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Contribution of the IUGONET Data Exchange System and Data Analysis Software to Space Weather and Climatology Researches

IUGONET

Inter-university Upper atmosphere Global Observation NETwork

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1. Introduction

<Coupling process of the upper atmosphere>

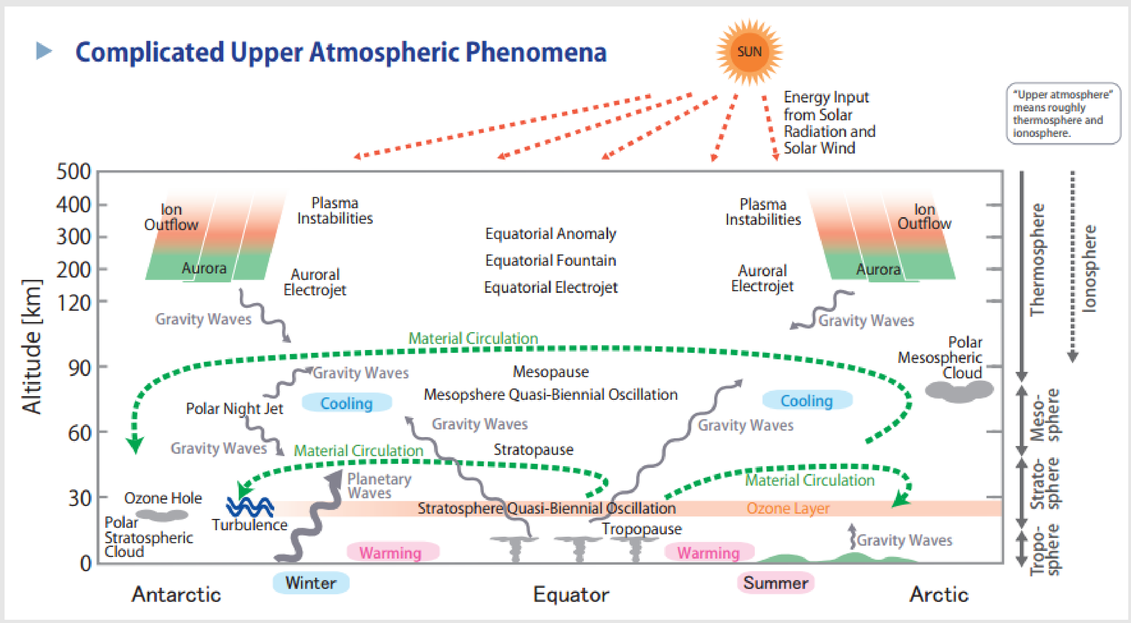


Fig 1. Various kinds of upper atmospheric phenomena observed in a wide region from both the poles to the equator in each atmospheric layer (from troposphere to ionosphere)

The energy source of various kinds of phenomena in the Earth's atmosphere and geospace originates primarily from solar radiation and solar wind. Energy transported from the Sun changes in form and causes various physical phenomena as it propagates through the space surrounding the Earth's upper atmosphere. Since the Earth is a globally complex system, it is also essential to investigate the coupling process of each atmospheric region.

<Ground-based observation networks>

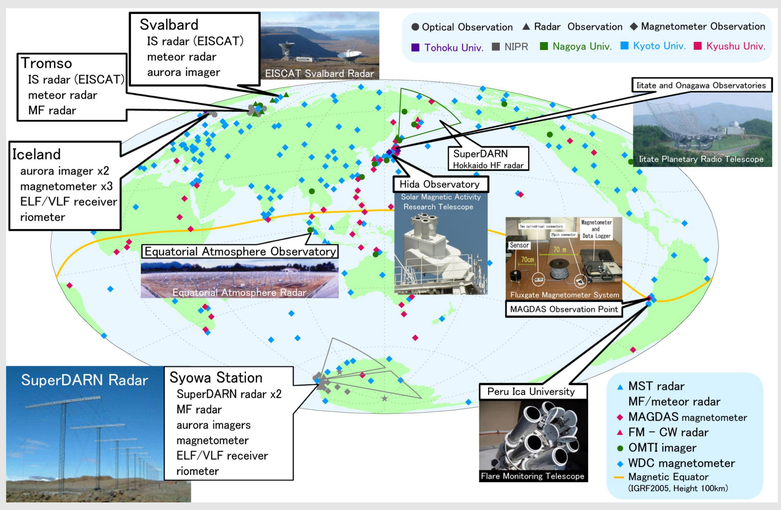


Fig 2. Ground-based observation network of the IUGONET institutes

Therefore,

Understanding the mechanism of short or long-term variations in the upper atmosphere associated with changes in solar activity and global warming requires an interdisciplinary integrated analysis of various long-term observational data from global ground-based observation networks as shown in Fig. 2.

2. Purpose of the IUGONET project

PROBLEM: Various kind, huge amount of data spread over institutes and universities

→ **SOLUTION:** Create a metadata database for cross-search of these distributed data

→ Promote new types of upper atmospheric research by analysis of multi-disciplinary data

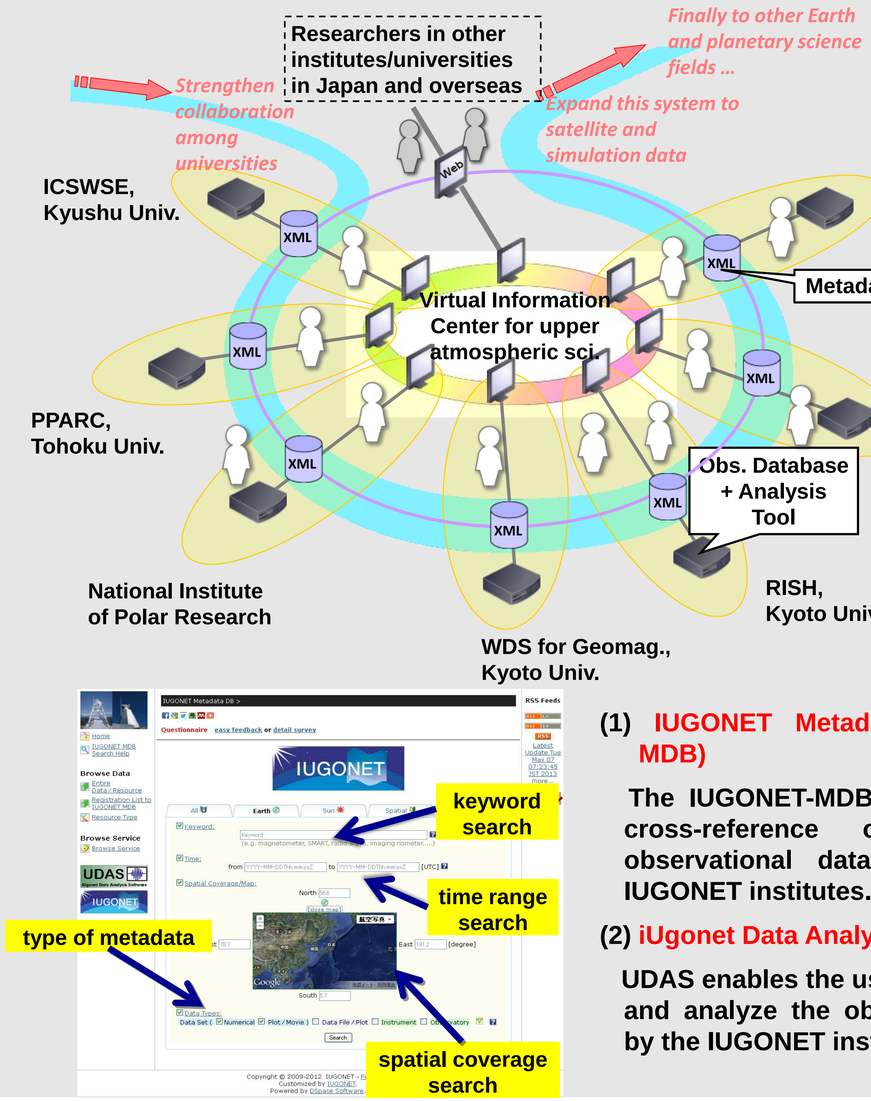


Fig 3. Schematic view of the IUGONET project

(1) IUGONET Metadata Database (IUGONET-MDB)

The IUGONET-MDB provides the service for cross-reference of various kinds of observational data distributed across the IUGONET institutes.

(2) iUgonet Data Analysis Software (UDAS)

UDAS enables the users to download, visualize, and analyze the observational data provided by the IUGONET institutes.

3. iUgonet Data Analysis Software (UDAS)

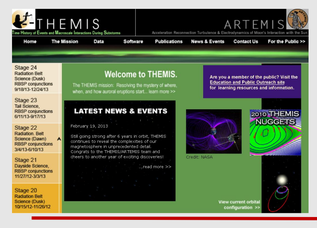
<An overview of UDAS>

- **UDAS** is written in **IDL** (Interactive Data Language), which is widely used in the solar-terrestrial physics community.
- UDAS is released as a plug-in software of **TDAS** (THEMIS Data Analysis Software suite), which is a set of IDL libraries for analyzing satellite and ground-based data obtained by the THEMIS mission.

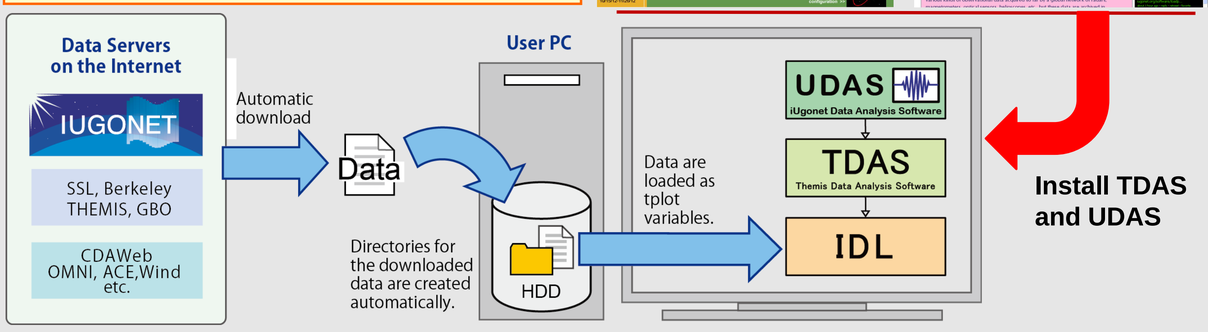
Data can be easily plotted by only three basic commands with the TDAS/UDAS-CUI tool.

1. timespan, 'yyyy-mm-dd' (Set a time span)
2. iug_load_xxx (Load xxx data)
3. tplot, ooo (Plot the loaded data)

TDAS web site



UDAS web site



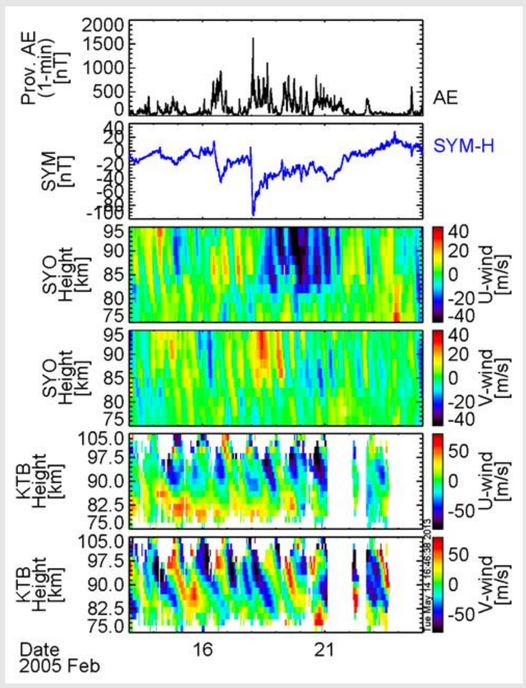
- UDAS is capable of automatically downloading data files through the internet without caring about location and format of the files.
- Since data servers and file format are generally different for each data set, we have developed individual load-routines for different data set.
- **Statistical analysis package** (cross-correlation test, difference test, trend test, coherence analysis, S (Stockwell) analysis) is also included in UDAS.

4. Examples of data visualization and analysis

Load routines included in the latest version of UDAS (v3.01.1)

No.	Dataset name	Load routines
1	Solar imaging telescope (SMART at Hida Obs)	iug_load_smart
2	Iitate Planetary Radio Telescope	iug_load_iprt
3	Jupiter's/solar wide band spectral data in HF-band	iug_load_hf_tohokuu
4	Automatic Weather Station	iug_load_aws_rish
5	Boundary layer radar	iug_load_blr_rish
6	L-band Lower Troposphere radar (@Shigaraki, Japan)	iug_load_ltr_rish
7	Equatorial Atmospheric Radar (@Sumatra, Indonesia)	iug_load_ear
8	MU radar (@Shigaraki, Japan)	iug_load_mu
9	Meteor radar	iug_load_meteor_rish
10	MF radar	iug_load_mf_rish
11	Wind Profiler radar	iug_load_wpr_rish
12	Ionosonde (@Shigaraki, Japan)	iug_load_ionosonde_rish
13	Radiosonde	iug_load_radiosonde_rish
14	SuperDARN radar ☆	iug_load_sdfit
15	EISCAT radar	iug_load_eiscat
16	Imaging Riometer	iug_load_irio_nipr
17	Low Frequency Radio Transmitter	iug_load_lfrto
18	Geomagnetic indices, WDC magnetometer stations	iug_load_gmag_wdc
19	NIPR fluxgate Magnetometers ☆	iug_load_gmag_nipr
20	210° Magnetic Meridian magnetometer network ☆	iug_load_gmag_mm210
21	MAGDAS ground magnetometers	iug_load_gmag_serc
22	STEL induction magnetometers	iug_load_gmag_stel_induction
23	NIPR induction magnetometers	iug_load_gmag_nipr_induction

The latest version of UDAS (v3.01.1 as of June, 2013) includes 23 load routines for data obtained by solar telescope, solar/planetary radio telescope, atmosphere and ionosphere radars, magnetometers, and so on.



An example of parallel display of time-series data of upper atmosphere

Geomagnetic indices, MF radar at auroral latitude, and Meteor radar at the equator.
Such a parallel display can be easily drawn by a few basic commands of the UDAS.

5. Summary

- The IUGONET project has been developing the e-infrastructures and common tools (metadata database and data analysis software (UDAS)) to facilitate the distribution and wide use of the ground-based upper atmospheric data provided by the IUGONET university/institutes.
  - Metadata database : http://search.iugonet.org/iugonet/
  - Data analysis software : http://www.iugonet.org/software.html
- The IUGONET data analysis system can handle many kinds of solar and upper atmosphere data and is one of the promising tools in the solar-terrestrial physics community.