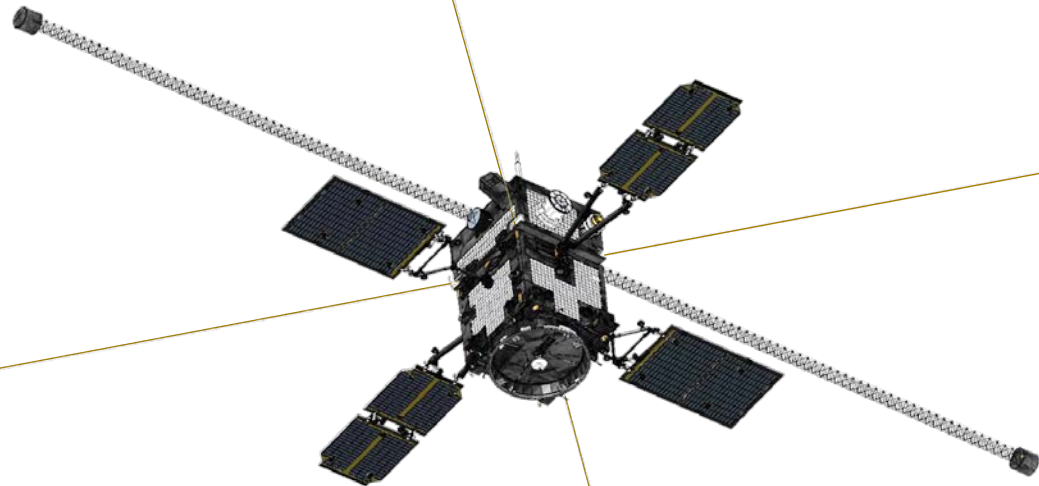




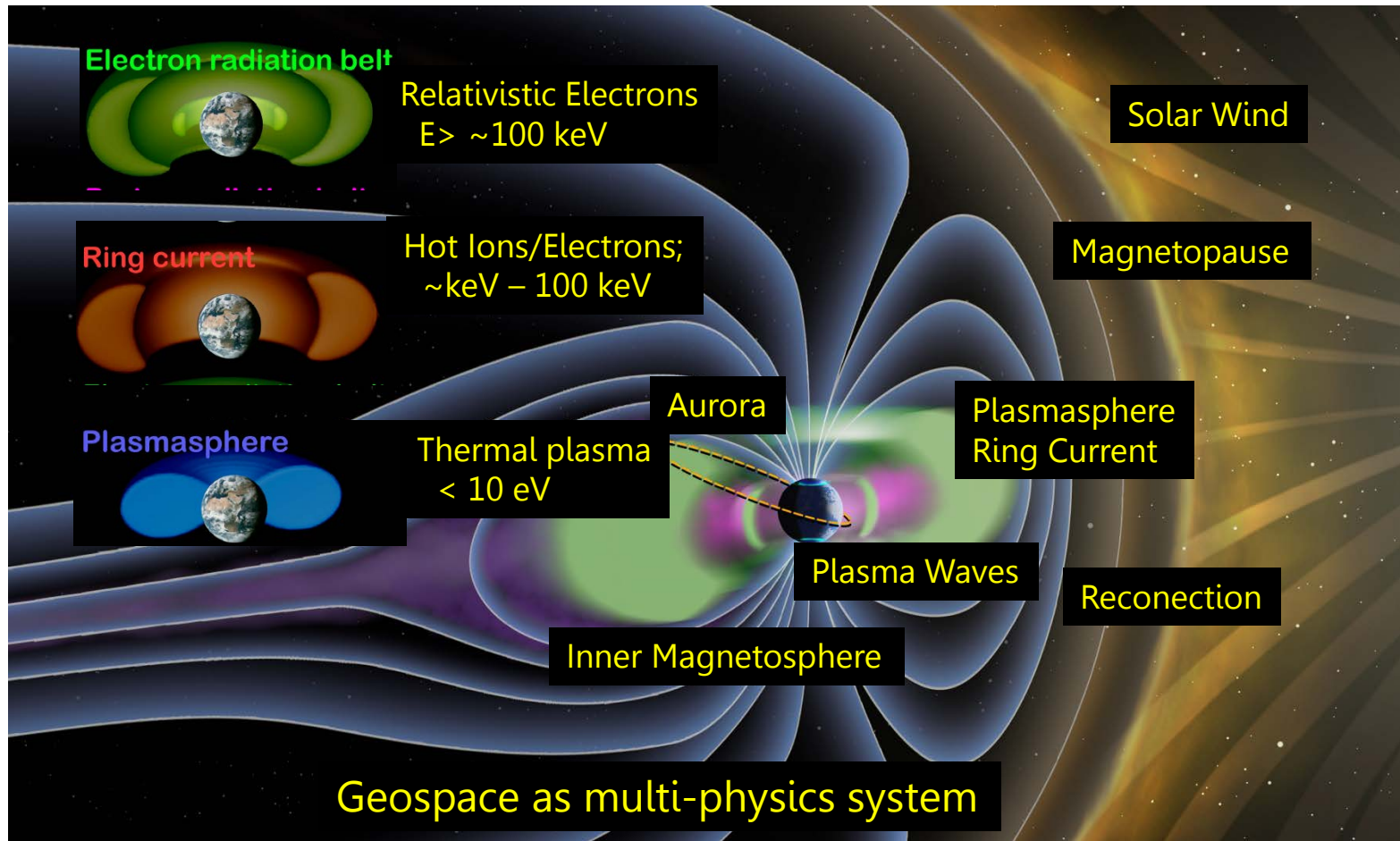
Current Status and Future Plan of Arase(ERG) Project

Y. Miyoshi, I. Shinohara
Geospace Exploration Mission
ERG project Team





1. ERG Mission Objectives

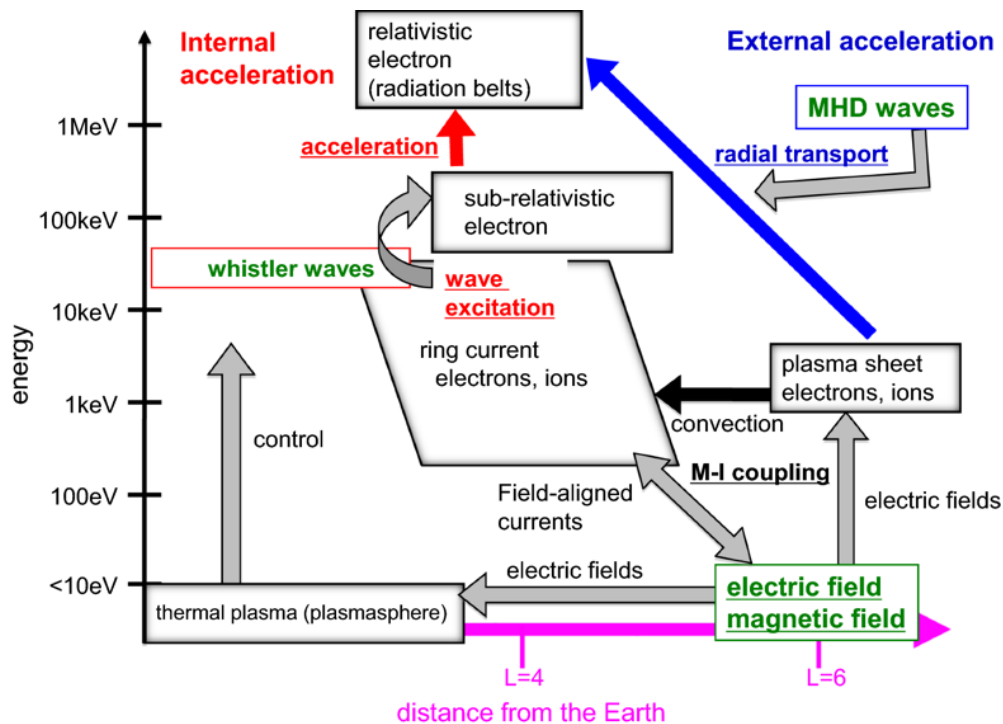


In the inner magnetosphere, different plasma/particle populations with energies ranging over 6 orders ($\text{eV} \sim \text{MeV}$) coexist and interact with each other. Dynamical coupling of different energy/regions through wave-particle interactions plays various roles in evolution of the radiation belts as well as geospace storm.



1. ERG Mission Objectives

To Understand acceleration, transport, and loss of outer belt electrons, dynamics of inner magnetosphere and geospace storms **in the context of cross-energy/cross-regional couplings**



Miyoshi+,2018a

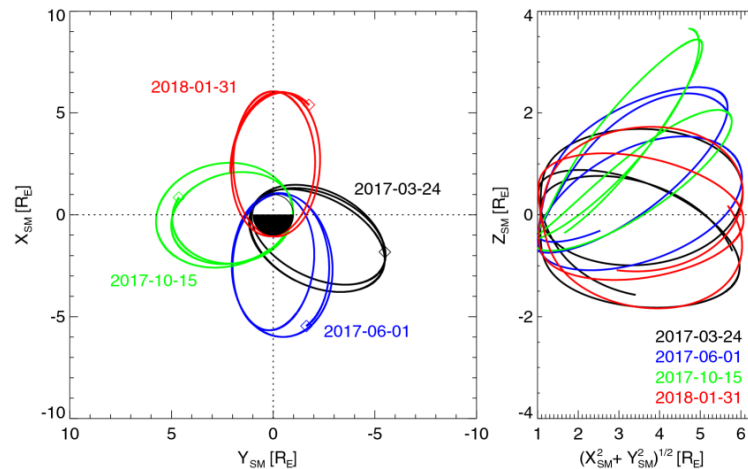
Key points of the ERG project:

- **Comprehensive observations to understand the whole process from the generation of waves to acceleration and losses by observations on wide energy plasma/particles and wide frequency field and waves in the inner magnetosphere.**
- **Conjugate observations with ground-based network and other geospace satellites.**



2. Status of Prime Mission: 2-2 Observation Status

- The prime mission started on March 24, 2017



Miyoshi+[2018a, EPS]

[Concepts of the initial full operation]

- at heart of the outer radiation belt
- at the region for chorus-wave particle interaction region
- for magnetic active periods (continuous substorm activities)

Considering these points, Arase started their full operation

- near the magnetic equator at $L=4\sim6$.
- at the dawn side (MLT $\sim 06:00$)
- around spring equinox (considering the Russell-McPherron effects)

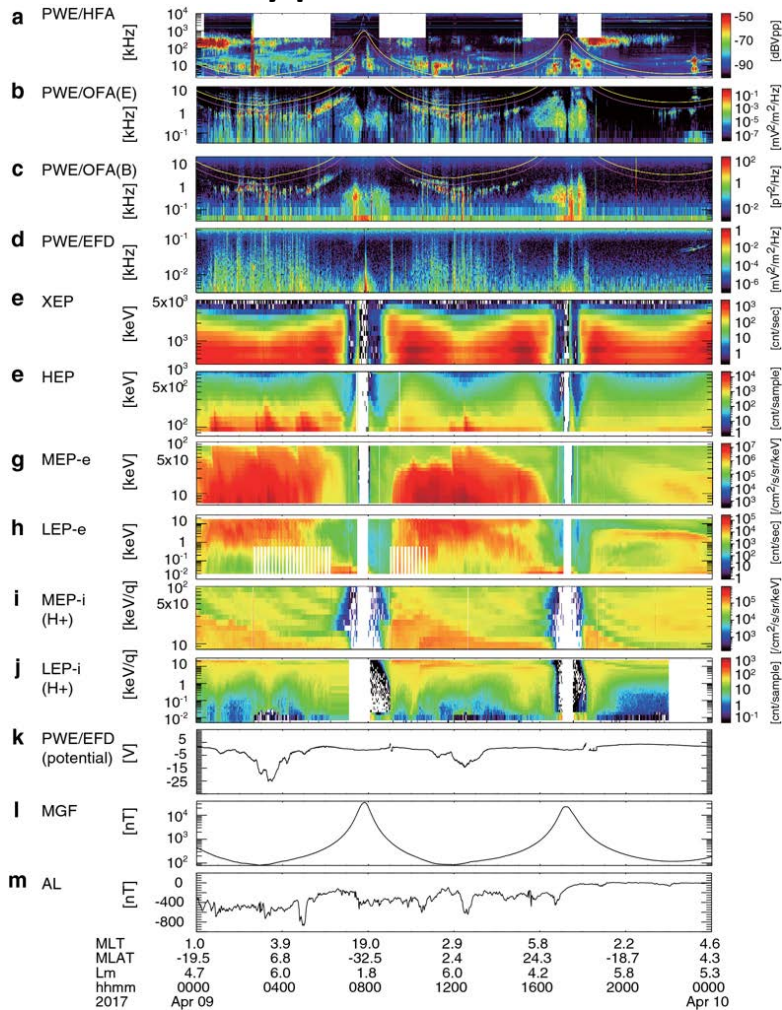


2. Status of Prime Mission

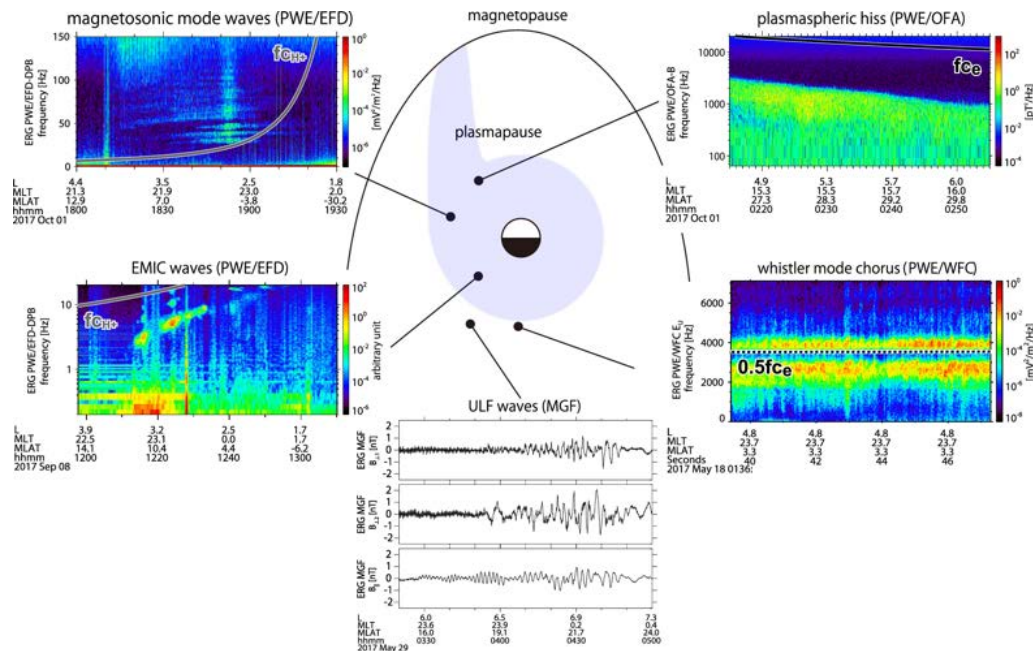
• Normal observations

All science instruments have operated without troubles and provided good data for radiation belts and geospace.

Summary plots for all instruments



Summary plots for plasma waves



Miyoshi+[2018a,EPS]



2. Status of Prime Mission

• Burst mode observations

PWE/WFC (chorus, EMIC) and S-WPIA have successfully been operated as burst-mode.

Operation strategy:

- 1) Scheduled operation:
the period for chorus/EMIC source region is scheduled based on the predictive orbit is scheduled.
- 2) Trigger mode operation:
the automatic trigger mode for chorus waves is also operated.

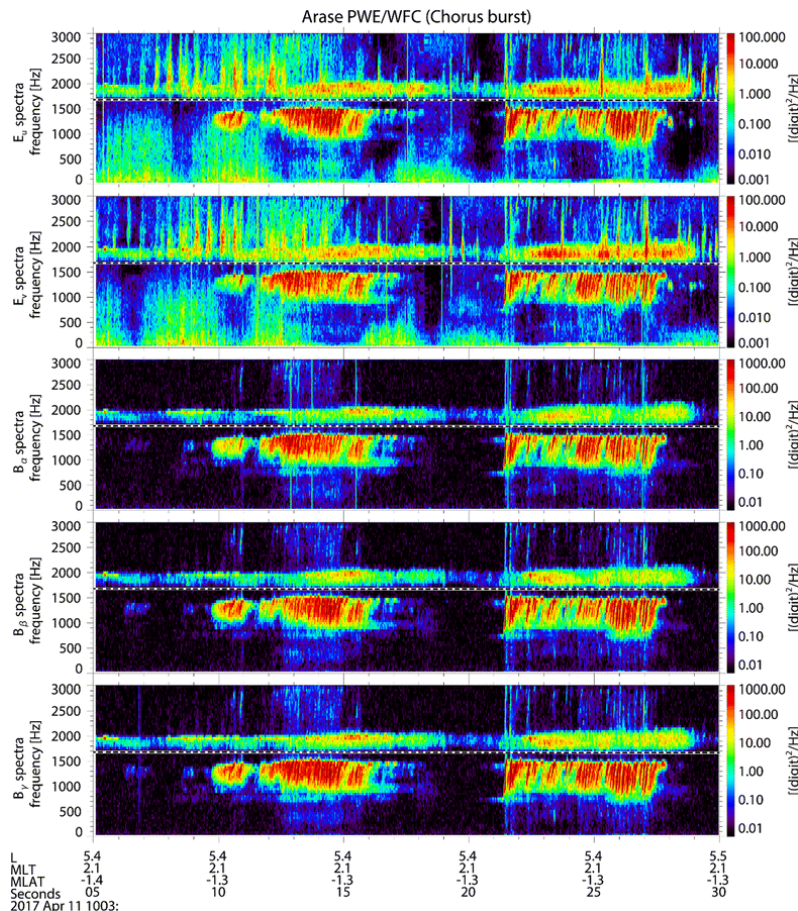
Downlink strategy:

- The burst data (PWE/WFC, S-WPIA) recorded in the onboard storage is selected to download to the ground by looking at PWE/OFA data.

Total amount of received data:

March 21, 2017 – July 11, 2018

- chorus burst: 156.0 Gbytes (7953min)
- EMIC burst: 23.0 Gbyte (74806min)
- SWPIA burst: 32.1 Gbyte (1634min)



Kasahara+[2018, EPS]



2. Status of Prime Mission: 2-3 Conjugate Observations

• Campaign Observations

- **Four campaign observations** between ERG and Ground-based network observations
 - 1: 2017/03/24 – 2017/04/30 : dawn: chorus-wave particle interactions
 - 2: 2017/06/12 – 2017/07/04 : midnight: substorm
(conjunctions with Syowa station)
 - 3: 2017/09/09 – 2017/10/06 : dusk: EMIC-wave particle interactions
 - 4: 2017/12/08 – 2018/01/09 : noon: EMIC/ULF-waves
 - 5: 2018/09/03 – 2018/09/17 : midnight- post-midnight
- **Conjunctions with**
 - Optical imager network
(Syowa, Iceland, Russia, Scandinavia, Alaska, THEMIS/GB0)
 - IS radars (EISCAT, PFISR, PANSY, Millstone Hill, Kharkiv)
 - SuperDARN
 - Magnetometer
 - Riometer
 - Loop antenna
- **Operations of Arase**
 - wave burst mode (PWE/WFC or S-WPIA for chorus)
(PWE/EFD and MGF w/ 256 Hz for EMIC)
 - LEP-e fine channel observations
 - particle observations with 8 sec time resolution



2. Status of Prime Mission: 2-3 Conjugate Observations

•Conjugate observations w/ ground-based network

- More than 1000 conjugate observations with ground network observations are realized.
- Burst mode (PWE/WFC or S-WPIA) were operated.

•Conjugate observations w/ Van Allen Probes

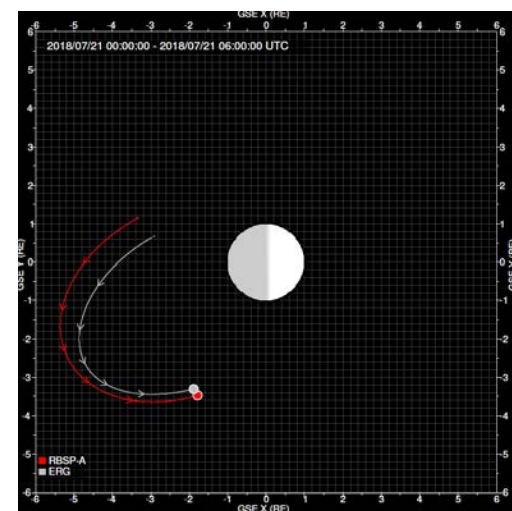
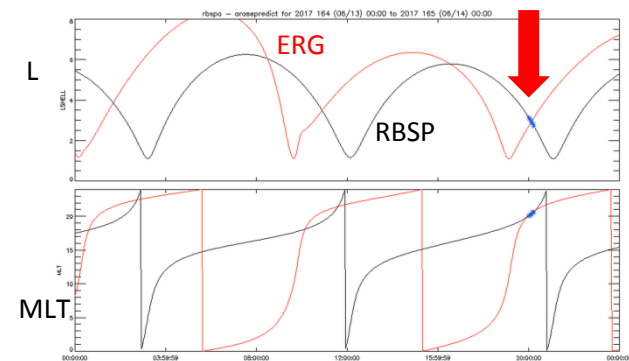
- Simultaneous burst mode observations have been operated with Van Allen Probes (~250 conjugate observations as of Oct 2018)

•Conjugate observations w/ THEMIS, MMS, etc

- Collaborations w/ THEMIS, MMS etc are also going.

Details are summarized in ERG-Wiki page

<https://ergsc.isee.nagoya-u.ac.jp/mw/index.php/ErgSat/>





2. Status of Prime Mission: 2-4 Collaborations

■ Collaborative Observations (cont.)

Collaborations with SuperDARN, PFISR (PokerFlat Incoherent Scatter Radar), Millstone Hill Radar, Kharkiv Radar, PANSY

- Simultaneous observations (scheduled operations by Arase)
- Ion instruments are operated with the NML mode when Arase has a conjunction with SuperDARN.

The observation plans are shared, and simultaneous observations (including ERG burst mode observations) have been operated. If you have any suggestions, please contact us.

ERG-SuperDARN conjunction summary plot

[ERG-SuperDARN conjunction summary plot](#)

Campaign observation for 2018-2019 fall to winter season

Scheduled operations for the Arase-Van Allen Probes-SuperDARN conjunctions aiming at satellite-ground multipoint obs

DD1:HH1 DD2:HH2 *schedule category [radars by which the special obs. is made] { Name of scan program }*

e.g., 22 UT, May 4 to 4 UT, May 5 --> **04:22 05:04**

September, 2018

09/01 04:00-09/01 12:00 Special Time (ARASE) (see Note A) [HKW HOK ADW ADE KSR KOD CVW CVE FHW FHE BKS WAL PGR normalscan }

09/03 02:00-09/03 12:00 Special Time (ARASE) (see Note A) [HKW HOK ADW ADE KSR KOD CVW CVE FHW FHE BKS WAL PGR normalscan }

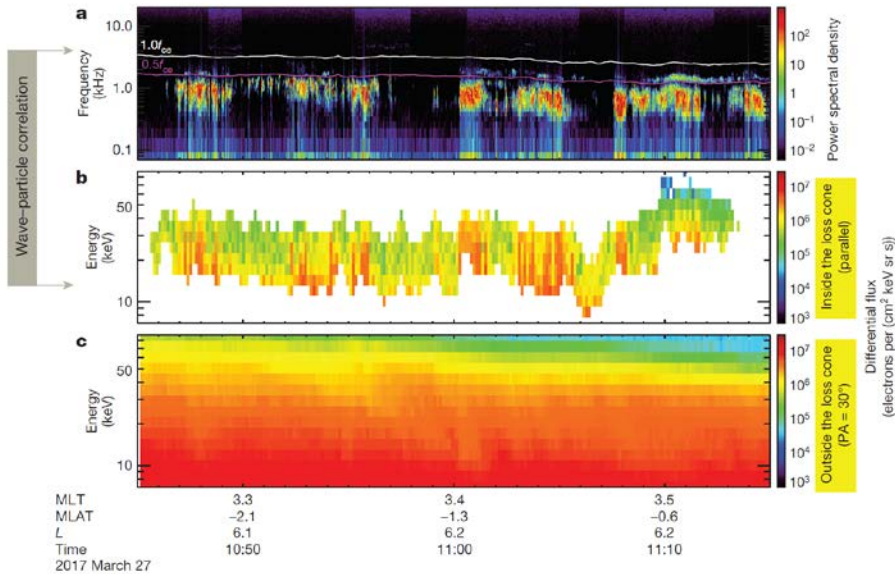
09/08 06:00-09/09 14:00 Special Time (ARASE) (see Note A) [HKW HOK ADW ADE KSR KOD CVW CVE FHW FHE BKS WAL PGR normalscan }

09/12 04:00-09/12 14:00 Special Time (ARASE) (see Note A) [HKW HOK ADW ADE KSR KOD CVW CVE FHW FHE BKS WAL PGR normalscan }

09/14 04:00-09/14 12:00 Special Time (ARASE) (see Note A) [HKW HOK ADW ADE KSR KOD CVW CVE FHW FHE BKS WAL PGR normalscan }

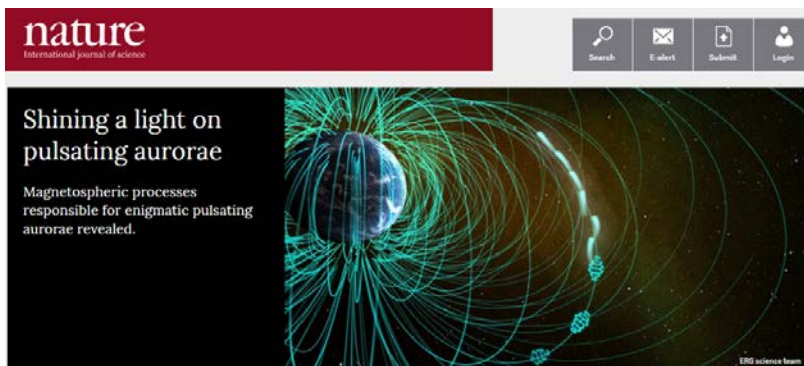
3. Conjugate observations w/ ground-based instruments

- First direct evidence of pitch angle scattering by plasma waves in space plasma



The electron flux modulations inside the loss cone were directly observed for the first time, and one-to-one correlation with chorus waves were identified.

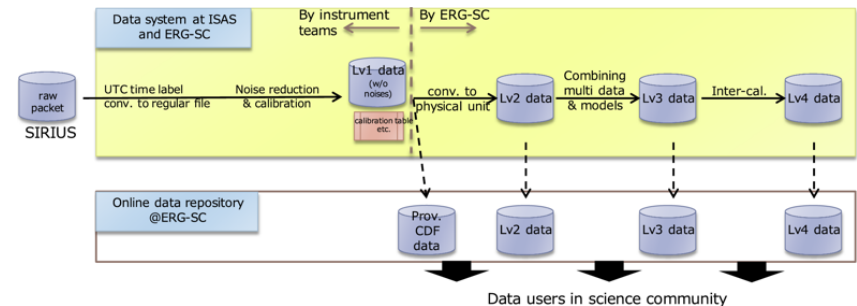
- The electron flux modulations inside the loss cone were directly observed for the first time, and one-to-one correlation with chorus waves were identified.
- Both electron flux and chorus waves have a good correlations with PsA observed at THEMIS GBO, which provides a definitive evidence for the precipitation of energetic electrons from the ground.



[Kasahara+, Nature, 2018]

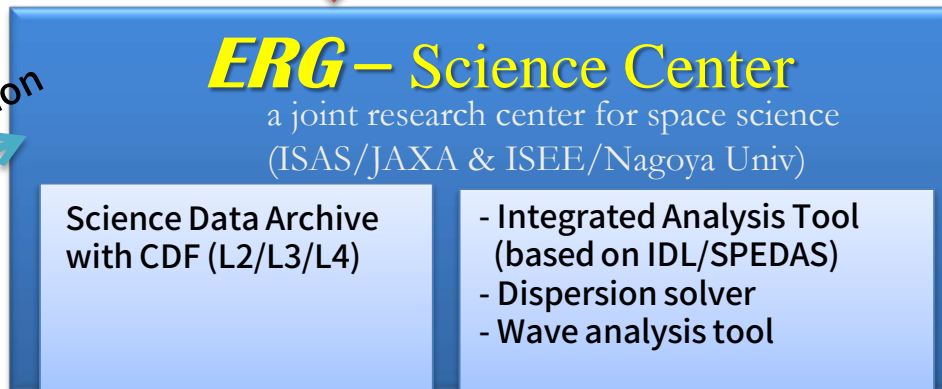


4. Status of Data Distribution (Science Center)



[Miyoshi+, EPS, 2018b]

collaboration



users

- All science data for satellite and ground data have been archived in the CDF format.
- Development of the data analysis software: ERG plug-ins for SPEDAS, which is de facto standard software for solar-terrestrial physics developed with IDL.

This software and standardized file format (CDF) are key to realizing the integrated data analysis using various kinds of data from observations and modeling.



4. Status of Data Distribution (Science Center)

ERG science data distribution

The following data sets are made publicly available after 1-year from data acquisition. Please contact us if you are interested in looking at the latest data.

- Arase/Particle data (LEP-e/i, MEP-e/i, HEP, and XEP)
- Arase E/B-field and plasma wave data
- Ground-based data

/data/ergsc/satellite/erg/hep/l2/omniflux/2018/07

Name	Last modified	Size	Description
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erg_hep_l2_omniflux_20180703_v01_01.cdf	2018-07-06 13:02	867K	
erg_hep_l2_omniflux_20180704_v01_01.cdf	2018-07-07 13:01	449K	
erg_hep_l2_omniflux_20180707_v01_01.cdf	2018-07-10 13:02	810K	
erg_hep_l2_omniflux_20180708_v01_01.cdf	2018-07-11 13:02	894K	
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erg_hep_l2_omniflux_20180712_v01_01.cdf	2018-07-15 13:02	809K	
erg_hep_l2_omniflux_20180713_v01_01.cdf	2018-07-16 13:01	801K	
erg_hep_l2_omniflux_20180714_v01_01.cdf	2018-07-17 13:02	804K	
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erg_mgf_l2_8sec_20180404_v01_01.cdf	2018-07-04 11:07	3.1M	
erg_mgf_l2_8sec_20180405_v01_01.cdf	2018-07-04 12:13	3.0M	
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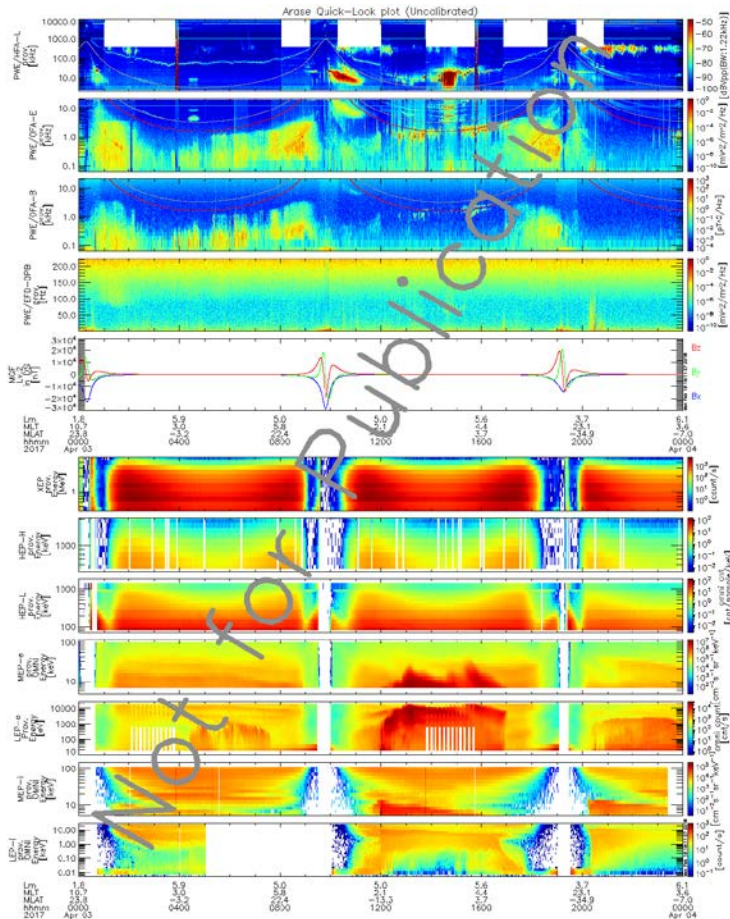
<https://ergsc.isee.nagoya-u.ac.jp/data/ergsc/satellite/erg/>

4. Status of Data Distribution (Science Center)

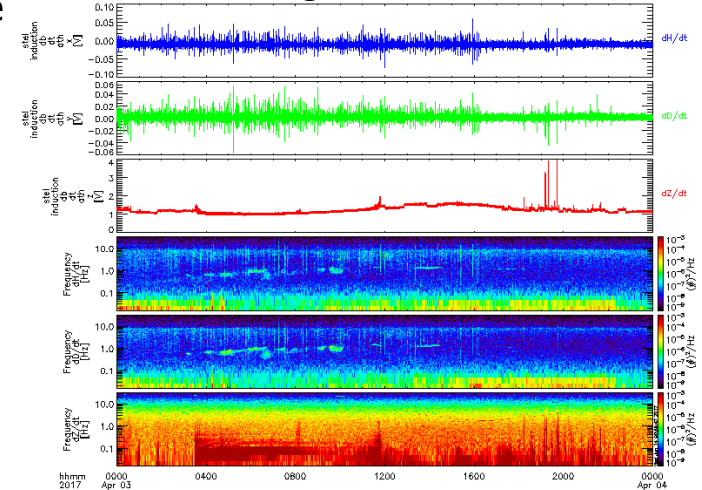
Various types of quick-look plots are available online.

All instrument data and the related ground-based observation network data on the Quick-look plot website

https://ergsc.isee.nagoya-u.ac.jp/cef/test/erg_test.cgi

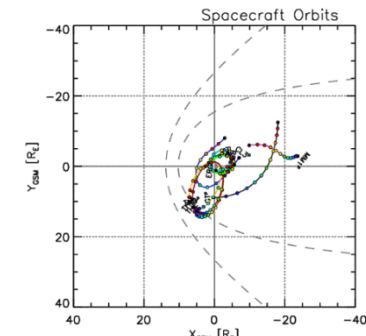
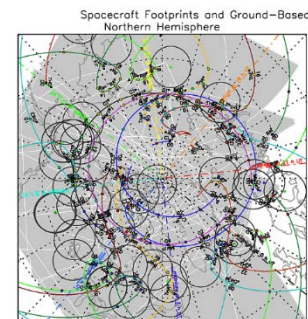


ERG-related ground network data



Spacecraft Footprints and Ground-Based Instruments for 1989-2019

Submit Previous 2018 0000-0200 UT Ground= High-Lat Size=100 Submit [Conjunction Event Finder](#)



Conjunction Event Finder (CEF) provides “at-a-glance” plots for satellite locations and ionospheric footprints.

<http://ergsc.isee.nagoya-u.ac.jp/cef/orbit.cgi>



6: Summary

- 1) Arase has successfully observed dynamical evolutions of Van Allen Belts and inner magnetosphere since March 2017. Conditions of satellite/science instruments are very good.
- 2) Various observations on accelerations and loss of energetic electrons in geospace have been realized. We appreciate great collaborations with SuperDARN.
- 3) The extended mission is planned in FY 2019 – FY 2021 (March, 2022). Your suggestions on collaborative observations are very welcome.