

JAXA's Contribution to Space Weather; Arase(ERG) and other satellites

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INTRODUCTION

- ✓ JAXA(The Research and Development Directorate : RRD) has measured the space radiation environment since 1987.
- ✓ Our purpose: Investigation possible relationship between satellite failure and space radiation environment
- ✓ The Kiku-5 (ETS-5) was our first satellite in geostationary Earth orbit (GEO) to measure electrons, heavy ions and protons.

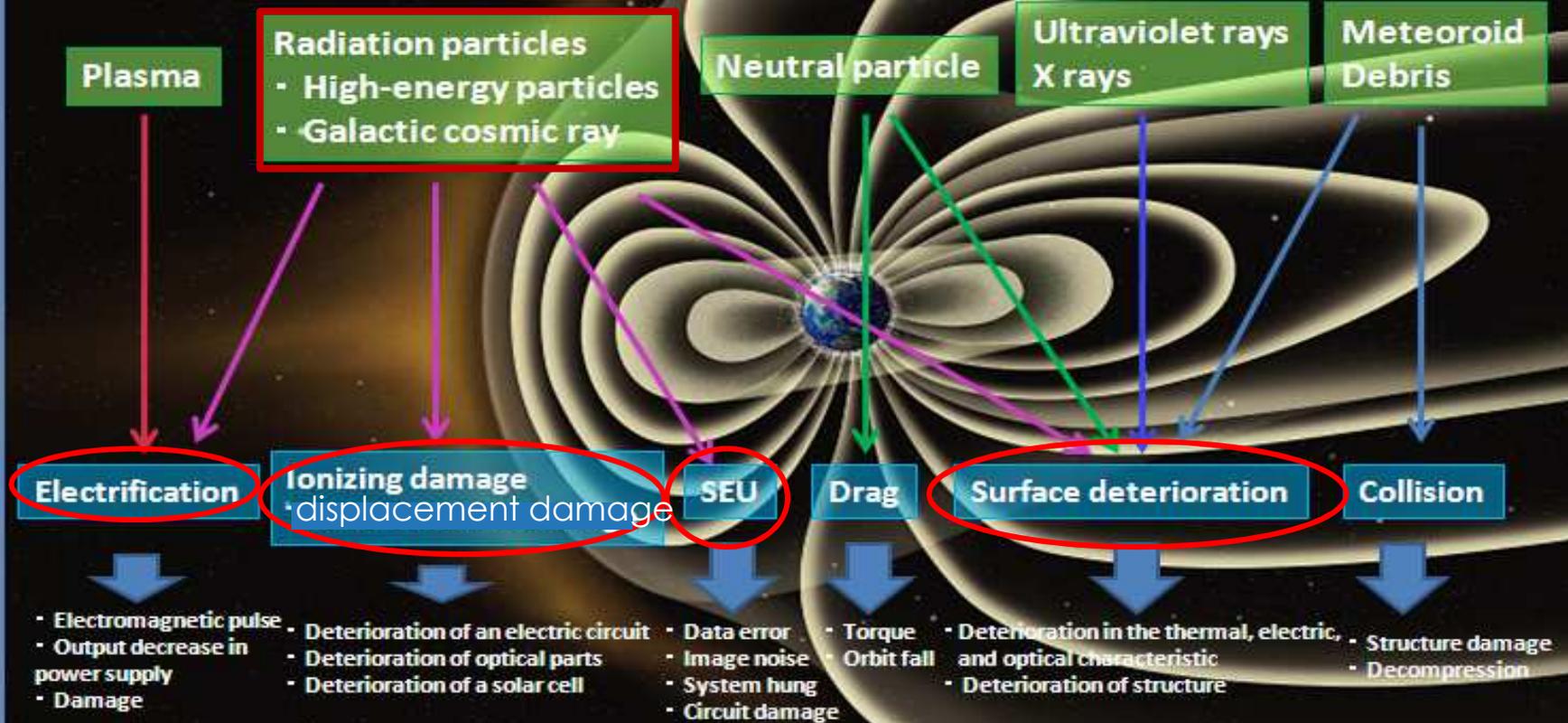
Kiku-5 (ETS-5)

Launch Date	Aug 27,1987 (~ Sept 27,1997)
Location	Tanegashima Space Center
Orbiter	GEO
Altitude	About 36,000km (east longitude 135°)
Inclination	0 degree
Period	24 hours



Relationship between satellite failure and space radiation environment

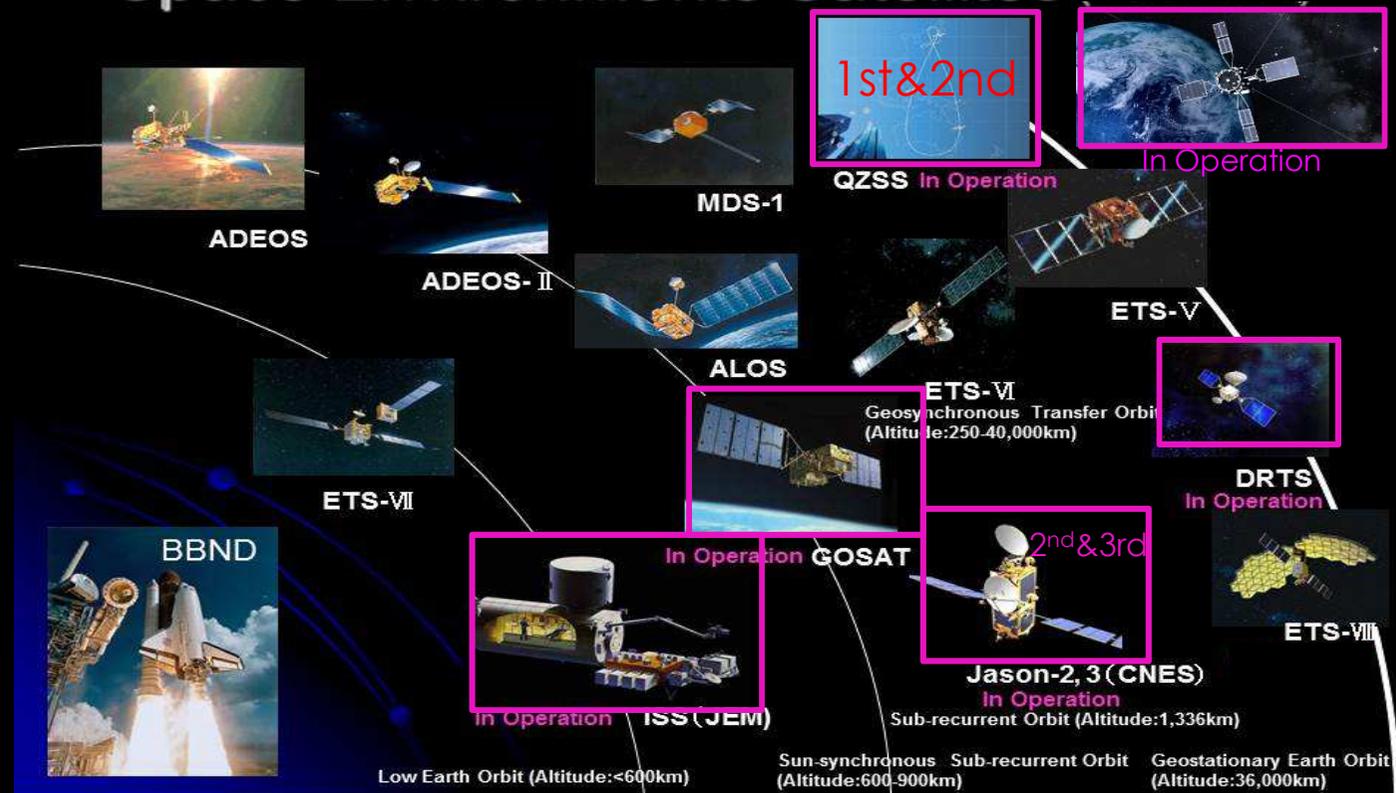
Influence on spacecraft by space environment



TEDA AND SEDA

- ✓ TEDA and SEDA are instruments that have been developed by JAXA to measure space environment. (high energy particles, galactic cosmic rays, atomic oxygen, plasma, magnetic fields, etc.)
- ✓ We have 16 types of instruments.
- ✓ TEDA and SEDA have been installed on seventeen spacecraft. Eight spacecraft are now in operation.

Space Environments Satellites



TEDA AND SEDA

	Equipment	Specifications
1	Dose Monitor (DOM)/Standard Dose Monitor (SDOM)	Electrons: 0.5 - 50 MeV Protons: 0.9 - 250 MeV Heavy ions: 6.7 - 270 MeV
2	High energy Particle Monitor (HPM)	Protons: 50 - 70 MeV/70 - 100 MeV/100 - 180 MeV
3	Heavy Ion Telescope (HIT)	Li, Be, B: 10 - 23 MeV C, N, O: 15 - 36 MeV Fe: 31 - 76 MeV
4	DOSimeter (DOS)	V_{gs} at $I_d = 1 \text{ mA}, 10 \text{ mA}, 100 \text{ }\mu\text{A}$ and $10 \text{ }\mu\text{A}$
5	MAGnetoMeter (MAM)	Range-H: $\pm 256 \text{ nT}$ Range-L: $\pm 65536 \text{ nT}$
6	Potential Monitor (POM)	Surface material OSR/Kapton evaporated Al/Teflon evaporated Ag/Metallic board insulator. Voltage: +5 kV to -10 kV
7	Atomic Oxygen Monitor (AOM)	10^{10} to 10^{13} atoms/ m^3
8	NEutron Monitor (NEM)	Bonner Ball type Neutron Detector (BBND) Neutrons: 0.025 eV - 15 MeV Scintillation Fiber Detector (FIB)
9	PLASma Monitor (PLAM)	Density and electron temperature of space plasma
10	Discharge Monitor (DIM)	Discharge •Specification 0.75 to 58 V
11	Single event Upset Monitor (SUM)/RAM Soft-error Monitor (RSM)	Monitoring errors by single event.
12	Integrated Circuit Monitor (ICM)	Measuring degeneration and change of IC.
13	Solar Cell Monitor (SCM)	Researching the properties of solar cells in the space environment.
14	CONtamination Monitor (COM)/Thermal control material Degradation Monitor (TDM)	Measuring the solar absorption and infrared emission of samples.
15	Light Particle Telescope (LPT)	ELS-A: Electrons: 0.03 MeV - 1.3 MeV ELS-B: Electrons: 0.3 MeV - 20 MeV APS-A: Protons: 0.4 MeV - 33 MeV, α 1.5 MeV - 250 MeV APS-B: Protons: 0.7 MeV - 40 MeV, α 2.5 MeV - 100 MeV
16	Extremely High-Energy Electron Experiment (XEP)	Electrons: 0.4 MeV - 20MeV

	Satellite name	Operational period	Orbit	Equipment
I. Geostationary Earth Orbit (GEO Altitude: 36,000 km)				
1	ETS-V	1987/8/27 - 1997/9/12	Altitude: approx. 36,000 km Inclination: 0 degrees	DOM/POM/DIM RSM/ICM/SCM/TDM
2	DRTS	2002/9/10 -	Altitude: approx. 36,000 km Inclination: 0 degrees	SDOM
3	ETS-VIII	2006/12/18 - 2017/1/10	Altitude: approx. 36,000 km Inclination: 0 degrees	DOS/MAM/POM/ SUM
4	Michibiki(QZS) 1st and 2nd	2010/09/11 -	Altitude: Perigee 32,600 km, Apogee 38,950 km Inclination: approx. 41 degrees	LPT/POM(only 1 st)/MAM
II. Geosynchronous Transfer Orbit (GTO Altitude: 250 to 40,000 km)				
5	ETS-VI	1994/8/28 - 1996/1	Altitude: Perigee 8,600 km Apogee 38,600 km Inclination: approx. 13 degrees	DOM/HIT/MAM POM/SUM//ICM/ SCM/COM
6	MDS-1	2002/2/4 - 2003/9/25	Altitude: Perigee 209 km Apogee 35,204 km Inclination: 29.1 degrees	SDOM/HIT/DOS/ MAM/SUM
7	ARASE(ERG)	2016/12/20 -	Altitude: Perigee: approx. 300 km Apogee: approx. 33,200 km Inclination: approx. 31 degrees	XEP
III. Sun-synchronous Sub-recurrent Orbit (LEO Altitude: 600 to 900 km)				
8	ADEOS	1996/8/17 - 1997/6/30	Altitude: approx. 800 km Inclination: 98.6 degrees	HPM/HIT/DOS POM/SUM/COM
9	ADEOS-II	2002/12/14 - 2003/10/31	Altitude: approx. 803 km Inclination: approx. 99 degrees	DOM/DOS/SUM
10	ALOS	2006/1/24 - 2011/5/12	Altitude: approx. 690 km Inclination: approx. 98 degrees	LPT/HIT
11	GOSAT	2009/1/23 -	Altitude: approx. 667 km Inclination: approx. 98 degrees	LPT/HIT
IV. Sub-recurrent Orbit				
12	JASON-2 (CNES)	2008/6/20 -	Altitude: approx. 1,336 km Inclination: approx. 66 degrees	LPT
13	JASON-3 (CNES)	2016/1/17 -	Altitude: approx. 1,336 km Inclination: approx. 66 degrees	LPT
V. Low Earth Orbit (LEO Altitude: < 600 km)				
14	ETS-VII	1997/11/28 - 1999/12/16	Altitude: approx. 550 km Inclination: approx. 35 degrees	AOM
15	Shuttle/Mir	1998/1/23 - 1998/1/26	Altitude: approx. 400 km Inclination: approx. 51.6 degrees	BBND
17	ISS	1998/1/23 - 1998/1/26	Altitude: approx. 400 km Inclination: approx. 51.6 degrees	BBND
16	ISS (SEDA-AP)	2009/8/24 -	Altitude: approx. 400 km Inclination: approx. 51.6 degrees	SDOM/HIT/AOM/ NEM/PLAM/SUM

SPACE ENVIRONMENT AND EFFECTS SYSTEM (SEES)

- ✓ SEES is a database system for our space environment data.
- ✓ We provided real time and quasi-real-time data through SEES web site (<http://sees.tksc.jaxa.jp>) for external users

How to find SEES web site??
[SEES JAXA] and search button click!



The image shows a detailed view of the SEES website. The header includes the SEES logo and the text "Space Environment & Effects System". There is a "registration" button and the JAXA logo. A navigation menu on the left lists: Top Page, Information, Notice, What's SEES, Instruments, Spacecraft, Data, Report, Member, Terms, Your Message, Links, and Application Form. The main content area has several sections: "Information" with news about system stop and QZSS data; "Offered function of SEES" with links for Satellite's Data, Alert mail system, Analysis Functions, and Satellite Environment Information; "Real-time data graph" with sub-sections for DRTS, ISS/SEDA-AP, GOSAT, QZSS, ERG, JASON-2, and JASON-3; and "Satellite Orbit plot" with sub-sections for ERG and QZSS. At the bottom, there is an "About SEES" section.

- Top Page
- Information
- Notice
- What's SEES
- Instruments
- Spacecraft
- Data
- Report
- Member
- Terms
- Your Message
- Links
- Application Form

【Past satellite
Txt data
(numeric
graph data)】

※TXT:Registration
only



New!! MD

Orbiter: Geo
transfer orbit
Altitude: Pe
Apogee 35,2
Inclination:
Operational
2002/2/4 - 20

SDOM: Stand
MAM: Magn

SEES>Registration

Registration

Fill in the following forms, and click "Submit" button.

Note

1. You will use the SEES after you get your login-ID and password.
In the worst case, it takes a month for getting your login-ID and password.
2. If we can not permit your purpose of usage or we can not understand your purpose clearly, we can not accept your request.
3. Please fill in a postal code, an address and the full name exactly.

* Required.

* category	<input checked="" type="checkbox"/> Modeling tool <input type="checkbox"/> Spacecraft Data
* Field	<input checked="" type="radio"/> Design of Spacecraft <input type="radio"/> Operation of Spacecraft <input type="radio"/> Science <input type="radio"/> etc.
* Name	<input type="text"/>
* Postal code	<input type="text"/>
* Address	<input type="text"/>
* Phone	<input type="text"/>
* E-mail	<input type="text"/>
* Company/Organization	<input type="text"/>
Section	<input type="text"/>
* Purpose (within 200 characters)	<input type="text"/>
Utilization Schedule (within 200 characters)	<input type="text"/>
etc. (within 200 characters)	<input type="text"/>

Please fill in the IP Address of the computers which a user uses mainly.(Max. 4 computers)
Only the access from an IP Address that had you input is admitted. It is not available from the network

CTS
RS

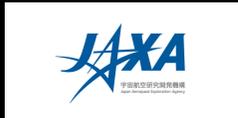
Real-
time
graph

3D
orbit
tool

through

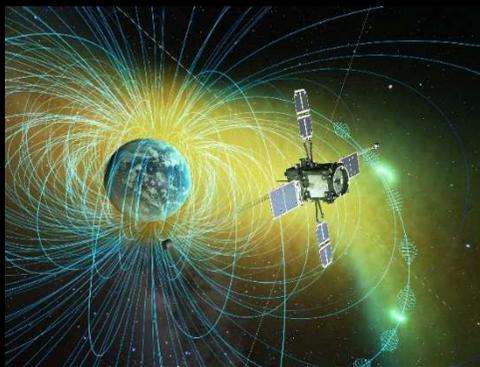
RECENT EVENTS

- ✓ Recently the Arase satellite (ISAS/JAXA) and the Japanese GPS satellite Michibiki (QZS) 2nd (Japanese Cabinet office) were successfully launched, and instruments are installed in these satellites.
- ✓ In future the QZS 4th (Japanese Cabinet office) will be launched.



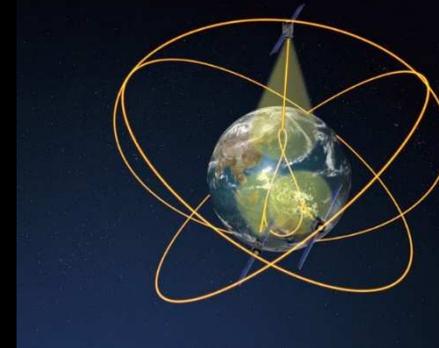
- ARASE(ERG) was launched on December 20, 2016
- Purpose: It is intended for use in elucidating how highly charged electrons are created as they appear and vanish repeatedly along with space storms caused by the disturbance of solar wind, and how space storms develop. It has eight instruments.
- XEP, HEP and MGF has Space Weather data.

Orbital Altitude	Perigee: about 300 km, Apogee: about 33,200 km
Orbital Inclination	about 31°
Type of Orbit	Elliptical orbit
Orbit Period	about 538 min.



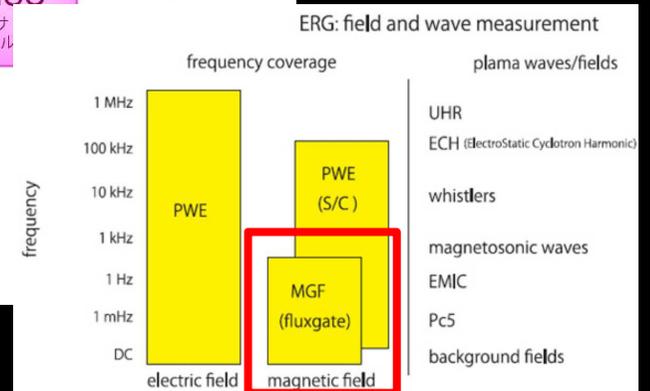
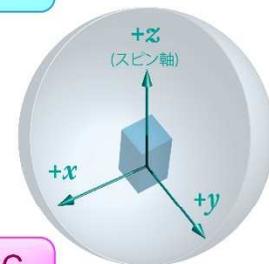
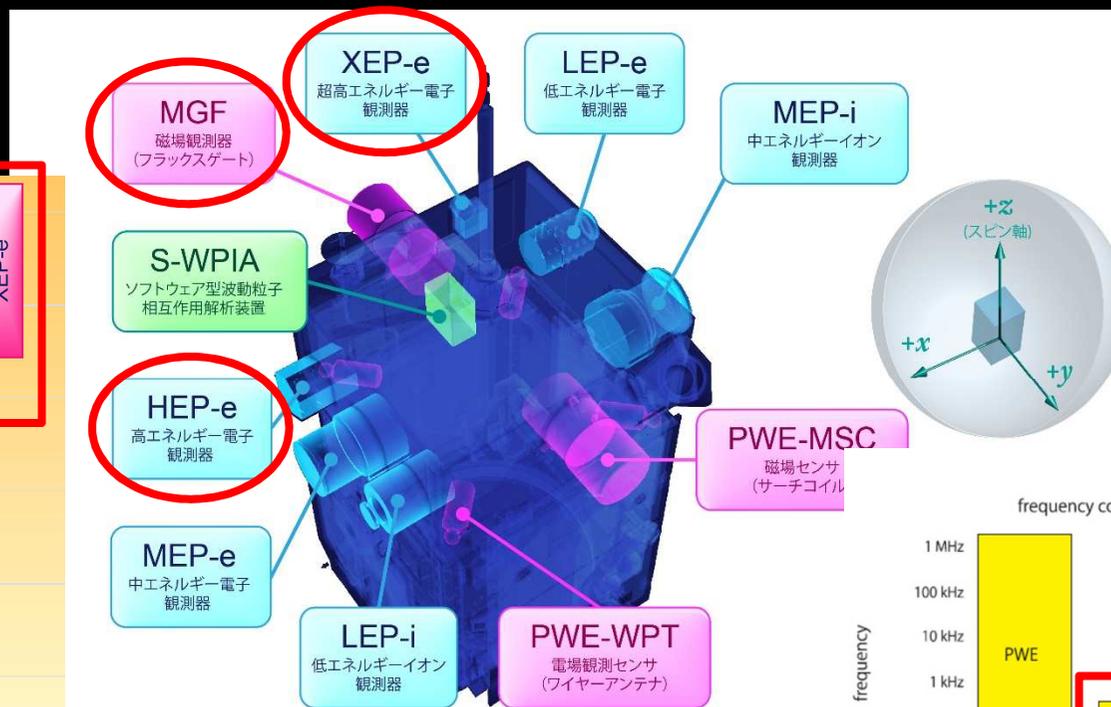
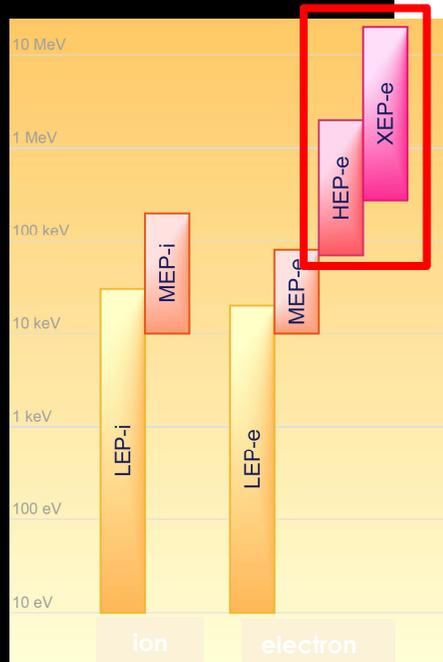
- QZS 2nd (Cabinet Office) was launched on June 1, 2017
- Purpose: Japanese GPS second satellite
- QZS 1st was launched on September 11, 2010.
- QZS 1st, 2nd and 4th have LPT (radiation particles) and MAM.
- QZS 4th will be launched soon.
- QZS 1st and 2nd space weather data graph will be published soon through SEES.

Orbital Altitude	32000~40000km
Orbital Inclination	about 40°
Type of Orbit	Quasi-Zenith Orbit
Orbit Period	about 23 h56 m.

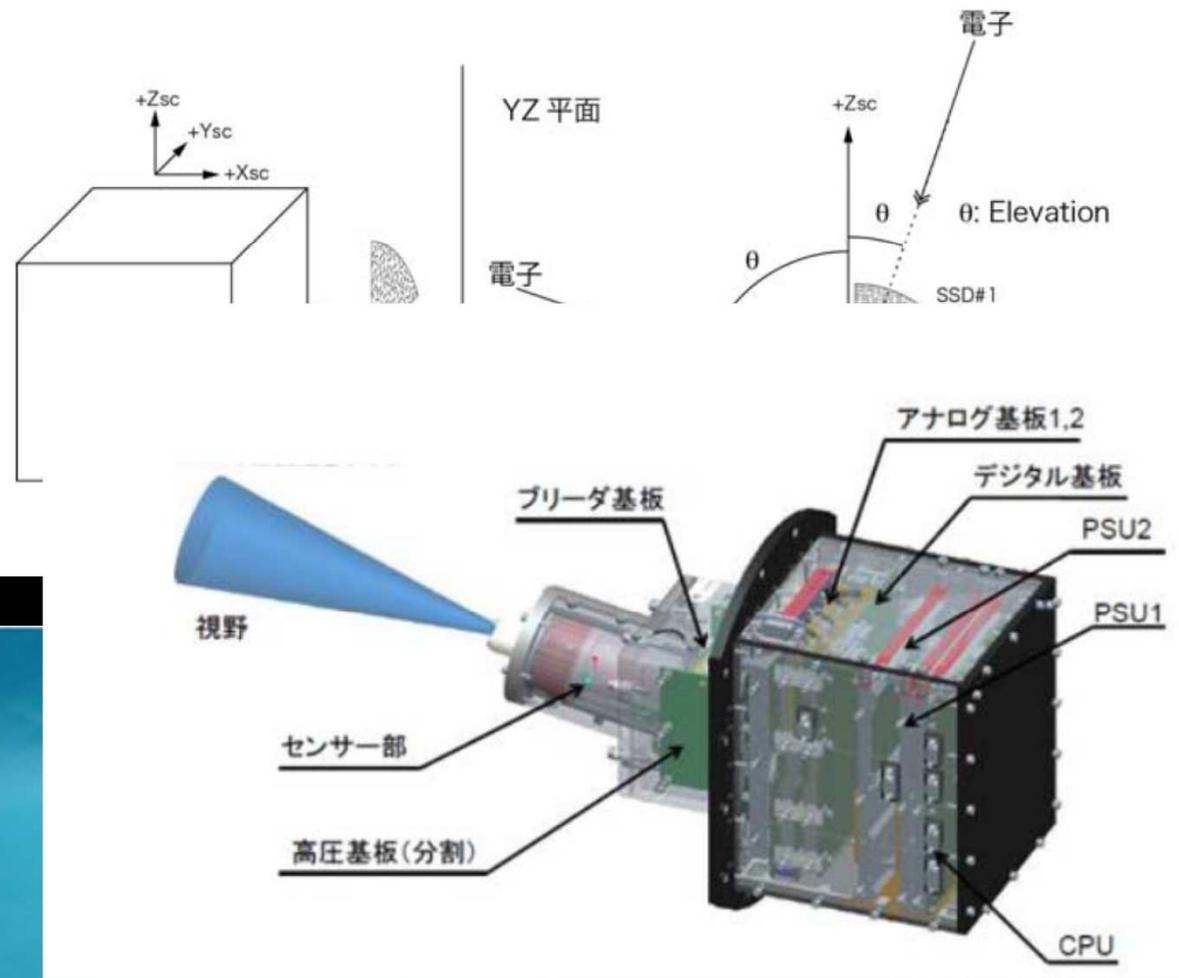


ARASE(ERG) SATELLITE

- ✓ The Arase has nine instruments.
- ✓ 2 instruments for ions (MEP-i/LEP-i) and 4 instruments for electrons (XEP/HEP/MEP-e/LEP-e).
- ✓ 1 instrument for magnetic field (MGF) and 1 instrument for electric field(PWE).
- ✓ XEP, HEP and MGF provide space environment data (quasi-real-time: update every minute).



MGF/HEP/XEP



MGF(PI): Ayako Matsuoka
 HEP(PI): Takefumi Mitani
 XEP(PI): Nana Higashio

xtremely high-energy electron
 experiments (XEP)

5 Solid-State Silicon Detectors + GSO

Energy range (6ch)	400keV- 20MeV(electron)
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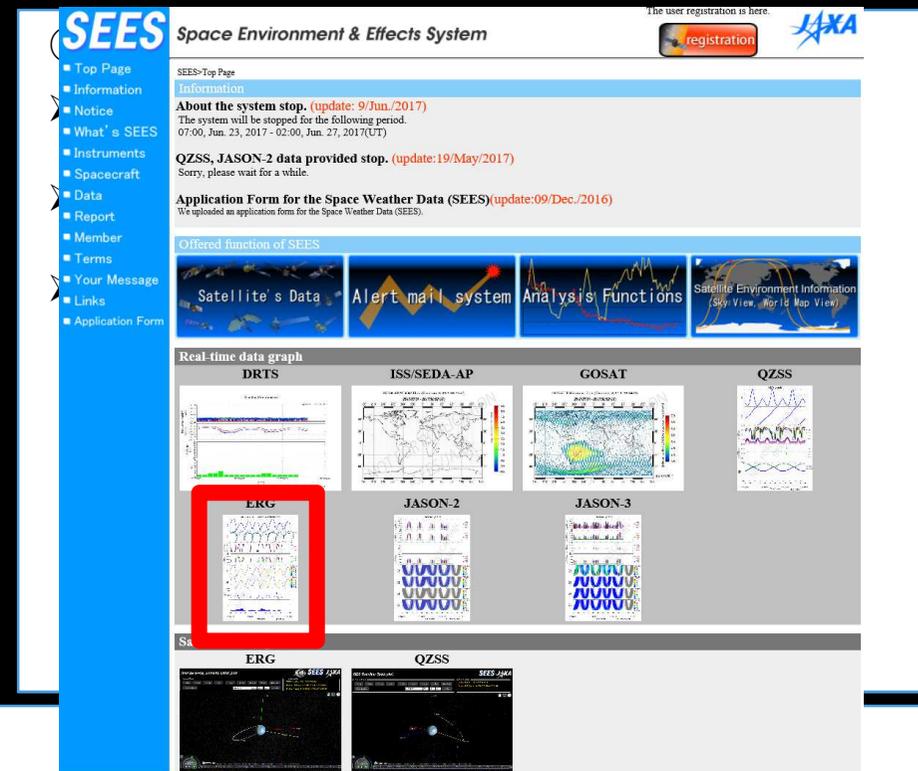
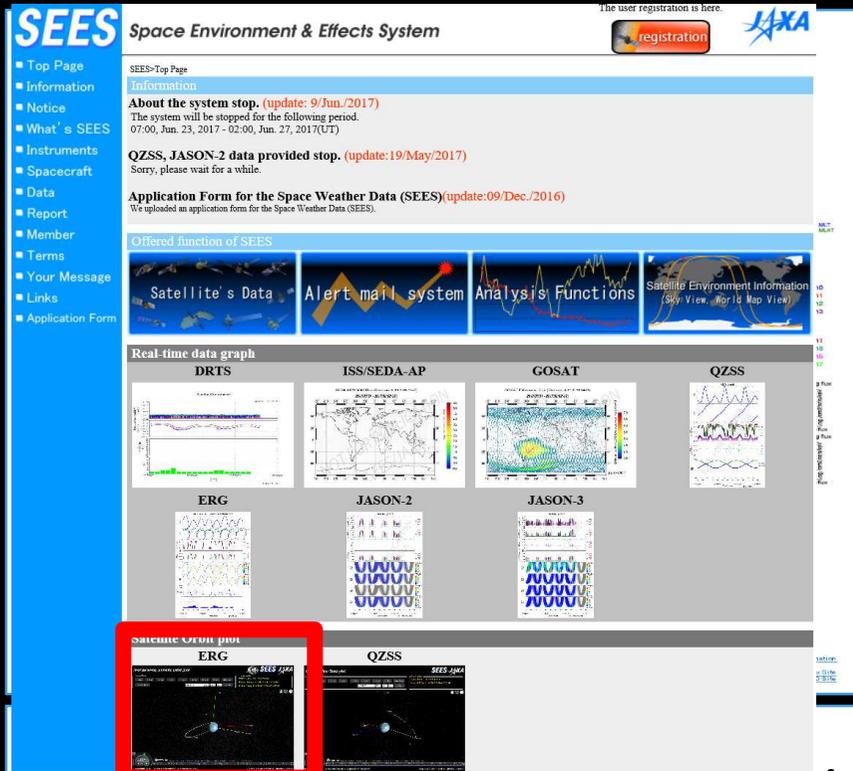
Viewing angle	$\pm 10^\circ$
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SPACE WEATHER DATA(MGF/HEP/XEP)

✘ uncalibrated data

We started to provide space weather data form the SEES/JAXA web site on March 20, 2017

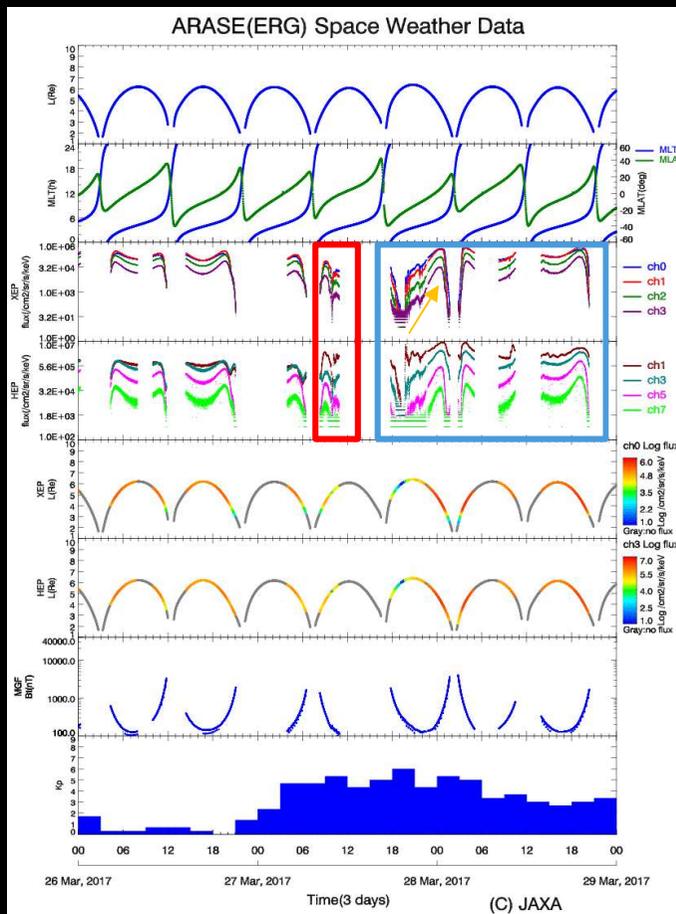


- ✓ An organization which send application form can use numeric data file (txt file). (SEES > application form).
- ✓ We provide txt files in quasi-real-time(update every minute).
- ✓ Purpose :We expect them to be used for study of space weather (Prediction).
- ✓ This data is uncalibrated, so users can not use them for science. these data to be used for space weather study.
- ✓ If you are interested in them, please ask us . (SEES > your message) or send us application form (SEES > application form).

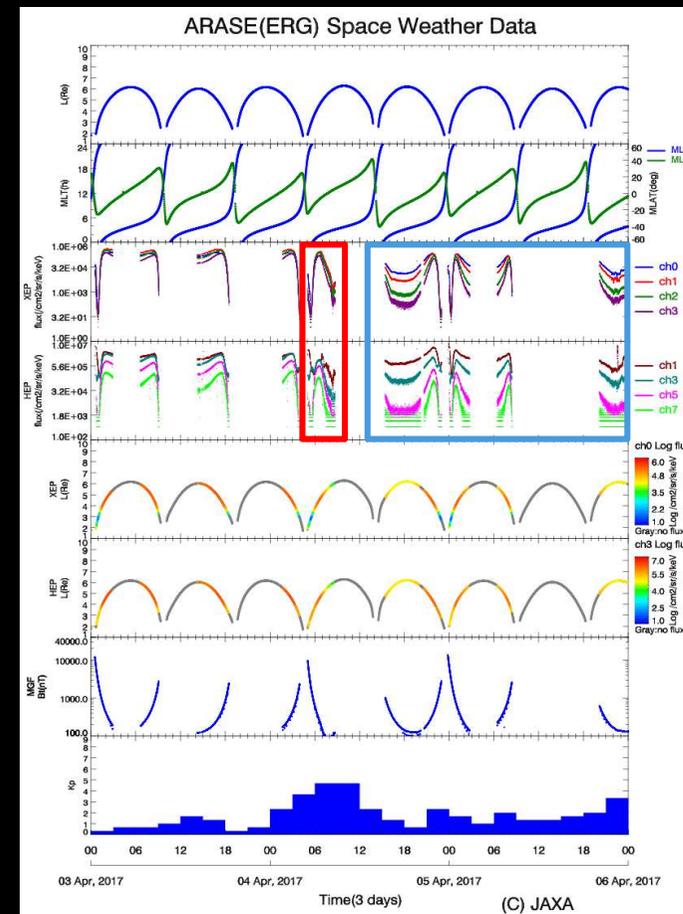
Many domestic and international organization/University started using our data!

OBSERVATION (ARASE SATELLITE)

- ✓ The March 27 storm: It is caused by the arrival of the high-speed coronal hole stream, accompanies a large increase of the relativistic electrons.
- ✓ The April 4 storm: It has a rapid Dst development and recovery, shows less acceleration and does not recover to the pre-storm level.



The March 27, 2017 storm



The April 4, 2017 storm

YOUR REQUEST AND QUESTION (ALL JAXA'S SPACE ENVIRONMENT DATA)

✓ How to contact with us

① SEES > your message

② Please send us your mail. (sees@jaxa.jp)

✓ How to get an application form (ARASE space weather data).

① SEES > application form

SEES Space Environment & Effects System

The user registration is here. [registration](#)

SEES>Your Message
Your Message

Fill in the form to send JAXA a message.
We appreciate hearing your comments about SEES.
We will use your comments for improvement SEES.
*** Required.**

Subject*

Category* ERG QZSS ETSS DRTS GOSAT
 SEDA-AP Modeling Tools Others

Name*

Organization

Section

Address

Phone

FAX

E-mail*

Message*

Copyright 2010 Japan Aerospace Exploration Agency [Contact US](#)

Page to send message

SEES Space Environment & Effects System

The user registration is here. [registration](#)

SEES>Application Form
Application Form

1. Application form for the Space Weather Data (SEES)
If you want to use the Space Weather Data(SEES, digital data), please download the application form and fill it.
The application form can be filled in either by handwriting or by typing into it. After that, please send the form to "JAXA(SEES)".
◦ Download the form [\[WORD\]](#)[\[PDF\]](#)(English)

2. Information on Publication/Presentation format
When the user makes any presentation/publication to the public using a fraction of or the entire part of the space weather data (SEES), the user should notify JAXA in advance with the form (Information on Publication/Presentation format).
◦ Download the form [\[WORD\]](#)[\[PDF\]](#)(English)

Address
Research Unit I(SEES system),
Research and Development Directorate
Japan Aerospace Exploration Agency (JAXA)

E-mail
sees@jaxa.jp

Tsukuba Space Center.
2-1-1, Sengen, Tsukuba-shi,
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Fax. (81)29-868-5969

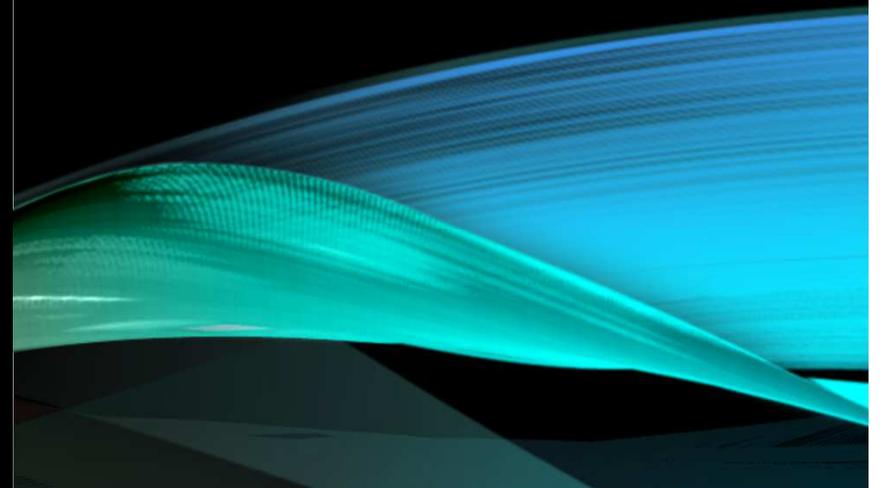
Page to application form

CONCLUSION

- ✓ JAXA (RRD) has measured the space radiation environment since 1987 and it has a database system called '**SEES**'
- ✓ Recently the Arase satellite and the Japanese GPS satellites Michibiki 2nd were launched, so we are getting many space environment data in real-time.
- ✓ We have provided mainly real time graph for external users without any limitation, and it is very useful to know space environment.
- ✓ Arase satellite data is the first attempt to provide numeric data file in quasi-real time to an organization/ University.
- ✓ But...Arase space weather data is uncalibrated, so users can not use them for science.
- ✓ We expect to use these our data for study of space weather nowcast as well as forecast.



THANK YOU FOR
YOUR ATTENTION !



【Reference】 Particle accelerator @ Tsukuba Space Center in Japan

We have own particle accelerator to calibrate our instruments.
This can irradiate to a instrument by low flux electrons/protons.
If you are also interested in this, please tell us.
We might help calibration of your instrument(radiation particles).



I used to be in charge of this laboratory for five years.

Accelerating voltage	0.4 MeV~2.0MeV
Particle	Electron, Proton
Beam current	1fA~10nA
Beam area	60mmX60mm (max)

- 
- ✘ TEDA: TEchnical Data Acquisition equipment
 - ✘ SEDA: Space Environment Data Acquisition equipment