

Importance of **International Data Management** for Ground-based Space Weather Monitoring

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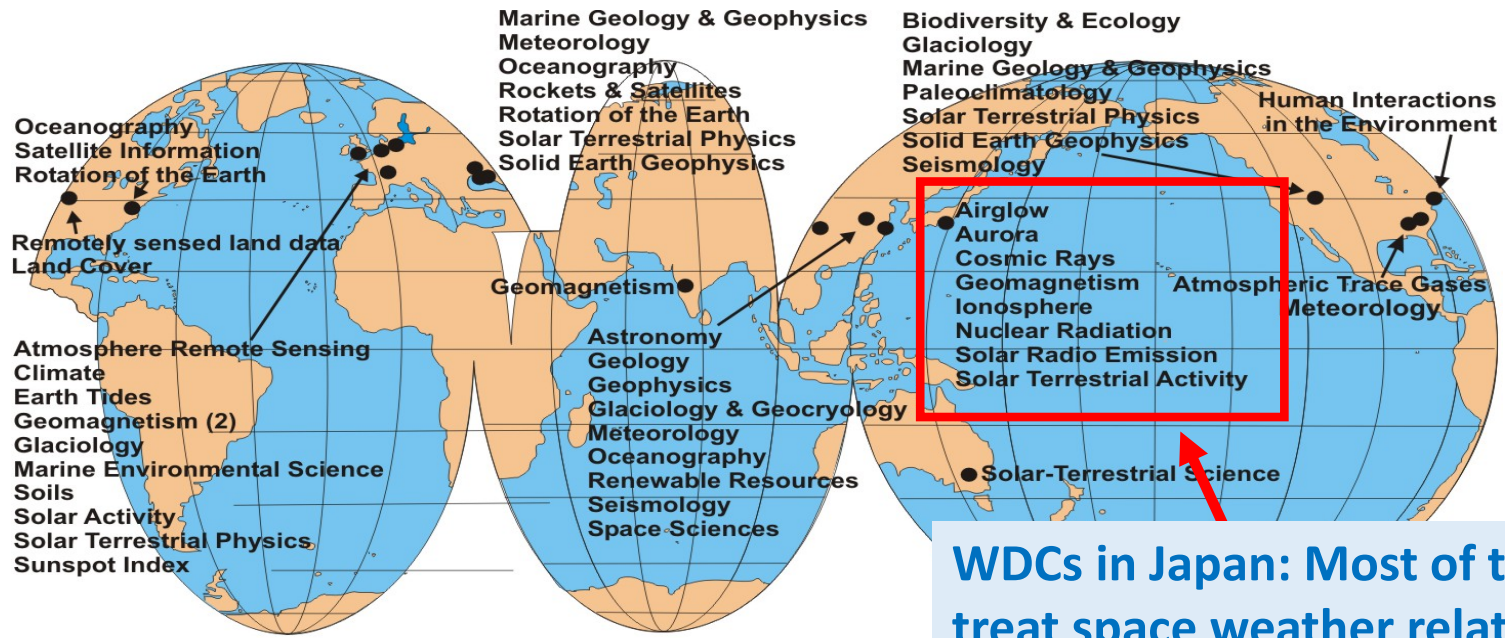
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² World Data System/Scientific Committee (a member)

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International Geophysical Year (IGY: 1957 – 1958)



ICSU World Data Centers

February 2004

IGY was very successful but **problems** appeared later, e.g.,

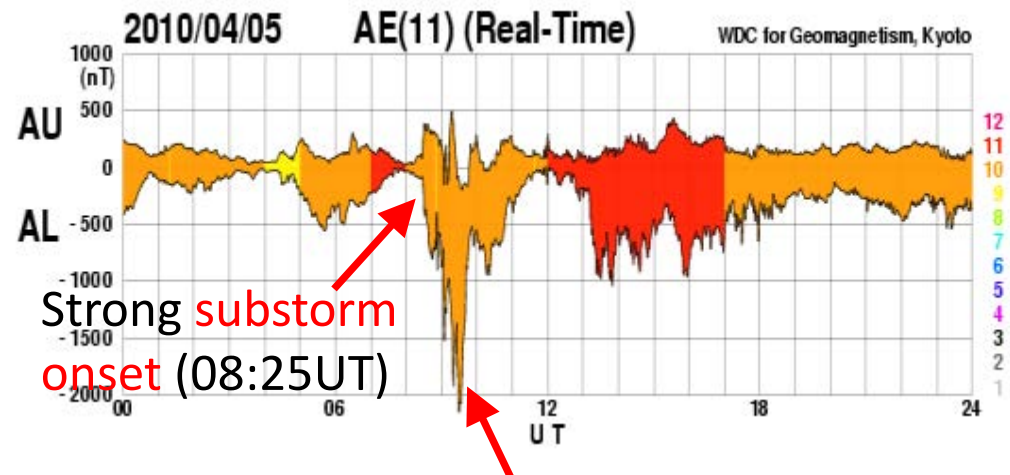
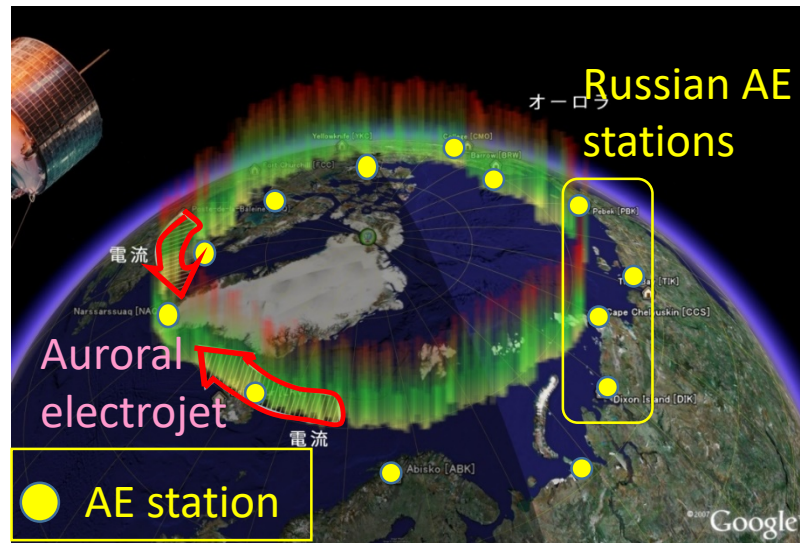
- **Continuity** of observation, quality control, and data center activity
- **Various barriers** in digital data exchange
- **Limited discipline** (mostly geosciences), **lack of interoperability**, etc.

[1] Japan-USA-Russia collaboration for real-time geomagnetic AE index derivation, RapidMag project

(Realtime Auroral and Polar Ionospheric Disturbance MAGnetometers)

What is the “AE index”:

A geomagnetic index which monitor the “Auroral Electrojet” activity. Useful to detect a magnetospheric substorm onset.



09:49UT Contact loss with Galaxy 15 communication satellite

Problem: Difficulty in real-time collection of geomagnetic data from 12 stations surrounding arctic ocean, in particular, from 4 stations in Siberia. → RapidMag project started in 2005

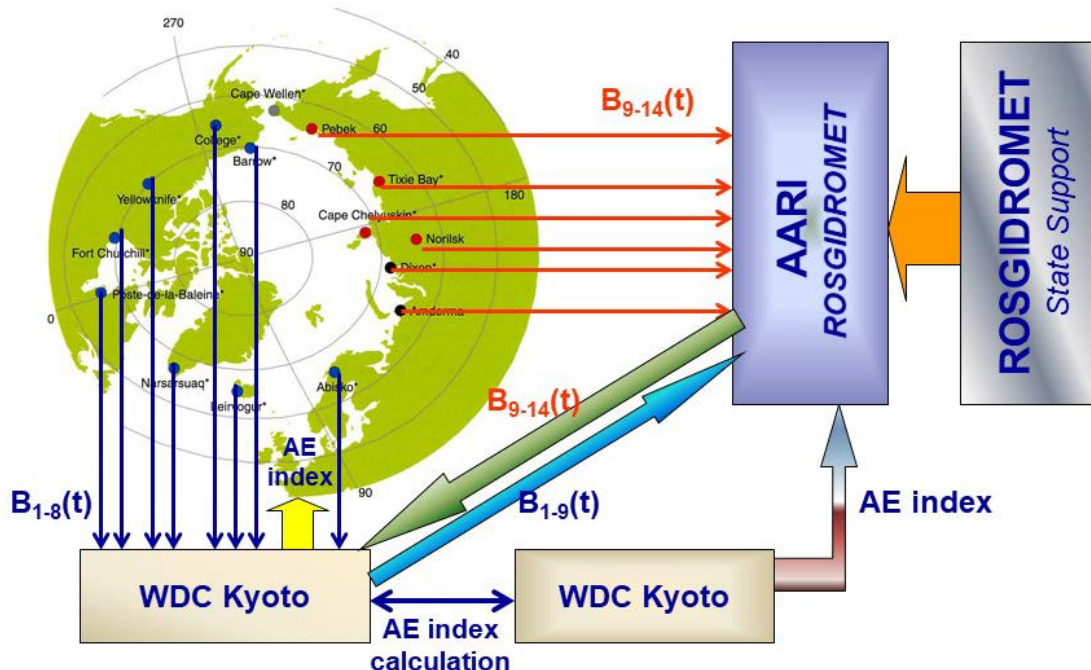
Current status of the RapidMag project

Successful but various problems still appear

[Institution]

[Main task of each institutions]

- **JHU/APL (USA):** Coordination, Grant administration
- **IGD (Russia):** legislative and legal actions from Russian party.
- **NICT (Japan):** Satellite data link (+ Financial support – during PURAES)
- **ROSGIDROMET (Russia):** Financial & infrastructure support
- **AARI (Russia):** Operation and maintenance of observation & data transfer
- **WDC Kyoto (Japan):** Derivation and dissemination of the AE index



[History]

1978 - AE index derivation at WDC-C2 (Kyoto) **started**.

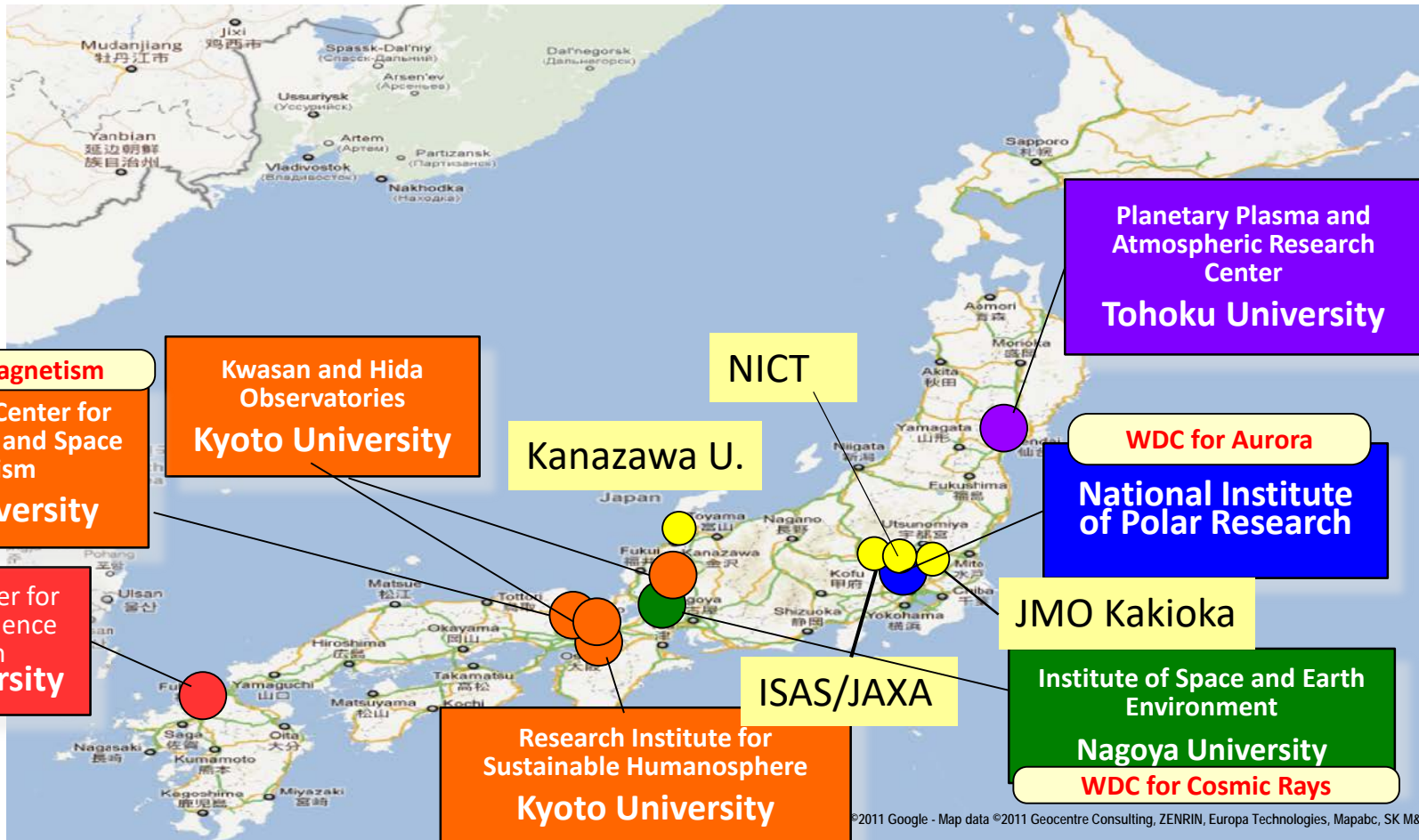
1986-1999 Various Supports from **SCOSTEP**, **IAGA**, **JSPS** etc.

2000.07 - **PURAES** (Project for Upgrading Russian AE Stations)

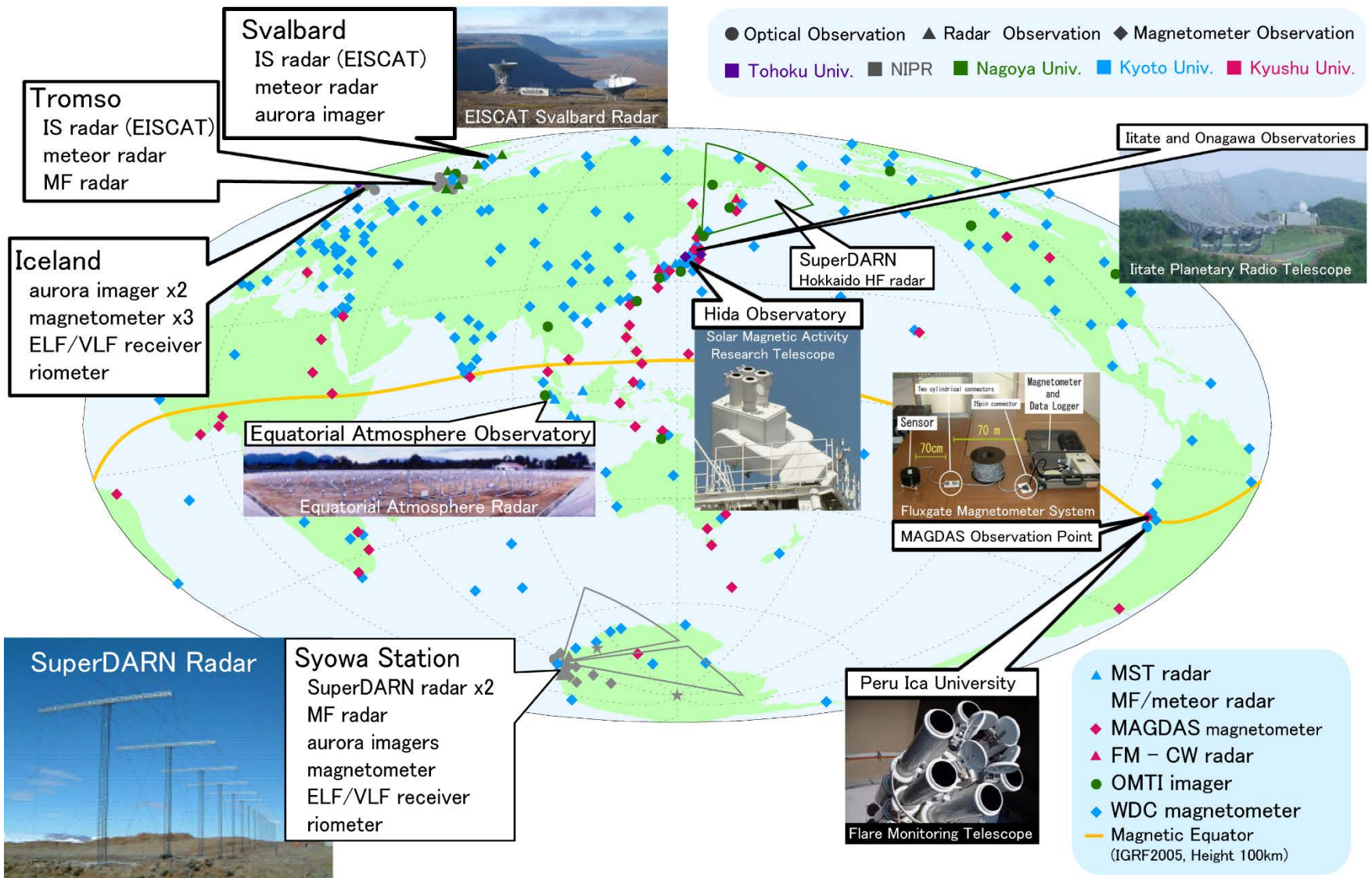
2005.07 – **RapidMag project**

[2] The IUGONET project (started in 2009) (Inter-university Upper atmosphere Global Observation Network)

The IUGONET project aims at building “e-infrastructure” for researchers to effectively find, get, and analyze various kinds of upper atmospheric data spread over universities and institutes.



Observations by IUGONET institutions

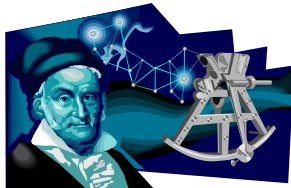
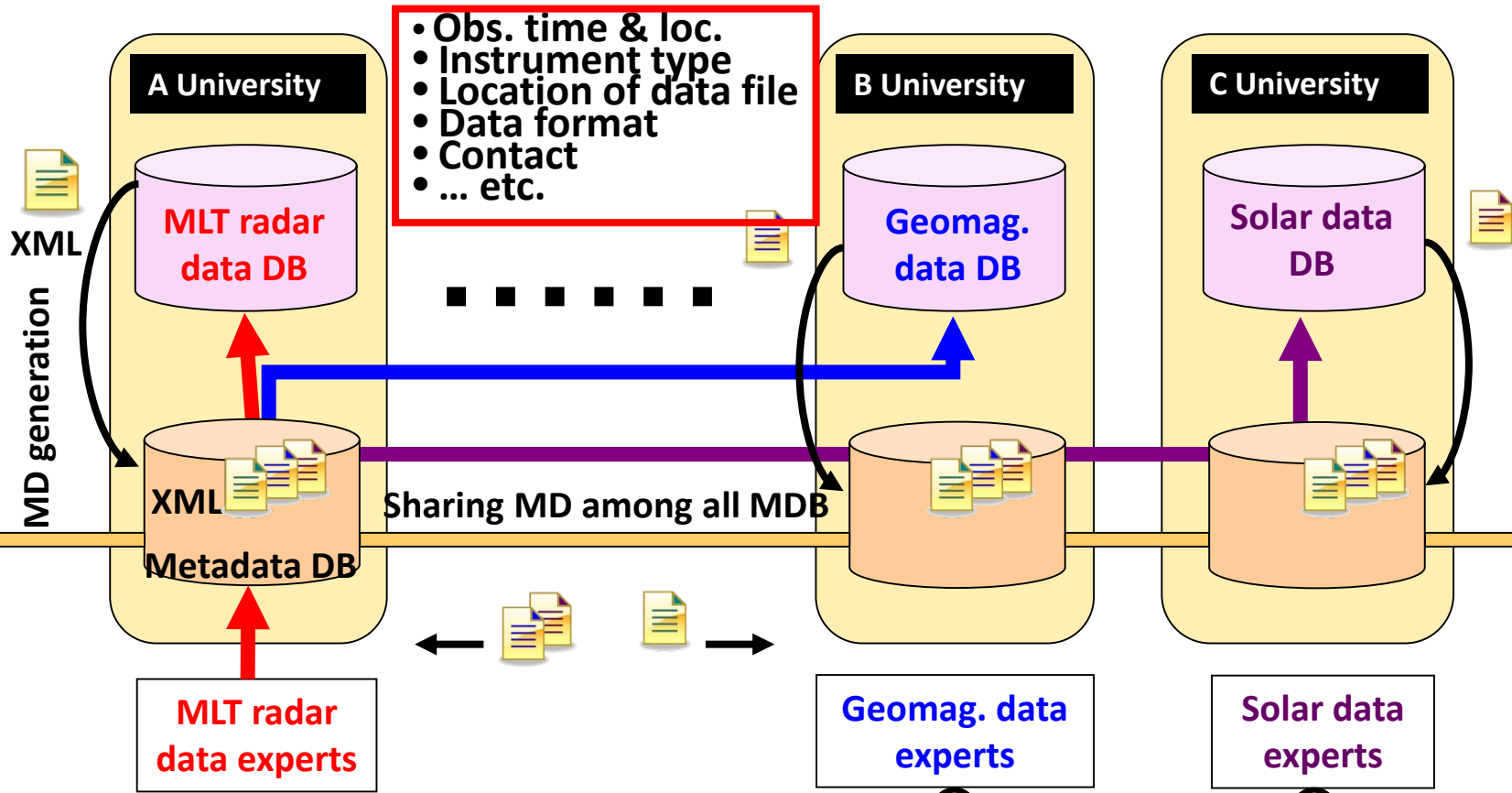


Problems before IUGONET project

1. Databases are distributed (spread)
 - Existence of data is often not known even within the same country/society.
2. Each database is constructed and curated by a small group
 - Difficulty to get enough funding to continue observation and to maintain the database.
3. Metadata and data format often depend on each observation group even for the same parameters.
 - Need format conversion, error check, etc. by the users.
4. Space Weather has various inter-disciplinary effects .
However, the data are not visible (or difficult to use) for the users in other disciplines.
 - Need international and interdisciplinary effort on data management.

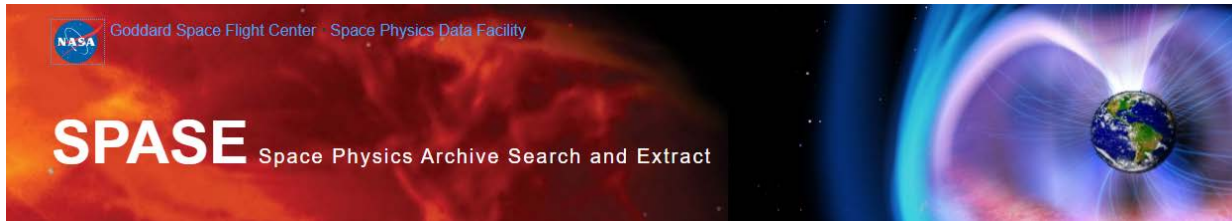
The key: Database access through a common metadata DB

Metadata = Information on the data set



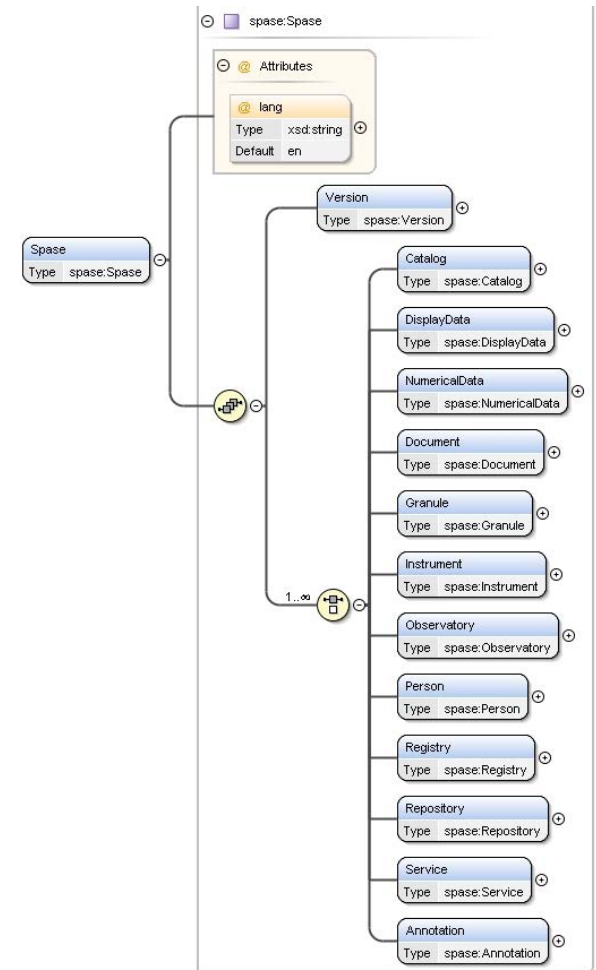
Easy to obtain various kinds of data from distributed research institutes/universities!

IUGONET adopted an internationally *de facto* standard metadata schema (format), **SPASE**



SPACE metadata schema

- IUGONET metadata was created based on **SPASE** (The **S**pace **P**hysics **D**ata **S**earch and **E**xtract) **metadata schema**.
- SPASE is a standard for Heliophysics and related disciplines and established by the **SPASE consortium**.
- The SPASE consortium consists of researchers from NASA, NOAA, ESA, JAXA, US and Japanese universities etc.
- **IUGONET** mainly contributed on the format for ground based observations.



Adoption of SPEDAS as a Data Analysis Software in IUGONET

- SPEDAS (Space Physics Environment Data Analysis Software) is a grassroots software that can handle data from **multiple satellite and ground-based missions**.
- Data supported by SPEDAS are basically open and **can be easily downloaded via internet** with a few commands.
- It is suitable for interdisciplinary study such as Space Weather study.

Data supported by SPEDAS

Satellite data

Stereo	SOHO	Wind	ACE	IMP-8	RBSP
THEMIS	GOES	LANL	NASA OMNI	ERG	MMS
POES	MAVEN				

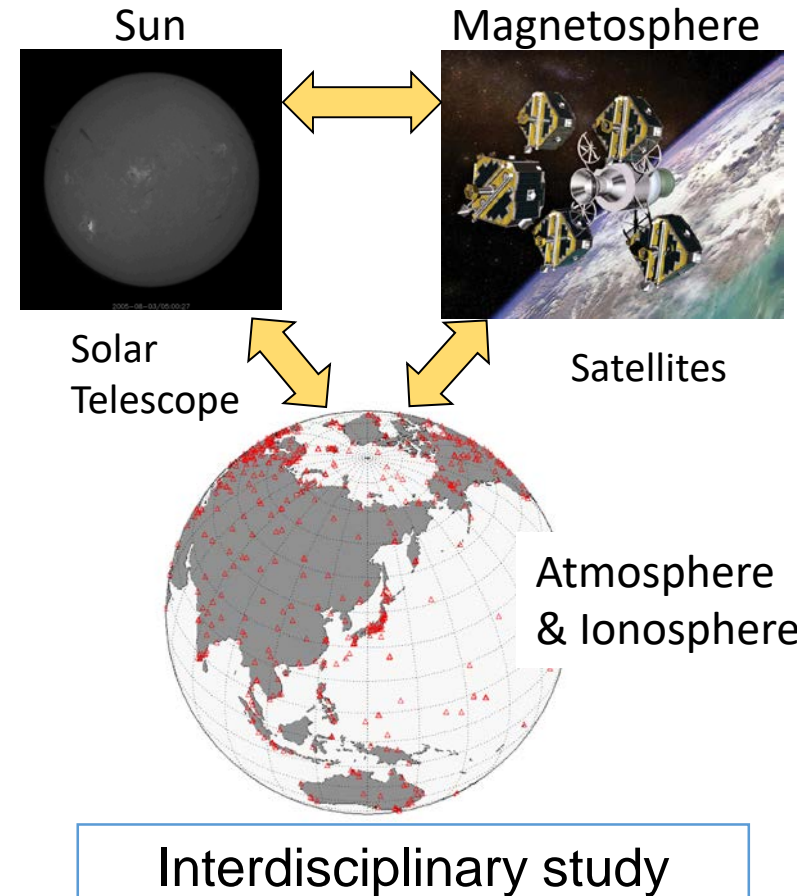
Ground-based observational data

THEMIS Mag.	THEMIS ASI
CARISMA Mag.	GIMA Mag.
Greenland Mag.	MACCS Mag.

ERG ground
210MM, SuperDARN, Magnetometer, etc.

IUGONET

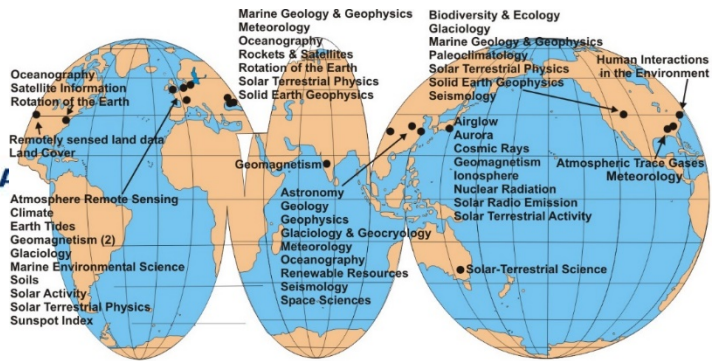
Solar Telescope, Solar and planetary radio telescope, Ionosphere radar (SuperDARN, EISCAT, etc.), Atmosphere radar (MU, EAR, etc.), Meteorological observation data, Geomag. network (WDC, MAGDAS, 210MM, Antarctica · Iceland, etc.)



[3] From World Data Centers to World Data System



**INTERNATIONAL
COUNCIL
FOR SCIENCE**



World Data Centers

February 2004

+ **FAGS**

Federation of Astronomical and Geophysical Data Analysis Services

Renovated in **2008**



WDS (difference from WDC)

- Covers much **wider disciplines**
- Requests **certification** as a trusted repository
- Aims at **Inter-operability** and **knowledge data system**



Era of **Data Centric Science** needs

- Inter-disciplinary data
- Big data
- Advanced data analysis
- good **data management**

In **2018**, **ICSU** and **ISSC** merged as **ISC** (International Science Council)

- 2011 **IPO** (International Programming Office) at NICT (Japan)
- 2018 **ITO** (International Technology Office) at Univ. of Victoria (Canada) (+ ...)
- Currently **111 Member** Organizations

Conclusion:

On the ground based space weather monitoring,

- (1) international collaboration/coordination,
- (2) governmental support in each country,
- (3) a view point of data management, i.e., treating the processes from observations to end users as a whole including getting fund, and
- (4) promotion of international data management by some appropriate groups such as the WDS (SC, IPO, ITO) under ICS are important and expected.

Thank you

Problems related to Russian AE stations before the RapidMag project

1. Difficulty in **data transfer** from the 4 stations
 - Distant place in Siberia
 - License necessary for radio communication
2. **Hardware** problems (magnetometer)
 - **Lack of funding** for replacement by AARI
(Arctic and Antarctic Research Inst.)
3. Difficulty in **maintenance**
 - Access by helicopter - expensive



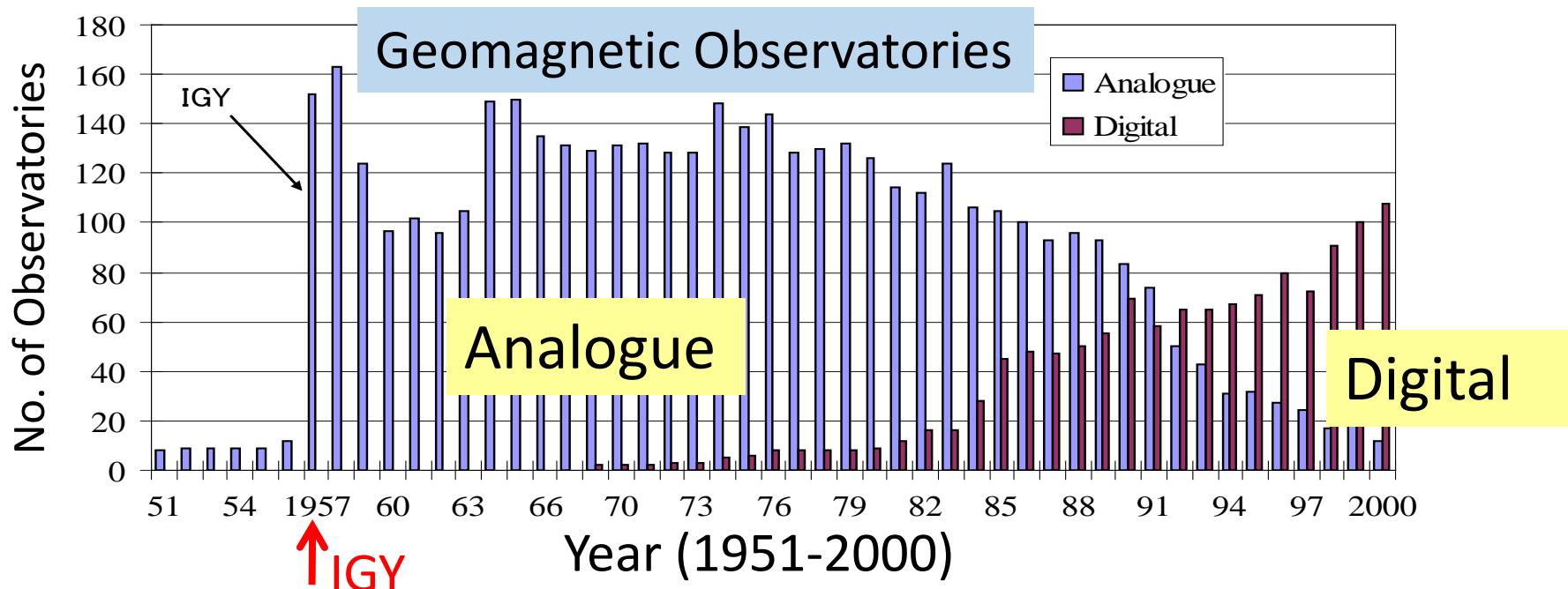
International Geophysical Year (IGY) and World Data Centers (WDCs)



1882-83: The First Polar Year 12 countries, 14 observatories in polar region

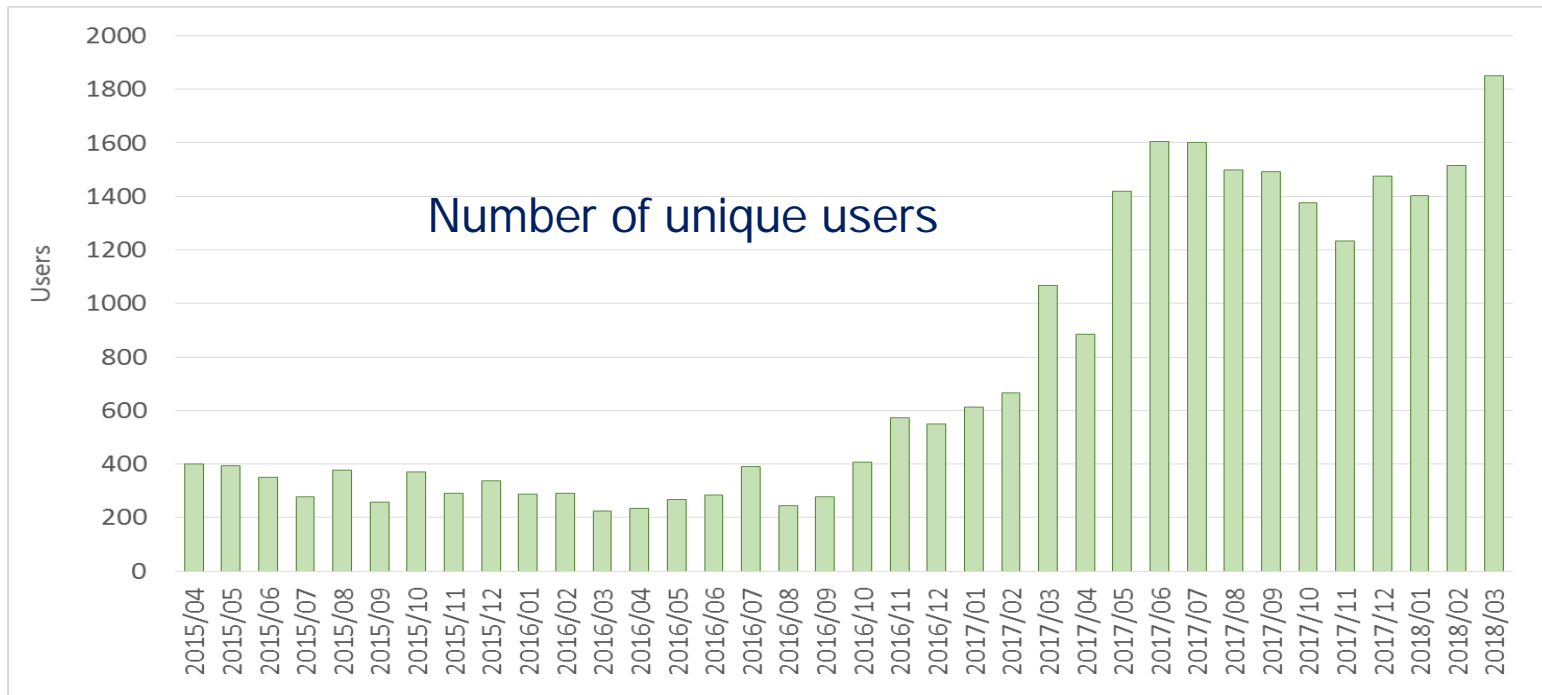
1932-33: The Second Polar year 44 countries, exchange of **meteorological** data for weather prediction

1957-58: The International Geophysical Year > 70 Institutions under ICSU
Full and Open Access to the data → ICSU World Data Centers



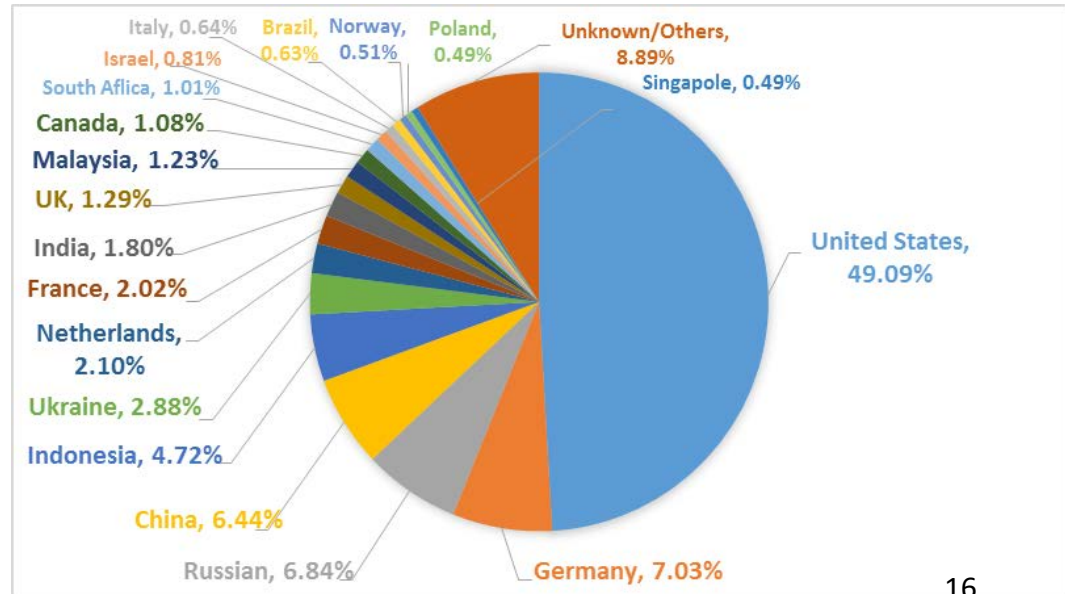
Number of geomagnetic observatories that provided the data to WDC for Geomagnetism, Kyoto

Usage of database (As of 31 March 2018)



Percentage of website visits accounted for by each country without Japan (2016.10-2017-9)

Japan: 71.69 %
Others: 28.31 %



IUGONET constructs a metadata database for cross-search of these distributed data

