Research data sharing in the field of solar-terrestrial physics

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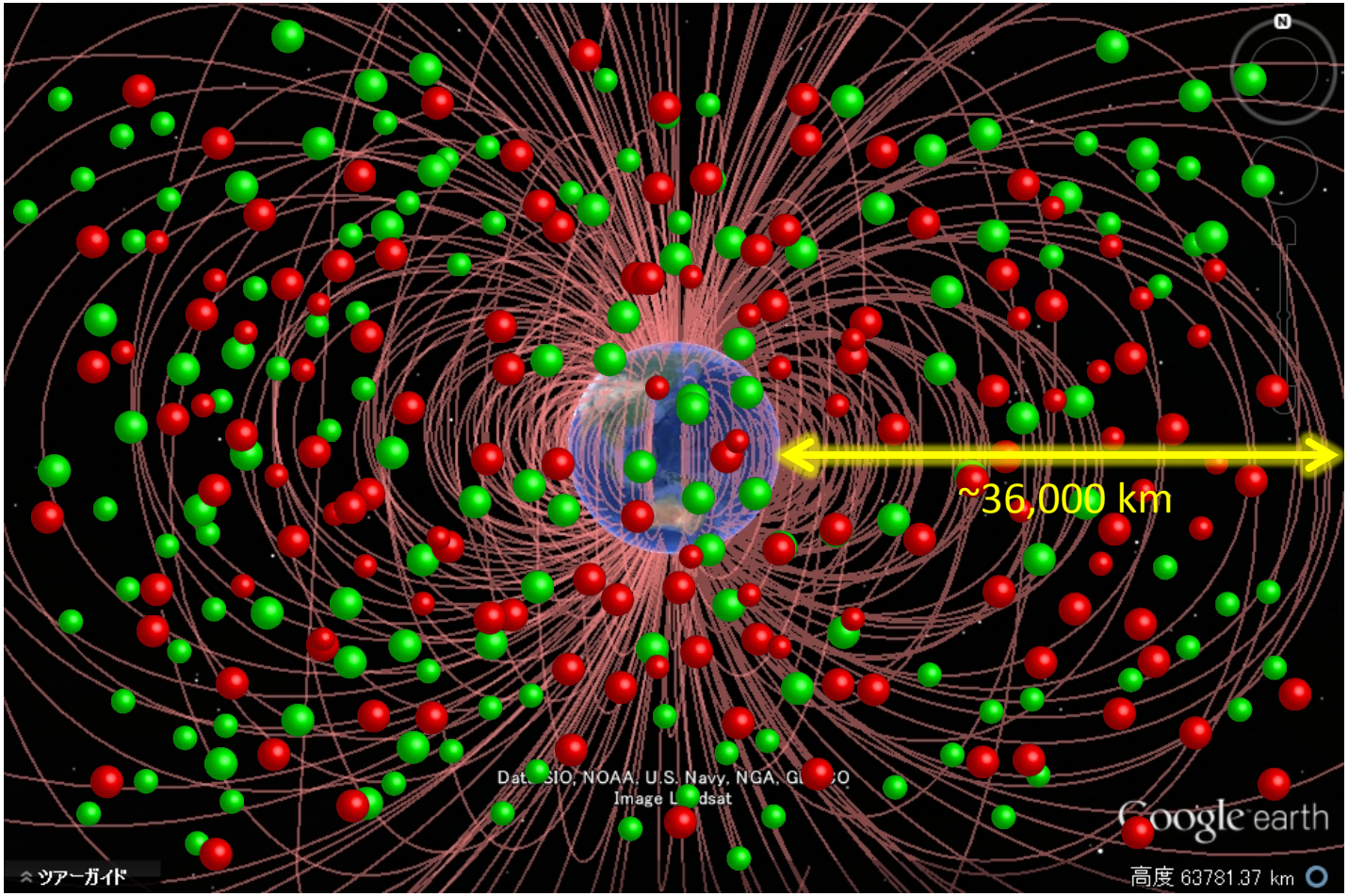
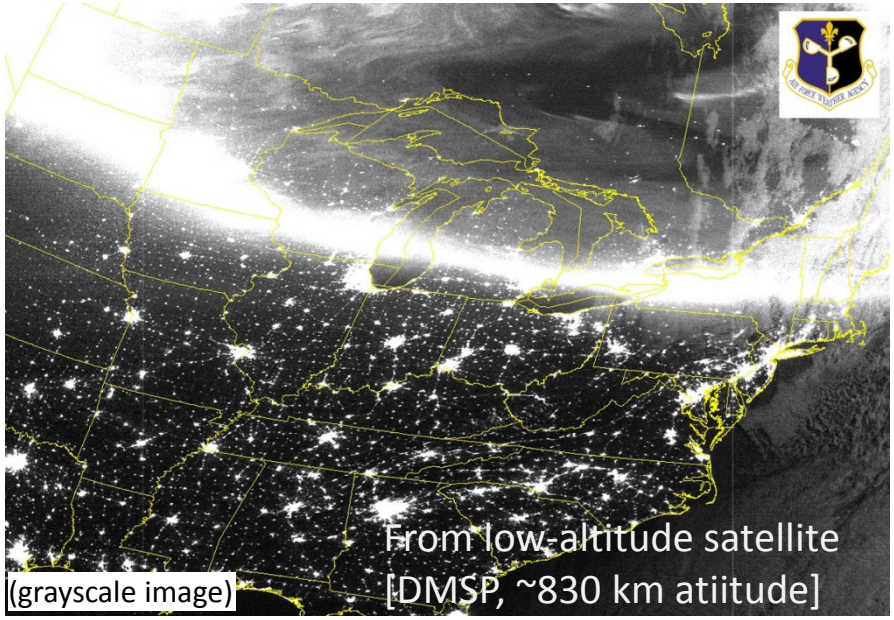
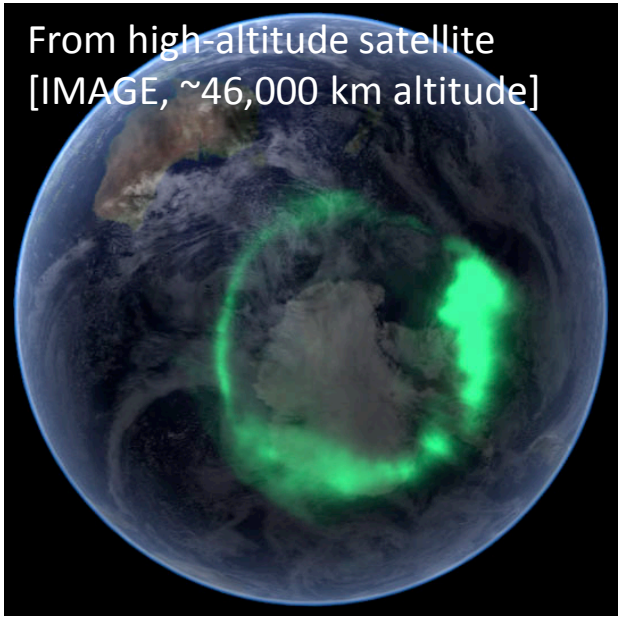
Solar-terrestrial physics?

- 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

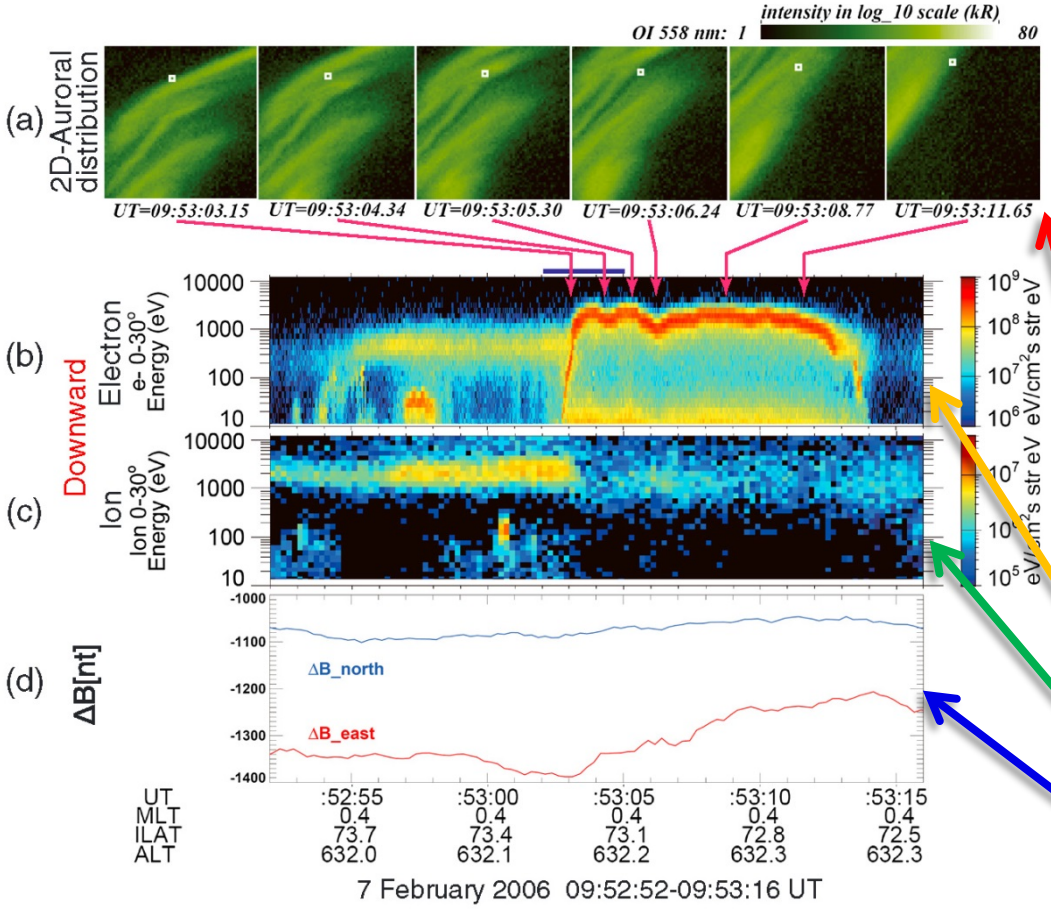


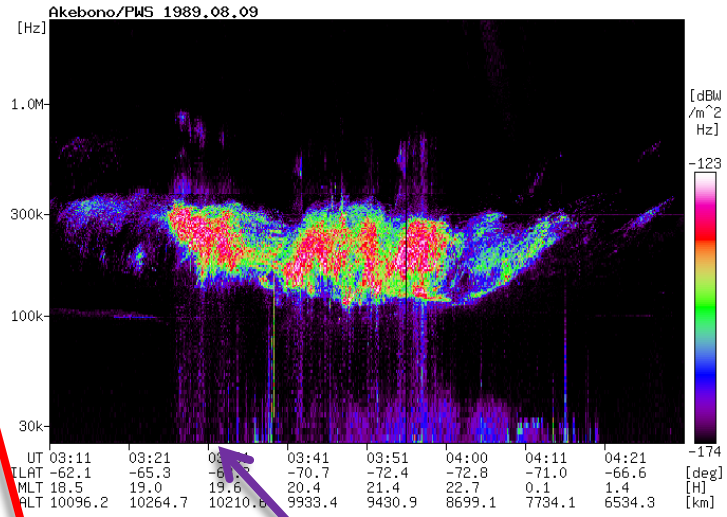


All images courtesy of NASA

Aurora from different points of view

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





[SGEPSS home page]

Optical images

Plasma wave

Electron

Ion

Magnetic field

Fukuda et al. [2014]

Observations in solar-terrestrial physics

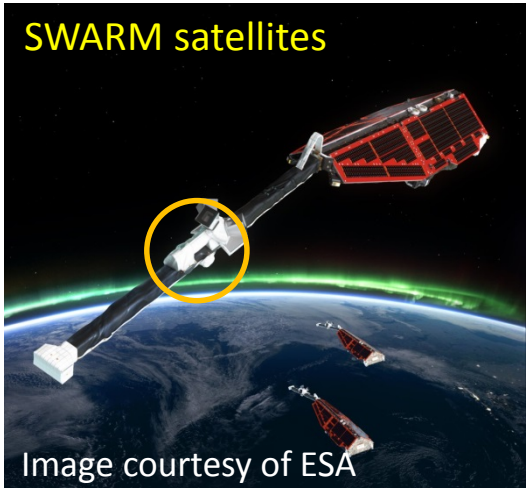
Method of observations

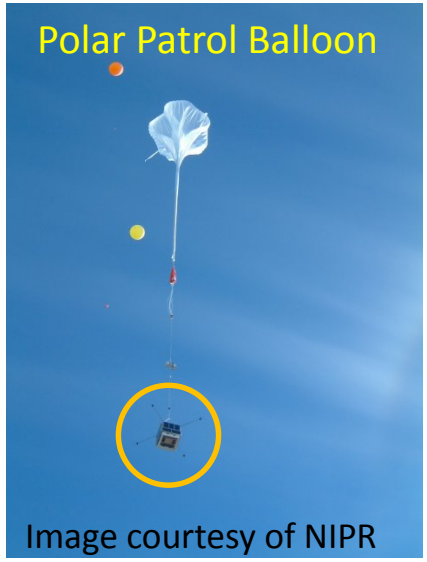
- Optical image
  - wavelength (frequency)
- Plasma wave
  - wavelength (frequency)
- Particle
  - species (e^-, p^+, He^+, He^{++}, O^+, …)
  - energy
- Field
  - magnetic field
  - electric field

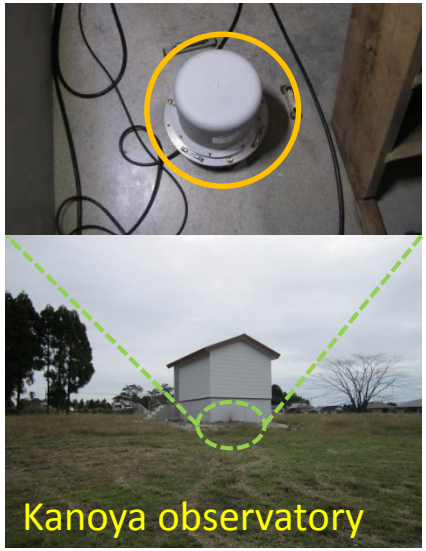
Carrier of instruments

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

Magnetometers in different carriers







Ishisaka et al.

Quiz

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

Quiz

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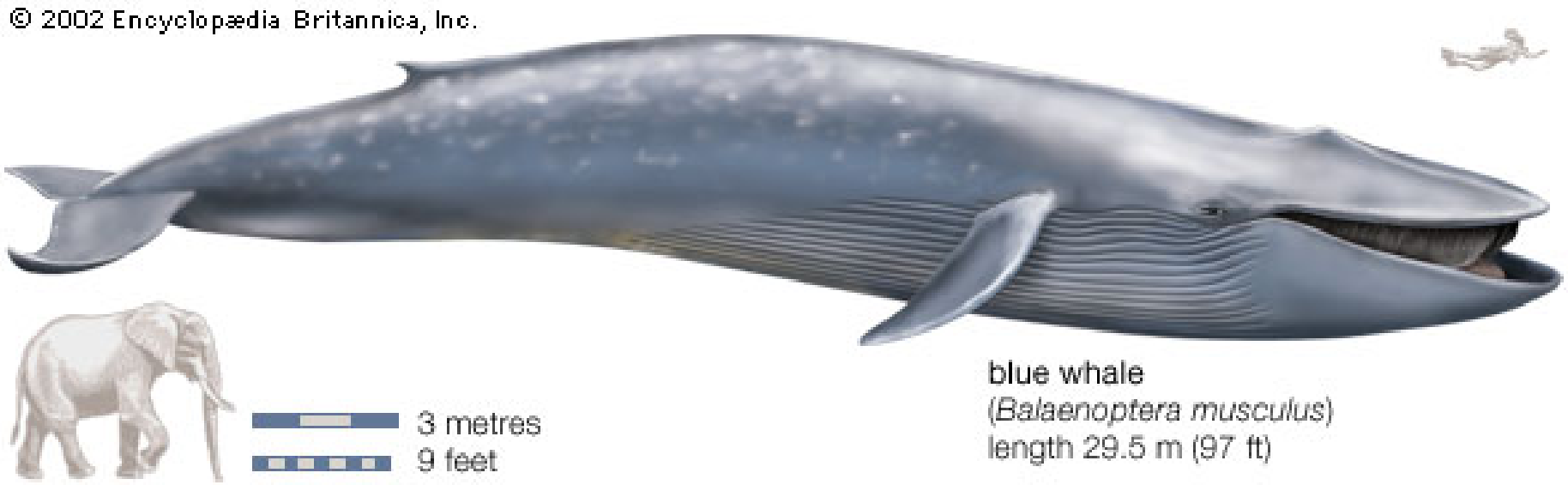
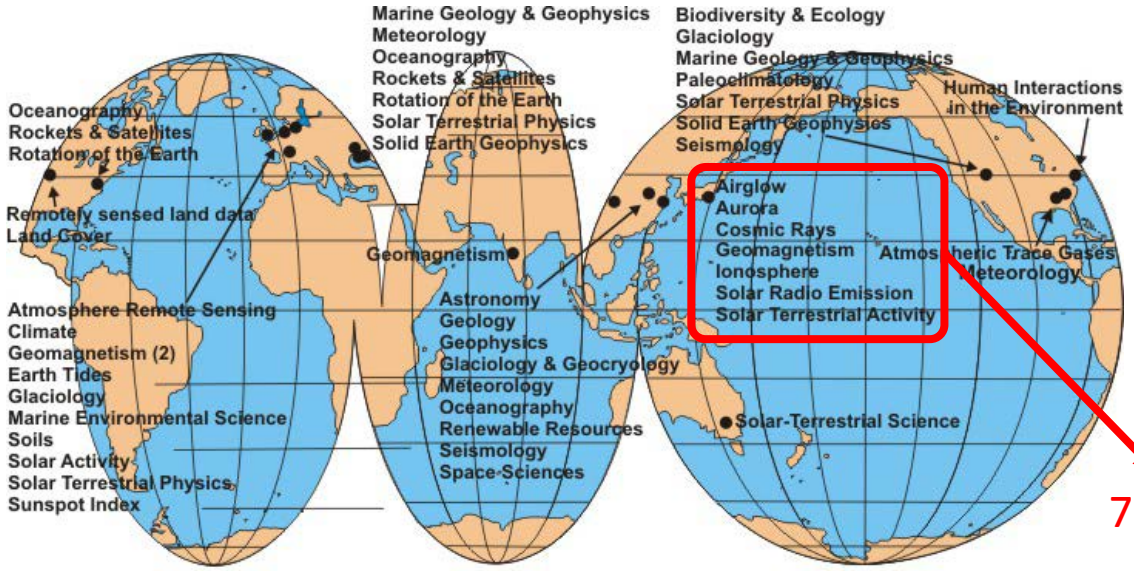


Sharing observational results

	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

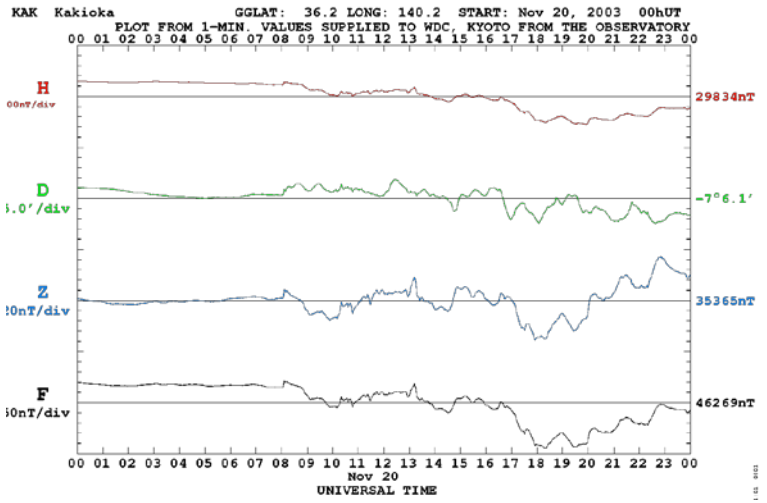


7 WDCs in Japan

WDC for Geomagnetism, Kyoto

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

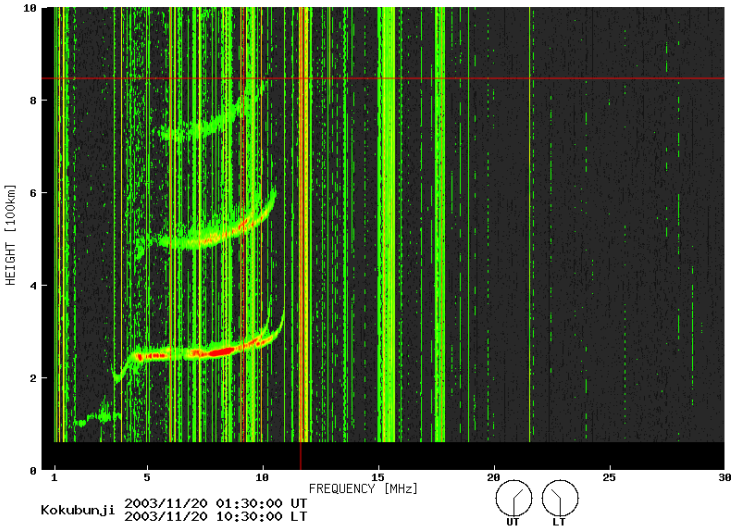
Geomagnetic field variations at Kakioka, Japan [November 20, 2003]



WDC for Ionosphere and Space Weather

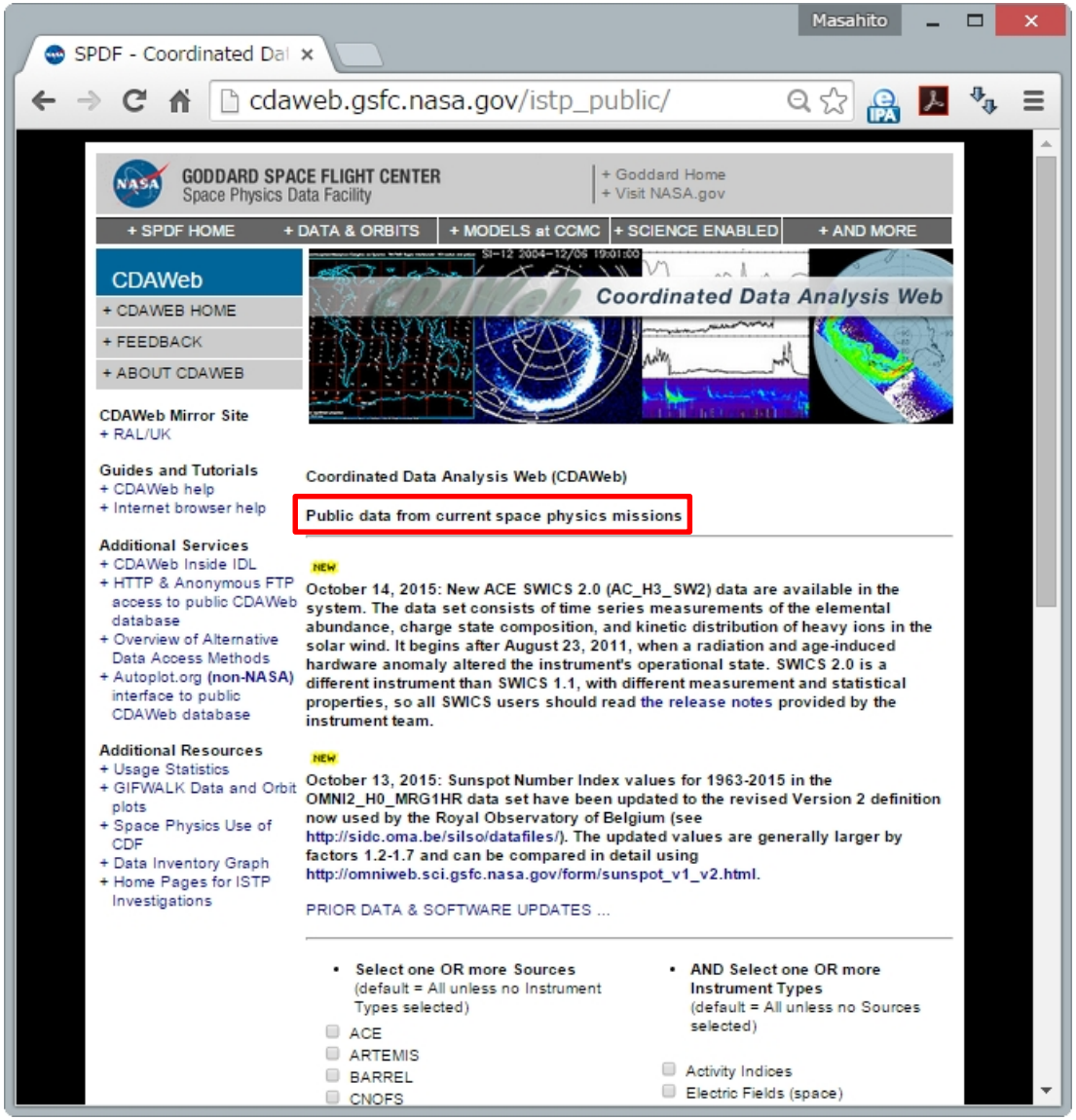
- Ionospheric parameters (ionograms, 7 observatories)

Ionogram at Kokubunji, Japan
[November 20, 2003]

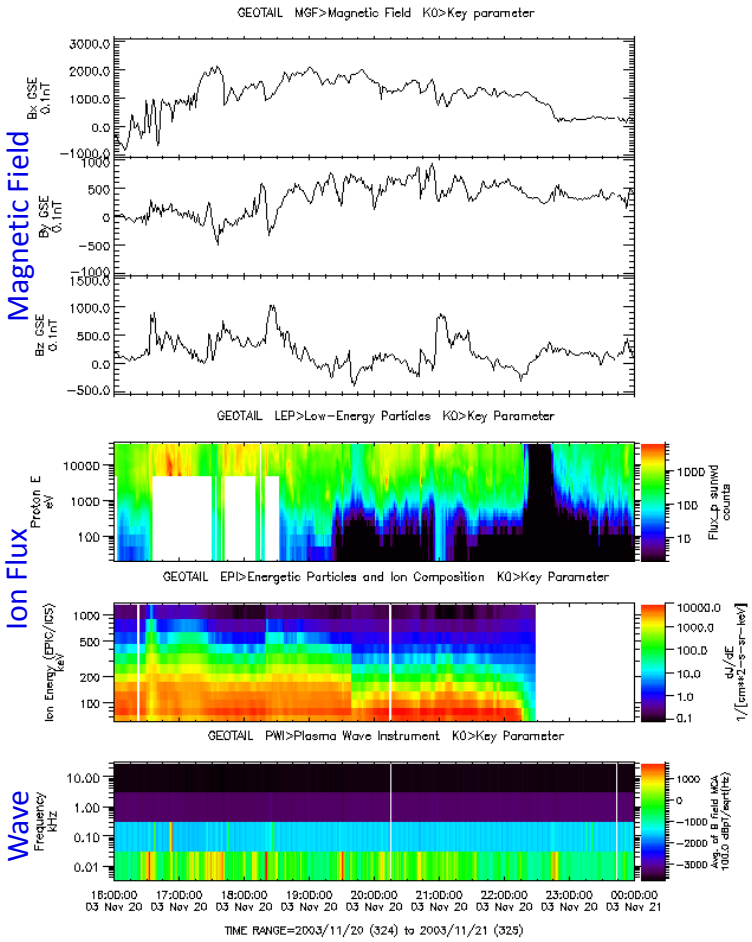


NASA, Coordinated Data Analysis Web

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



GEOTAIL satellite data [November 20, 2003]



European Space Agency (ESA), Cluster Science Archive

- Data archive for CLUSTER and DOUBLE STAR satellite missions

Masahito

Cluster Science Archive

www.cosmos.esa.int/web/csa

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cluster science archive

esa

Cosmos » Cluster Science Archive » Access to the Archive

cluster

THE CLUSTER AND DOUBLE STAR SCIENCE ARCHIVE

VERSION 1.3.2

- Access to the Archive
- Mission overview & Operations timeline
- Registration
- Frequently Asked Questions (FAQ)
- Cluster Helpdesk
- Cluster quicklook plots
- Double Star quicklook plots
- Documentation
- Software links
- Other useful links
- Workshops
- Rules of the road
- About this archive

→ START THE CSA GRAPHICAL USER INTERFACE

To access the archive through its Java **user interface**, please use the above link. This interface includes the following data services

Direct data download up to 1 GB

Schedule data download up to 40 GB

Visualize key datasets (on-demand & pregenerated plots)

Visualize particle distributions (on-demand only)

Visualize inventory information

Store data profiles

Automatic login

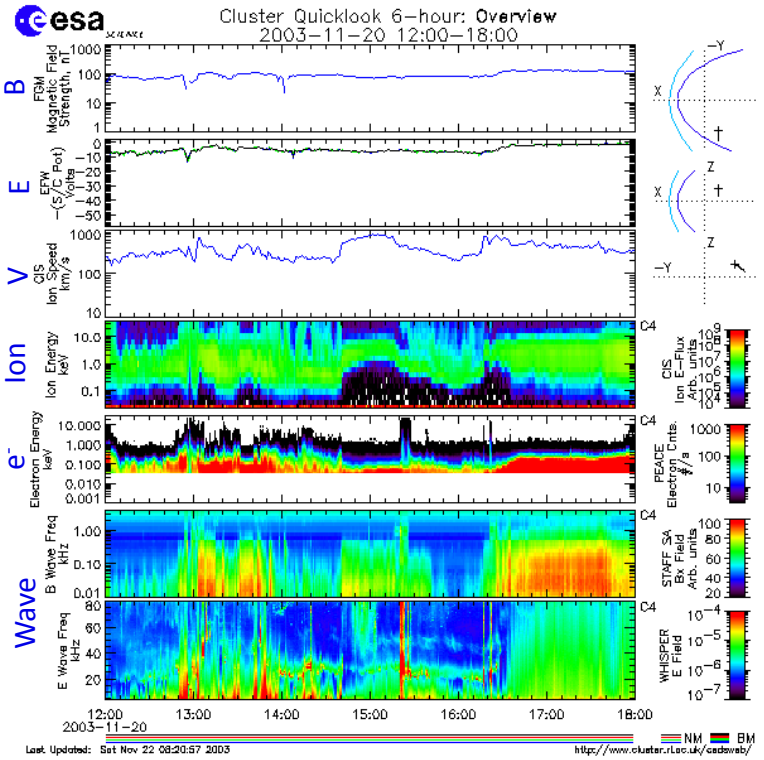
→ COMMAND-LINE WEBSITE

Use the above link to learn how to access the Cluster science archive data products via several ways including: **wget, Matlab, IDL and data streaming.**

Mac users: (9 March 2015) major bug and solution found with Java 8.40 on Mac Yosemite OSX 10.10.2 which unables users to enter any text in text boxes, e.g. credentials. The CSA team has found a workaround: see FAQ section11 . Also, be aware that security measures in recent versions of Mac OS X require actions to authorize third party programs like CSA. Click on the following FAQ shortcut for more information

Check the FAQ section if any problem occurs, or contact us.

CLUSTER satellite data [November 20, 2003]

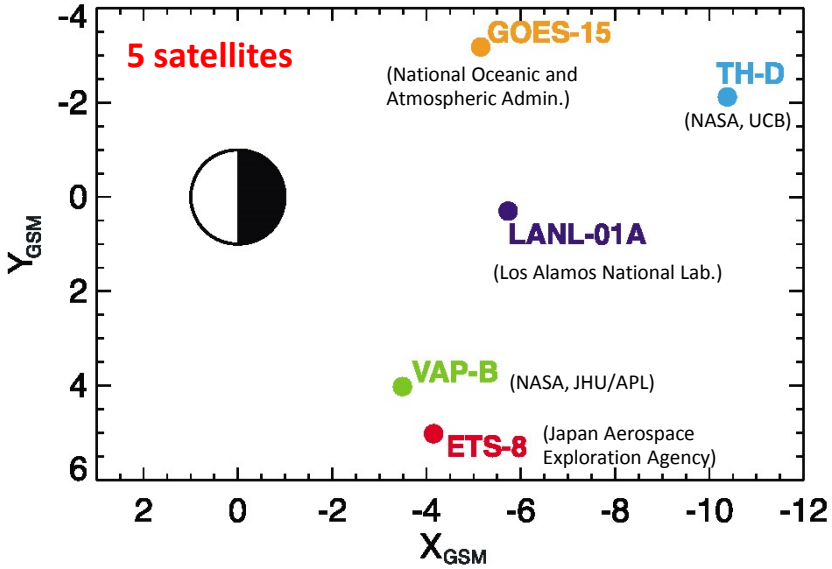


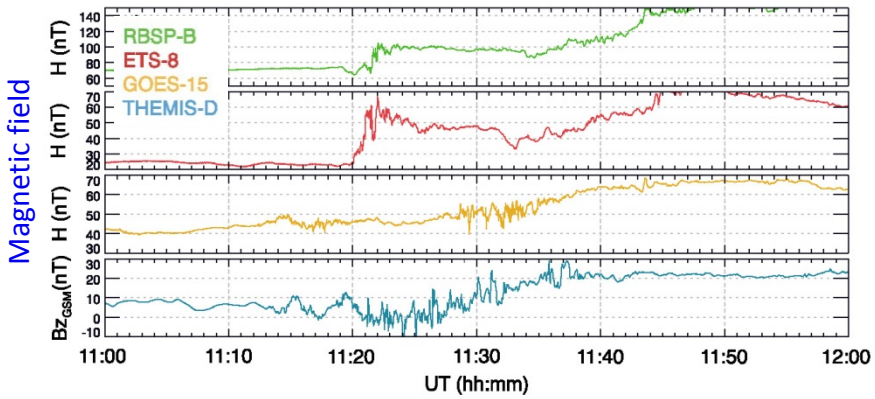
Examples of papers employing multi-satellites

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 Gkioulidou[1], S. Ohtani[1], D. G. Mitchell[1], A. Y. Ukhorskiy[1], G. D. Reeves[2], D. L. Turner[3], J. W. Gjerloev[1], M. Nosé[4], K. Koga[5], J. V. Rodriguez[6,7], and L. J. Lanzerotti[8]

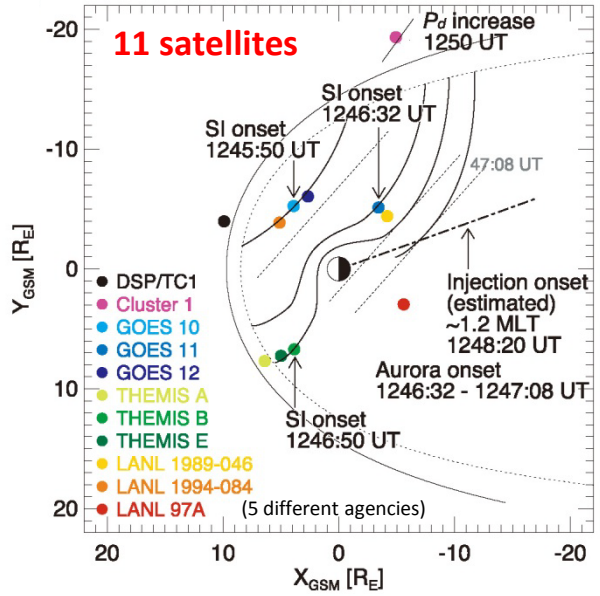


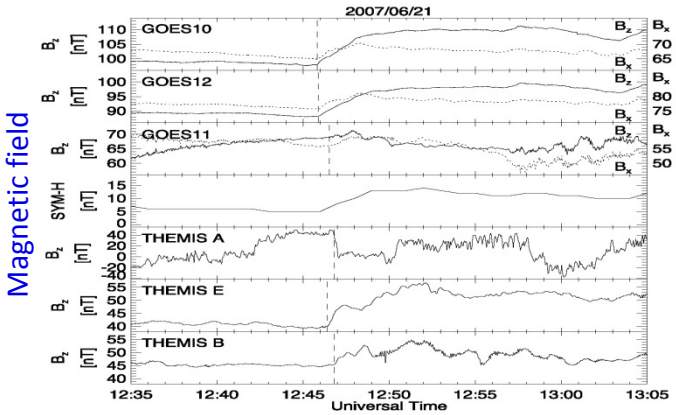


Keika et al. [2009], 14 co-authors

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

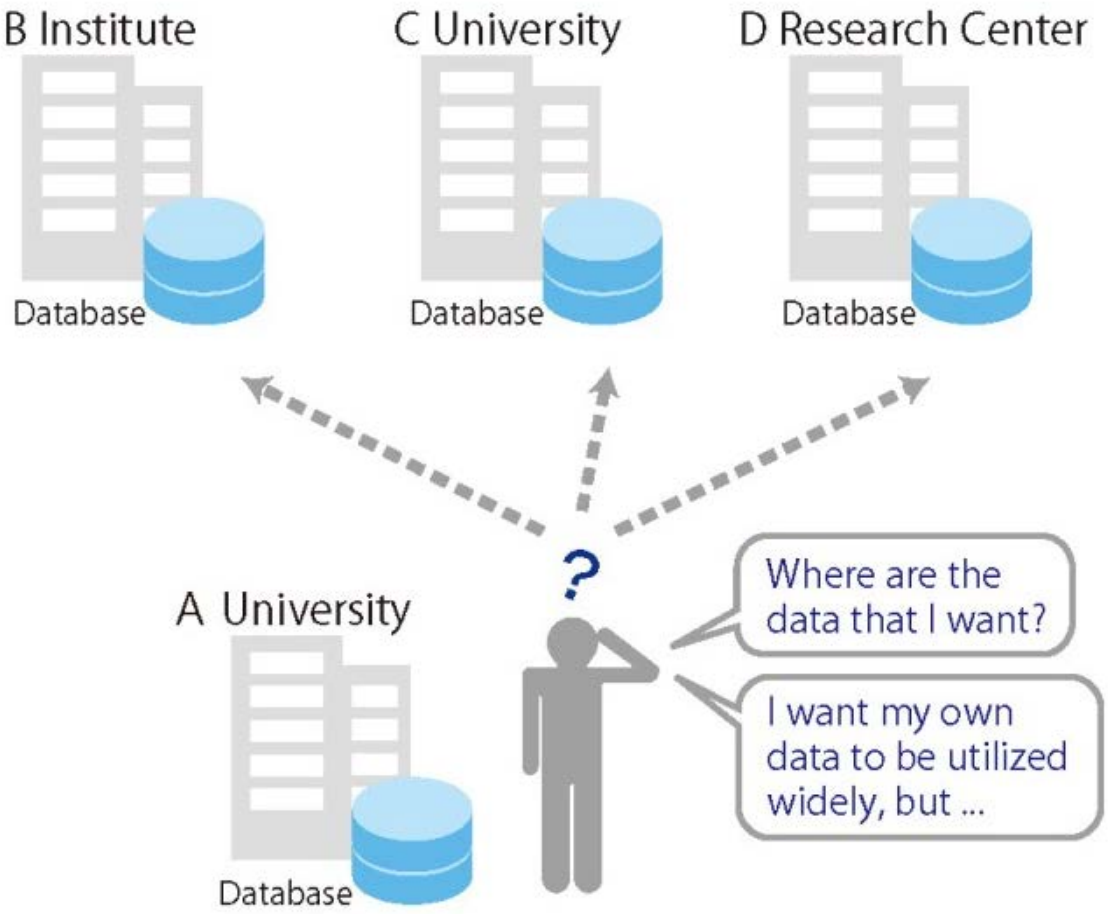
K. Keika,[1] R. Nakamura,[1] W. Baumjohann,[1] V. Angelopoulos,[2] P. J. Chi,[2] K. H. Glassmeier,[3,4] M. Fillingim,[5] W. Magnes,[1] H. U. Auster,[3] K. H. Fornaçon,[3] G. D. Reeves,[6] K. Yumoto,[7] E. A. Lucek,[8] C. M. Carr,[8] and I. Dandouras[9]





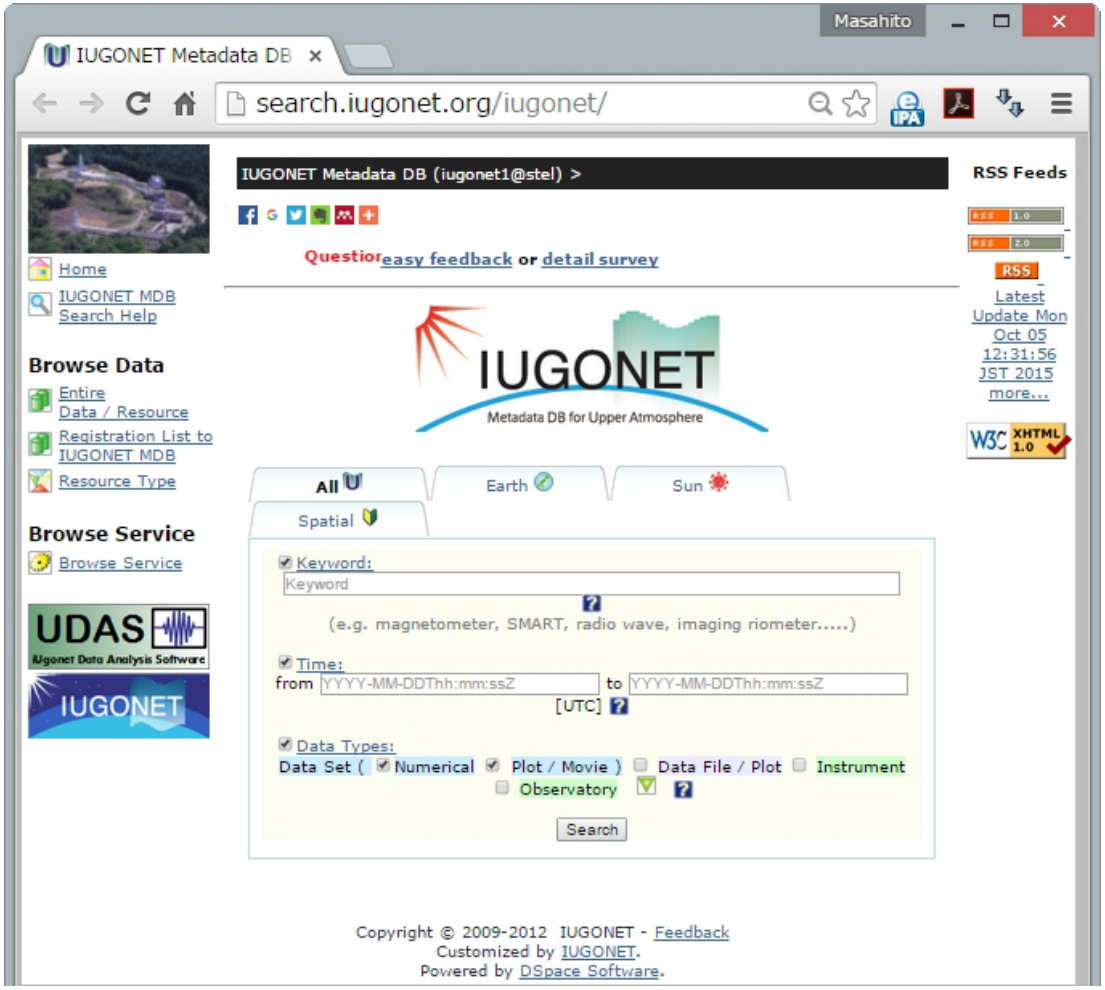
Difficulty in finding database

- 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.



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”.