

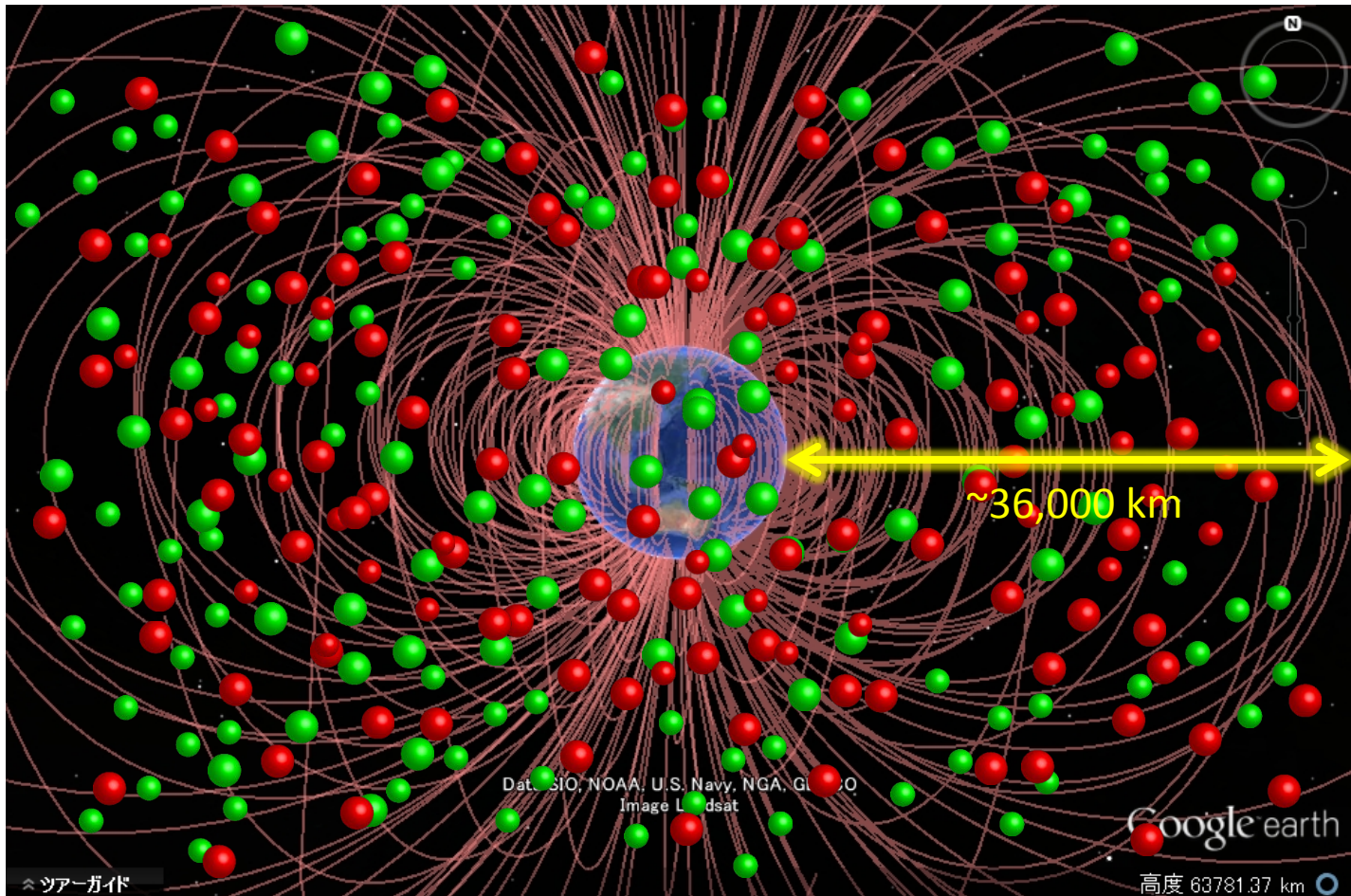
Research data sharing in the field of solar-terrestrial physics

Masahito Nosé

World Data Center for Geomagnetism, Kyoto
Graduate School of Science, Kyoto University

Solar-terrestrial physics?

- Solar-terrestrial physics
 - is the study of various phenomena taking place in the area from approximately 50 km altitude to the Moon's orbit (~360,000 km altitude).

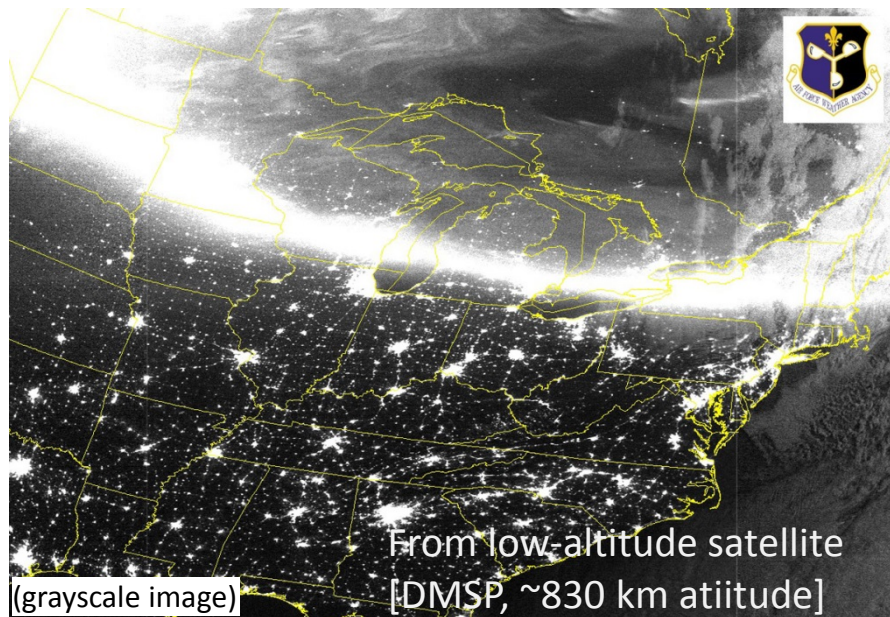


Auroral optical images

From ground

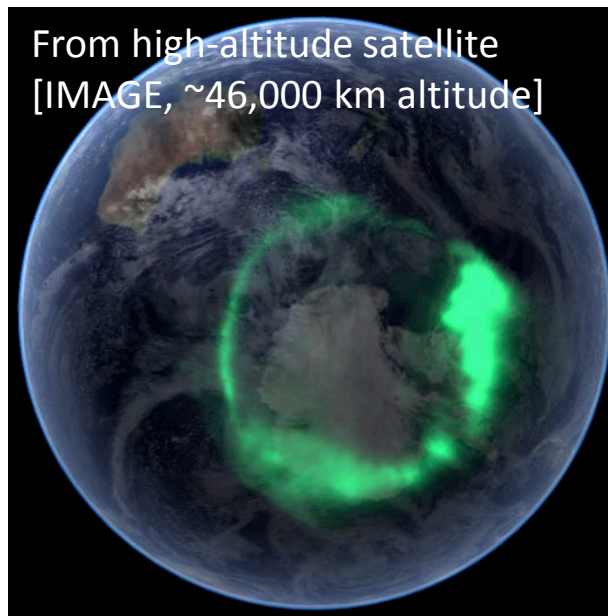


From Space Shuttle
[~400 km altitude]



From low-altitude satellite
[DMSP, ~830 km altitude]

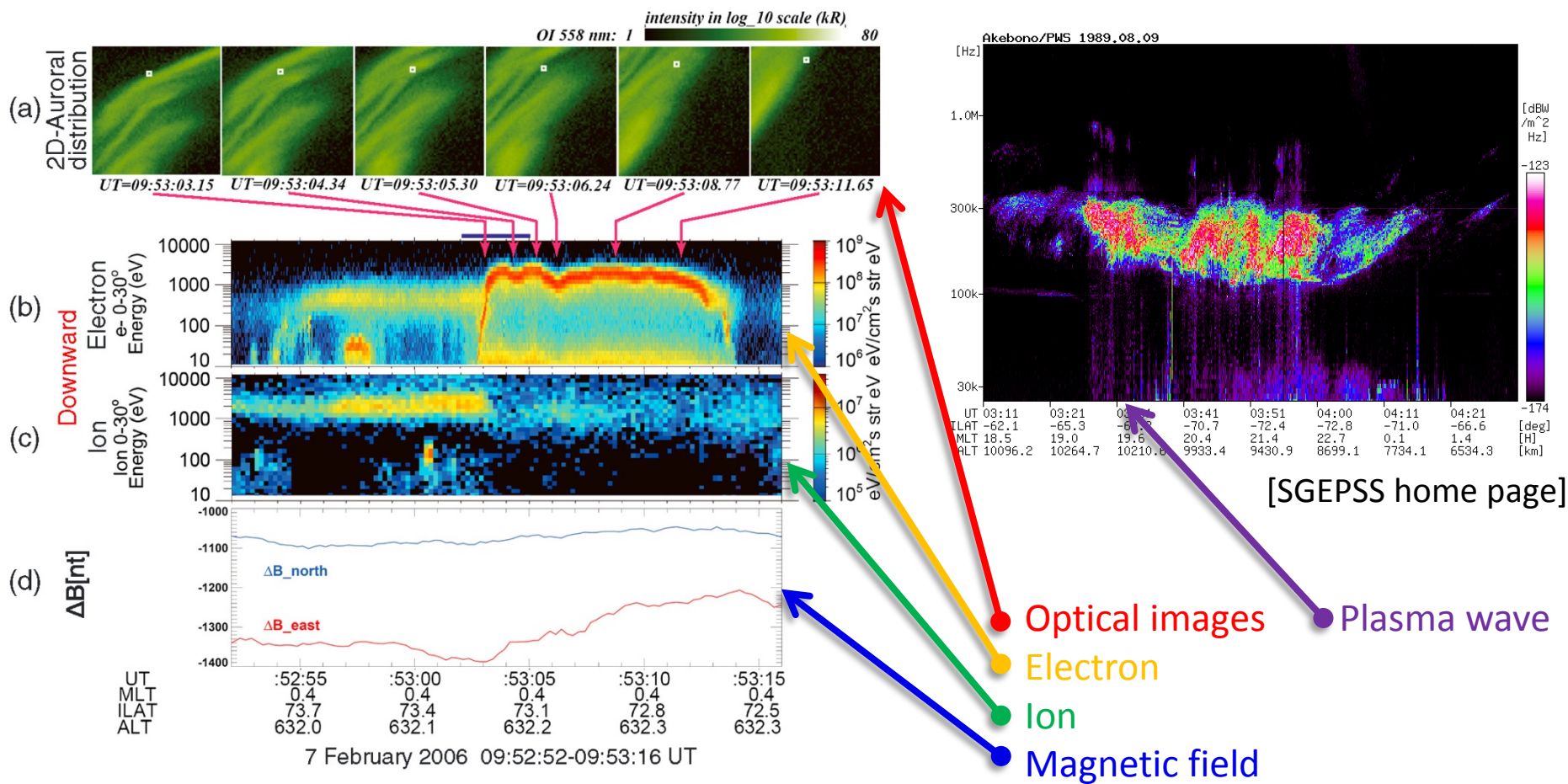
From high-altitude satellite
[IMAGE, ~46,000 km altitude]



All images
courtesy of
NASA

Aurora from different points of view

- It is important to observe aurora from different points of view.



Fukuda et al. [2014]

Observations in solar-terrestrial physics

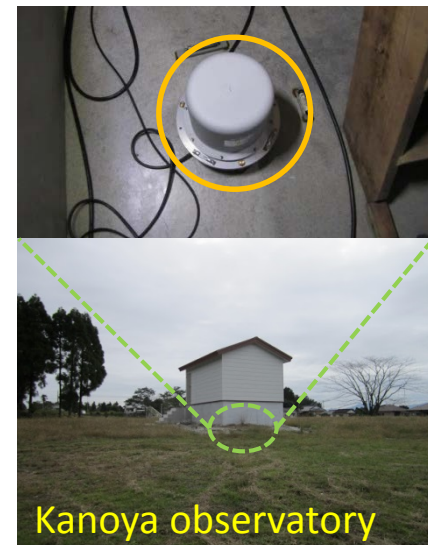
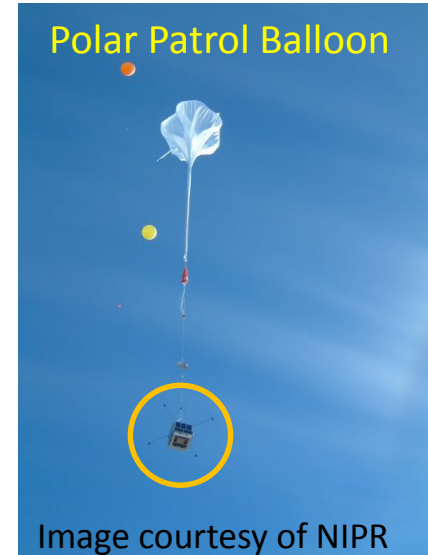
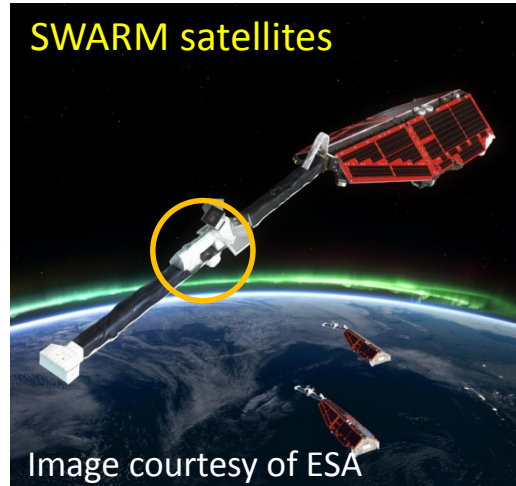
Method of observations

- Optical image
 - wavelength (frequency)
- Plasma wave
 - wavelength (frequency)
- Particle
 - species (e^- , p^+ , He^+ , He^{++} , O^+ , ...)
 - energy
- Field
 - magnetic field
 - electric field

Carrier of instruments

- Space-borne
- Rocket-borne
- Balloon-borne
- Ground-based

Magnetometers in different carriers



Quiz

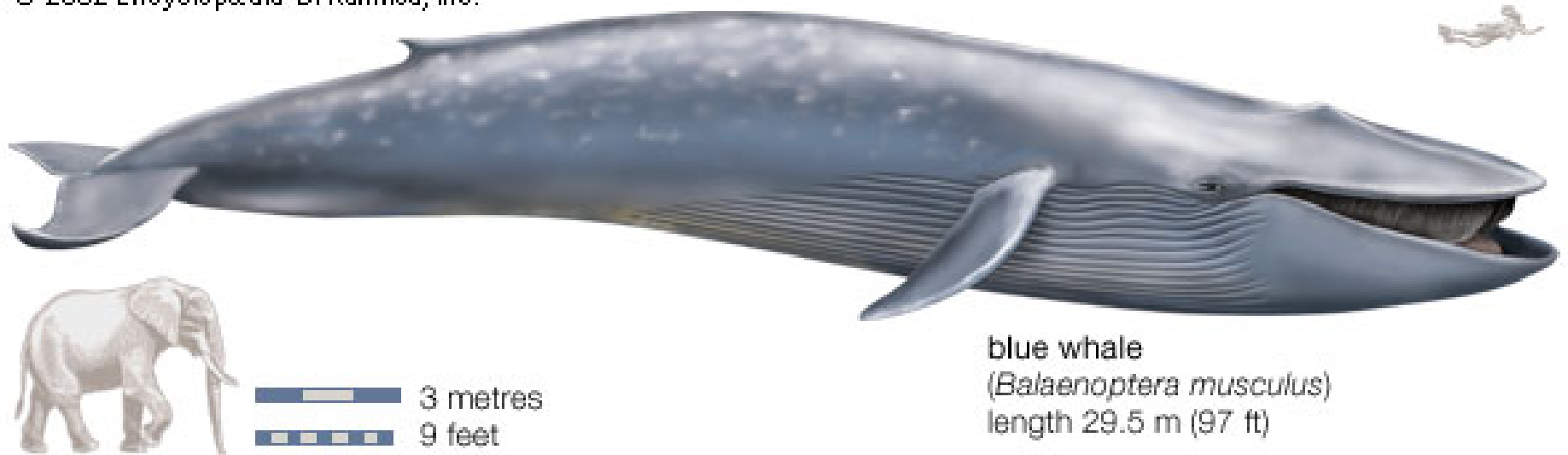
- Imagine that you are in the dark with your friends.
- Identify an animal in the dark with your flashlights and microphones.



Quiz

- Imagine that you are in the dark with your friends.
- Identify an animal in the dark with your flashlights and microphones.

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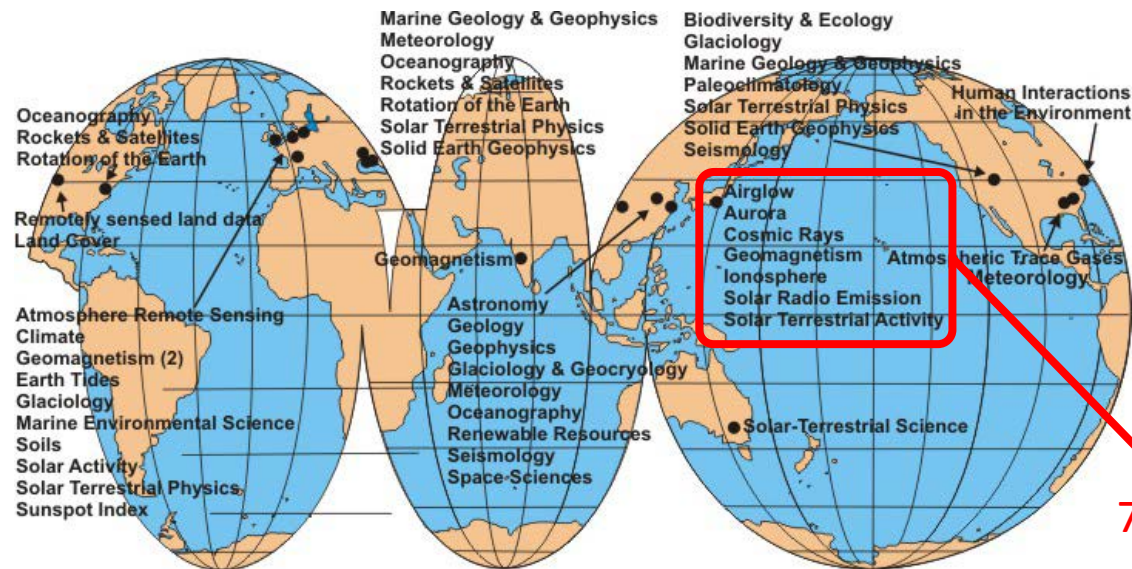


Sharing observational results

	Quiz	Observational physics (Solar-Terr. Phys.)	Experimental physics
Target	Blue whale	Plasma phenomena in vast space	(Depend on research fields)
Size relative to observer	Huge	Huge	Small in most cases
Method of observation	Visual, auditory, tactile senses, ...	Optical image, wave, particle, field, ...	(Depend on research fields)
Attitude of observation	Passive	Passive	Active
Chance of observation	One-time-only	One-time-only	Multiple times
Strategy	Share observations	Share observations	Not share observations

World Data Center (WDC) & World Data System (WDS)

- 1957-1958: International Geophysical Year (IGY)
 - 67 countries, ~4000 observational sites
 - **Earth sciences:** Aurora, airglow, cosmic rays, geomagnetism, gravity, glacier, ionospheric physics, longitude and latitude determinations, meteorology, oceanography, seismology, and solar activity
- 1957-1958: The World Data Center (WDC) system was created.
 - to archive and distribute data collected from the IGY observational programs
- 2008: Reformed into the World Data System (WDS)
 - to promote **universal and equitable access to scientific data** covering a broad range of disciplines from the natural and social sciences, and humanities

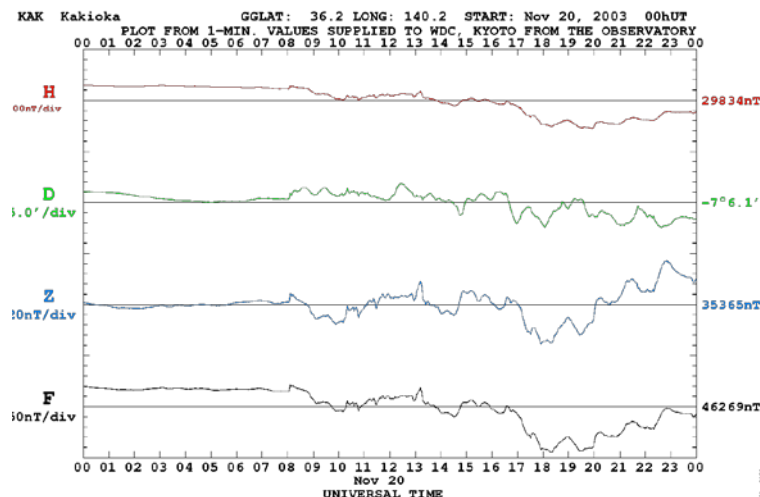


7 WDCs in Japan

WDC for Geomagnetism, Kyoto

- Geomagnetic field data (>150 observatories), geomagnetic indices, etc.

Geomagnetic field variations at Kakioka, Japan
[November 20, 2003]



WDC for Geomagnetism x

← → ↺ ↻ wdc.kugi.kyoto-u.ac.jp/index.html

What's New World Data Center for Geomagnetism, Kyoto Japanese

operated by
Data Analysis Center for Geomagnetism and Space Magnetism
Graduate School of Science, Kyoto University
Kitashirakawa-Oiwake Cho, Sakyo-ku
Kyoto 606-8502, JAPAN

TEL: +81-75-753-3929 (075-753-3929, inside Japan)
FAX: +81-75-722-7884 (075-722-7884, inside Japan)

WORLD DATA CENTER FOR GEOMAGNETISM ICSU WORLD DATA SYSTEM

WDC for Geomag. KYOTO Home Page WDC for Geomag. Kyoto E's magnetic field? Data Service I-Magnet Link

1. [World Data Center for Geomagnetism, Kyoto](#)
Data Analysis Center for Geomagnetism and Space Magnetism, Research, Publication list, Staff, Access Guide and Map, WDC system and others
2. [What is the Earth's magnetic field?](#)
Magnetic north, geomagnetic and magnetic poles, Geomagnetic elements, Geomagnetic field observation and collection of the data (Geomagnetic observatories on the Google Earth), International Geomagnetic Reference Field and others
3. [Geomagnetic Data Service](#)
Indices, Geomagnetic Field Data at the Observatories, Models, Data Catalogue and others
4. [INTERMAGNET Kyoto GIN Home Page](#)
QL monitor of INTERMAGNET data, about INTERMAGNET and others
5. [Link to other sites](#)
Kyoto University, ICSU/WDS's, Geomagnetic Observatories, Societies and others

Contact on this page: ivemori@kugi.kyoto-u.ac.jp

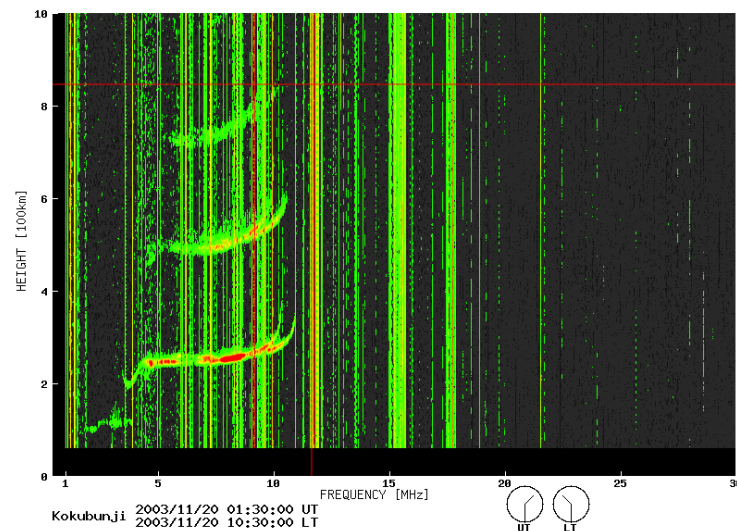
Logomark is designed by T. Hashimoto

WDC for Geomag. KYOTO WDC for Geomag. KYOTO WDC for Geomag. KYOTO WDC for Geomag. KYOTO WDC for Geomag. KYOTO WDC for Geomag. KYOTO

WDC for Ionosphere and Space Weather

- Ionospheric parameters (ionograms, 7 observatories)

Ionogram at Kokubunji, Japan
[November 20, 2003]



ICSU World Data System and World Data Center for Ionosphere and Space Weather

The ICSU World Data System (WDS) was created through a decision of the General Assembly in 2008, restructuring the former ICSU World Data Centers (WDCs) established during the International Geophysics Year (IGY) of 1957-1958 and former Federation of Astronomical and Geophysical data-analysis Services (FAGS). WDS aims to ensure the long-term stewardship and provision of quality-assessed data and data services to the international science community in order to support the scientific research projects ICSU actively promotes.

National Institute of Information and Communications Technology (NICT) has been operating a Regional Warning Center (RWC) of the International Space Environment Service (ISES). We also hosted and operated the WDC for Ionosphere under the auspices of ICSU WDC. Recognized for these contributions to international data-sharing efforts, the WDC for Ionosphere and Space Weather operated by NICT has been officially accepted as a Regular Member of ICSU WDS. Our organization collects and archives data and information on ionosphere and space weather, and makes them available to the public. Published data are used by a wide range of users including public organizations, research institutions, and universities.



Latest Archives

August 2015

[Vol.67 No.6 Ionospheric Data in Japan for June 2015 \(PDF\)](#)

July 2015

[Vol.67 No.5 Ionospheric Data in Japan for May 2015 \(PDF\)](#)

June 2015

[Vol.67 No.4 Ionospheric Data in Japan for April 2015 \(PDF\)](#)

NICT Space Weather and Environment Informatics Laboratory

Data Download

NASA, Coordinated Data Analysis Web

- Public data from current space physics missions (>35 satellites)

SPDF - Coordinated Data Analysis Web

cdaweb.gsfc.nasa.gov/istp_public/

GODDARD SPACE FLIGHT CENTER
Space Physics Data Facility

+ SPDF HOME + DATA & ORBITS + MODELS at CCMC + SCIENCE ENABLED + AND MORE

CDAWeb

+ CDAWEB HOME
+ FEEDBACK
+ ABOUT CDAWEB

CDAWeb Mirror Site
+ RAL/UK

Guides and Tutorials
+ CDAWeb help
+ Internet browser help

Additional Services
+ CDAWeb Inside IDL
+ HTTP & Anonymous FTP access to public CDAWeb database
+ Overview of Alternative Data Access Methods
+ Autoplot.org (non-NASA) interface to public CDAWeb database

Additional Resources
+ Usage Statistics
+ GIFWALK Data and Orbit plots
+ Space Physics Use of CDF
+ Data Inventory Graph
+ Home Pages for ISTP Investigations

Coordinated Data Analysis Web (CDAWeb)

Public data from current space physics missions

NEW
October 14, 2015: New ACE SWICS 2.0 (AC_H3_SW2) data are available in the system. The data set consists of time series measurements of the elemental abundance, charge state composition, and kinetic distribution of heavy ions in the solar wind. It begins after August 23, 2011, when a radiation and age-induced hardware anomaly altered the instrument's operational state. SWICS 2.0 is a different instrument than SWICS 1.1, with different measurement and statistical properties, so all SWICS users should read the release notes provided by the instrument team.

NEW
October 13, 2015: Sunspot Number Index values for 1963-2015 in the OMNI2_H0_MRG1HR data set have been updated to the revised Version 2 definition now used by the Royal Observatory of Belgium (see <http://sidc.oma.be/silso/datafiles/>). The updated values are generally larger by factors 1.2-1.7 and can be compared in detail using http://omniweb.sci.gsfc.nasa.gov/form/sunspot_v1_v2.html.

PRIOR DATA & SOFTWARE UPDATES ...

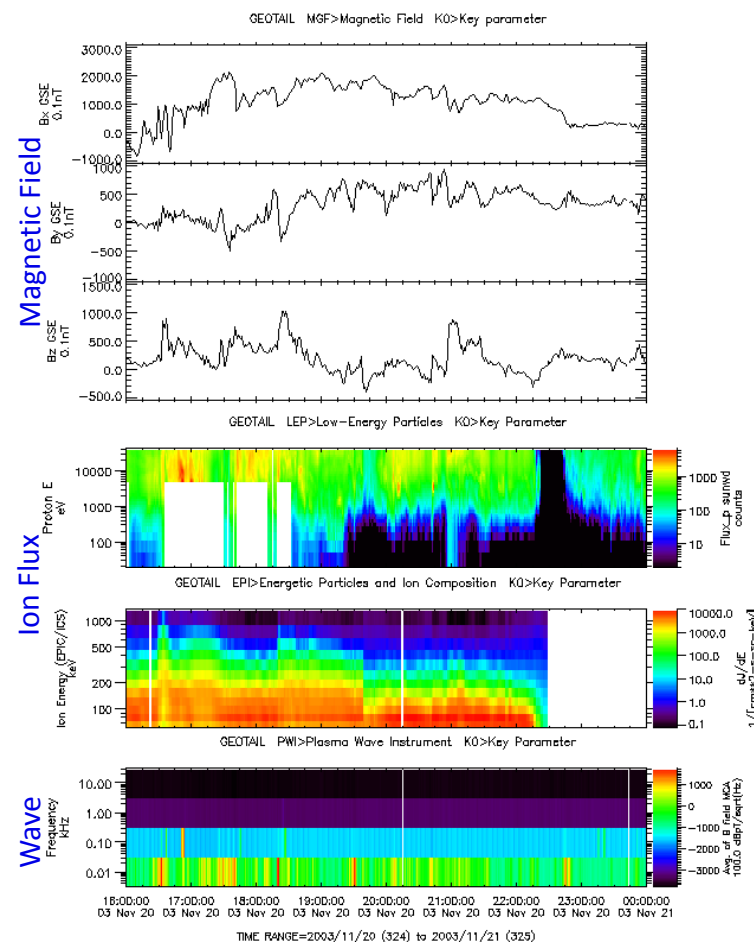
Select one OR more Sources
(default = All unless no Instrument Types selected)

ACE
ARTEMIS
BARREL
CNOFS

AND Select one OR more Instrument Types
(default = All unless no Sources selected)

Activity Indices
Electric Fields (space)

GEOTAIL satellite data [November 20, 2003]

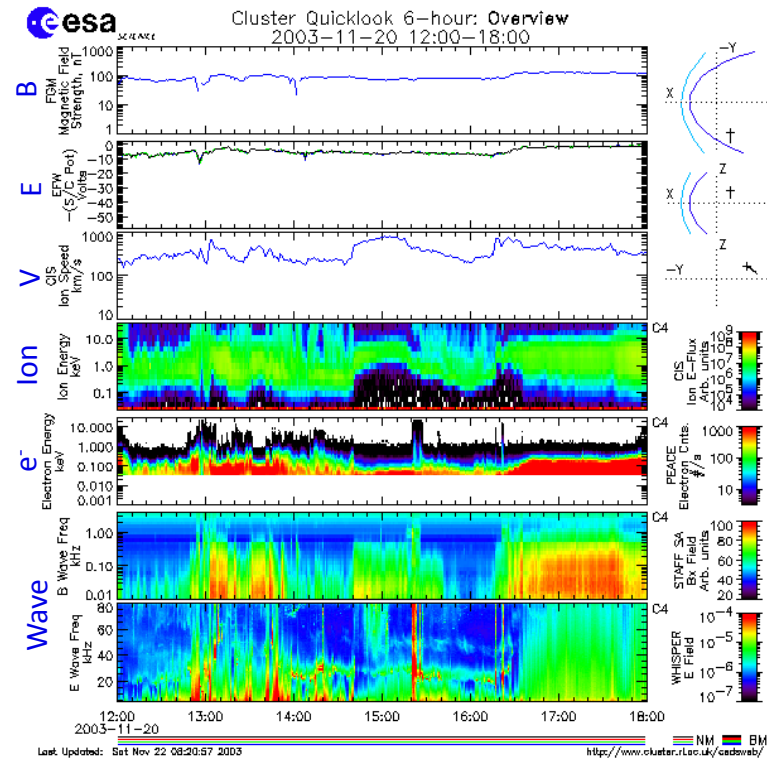


European Space Agency (ESA), Cluster Science Archive

- Data archive for CLUSTER and DOUBLE STAR satellite missions

The screenshot shows the Cluster Science Archive website in a web browser. The browser window has a single tab titled 'Cluster Science Archive' and the address bar shows 'www.cosmos.esa.int/web/csa'. The website header includes navigation links for 'SRE SCIENCE MISSIONS', 'SCIENCE & TECHNOLOGY', and 'EUROPEAN SPACE AGENCY', along with a 'SIGN IN' button. The main banner features the 'cluster science archive' logo and the text 'Cosmos » Cluster Science Archive » Access to the Archive'. Below this, a section titled 'THE CLUSTER AND DOUBLE STAR SCIENCE ARCHIVE VERSION 1.3.2' is visible. A sidebar on the left contains a list of links, with 'Access to the Archive' highlighted in a red box. The main content area provides instructions on how to access the archive through its Java user interface, listing services such as direct data download (up to 1 GB), scheduled data download (up to 40 GB), visualization of key datasets, particle distributions, and inventory information. It also includes a link for 'Automatic login' and a section for 'COMMAND-LINE WEBSITE' with instructions on using tools like wget, Matlab, IDL, and data streaming. At the bottom, there is a 'Mac users' section with a note about a major bug and solution found with Java 8.40 on Mac Yosemite OSX 10.10.2, and a link to the FAQ section for more information. A footer note suggests checking the FAQ section if any problem occurs or contacting the support team.

CLUSTER satellite data [November 20, 2003]

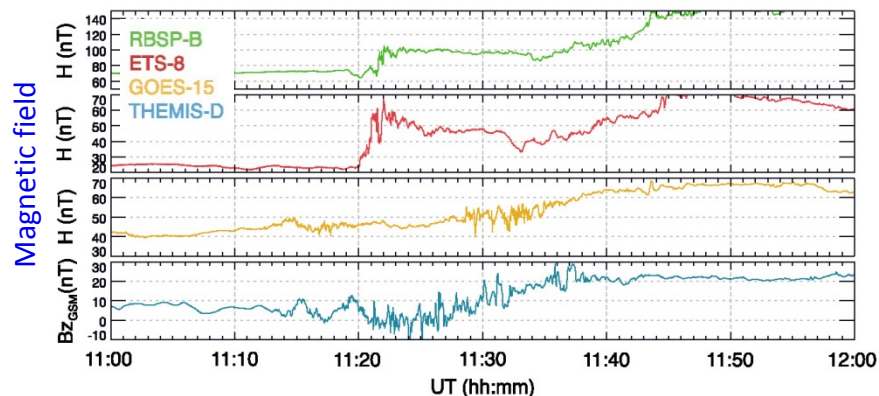
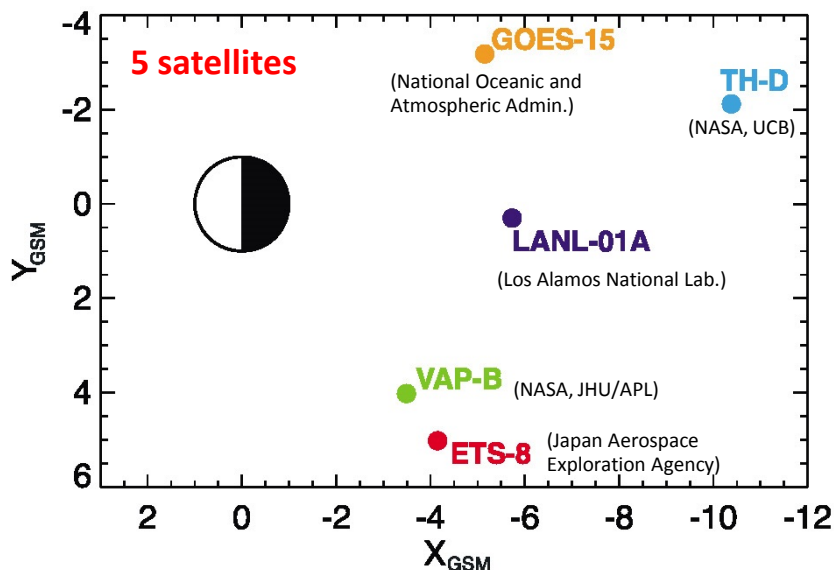


Examples of papers employing multi-satellites

Gkioulidou et al. [2015], 10 co-authors

Spatial structure and temporal evolution of energetic particle injections in the inner magnetosphere during the 14 July 2013 substorm event

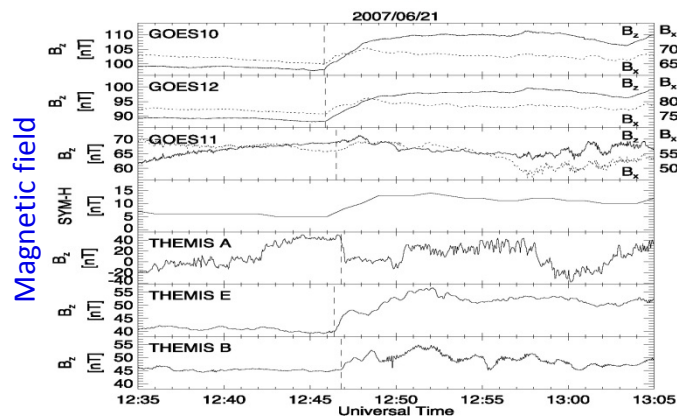
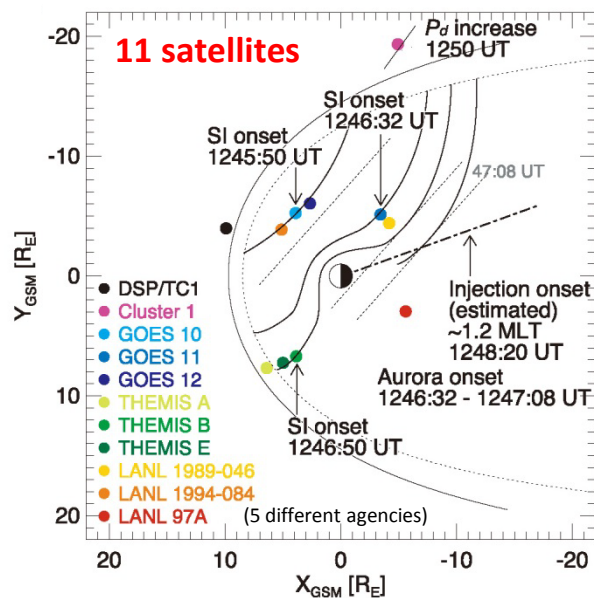
Matina Gkioulidou¹, S. Ohtani¹, D. G. Mitchell¹, A. Y. Ukhorskiy¹, G. D. Reeves², D. L. Turner³, J. W. Gjerloev¹, M. Nosé⁴, K. Koga⁵, J. V. Rodriguez^{6,7}, and L. J. Lanzerotti⁸



Keika et al. [2009], 14 co-authors

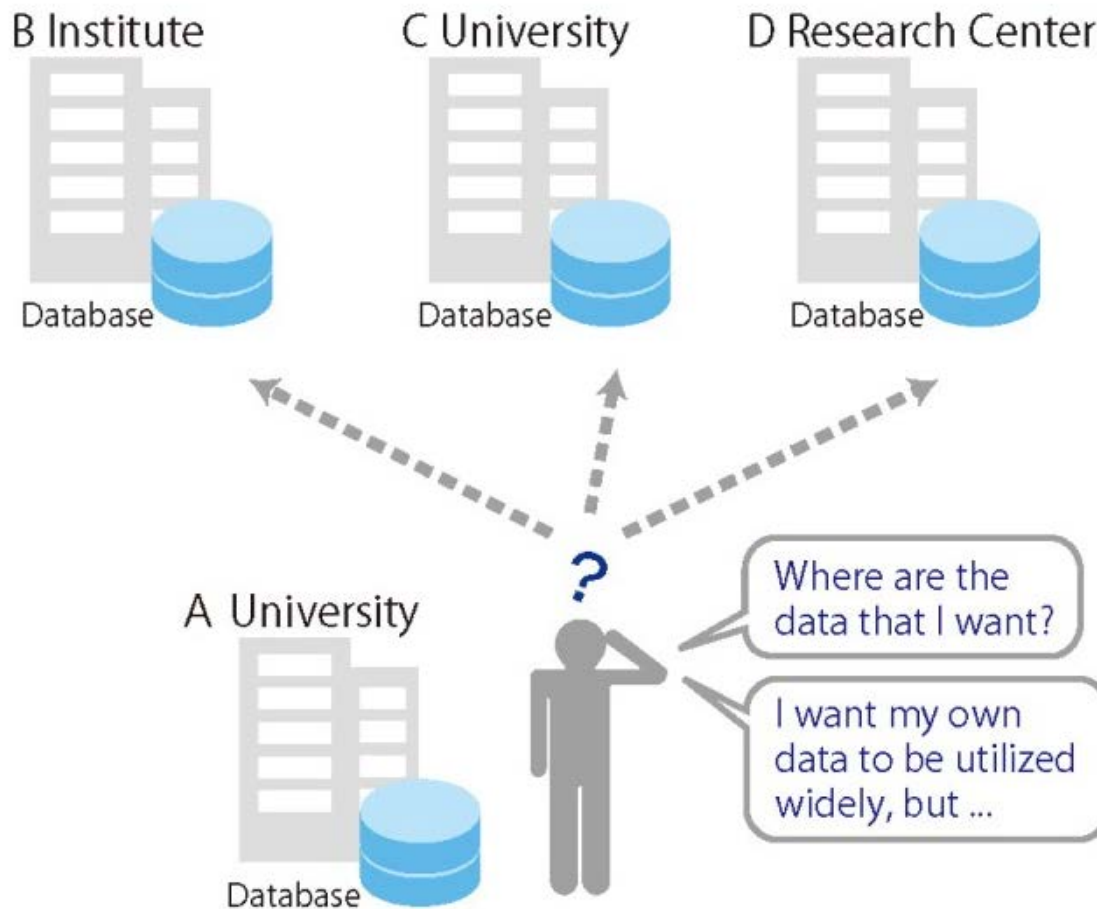
Substorm expansion triggered by a sudden impulse front propagating from the dayside magnetopause

K. Keika,¹ R. Nakamura,¹ W. Baumjohann,¹ V. Angelopoulos,² P. J. Chi,² K. H. Glassmeier,^{3,4} M. Fillingim,⁵ W. Magnes,¹ H. U. Auster,³ K. H. Fornacon,³ G. D. Reeves,⁶ K. Yumoto,⁷ E. A. Lucek,⁸ C. M. Carr,⁸ and I. Dandouras⁹



Difficulty in finding database

- Data are open and ready to be shared, but it sometimes happens that users cannot discover the open database.
- This problem can be solved by creation and search of metadata database.



IUGONET (Inter-university Upper atmosphere Global Observation NETwork)

- Metadata database for upper atmospheric physics
- Users are able to search the metadata DB via any web browsers.

IUGONET Metadata DB (iugonet1@stel) >

[Question](#) [easy feedback](#) or [detail survey](#)

IUGONET
Metadata DB for Upper Atmosphere

Browse Data

- Entire Data / Resource
- Registration List to IUGONET MDB
- Resource Type

Browse Service

- Browse Service

UDAS
Iugonet Data Analysis Software

IUGONET

Search Form:

- Keyword:** [Keyword] (e.g. magnetometer, SMART, radio wave, imaging riometer....)
- Time:** from [YYYY-MM-DDThh:mm:ssZ] to [YYYY-MM-DDThh:mm:ssZ] [UTC]
- Data Types:**
 - Data Set (☒ Numerical ☒ Plot / Movie ☐ Data File / Plot ☐ Instrument ☐ Observatory)
- Search**

Copyright © 2009-2012 IUGONET - [Feedback](#)
Customized by IUGONET.
Powered by [DSpace Software](#).

List of Data Registered in the IUGONET Metadata DB As of March 2014

<ul style="list-style-type: none"> Tohoku University <ul style="list-style-type: none"> Onagawa Geomagnetic Data (Search Coil) Iitate HF-Band Jupiter-Sun Wide-Band Radio Data Iitate UHF-Band Jupiter Narrow-Band Radio Data Iitate VHF-Band Solar Radio Spectral Data Zao HF-Band Jupiter Narrow-Band Radio Data Zao HF-Band Jupiter Wide-Band Radio Data Athabasca LF-Band Standard Radio Wave Phase-Amplitude Variation Data Ny-Alesund LF-Band Standard Radio Wave Phase-Amplitude Variation Data Alaska Geomagnetic Data (Search Coil) Alaska Aurora Imaging Data Asia VLF Observation Network (AVON) National Institute of Polar Research <ul style="list-style-type: none"> Syowa Station: <ul style="list-style-type: none"> Auroral Observation Geomagnetic Observation Upper Atmosphere Physics Monitoring Observation Imaging Riometer 1-100kHz ULF/ELF Electromagnetic Wave Observation Fabry-Perot Imager SuperDARN HF-Radar MF Radar Sodium Lidar Unmanned Magnetometer Network Observation around Syowa Station Upper Atmosphere Physics Observation at Zhongshan Station All-Sky Imager at South Pole Station Conjugate Observation at Iceland EISCAT Radar NIPR/Norway Svalbard Meteor Radar (NSMR) NIPR/Norway Tromsø Meteor Radar (NTMR) Auroral and Airglow Observation (Svalbard, Tromsø) Kyoto University; Kwasan and Hida Observatories <ul style="list-style-type: none"> Flare Monitoring Telescope (FMT): <ul style="list-style-type: none"> FMT Full-Disk Solar Images FMT Event List FMT Event Movies Solar Magnetic Activity Research Telescope (SMART): <ul style="list-style-type: none"> SMART H α Full-Disk Solar Images SMART H α Partial Solar Images SMART Event Catalogue SMART Event Movies SMART Solar Photospheric Magnetograms Dome Solar Telescope (DST): <ul style="list-style-type: none"> DST H α Partial Solar Images DST Spectrograph Quick-look Solar Images DST Spectrograph Data Ca II K Full-disk Heliograms 	<ul style="list-style-type: none"> Kyoto University; Data Analysis Center for Geomagnetism and Space Magnetism <ul style="list-style-type: none"> Geomagnetic Indices (Final) Geomagnetic Indices (Provisional) Geomagnetic Indices (Quick Look) Geomagnetic Field Digital Data (WDC Final) Geomagnetic Field Digital (WDC Prompt) Geomagnetic Field Analog Data Geomagnetic Field Digital Data (Original Observations by WDC for Geomag., Kyoto) Statoscope Data (Original Observations by WDC for Geomag., Kyoto) Geomagnetic Field Model (IGRF) Ionospheric Conductivity Model Catalogue for Archived Geomagnetic Field Data Kyoto University; Research Institute for Sustainable Humanosphere <ul style="list-style-type: none"> Shigaraki MU Observatory: <ul style="list-style-type: none"> MU Radar (Troposphere and Stratosphere) MU Radar (Mesosphere) MU Radar (Ionosphere) MU Radar (Special Obs.: Meteor/RASS/FAI) Radioisotope <ul style="list-style-type: none"> Boundary Layer Radar L-Band Lower Troposphere Radar Wind Profiler Radar (LQ-7) Ionosonde <ul style="list-style-type: none"> Meteor Radar Lower Thermosphere Profiler Radar Lidar Ceiliometer <ul style="list-style-type: none"> AWS All Sky Camera <ul style="list-style-type: none"> Equatorial Atmosphere Observatory: <ul style="list-style-type: none"> EAR (Troposphere and Stratosphere) EAR (FAI) Boundary Layer Radar Kotobang Meteor Radar X-band Weather Radar Ceiliometer Radioisotope AWS All Sky Camera Others: <ul style="list-style-type: none"> MF Radar (Pontianak, Pameungpeuk) Serpang Boundary Layer Radar Meteor Radar (Serpang, Blak) Dawin Radioisotope (Campaign Observation) GNU Radio Beacon Receiver (GBRR) GPS Wind Profiler Radar (LQ7) (Blak, Manado, Pontianak) Automatic Weather Station (AWS) (Blak, Manado, Pontianak) Radioisotope (Bandung, Pontianak, Serpong, Uji) 	<p>in preparation for registering its dataset metadata</p> <ul style="list-style-type: none"> Nagoya University <ul style="list-style-type: none"> Atmosphere: <ul style="list-style-type: none"> Campaign Observation of NOx and Ozone Mixing Ratio Aerosol Observation Atmospheric Molecule Observation by Infrared Spectrometer in Japan Atmospheric Molecule Observation by Millimeter Wave Spectrometry at Japan and South America Ionosphere and Magnetosphere: <ul style="list-style-type: none"> 210 Magnetic Meridian (210MM) Magnetometer Chain STEL Magnetometer Optical Mesosphere Thermosphere Imager (OMTI) Ionospheric Scintillation at Indonesia and Norway VHF Radar at Indonesia VLF/ELF Measurement in Japan and Canada EISCAT Radar MF/Meteor Radars at Norway Optical Observations at Norway SuperDARN Hokkaido HF Radar Heliosphere: <ul style="list-style-type: none"> Multi-Directional Cosmic-Ray Muon Telescope Interplanetary Scintillation Kyushu University <ul style="list-style-type: none"> Ground Geomagnetic Observation Data FM-CW Radar Observation Data Geomagnetic Pc5 Index Data Geomagnetic EE Index Data Geomagnetic P2 Index Data Sq Equivalent Current Pattern Model from MAGDAS/CPMIN Observation Collaborative Members <ul style="list-style-type: none"> Solar Observatory <ul style="list-style-type: none"> National Astronomical Observatory of Japan White-Light/H-Alpha Full Disk Image Full Disk Stokes Map (He-I 10830, Si-I 10827, Fe-I 15648) National Institute of Information and Communications Technology <ul style="list-style-type: none"> Aurora Web Camera (Alaska) MF Radar (Alaska/Wakkanai/Yamagawa) 1.3GHz Wind Profiler Radar (LQ4) Kakioka Magnetic Observatory, Japan Meteorological Agency <ul style="list-style-type: none"> Geomagnetic Field Data (1-hour/1-min/1-sec, Kakioka/Memambetsu/Kanoya/Chichijima) Geomagnetic Field Data (0.1-sec, Kakioka/Memambetsu/Kanoya) Geoelectric Field Data (1-hour/1-min/1-sec, Kakioka/Memambetsu/Kanoya) Atmospheric Electric Field Data (1-hour/1-min, Kakioka/Memambetsu)
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Summary

- Solar-terrestrial physics is a study of plasma phenomena in near-Earth space.
- The plasma phenomena
 - are naturally excited and cannot be controlled by observers, who can only make passive observations.
 - are transient and the same event does not occur.
 - have so large spatial scale that it is difficult for observers to cover completely.
- This makes researchers in solar-terrestrial physics share observational data.
- World Data Centers are established in 1957-1958 to archive and distribute data collected during IGY.
- Data from satellite missions and ground observation projects are usually open to public.
- Data sharing is an accepted culture in solar-terrestrial physics.
- Metadata database provides potential users with an opportunity to discover data that are already available but are not noticed by them. → IUGONET
- Solar-terrestrial physics is a good showcase for data scientist/informatics scientists to evaluate future possibility of “open science data” or “open research data”.