Database for upper atmospheric science
~Activity of the IUGONET project~

超高層大気研究のためのデータベース
～IUGONETプロジェクトの活動～

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Essentially global phenomena.

Caused by many complex factors, such as human activity, atmospheric circulation, volcanic eruption, and solar activity.

http://climate.nasa.gov/causes/
• Consists of multiple layers existing from about 60 km altitude to the Sun.
• Meridional coupling also plays an important role in the structure of the Earth’s atmosphere.
• Variety of data sets
  - Data are obtained by various kinds of instruments, such as telescope, imager, radar, and magnetometer (on the ground and spacecraft).
  - Various physical parameters for neutral gas and plasma.

• Long-term variation
  - Long-term monitoring observation is important.

• Collaboration & Data sharing
  - Since phenomena in the upper atmosphere often occur globally and/or across multiple layers, collaboration and data sharing are indispensable to understand the mechanism completely.
① Analyze only one kind of data obtained by themselves (e.g., geomagnetic field)

② Analyze comprehensively many kinds of data provided by data providers (e.g., radar data, images, satellite data)

③ Compare observed data with simulation, Data assimilation
(1) Observations by the Japanese Antarctic Research Expedition (JARE)

- **Auroral observation at Syowa (1959~)**
- **Geomagnetic observation at Syowa (1966~)**
- **Upper atmosphere monitoring observation at Syowa (1981~)**
- **Imaging riometer at Syowa (1992~)**
- **1-100Hz ULF/ELF electromagnetic wave at Syowa (2000~)**
- **Fabry-Perot imager at Syowa (2001~)**
- **SuperDARN HF radar (1995~)**
- **MF radar (1999~)**
- **DMSP satellite data received at Syowa (1997~)**
- **Akebono satellite data received at Syowa (1989~)**
- **Unmanned magnetometer network (2003~)**
- **Polar Patrol Balloon (PPB) experiment (2003~2004)**
(2) International cooperative observations in the Antarctic

Upper atmosphere physics observation at Zhongshan station (1994～)

Auroral imager at South Pole station (1997～)

(3) Observations in the Arctic

All-sky/Narrow FOV parallel Imager Observations at Tromso/Longyearbyen (2010～)

Digital beacon receiver observation (2011～)

Aurora Spectrograph (2000～)

Conjugate observation at Iceland (1984～)

EISCAT radar (1984～)
Global network of ground-based observations

Svalbard
IS radar (EISCAT)
meteor radar
aurora imager

Tromso
IS radar (EISCAT)
meteor radar
MF radar

Iceland
aurora imager x2
magnetometer x3
ELF/VLF receiver
riometer

Equatorial Atmosphere Observatory

SuperDARN Radar
SuperDARN radar x2
MF radar
aurora imagers
magnetometer
ELF/VLF receiver
riometer

Hida Observatory
Solar Magnetic Activity
Research Telescope

SuperDARN
Hokkaido HF radar

Iitate and Onagawa Observatories
Iitate Planetary Radio Telescope

MAGDAS Observation Point

Syowa Station
SuperDARN radar x2
MF radar
aurora imagers
magnetometer
ELF/VLF receiver
riometer

Peru Ica University

Optical Observation
Radar Observation
Magnetometer Observation

Tohoku Univ.
NIPR
Nagoya Univ.
Kyoto Univ.
Kyushu Univ.

MST radar
MAGDAS magnetometer
OMTI imager
WDC magnetometer
Magnetic Equator
(IGRF2005, Height 100km)
• Database has been maintained individually by each university/institute, so it is difficult for researchers to discover and access the data due to lack of information of them.

• Database has been built and maintained by domain researchers.

• Due to a variety of data, collection of the data and metadata is time consuming.

• File format is different for each instrument type, thus it usually takes time to analyze many kinds of data.
Goals of the IUGONET project:

- To provide new research infrastructure that enables the upper atmosphere data to be shared, which have been archived by the members of IUGONET since the International Geophysical Year (1957-1958).
- To comprehensively understand the mechanisms of long-term variations in the upper atmosphere (and also promote new interdisciplinary studies regarding the upper atmosphere).

IUGONET : Inter-university Upper atmosphere Global Observation NETwork.
Main tools developed by the IUGONET

- **Metadata Database** for cross-searching various data distributed across the members of IUGONET
- **Data Analysis Software** for visualizing and analyzing various data in an integrated fashion

**Metadata Database**

- [http://search.iugonet.org/iugonet](http://search.iugonet.org/iugonet)

**Data Analysis Software**

- [http://www.iugonet.org/software.html](http://www.iugonet.org/software.html)
The IUGONET common metadata format was created on the basis of the Space Physics Archive Search and Extract (spase) format. The IUGONET-MDB is a modified system based on DSpace, an open-source software that creates open digital repositories. It has OpenSearch interface for sharing the search results with other websites and data analysis software.
Data Analysis Software (SPEDAS)

**SPEDAS : Space Physics Environment Data Analysis Software.**
- Grass-roots data analysis software for Space Physics Community.
- Is based on Interactive Data Language (IDL).
- Was developed by scientists and programmers of the UC Berkeley's Space Sciences Laboratory, UCLA's IGPP and other contributors.

Data Servers on the Internet
- SSL, Berkeley, THEMIS, GBO
- CDAWeb, OMNI, ACE, Wind, etc.

Automatic download via the internet

Data can be easily plotted, for example, by only three basic commands:

1. Set a time period
2. Load *** data
3. Plot the loaded data

- timespan, ‘yyyy-mm-dd’
- iug_load_***
- tplot, +++
Data supported by SPEDAS

**Satellite data**
- Stereo
- THEMIS Satellite
- SOHO
- GOES
- Wind
- LANL
- ACE
- NASA OMNI
- IMP-8
- ERG
- VAP Satellite
- EFW
- RBSPICE

**Ground-based observational data**
- THEMIS Geomag.
- THEMIS Camera
- CARISMA Geomag.
- GIMA Geomag.
- Greenland Geomag.
- MACCS Geomag.
- USGS Geomag.

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**IUGONET, ERG**
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.)

- Many missions have provided plugins for SPEDAS.
- IUGONET has also provided a plugin for SPEDAS, which includes many routines for loading various ground-based observation data.
- SPEDAS is suitable for interdisciplinary study of the upper atmosphere.
Both CUI and GUI are available

Parallel display of various time-series data

2D display

Solar images taken by the SMART telescope

Magnetic field

Solar wide band spectral data in HF-band

Examples of plots by using SPEDAS
Collaboration with other projects/institutions

The other institutes and universities in the Japanese STP community (JAXA, Hokkaido Univ., Kanazawa Univ., ...)

Japanese Geoscience Group

STP community in the countries of Asia/Africa

NASA/Virtual Observatory (VMO, VHO, VWO, ...)

SPASE

Metadata Format

Cross-Searching

ESPAS (Europe)

THEMIS (USA)

Analysis Software

Metadata Registration

NAOJ, NICT, JMA (Japan)

ERG (Japan)

IUGONET welcomes any type of support and feedback from users!

Support for continuous activity of IUGONET from the international scientific activities and council.

The 2nd SPARC Japan Seminar 2015
Summary

• The upper atmosphere, corresponding to the region from the Earth’s atmosphere about 60 km altitude to the Sun, is characterized by the existence of various data observed with telescope, camera, radar, etc. on the ground and satellite.

• It was difficult to find and access such various data, because these data are distributed across universities /institutes.

• The IUGONET project has developed the infrastructure for the upper atmospheric sciences, such as metadata database and data analysis software that allows researchers to search, retrieve, and analyze various data.