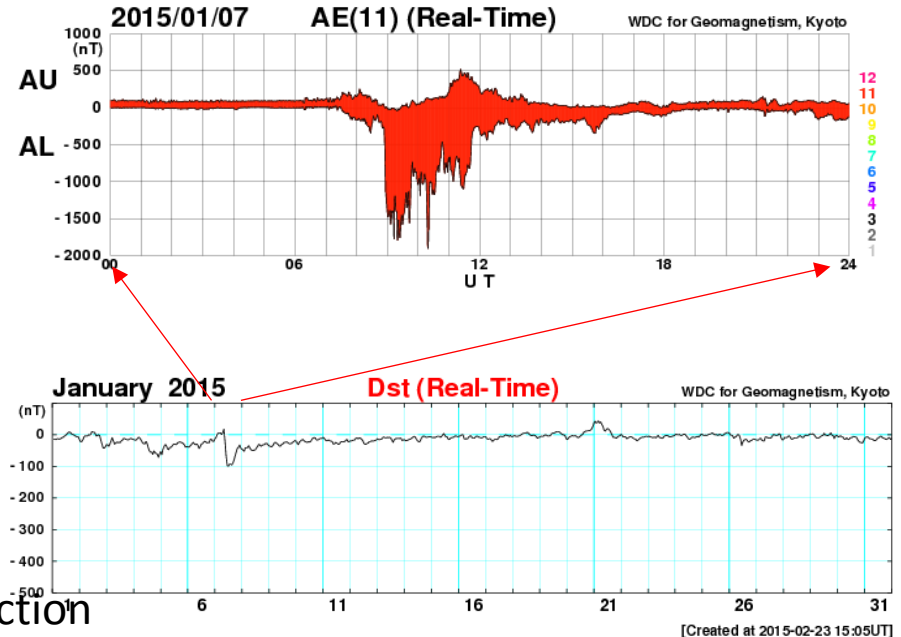
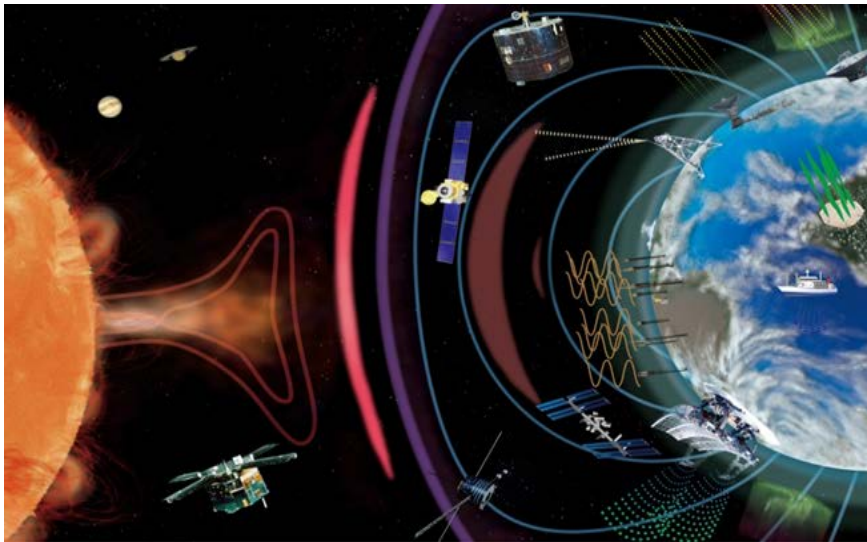


Introduction of global data systems for Solar Terrestrial science in Asia-Oceania



T. Iyemori, B. Ritschel,
IUGONET Advisory Board and
IUGONET Developer Team



Advanced space weather research and prediction
need **interdisciplinary** databases including **real-time** data served by proper **data system**.

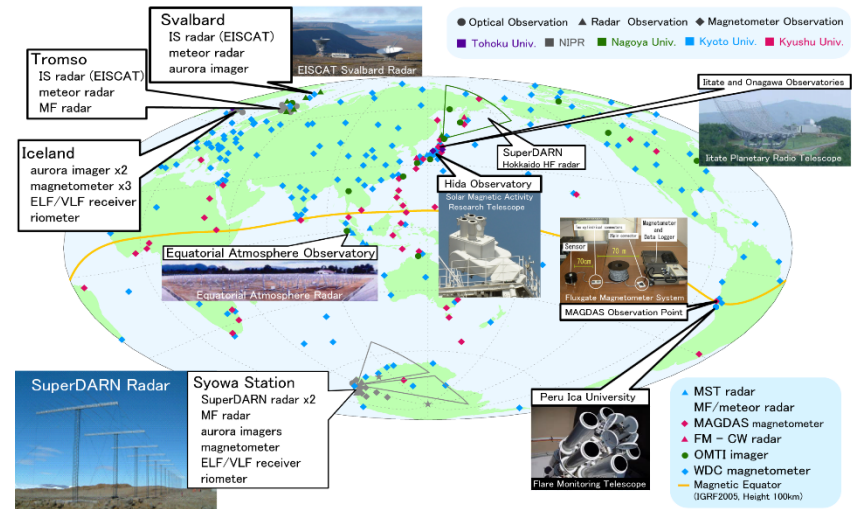
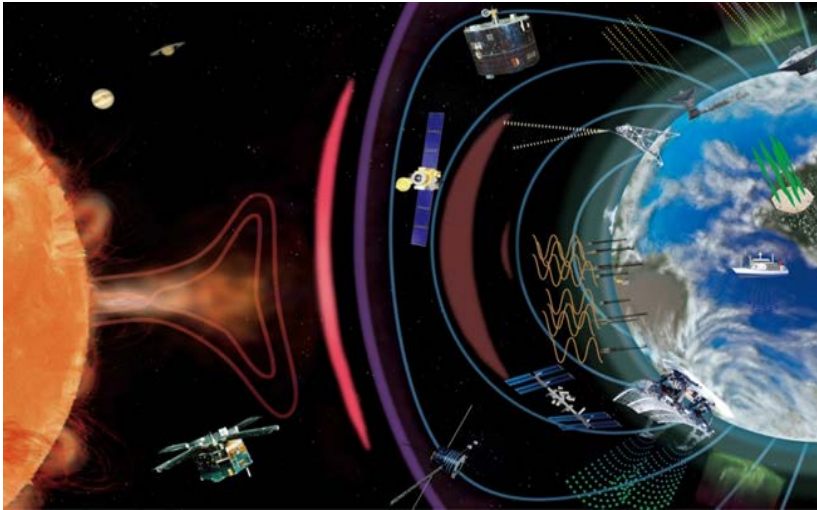
Contents

1. Necessity of “**data system**” for space weather (SW) research and forecast.
2. Introduction of the “**IUGONET**” and “**METADATA**”, and a plan of its extension and enhancement of interoperability with other data systems.
3. Collaboration in Asia/Oceania SW community through “**metadata exchange**”

IUGONET: **I**nter-university **U**pper-atmosphere **G**lobal **O**bservation
NETwork

(2009-2015 MEXT project by 4 universities and a national institution)

Solar-Terrestrial science and space weather research/prediction need “Global”, “Multi-scale”, “Multi-sphere”, “Interdisciplinary” data



However, **essential databases are distributed** in various countries and institutions, and finding the location and collecting **other useful data sets** are not easy.

For example,

Solar activity and Flare: [SIDC](#), [NOAA](#), etc.

Solar wind: [NASA](#), [NOAA](#)

Geomagnetic disturbances: [WDC for Geomagnetism](#), [INTERMAGNET](#), etc.

Ionosphere/GPS TEC: [NICT](#), [RAL](#) etc.



Necessity of a “**Data System**”

A History of “Data System”

1st Polar Year (1881-1884) 11 nations

2nd Polar Year (1932-1933) 40 nations

ICSU/**World Data Centers** established during the **IGY** (International Geophysical Year **1957-1958** 67 nations)

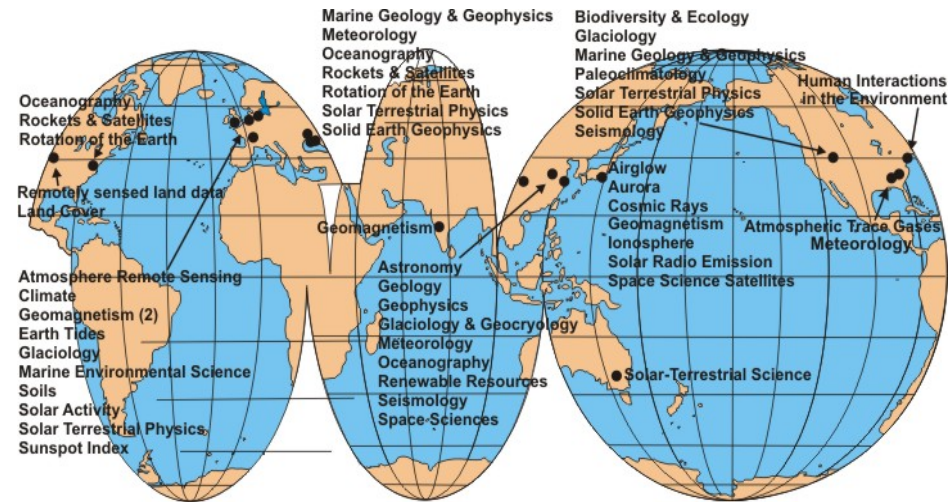
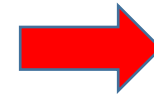
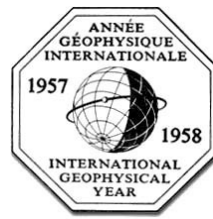
[Problems]

- Mostly for geoscience
- Insufficient interoperability among data centers



ICSU/**World Data System** was established in **2009**.
“System of data systems”

- Covers very wide discipline
- 89 members (as of Sept. 2014)



World Data Centers

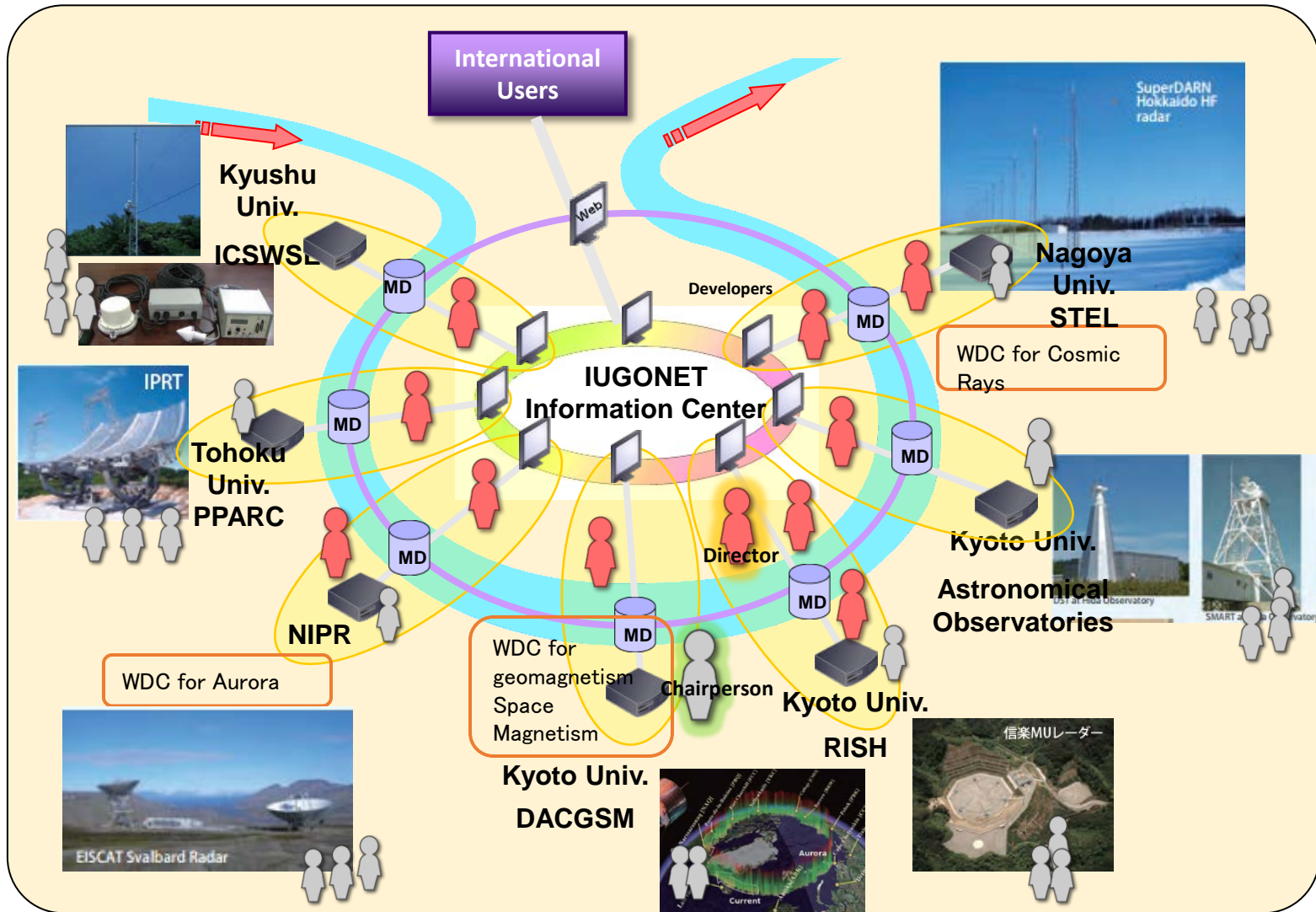
May, 2007

Data Systems in Solar-Terrestrial Science

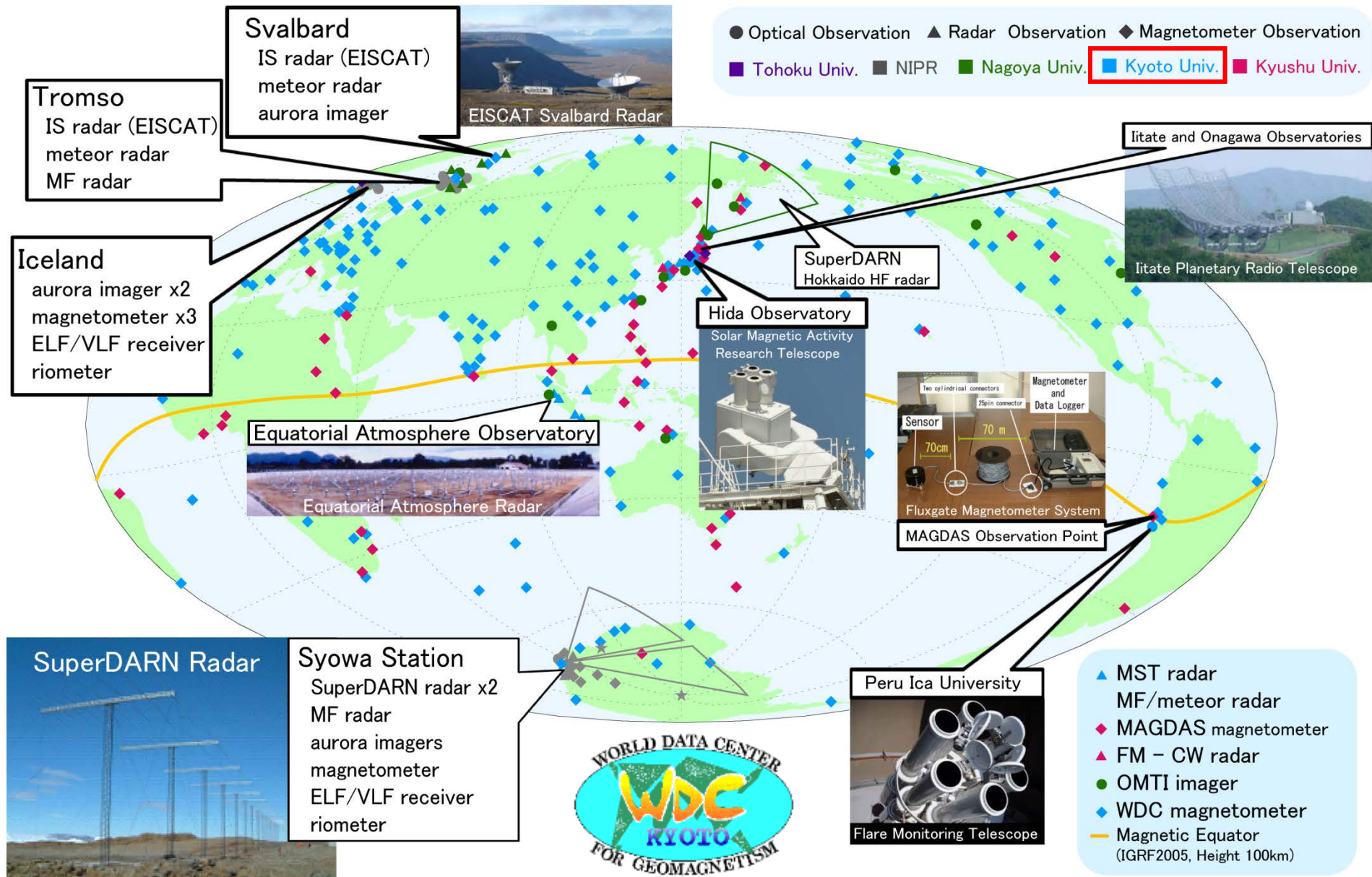
~ 2005 →

- Virtual Observatory (NASA/VOs)
- **IUGONET** (Japan)
- ESPAS (EU)
- etc.

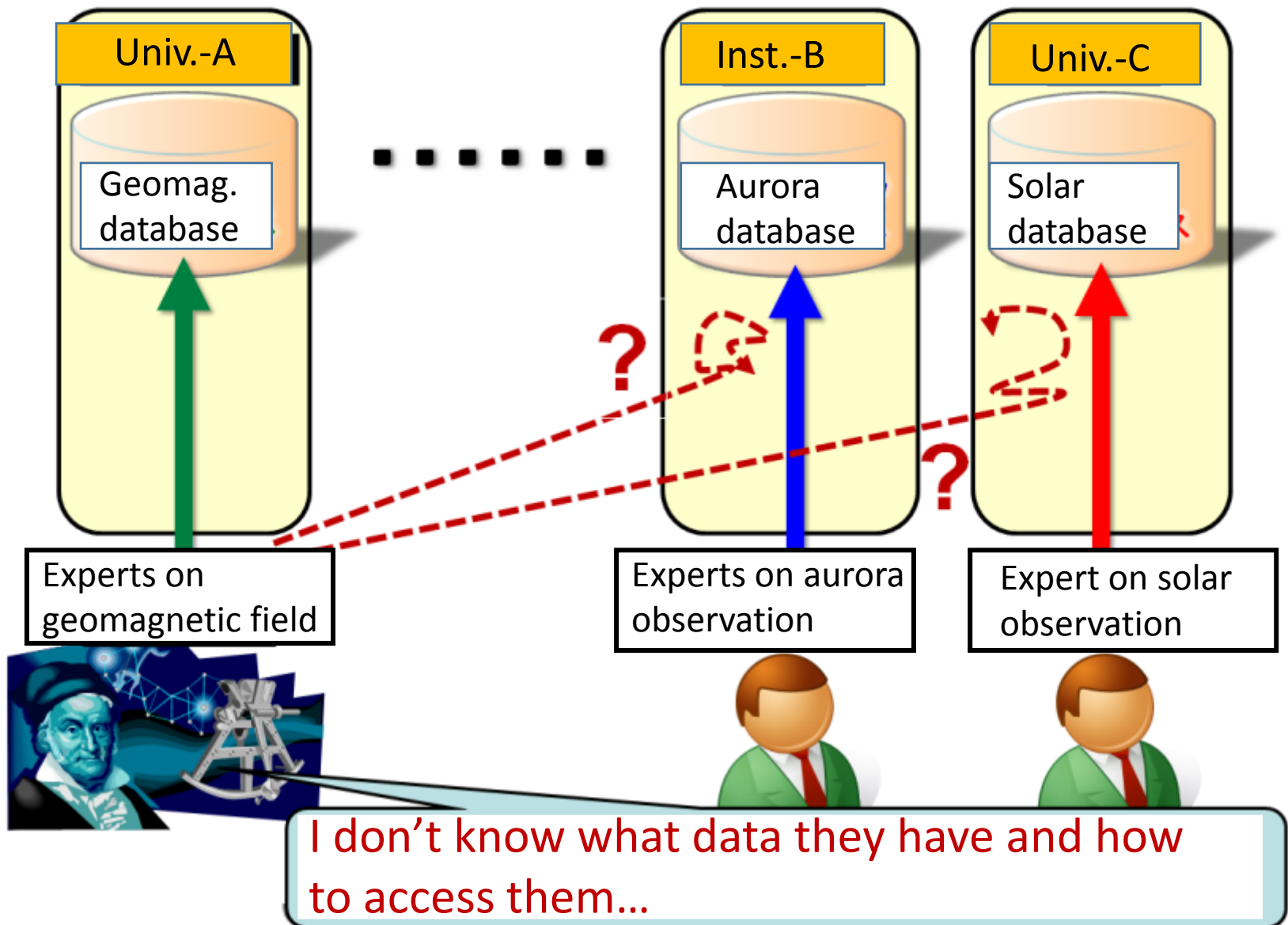
The **IUGONET** project aimed at building an “e-infrastructure” for researchers to effectively find, get, and analyze various kinds of upper atmospheric data spread over universities and institutions.



Global observation network treated in the IUGONET



When we start IUGONET project in 2009



Basic idea 1: Synthetic use of distributed/interdisciplinary databases with a “metadata database”

What is ‘metadata’?

Metadata describe (explain) the contents and context of each dataset.
(e.g., Instrument, Date, Location, Format, Name of PI, data policy, etc.)

Advantage of using metadata:

- Easy to exchange internationally and interdisciplinary.
Barrier of data policy is, in general, lower than exchanging real data.
Size of each metadata is small.
- Easy to construct a single database of metadata for distributed and variety of databases with a common metadata format for searching necessary dataset.
- Useful to know the contents of a database

Metadata format:

We (IUGONET) adopt the “SPASE” data model which is suitable for space weather research.

(Many other formats)

- ISO 19139, 19115
- Dublin Core
- OpenSearch
- WCS, WFS, WMS, WPS
- GBIF
-

Format and Structure of IUGONET Metadata (**SPASE**)

Description of data set

<NumericalData>

...

XML

<DisplayData>

...

XML

<Catalog>

...

XML

Observatory

<Observatory>

...

XML

Instrument

<Instrument>

...

XML

Person data

<Person>

...

XML

Repository

<Repository>

...

XML

Each data file

<Granule>

...

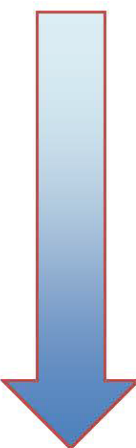
XML

Metadata file

SPASE (Space Physics Archive Search and Extract) format has been developed originally by a Heliophysics community **mainly in USA for satellite data**. IUGONET contributed in its extension to ground based observation data.

<http://www.spase-group.org/>

Number of Metadata in Metadata Database



	Metadata of Data Sets (+misc.)	Metadata of Granule	Total
2010	260	28,179	28,439
2011	2,188	514,925	517,113
2012	2,326 + 45	3,369,503 + 594,025	3,371,829 + 594,077
2013	2,610 + 110	7,401,505 + 1,637,265	7,404,115 + 1,637,385
2014	2,850 + 107	8,963,838 + 1,712,401	8,966,688 +1,712,508
2015	3,154 +110	9,721,245 +2,012,401	9,724,399 +2,012,511

Total
11,736,910

Black: Metadata from IUGONET member institutions

Blue: Metadata from non-IUGONET member

Basic idea 2: Constructing a common metadata database and Use de-fact standard software as much as possible

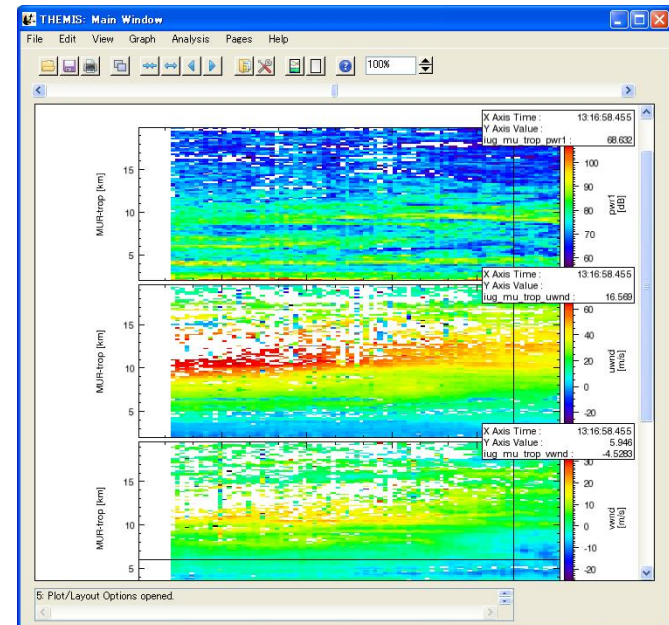
Metadata Database and search system



“SPASE” data model for metadata and “DSpace” for dataset search

<http://search.iugonet.org/iugonet>

Analysis Software (UDAS)

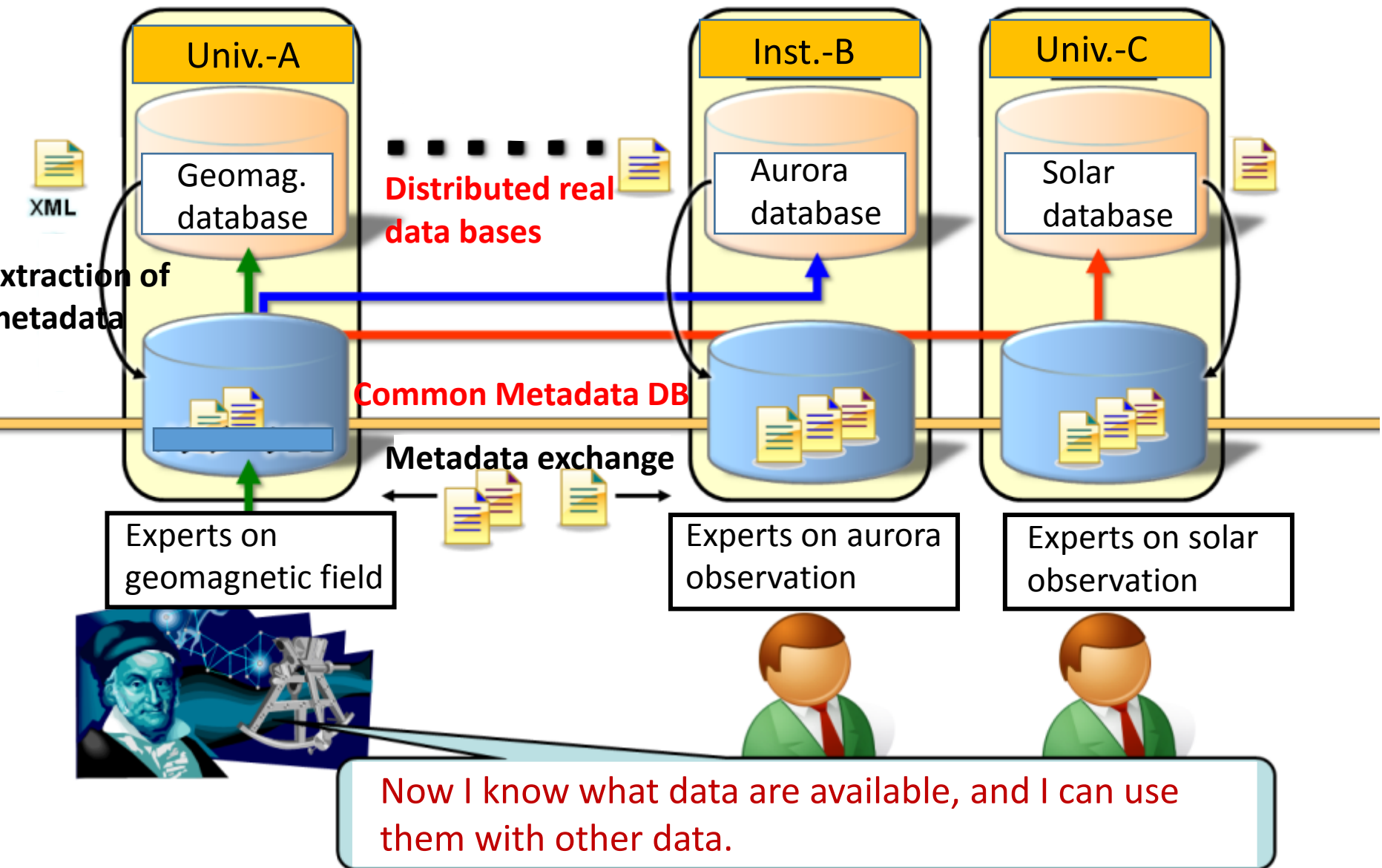


THEMIS analysis software “TDAS” with extension for ground based observation

<http://www.iugonet.org/software.html>

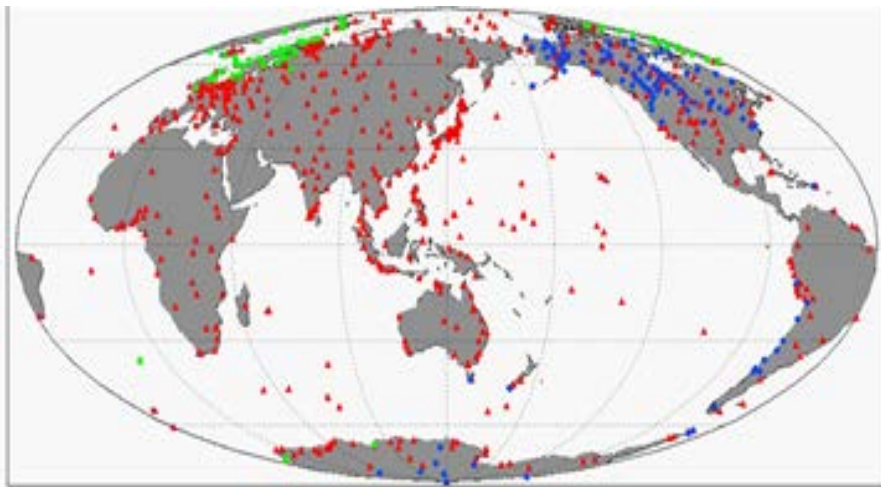
present

Common metadata database for synthetic use of databases located at different institutions.

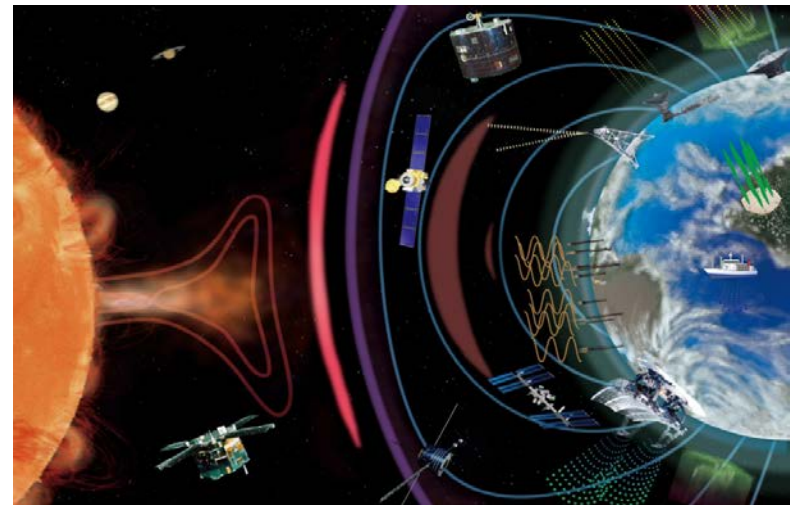
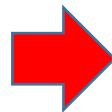


Necessity of extension to satellite observation data

- IUGONET treats the data from ground-based observations
However, **satellite observation is essential** in Solar-Terrestrial Science.
- The **satellite data are also distributed** and have much variety, i.e., the situation is the same with that of the ground based observation before IUGONET project started.



Red: IUGONET, Blue: US/Canadian databases
Green: European databases



Wide variety of satellite data

◀ There must be much more for blue and green – We (IUGONET) do not know!

Promotion of the collaboration with **ESPAS** and IUGONET

(**ESPAS**: Near Earth Space Data Infrastructure for e-Sciences)

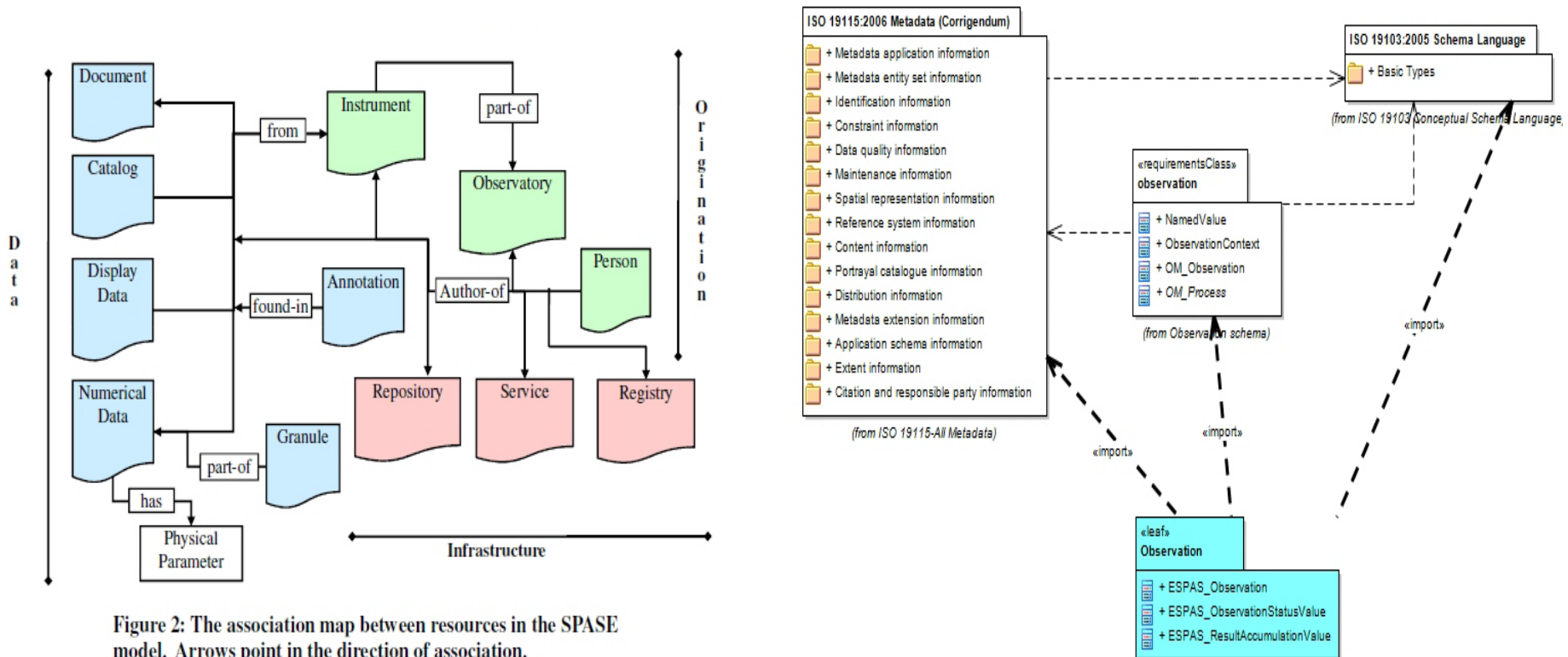
Example: We have started a collaboration to have a common vocabulary

SPASE ontology

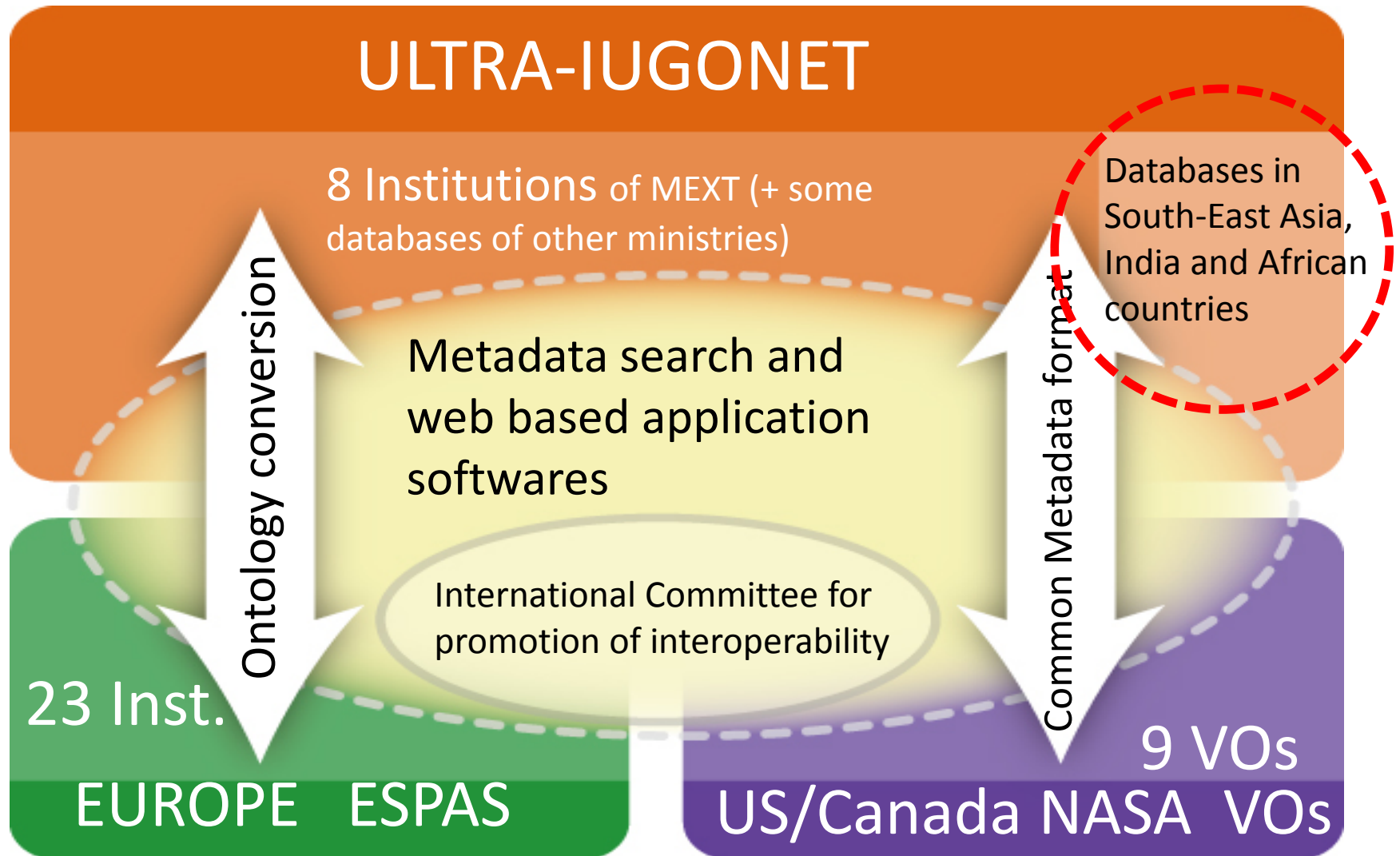


ESPAS ontology

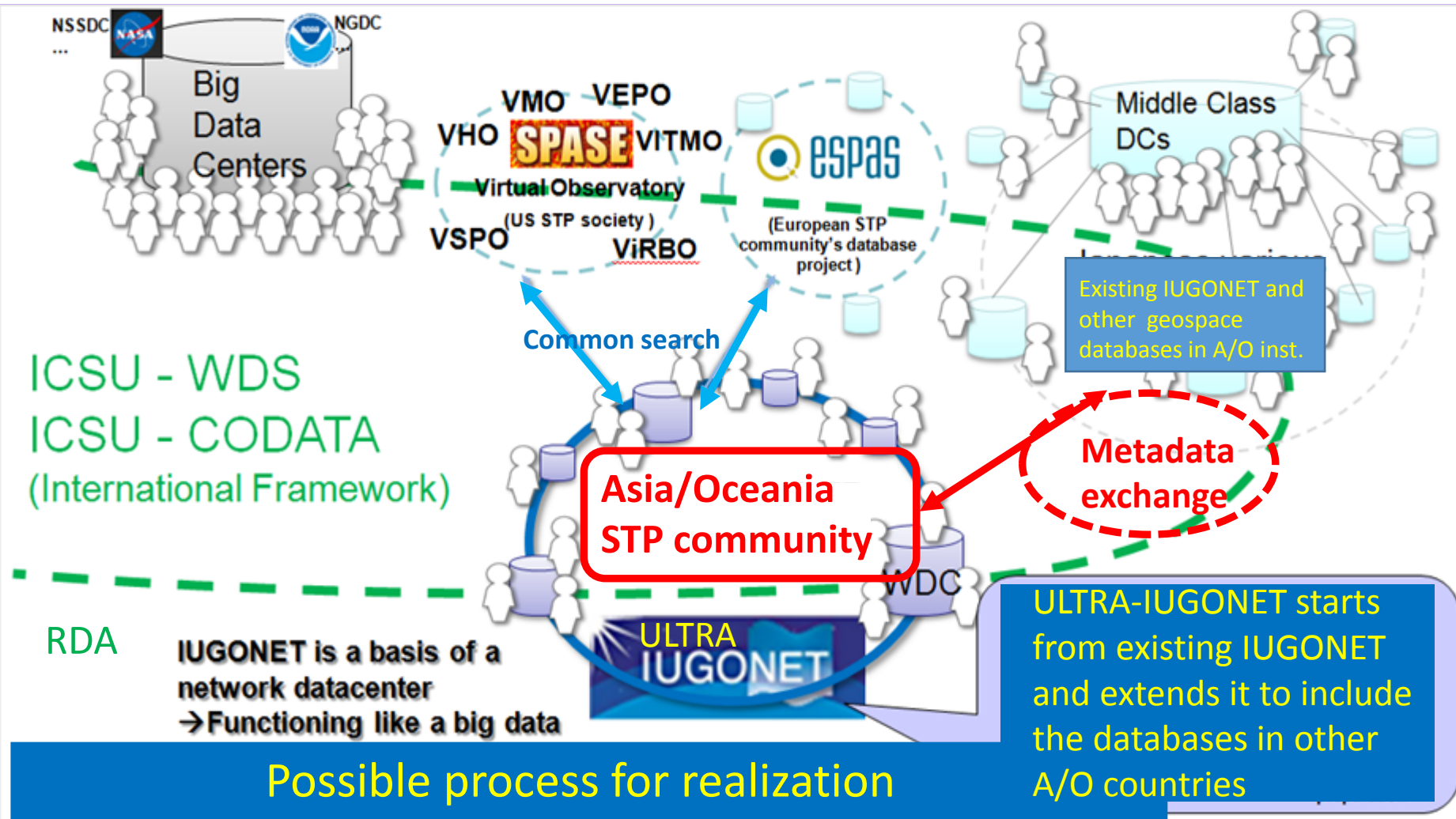
Ontology (structure of concepts) is different.



Proposed collaboration among IUGONET, ESPAS, NASA/Vo and Asia/Oceania institutions



A proposal of a data system for AOSWA: ULTRA-IUGONET



Possible process for realization

1. Metadata → Existing IUGONET metadata database
2. Open real data ← Existing UDAS system
3. International operation of ULTRA-IUGONET ??

Summary and a proposal for AOSWA

- Having a **common metadata database** is effective for space weather research.
- We plan to extend the IUGONET to **satellite** data.
- Promotion of **interoperability among internationally distributed data systems** such as the ESPAS, NASA/VOs and the IUGONET is an important international collaboration.
- To promote space weather research and collaboration in Asia/Oceania, a possible way is to enhance **IUGONET metadata database system**.
- For the **open data sets**, it is desirable to make them downloadable through “**UDAS**” system from databases at each institutions.



Thank you.



<http://www.iugonet.org/en/software.html>

<http://wdc.kugi.kyoto-u.ac.jp/index.html>

[Some References]

About IUGONET project

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About UDAS

- Adv. Polar Sci., 24, 231-240, doi: 10.3724/SP.J.1085.2013.00231, 2013.

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