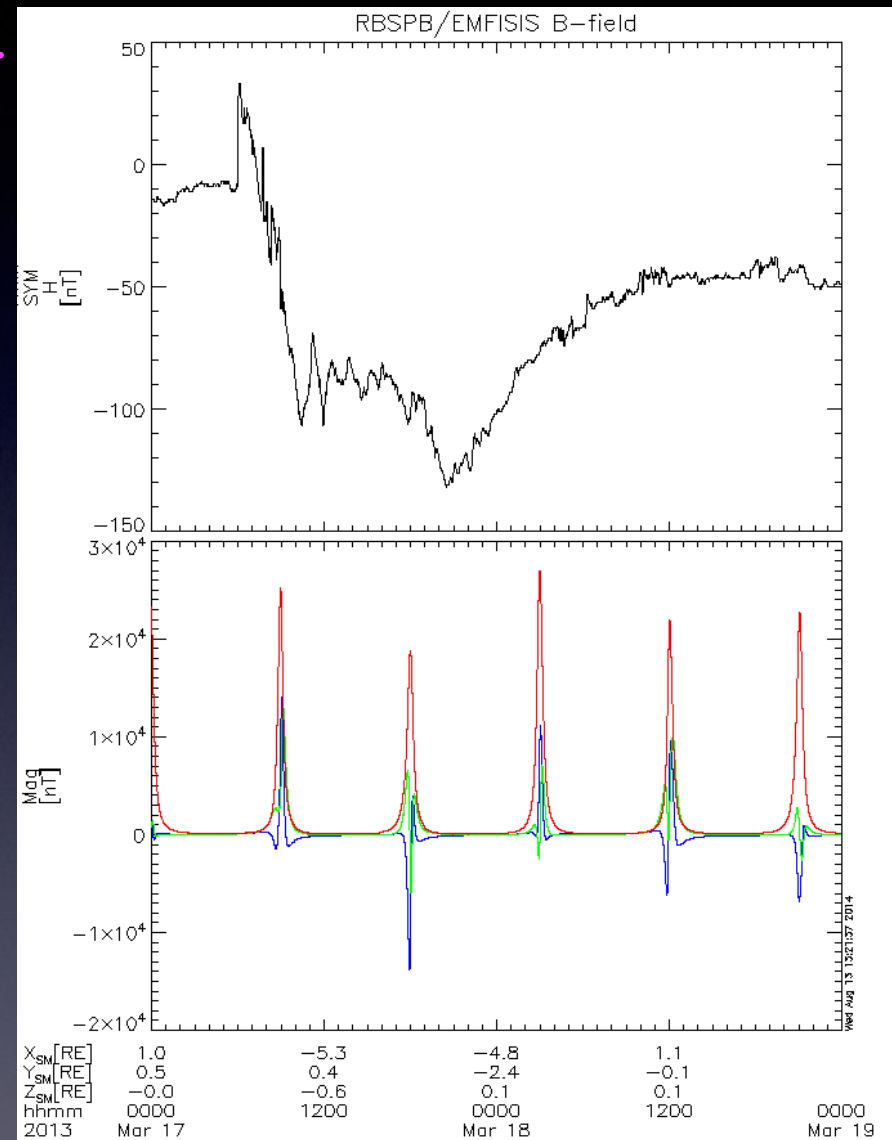
4-sec data in GSM coordinates

```
IDL> rbsp_load_emfisis, level='I3', cadence='4sec',  
coord='gsm', probe='b'
```

64-Hz data in GSM coordinates

```
IDL> rbsp_load_emfisis, level='I3', cadence='hires',  
coord='gsm', probe='b'
```

See details in ERGプロジェクトTDASツールマニュアル
available at <http://ergsc.stelab.nagoya-u.ac.jp/analysis/>



★同時に軌道データも読み込まれるので、例えば、
`tplot, var_label='rbspa_emfisis_I3_4sec_sm_coordinates'`
とすると時刻の下に軌道情報が表示される。

EMFISIS: Data access (Wave spectra CDF files)



- Data menu
 - Data Index
 - Data Use Policy
 - Data Products Level Descriptions
 - Data Products - Level 2
 - Data Products - Level 3
 - Data Products - Level 4
 - Data Products General File Description

Data Index

| | RBSP-A | RBSP-B |
|--------------|--|--|
| Data files | L2, L3, L4, and Quick-look | L2, L3, L4, and Quick-look |
| HFR-WFR | PNG Walk, daily PNG Walk, orbital | PNG Walk, daily PNG Walk, orbital |
| WFR Diagonal | PNG Walk | PNG Walk |

PNG Walk (Java) with links to autoplot

Index of /Flight/RBSP-A

| <u>Name</u> | <u>Last modified</u> | <u>Size</u> | <u>Description</u> |
|----------------------------------|----------------------|-------------|--------------------|
| Parent Directory | | - | |
| L2/ | 23-Aug-2012 19:32 | - | |
| L3/ | 26-Feb-2013 09:16 | - | |
| Quick-Look/ | 05-Sep-2012 03:42 | - | |

EMFISIS: Wave power spectra HFR (> 10 kHz)

`rbsp_load_emfisis_hfr.pro` is prepared by ERG-SC, available at `spedas-j` on GitHub.

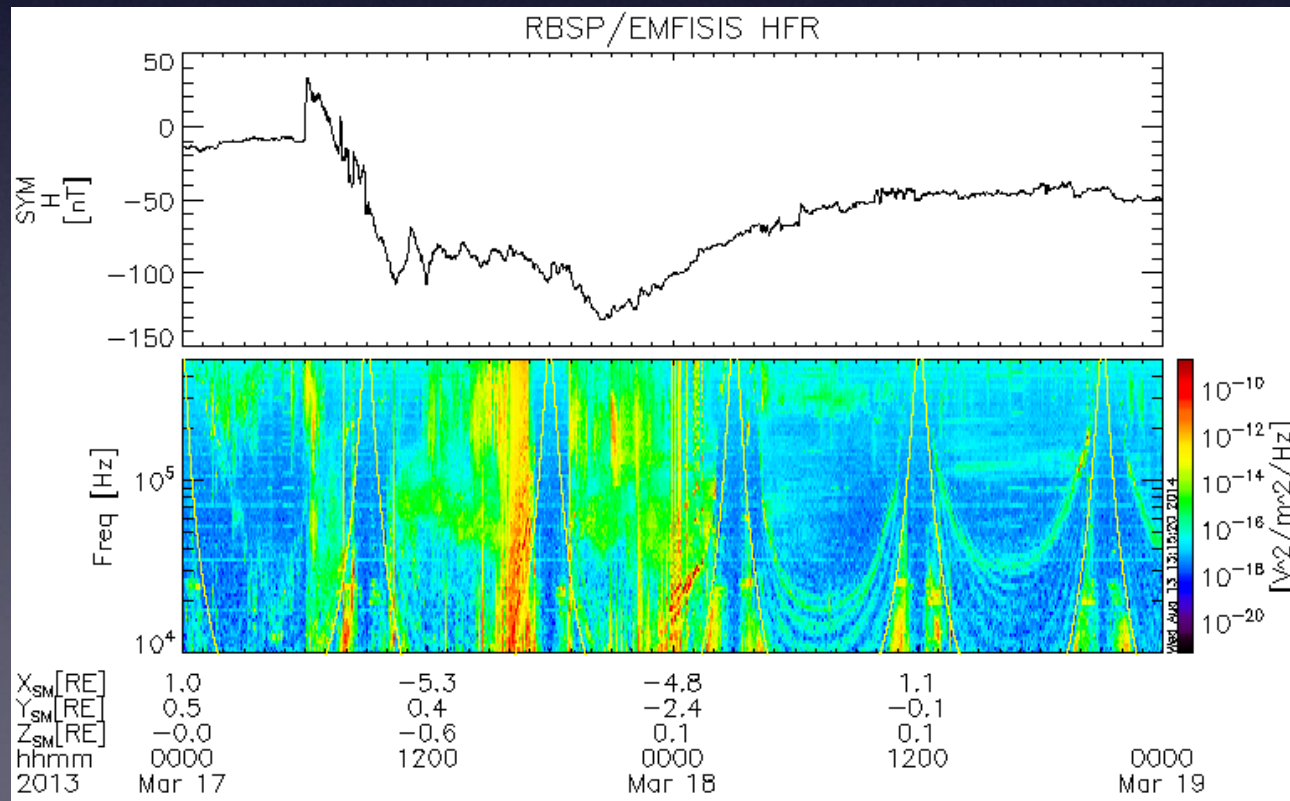
```
IDL> timespan, '2013-03-17', 1, /days
```

```
IDL> rbsp_load_emfisis_hfr, probe='b', datatype = 'spectra'
```

for Survey data (`rbsp-b_HFR-spectra_emfisis-L2_YYYYMMDD_v??.?.cdf`)

```
IDL> rbsp_load_emfisis_hfr, probe='b', datatype = 'spectra-merged'
```

for Survey + burst data (`rbsp-b_HFR-spectra-merged_emfisis-L2_YYYYMMDD_v??.?.cdf`)



EMFISIS: Wave power spectra WFR (a few Hz - 10 kHz)

[rbsp_load_emfisis_wfr.pro](#) is prepared by ERG-SC, available at [spedas-j](#) on GitHub.

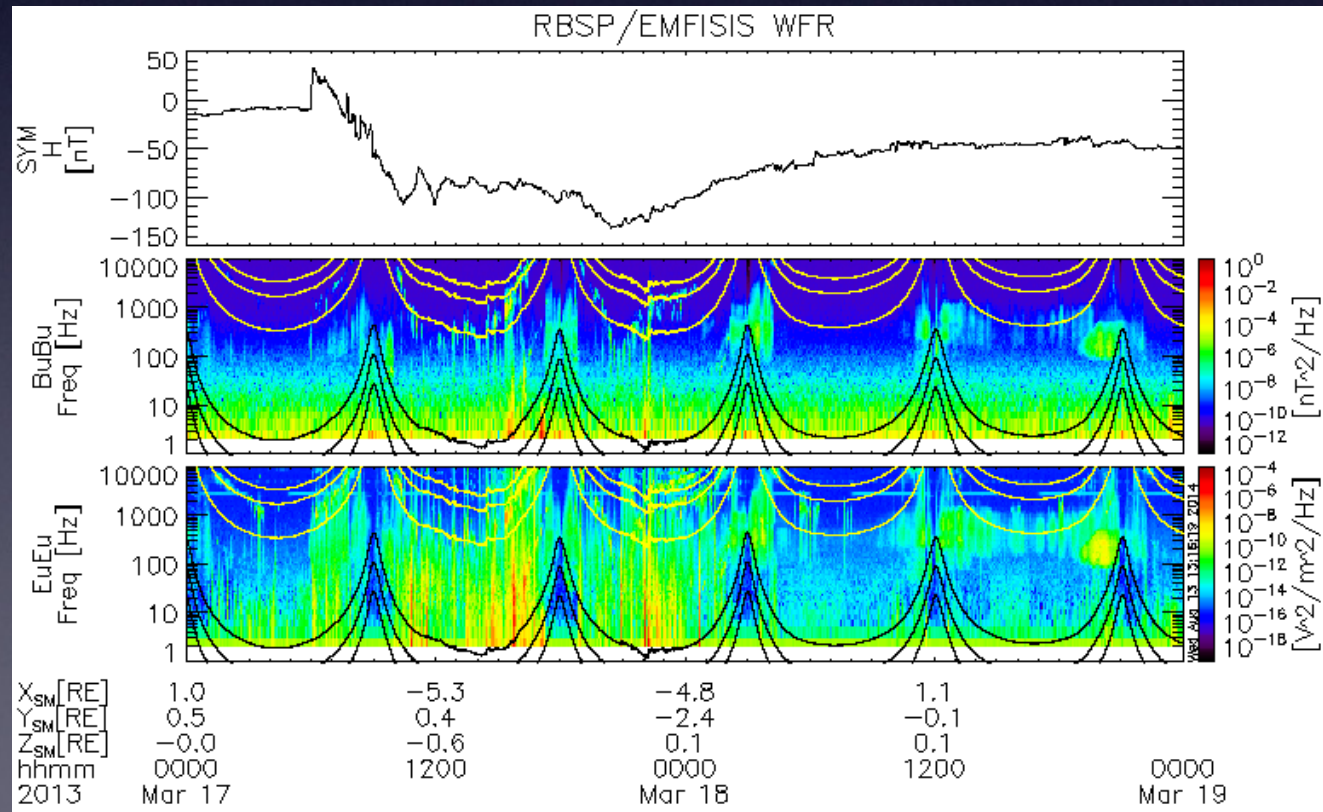
```
IDL> timespan, '2013-03-17', 1, /days
```

```
IDL> rbsp_load_emfisis_wfr, probe='b', datatype = 'spectra' (for Survey data)
```

([rbsp-b_WFR-spectral-matrix-diagonal_emfisis-L2_YYYYMMDD_v??.?.cdf](#))

```
IDL> rbsp_load_emfisis_wfr, probe='b', datatype = 'spectra-merged' (for Survey and burst data)
```

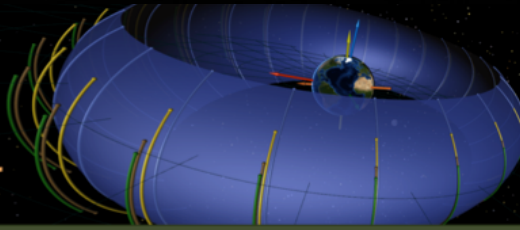
([rbsp-b_WFR-spectral-matrix-diagonal-merged_emfisis-L2_YYYYMMDD_v??.?.cdf](#))



ECT: Data access (QL & autoplot)

Radiation Belt Storm Probes
ECT Energetic Particle Composition
& Thermal Plasma Suite

Science Operations and Data Center



RBSP-ECT Home Other Data Links Mission Links Documentation Instrument Team Pages

RBSP-ECT Public Data

- » ECT Summary Plots
- » ECT Digital Data Files
- » Qin-Denton Parameters
- » A Magnetic Ephemeris
- » B Magnetic Ephemeris

Autoplot for ECT

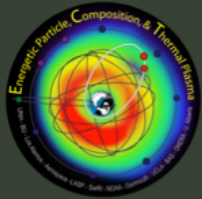
- » Launch Autoplot
- » Autoplot Information

Publications

- » Published Papers
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Image & Movie Gallery

Current S/C Locations



The RBSP-ECT Science Investigation

The structure and content of the RBSP-ECT web pages is changing. Some of the sections before we actually started getting data and is either outdated or not ideal for our current needs. We're trying to update things to make it easier to find the information that you need.

The menu at the top of this page is available on every page on this site. The RBSP-ECT logo is also available on this page.

The side menu may have links that are specific to a particular page. But, by default, the links point to science plots and digital data from the RBSP-ECT instruments, launchers and instruments - software for browsing and manipulating data, RBSP-ECT publications and science operations.

RBSP-ECT Home Other Data Links Mission Links Documentation Instrument Team Pages

RBSP-ECT Public Data

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Current S/C Locations

RBSP-ECT Publication and Communication Policy

v.12 September 2012

Contents

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- 2 The RBSP-ECT Team
- 3 Publications
- 4 Communications
 - 4.1 Talks and Posters
 - 4.2 Press Releases
- 5 Contact Information

The WORD version of this page is available [here](#).

1 Introduction

This document establishes the policy for publications (articles, conference proceedings, etc.) and communications (talks, posters, press releases, etc.) prepared by members of the RBSP-ECT team. The official definition of the RBSP-ECT team membership is defined below in Section 2. This unified policy allows the team to:

- Maintain the quality of early and critical RBSP-ECT publications by ensuring consultation with members of the team who are familiar with the operation of the instrument, subtleties in the instrument response, and any potential pitfalls;
- Acknowledge the work put into the design and development of the RBSP-ECT instrument to produce the capable and calibrated instrument now available for science;
- Coordinate the efforts across the team to avoid duplication of effort and maximize science return.

2 The RBSP-ECT Team Members

Membership in the RBSP-ECT team is defined based on contributions to the original RBSP-ECT flight proposal and to the design, construction, calibration of the instrument and the data processing pipeline used to produce science quality data and analysis methods. We have divided the team into a "Core" group that had hands-on involvement in the proposal that made this project possible and the hardware and simulation efforts used in that process. A second group is "Significant contributors". The final group of "Scientists" may not have worked on the instrument itself but either enabled development of the instrument or are conducting early scientific studies with RBSP-ECT data.

| Core ECT team | ECT Significant contributor | ECT Scientists |
|---------------|--------------------------------------|---|
| Harlan Spence | All official Co-Is and collaborators | Closest colleagues at core institutions |
| Geoff Reeves | | |
| Herb Funsten | | Those who join team after launch |
| Bern Blake | | |
| Dan Baker | | |

Table 1: The RBSP-ECT team.

RBSP-ECT Preliminary Science Data Products

The data and plots provided here are **preliminary**. There are known errors and inconsistencies that are being actively worked on. For example the units and absolute flux values may not be exactly as indicted in the data files. The products that are provided here are for quick-look purposes and are not for publication. We also recommend and request that you contact the ECT team prior to using preliminary plots or data in a public presentation. (Harlan Spence, Geoff Reeves)

Data are provided in .cdf format. Plots are provided in .png format. All data and plots have been developed to be compliant with Autoplot. We have not yet completed all of the nice autoplot linkages for these files. However, if you know how to use the autoplot pngwalk tool you can point it at any of these directories. Also, this page is a temporary location for access to ECT science data and plots. We will be redesigning the ECT web site to make navigation and access to data products easier so the contents of this page could be moving soon.

All data and plots can be accessed by ftp in a directory format at [RBSP Data Files FTP Root](#)

All data and plots can be accessed by http in directory format at [RBSP Data Files HTTP Root](#)

To get to data the structure of the directories generally follows the path /spacecraft (e.g. rbspa) / instrument (e.g. REPT) / data level (e.g. level2) /

To get to data the structure of the directories generally follows the path /spacecraft (e.g. rbspa) / instrument (e.g. REPT) / data level (e.g. level2) / plots / plot type

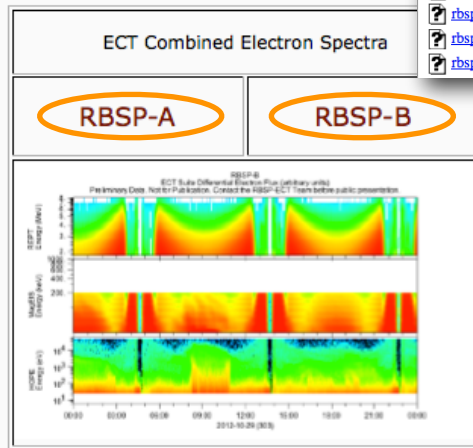
More direct access to specific data and plots is provided using the links below.

Data Access

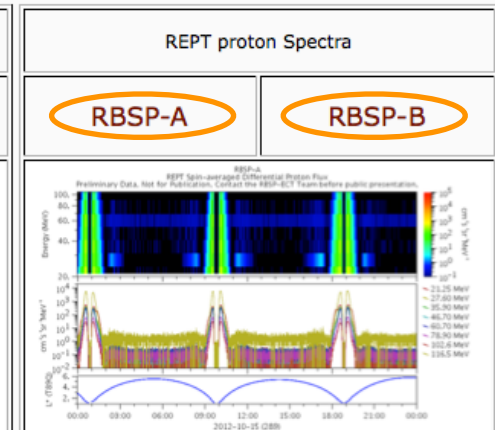
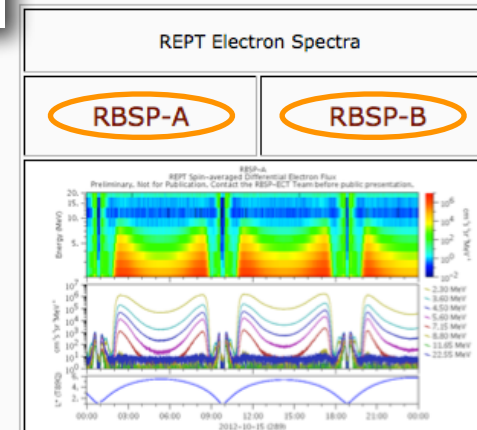
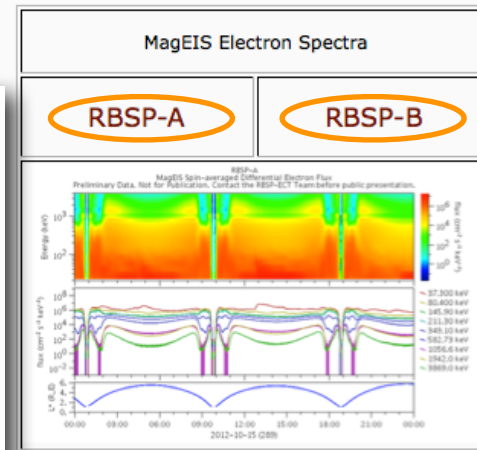
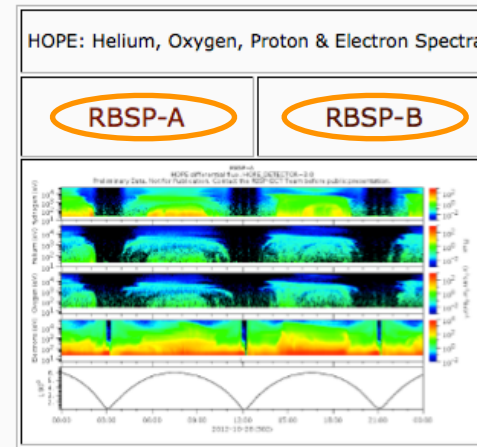
| | |
|-------------|-------------|
| RBSP-A | RBSP-B |
| HOPE Data | HOPE Data |
| MagEIS Data | MagEIS Data |
| REPT Data | REPT Data |

Index of /data_pub/rbspa/hope/level2

| Name | Last modified | Size | Description |
|---|-------------------|------|-------------|
| Parent Directory | - | - | - |
| plots/ | 04-Mar-2013 13:46 | - | - |
| pre-launch/ | 01-Apr-2013 19:13 | - | - |
| rbspa_pre_ect-hope-sci-L2_20121101_v1.0.0.cdf | 26-Mar-2013 17:17 | 324M | |
| rbspa_pre_ect-hope-sci-L2_20121102_v1.0.0.cdf | 26-Mar-2013 17:18 | 324M | |
| rbspa_pre_ect-hope-sci-L2_20121103_v1.0.0.cdf | 26-Mar-2013 17:12 | 324M | |
| rbspa_pre_ect-hope-sci-L2_20121104_v1.0.0.cdf | 26-Mar-2013 17:13 | 324M | |
| rbspa_pre_ect-hope-sci-L2_20121105_v1.0.0.cdf | 26-Mar-2013 17:14 | 322M | |
| rbspa_pre_ect-hope-sci-L2_20121106_v1.0.0.cdf | 26-Mar-2013 17:15 | 321M | |
| rbspa_pre_ect-hope-sci-L2_20121108_v1.0.0.cdf | 26-Mar-2013 17:11 | 320M | |
| rbspa_pre_ect-hope-sci-L2_20121110_v1.0.0.cdf | 26-Mar-2013 17:10 | 321M | |
| rbspa_pre_ect-hope-sci-L2_20121120_v1.0.0.cdf | 27-Mar-2013 08:56 | 309M | |
| rbspa_pre_ect-hope-sci-L2_20121121_v1.0.0.cdf | 27-Mar-2013 08:55 | 310M | |
| rbspa_pre_ect-hope-sci-L2_20121122_v1.0.0.cdf | 27-Mar-2013 08:55 | 310M | |

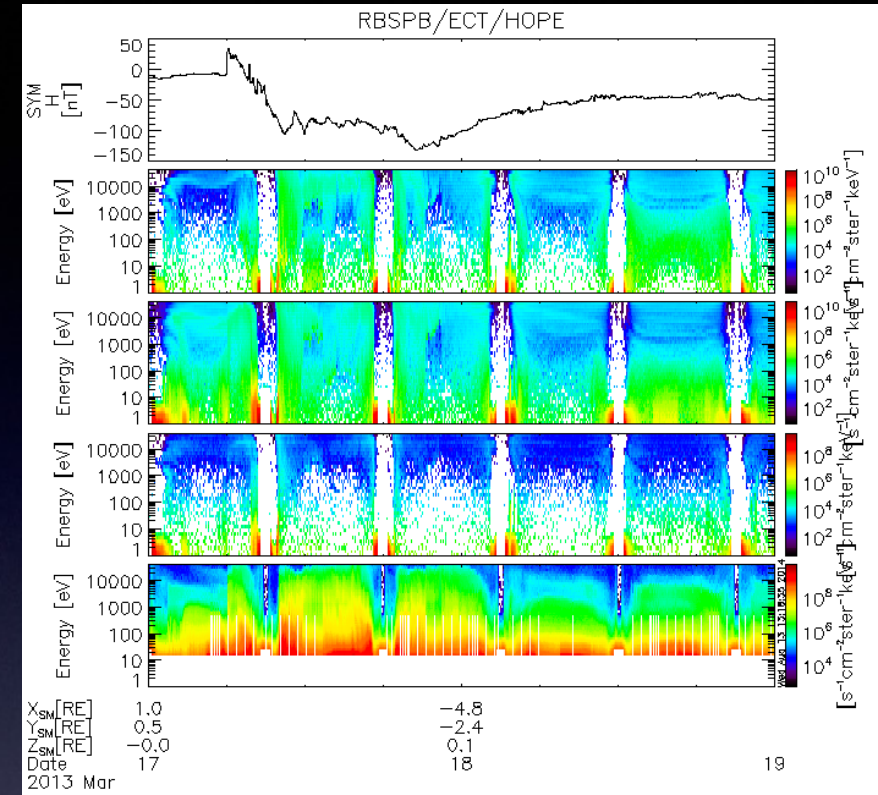


Summary Plot Access



ECT/HOPE: Lev-2 data

- FESA > Spin-Averaged Differential Electron Flux
- FPSA > Spin-Averaged Differential Proton Flux
- FHESA > Spin-Averaged Differential Helium Flux
- FOSA > Spin-Averaged Differential Oxygen Flux
- FEDU > Uni-directional Differential Electron Flux
- FPDU > Uni-directional Differential Proton Flux
- FHEDU > Uni-directional Differential Helium Flux
- FODU > Uni-directional Differential Oxygen Flux



[rbsp_load_ect_hope.pro](#) is prepared by ERG-SC, available at [spedas-j](#) on GitHub.

```
IDL> timespan, '2013-03-17', 1
```

```
IDL> rbsp_load_ect_hope, probe='b', /spin_avg
```

for spin-averaged flux data (rbspb_rel02_ect-hope-sci-L2SA_20130317_v???.cdf)

```
IDL> rbsp_load_ect_hope, probe='b'
```

for uni-directional flux data (rbspb_rel02_ect-hope-sci-L2_20130317_v???.cdf)

ECT/MagEIS: Lev-2 data

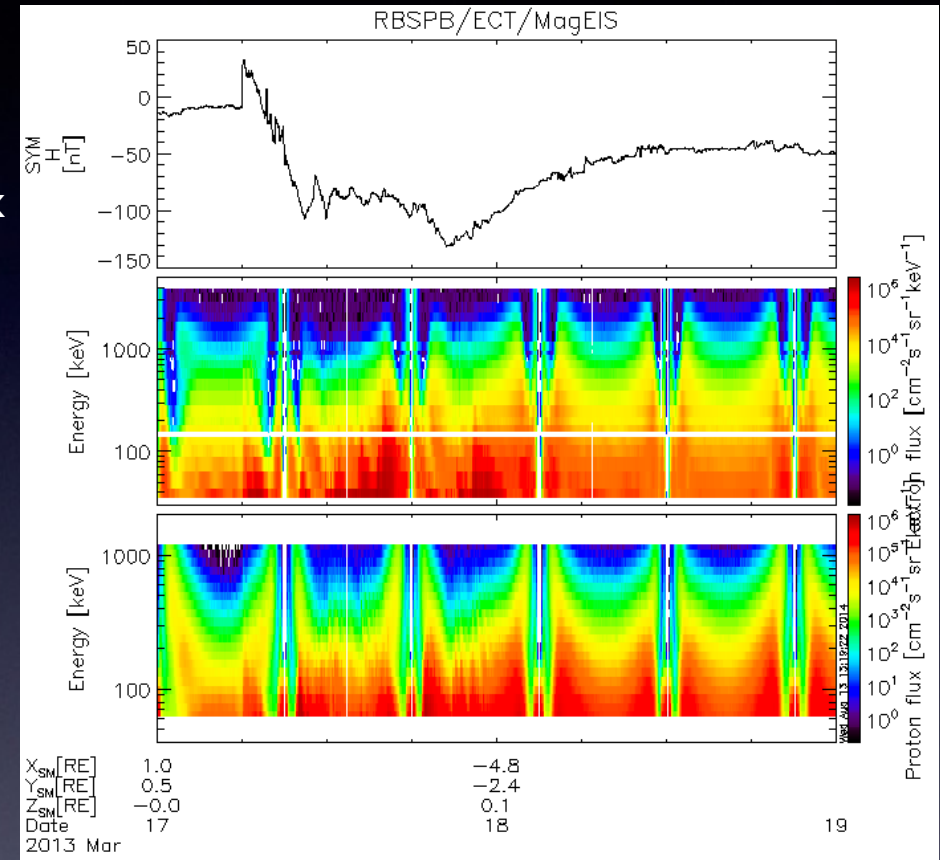
- FESA > Spin-Averaged Differential Electron Flux
- FPSA > Spin-Averaged Differential Proton Flux
- FEDU > Uni-directional Differential Electron Flux
- FPDU > Uni-directional Differential Proton Flux

[rbsp_load_ect_mageis.pro](#) is prepared by ERG-SC, available at [spedas-j](#) on GitHub.

```
IDL> timespan, '2013-03-17', 1
```

```
IDL> rbsp_load_ect_mageis, probe='b'
```

```
for flux data (rbspb_rel02_ect-mageis-  
L2_20130317_v?????.cdf)
```



Solar wind and geomagnetic indices

Solar wind data, SYM-H, etc.

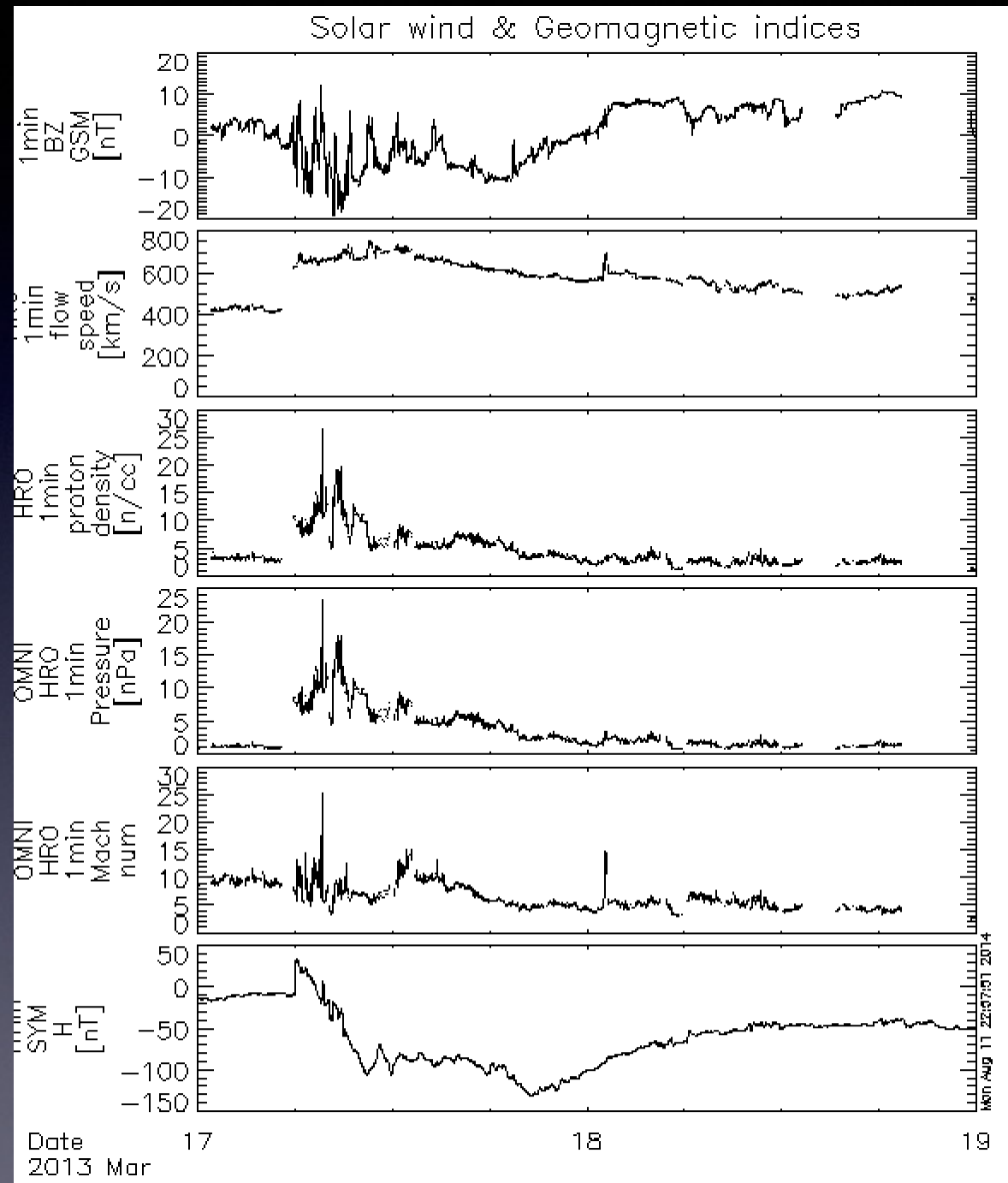
IDL> omni_hro_load

Dst

IDL> kyoto_load_dst

AE

IDL> kyoto_load_ae



Ground-based observations

- Check conjunctions with Conjunction Event Finder (<http://ergsc.stelab.nagoya-u.ac.jp/analysis/cef/>)