IUGONET activity for upper atmosphere study

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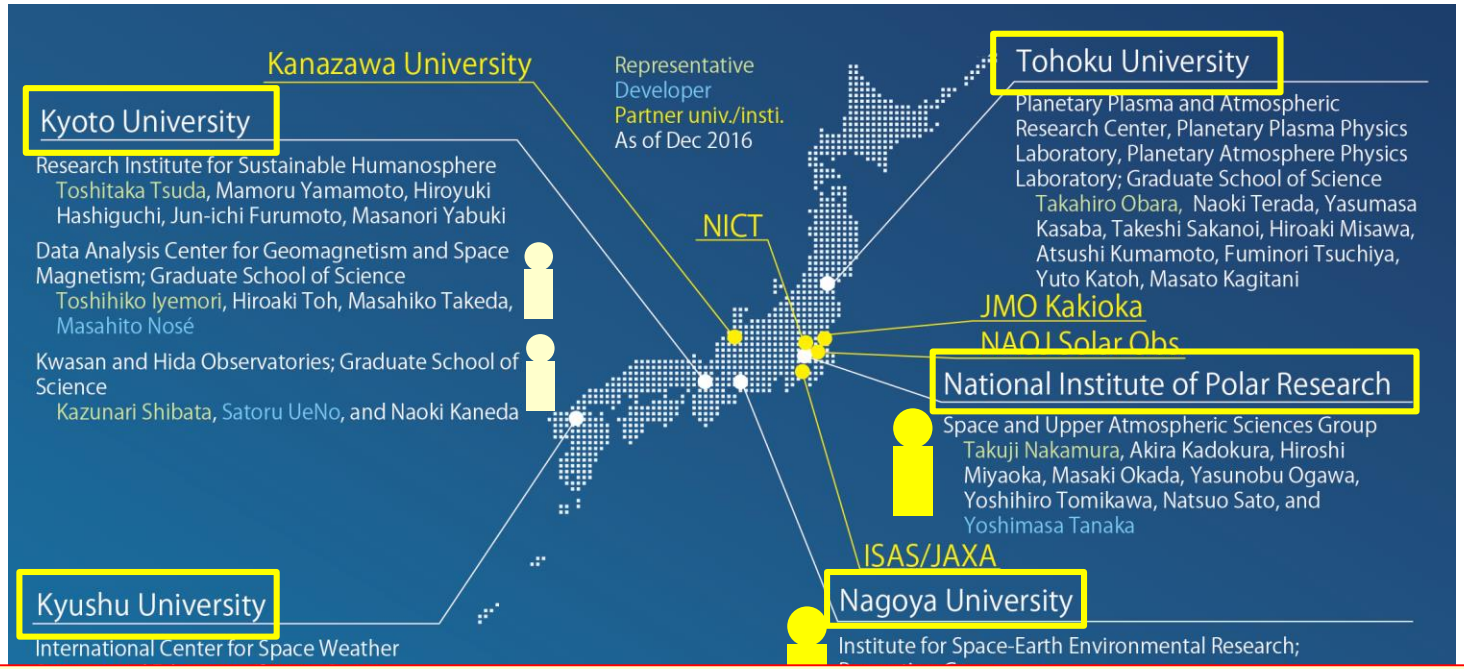
[2] National Institute of Polar Research
[3] Department of Polar Science, Graduate University for Advanced Studies (Sokendai)
[4] Institute for Space-Earch Environmental Research, Nagoya University,
[5] International Center for Space Weather Science and Education, Kyushu University,
[6] Kwasan and Hida Observatories, Graduate School of Science, Kyoto University.

IUGONET project

IUGONET (Inter-university Upper atmosphere Global Observation NETwork)

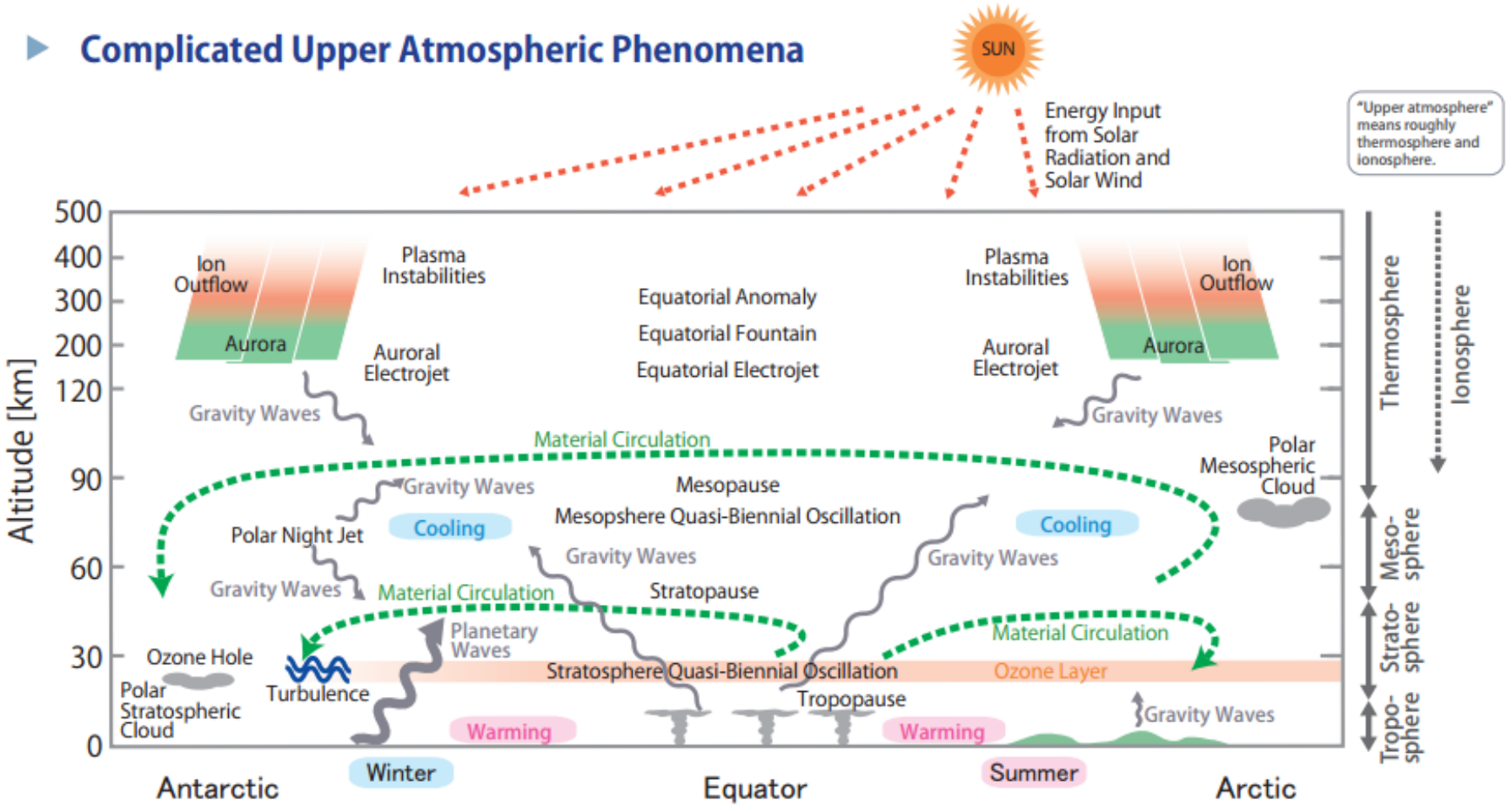


IUGONET project started in 2009

- to develop the tools for sharing the upper atmospheric data, which have been archived separately by many Japanese universities and institutes since the International Geophysical Year (1957-1958).
- to comprehensively understand the mechanisms of long-term variations in the upper atmosphere and facilitate interdisciplinary studies regarding the Solar-Terrestrial Physics.

Upper Atmosphere

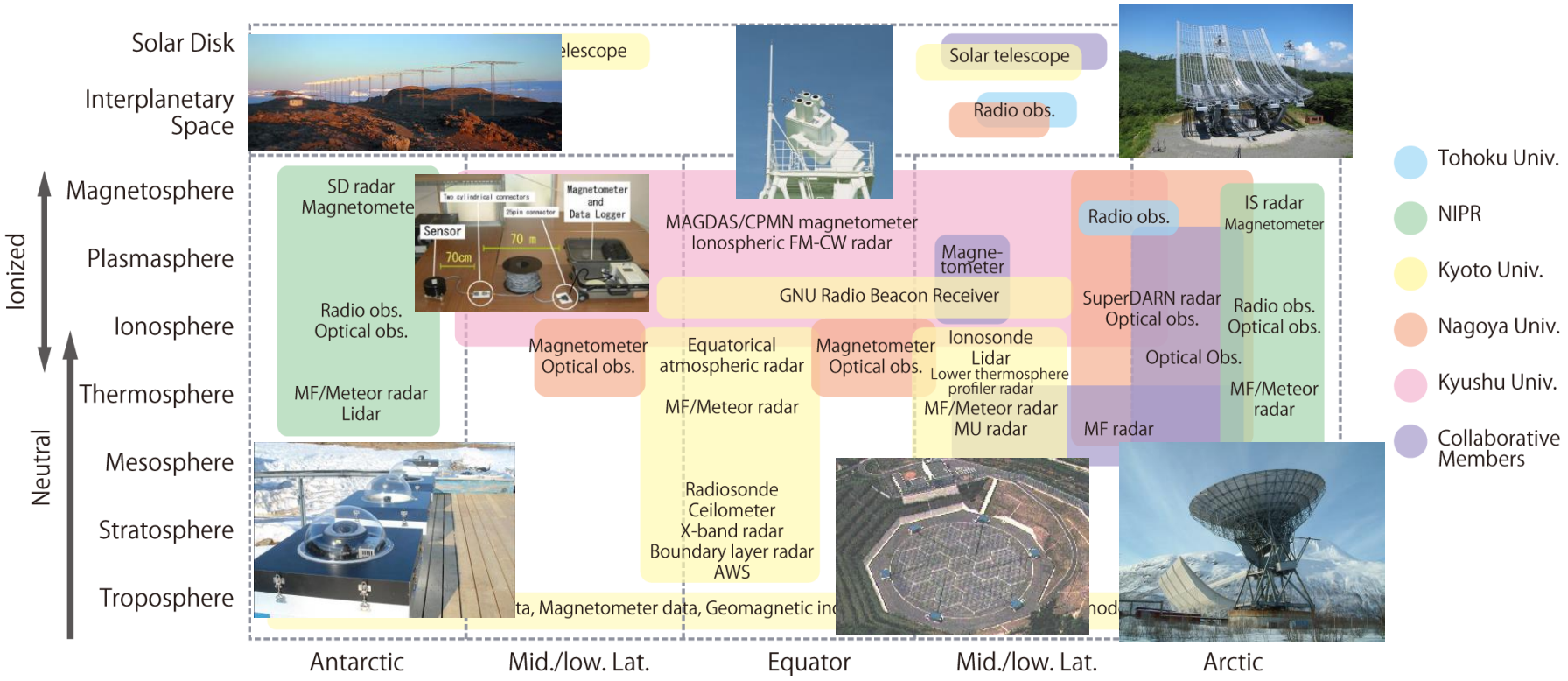
Complicated Upper Atmospheric Phenomena



- Consists of multiple layers, such as the stratosphere, mesosphere, and thermosphere.
- Various phenomena are generated by energy inputs both from upper region (e.g., solar radiation, solar wind, energetic particle precipitation) and lower atmosphere (e.g., atmospheric waves).
- Both vertical coupling and horizontal circulation play an important role in the formation of the Earth's atmosphere.

What data do we handle?

IUGONET Global Network of Ground-Based Observations



- IUGONET has handled data obtained by various kinds of instruments, such as telescopes, imagers, radars, and magnetometers, distributed globally all over the world.
- To understand the coupling processes in the solar-terrestrial system, it is important to comprehensively analyze these various kinds of data.

Collaboration with various STP projects

Master Plan "Study of coupling processes in the solar-terrestrial system"

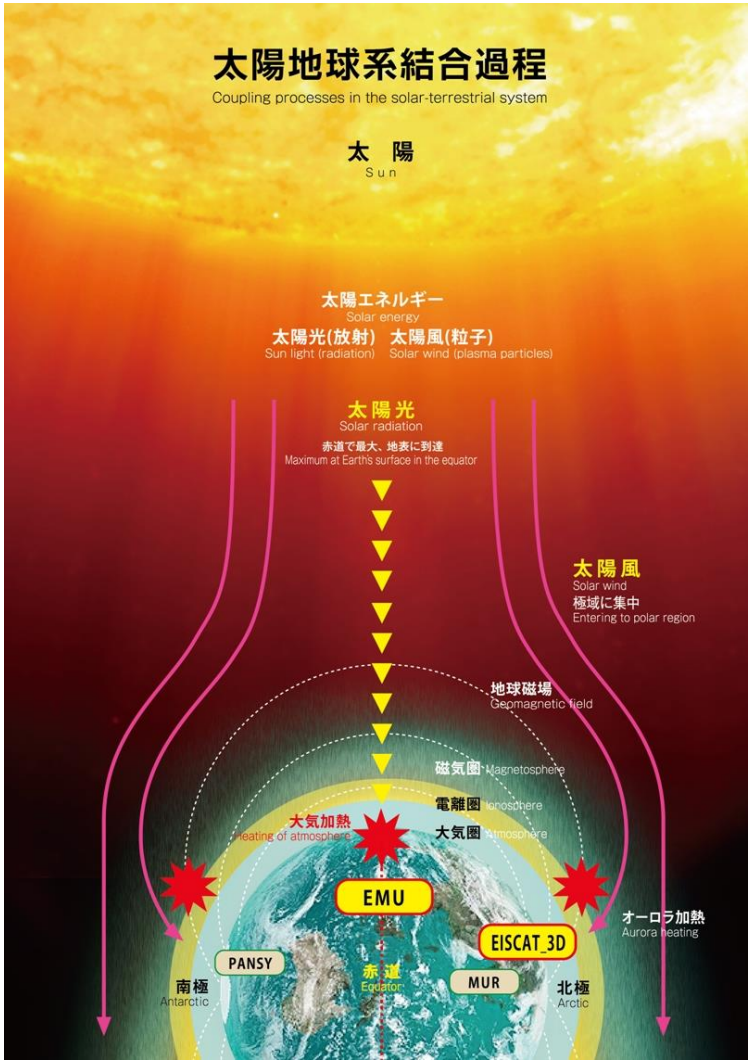
2014~2018

2015~2019

2016~

2016~2020

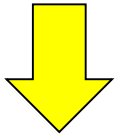
2015~2019



- We have collaborated with various projects associated with solar-terrestrial physics.
- We have supported publishing their data and have also provided useful tools for producing scientific results effectively.

Questions

- How can we produce scientific results effectively?
- How can we make new discoveries from a lot of data?



Our answers

- Connect seamlessly our research procedures (i.e., Search → Know (get metadata & QL plot) → Download → Visualize → Analyze data) using advanced tools.
- Remove barriers among various missions and communities.
- Contribute to the education of young researchers and promote international collaboration.

Strategy

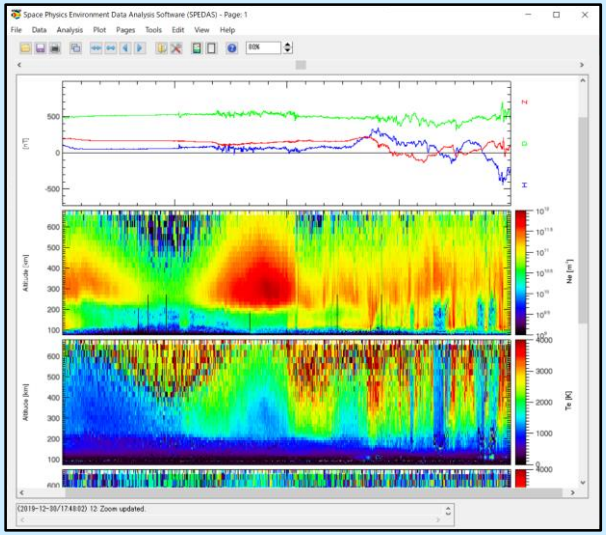
Our strategy is to help researchers perform comprehensive data analysis by connecting seamlessly research procedures using the advanced tools, i.e., metadata database (IUGONET Type-A) and analysis software (SPEDAS) for upper atmosphere data.

1. Search (find data and event) → **2. Know** (get metadata & QL plot) → **3. Examine** (plot interactively with UDAS web) → **4. Advance** (know how to analyze data)

IUGONET Type-A

5. Analyze (analyze data with SPEDAS) → **6. Create** (create figures for papers)

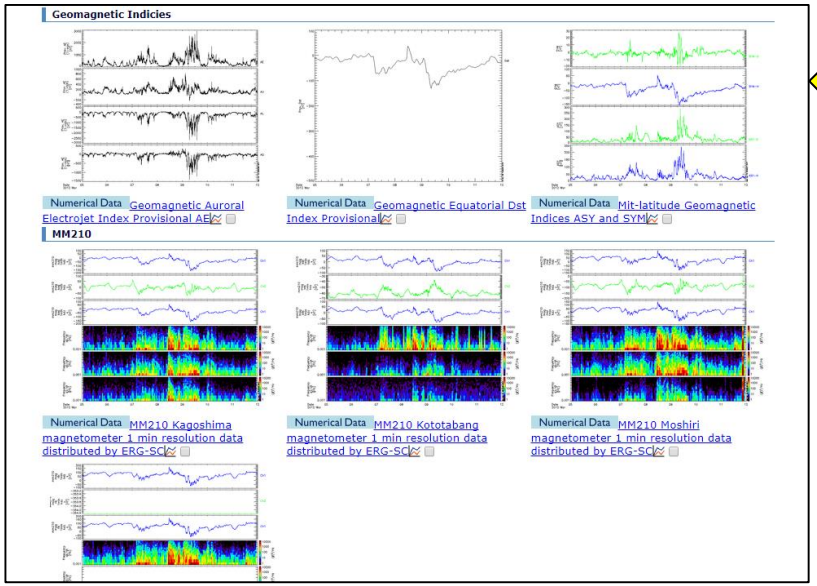
SPEDAS



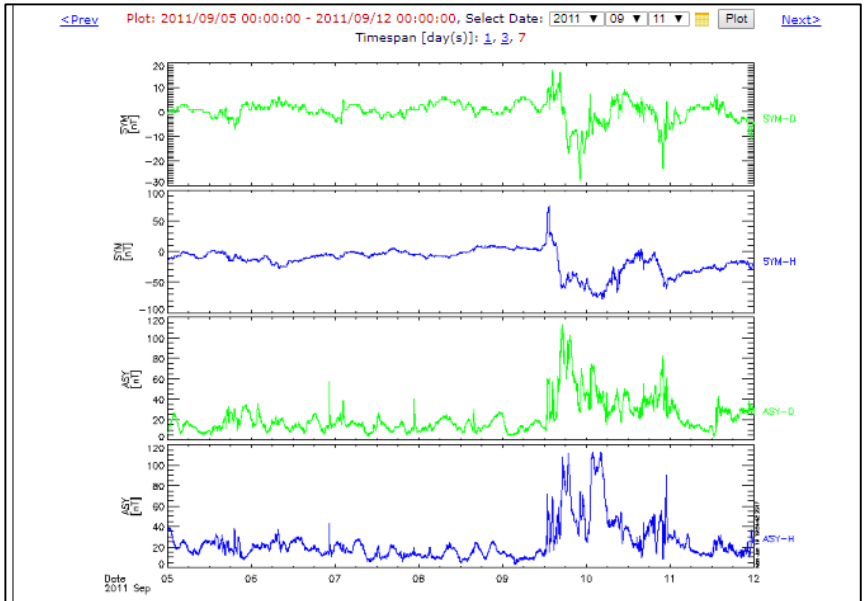
IUGONET Type-A (1)

http://search.iugonet.org/

1. Search data



2. Find interesting events



Description:
The mit-latitude geomagnetic indices at 1-min time resolution, derived at World Data Center for Geomagnetism, Kyoto, Kyoto University.
Acknowledgement: If the data are used in publications and presentations, the data suppliers and the WDC for Geomagnetism, Kyoto must properly be acknowledged.
ReleaseDate: 2011-02-17T08:00:00

Contact (GeneralContact):
Toshihiko Iyemori, Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University / World Data Center (WDC) for Geomagnetism, Kyoto, iyemori@kugi.kyoto-u.ac.jp
Contact (MetadataContact):
Masahito Nose', Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University / World Data Center (WDC) for Geomagnetism, Kyoto, nose@kugi.kyoto-u.ac.jp

AccessInformation:
Acknowledgement: If the data are used in publications and presentations, the data suppliers and the WDC for Geomagnetism, Kyoto must properly be acknowledged.
URL: http://wdc.kugi.kyoto-u.ac.jp/wdc/Sec3.html
Availability: Online
Access Rights: Open
Format: Text

Processing Level: Calibrated
Measurement Type: ActivityIndex

Time Span:
StartDate: 1981-01-01T00:00:00
StopDate: -P1D

Observed Region: Earth.Surface

Instrument:
Name: Magnetometers at San Juan (SJG)
Description: Information about magnetometers at San Juan (SJG)
Contact (GeneralContact):
Toshihiko Iyemori, Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University / World Data Center (WDC) for Geomagnetism, Kyoto, iyemori@kugi.kyoto-u.ac.jp

3. Know (get metadata and QL plots of data)

IUGONET Type-A (2)

The IUGONET metadata is based on the Space Physics Archive Search and Extract (SPASE) data model.

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StartDate: 1981-01-01T00:00:00
StopDate: -P1D

Observed Region: Earth.Surface

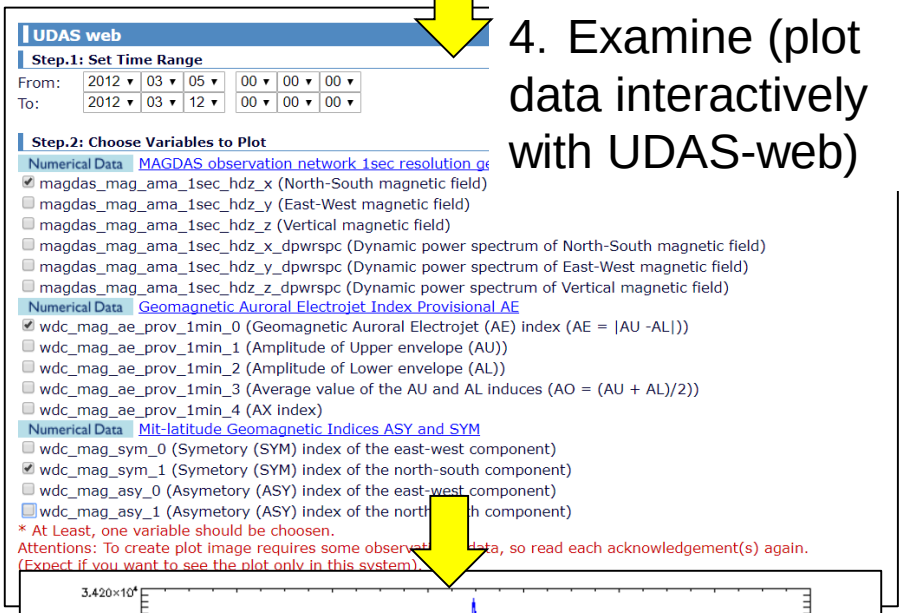
3. Know (get metadata and QL plots of data)

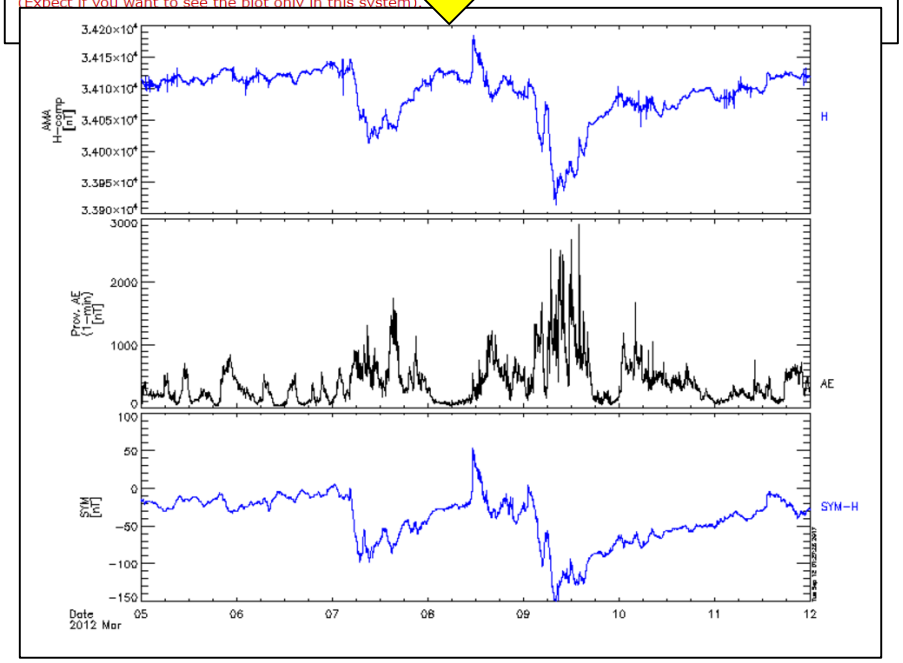
SPASE base model

<NumericalData>
<Person>
<Observatory>
<Instrument>
<Repository>

IUGONET Type-A (3)

4. Examine (plot data interactively with UDAS-web)





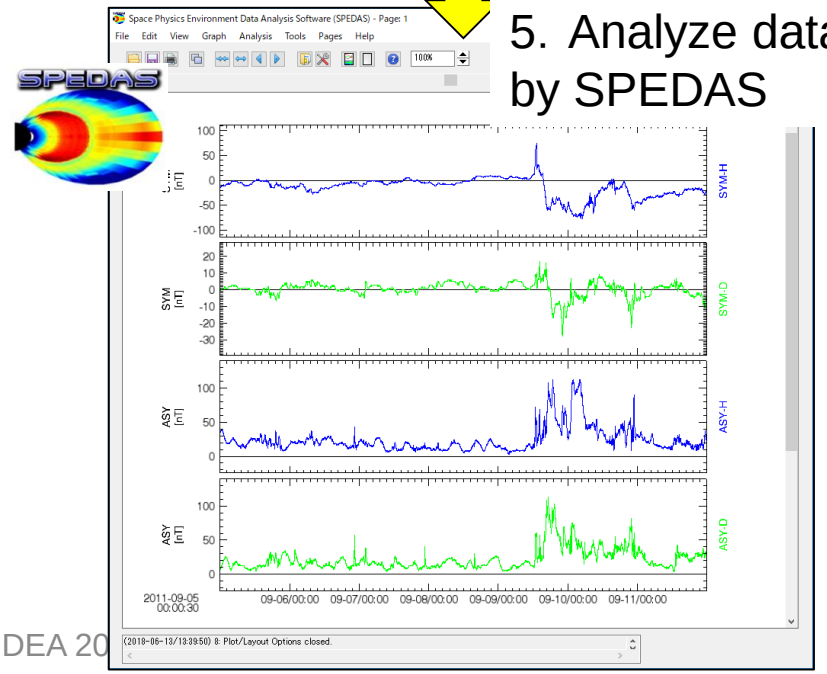
4'. Advance (know how to analyze data by SPEDAS).

```
How to Plot (SPEDAS-CUI #Basic):
IDL>      thm_init
THEMIS> timespan, ['2012-03-05 00:00:00', '2012-03-12 00:0
THEMIS> iug_load_gmag_wdc, site='sym asy'
THEMIS> tplot, ['wdc_mag_sym', 'wdc_mag_asy']

How to Plot (SPEDAS-CUI #Advanced [*Quick-Look was created
IDL>      thm_init
THEMIS> timespan, ['2012-03-05 00:00:00', '2012-03-12 00:00:00']
THEMIS> iug_load_gmag_wdc, site='sym asy'
THEMIS> split_vec, 'wdc_mag_sym'
THEMIS> split_vec, 'wdc_mag_asy'
THEMIS> tplot, ['wdc_mag_sym_0', 'wdc_mag_sym_1', 'wdc_mag_asy_0', 'wdc_mag_asy_1']

How to Plot (SPEDAS-GUI):
Step 1:   Start SPEDAS GUI Program.
Step 2:   Choose [FILE] -> [Load Data].
Step 3:   Choose [IUGONET] Tab.
Step 4:   Uncheck 'Use Single Day'.
Step 5:   Set Start Time: '2012-03-05 00:00:00' and Stop Time: '2012-03-12 00:00:00'.
Step 6:   Choose Instrument Type: 'geomagnetic_field_index'.
Step 7:   Choose Data Type: 'ASY_index', Site or parameter(s)-1: 'WDC_kyoto' and parameter(s)-2: 'asy', 'sym'.
Step 8:   Push [->] button. (Please wait a few minutes).
Step 9:   Push [Done] button.
Step 10:  Choose [Graph] -> [Plot Layout Options].
Step 11:  Choose 'wdc_mag_asy', 'wdc_mag_sym' and pu [ine->] button.
Step 12:  Push [OK] button.
```

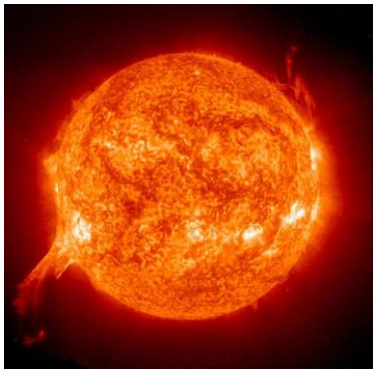
5. Analyze data by SPEDAS



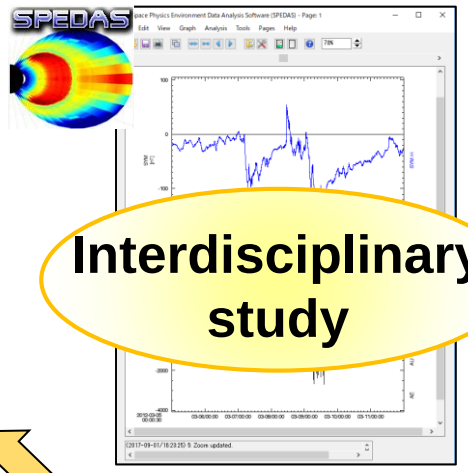
Data Analysis Software : SPEDAS

- SPEDAS (Space Physics Environment Data Analysis Software) was developed by scientists and programmers of the UC Berkeley's Space Sciences Laboratory, UCLA's IGPP and other contributors.
- IUGONET has provided the plugin software for SPEDAS to handle the IUGONET data.
- It is useful for the interdisciplinary study about solar-terrestrial physics.

Sun & Solar wind

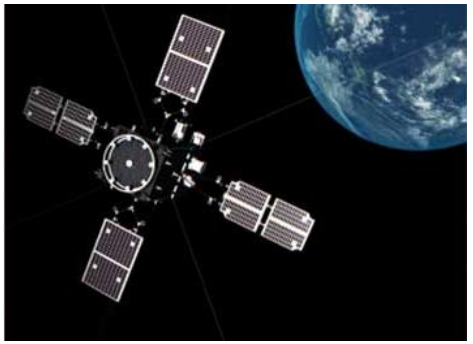


DSCOVR	SOHO	Wind	NASA OMNI
Stereo	ACE	IMP-8	….

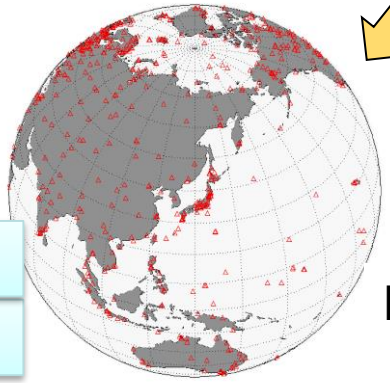


Interdisciplinary study

Geospace



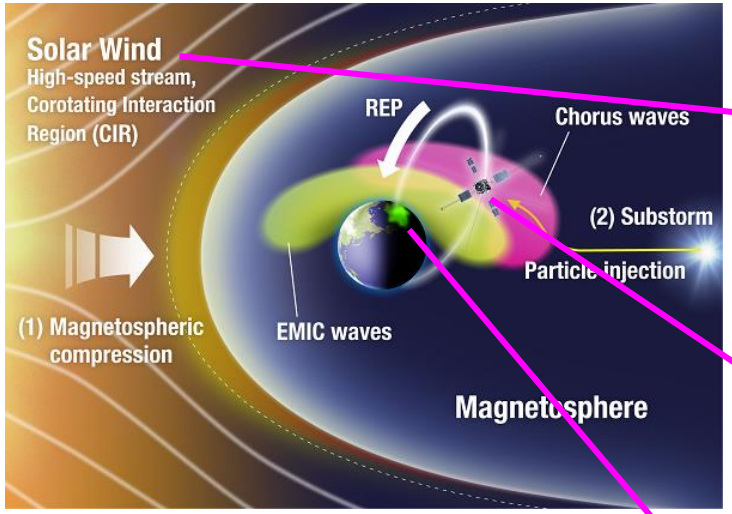
ERG	RBSP	THEMIS	LANL
GOES	MMS	POES	….



Earth's atmosphere

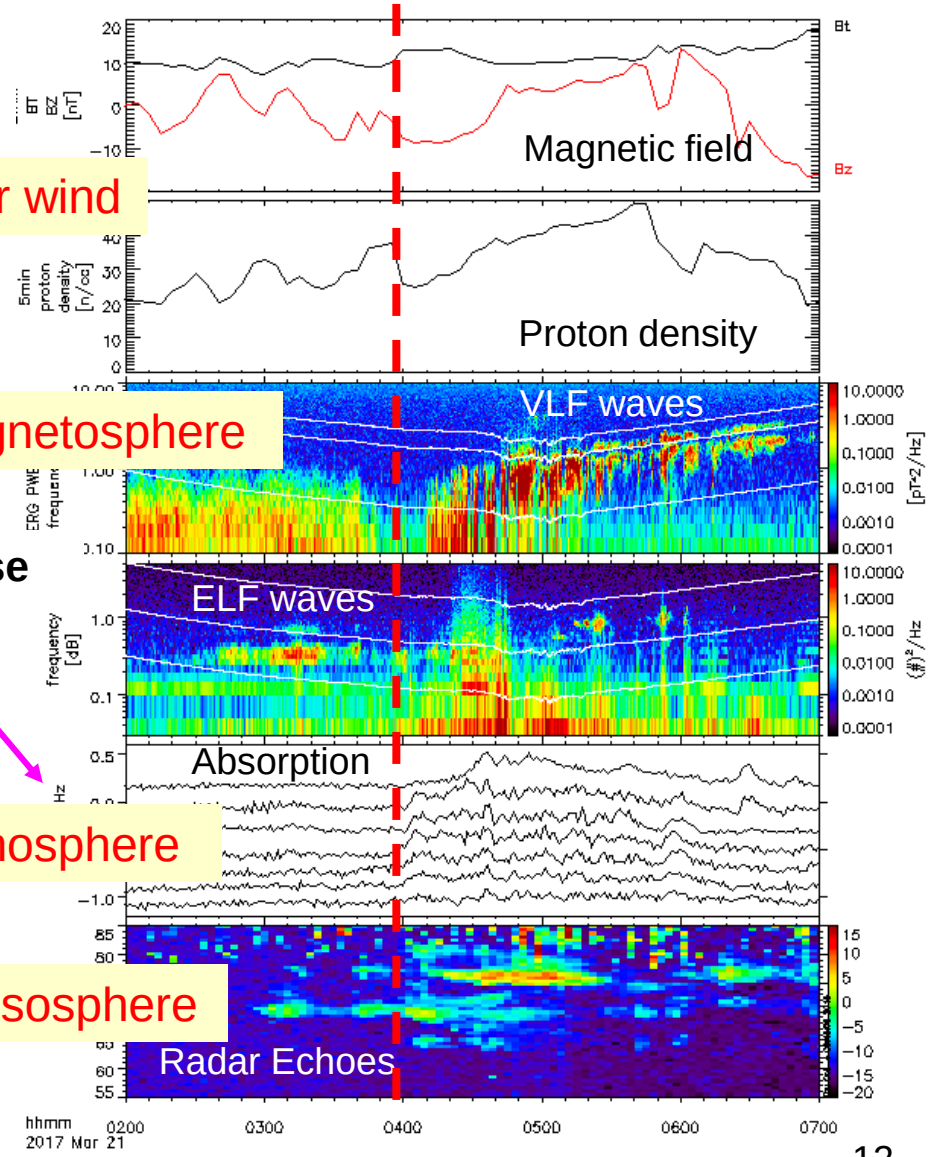
IUGONET	EISCAT	CARISMA	GIMA	ERG
Super DARN	THEMIS-GBO	MACCS	BARREL	….

An example of researches using IUGONET tools



Data from multiple regions

Tanaka et al., 2019



Data from multiple projects

ERG Science Center

極地研

PANSY

Outreach activity

Education of young researchers and construction of international network

at Covenant Univ. in Nigeria (2017)

In Japan (2010~2019)

at PRIC, China (2019)

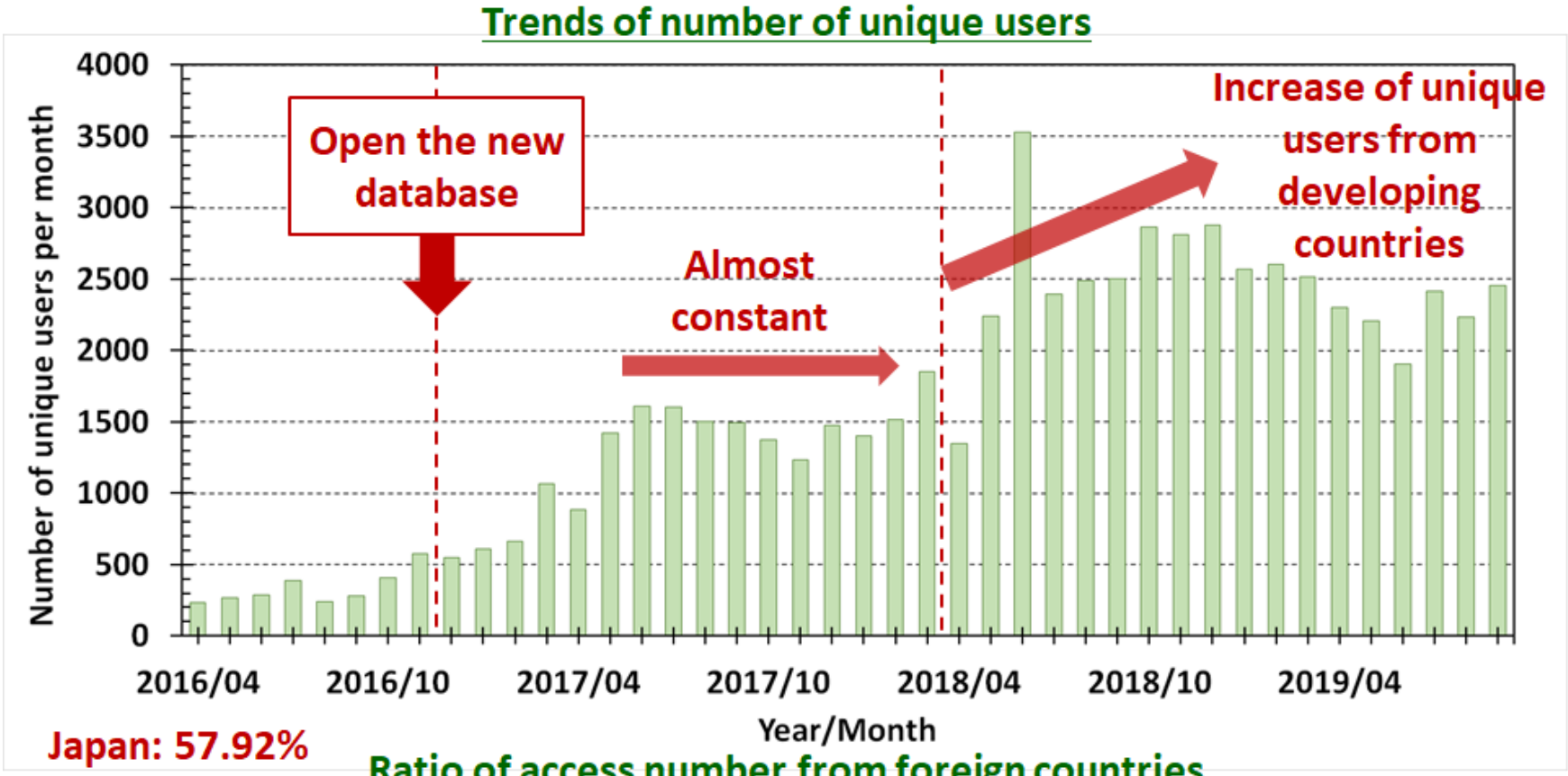
at LAPAN in Indonesia (2017~2019)

at PRL, India(2018)

at Universiti Teknologi MARA in Malaysia (2018)

Outcome (1)

Access number of unique users to IUGONET Type-A



Japan: 57.92%

Foreign: 42.08%

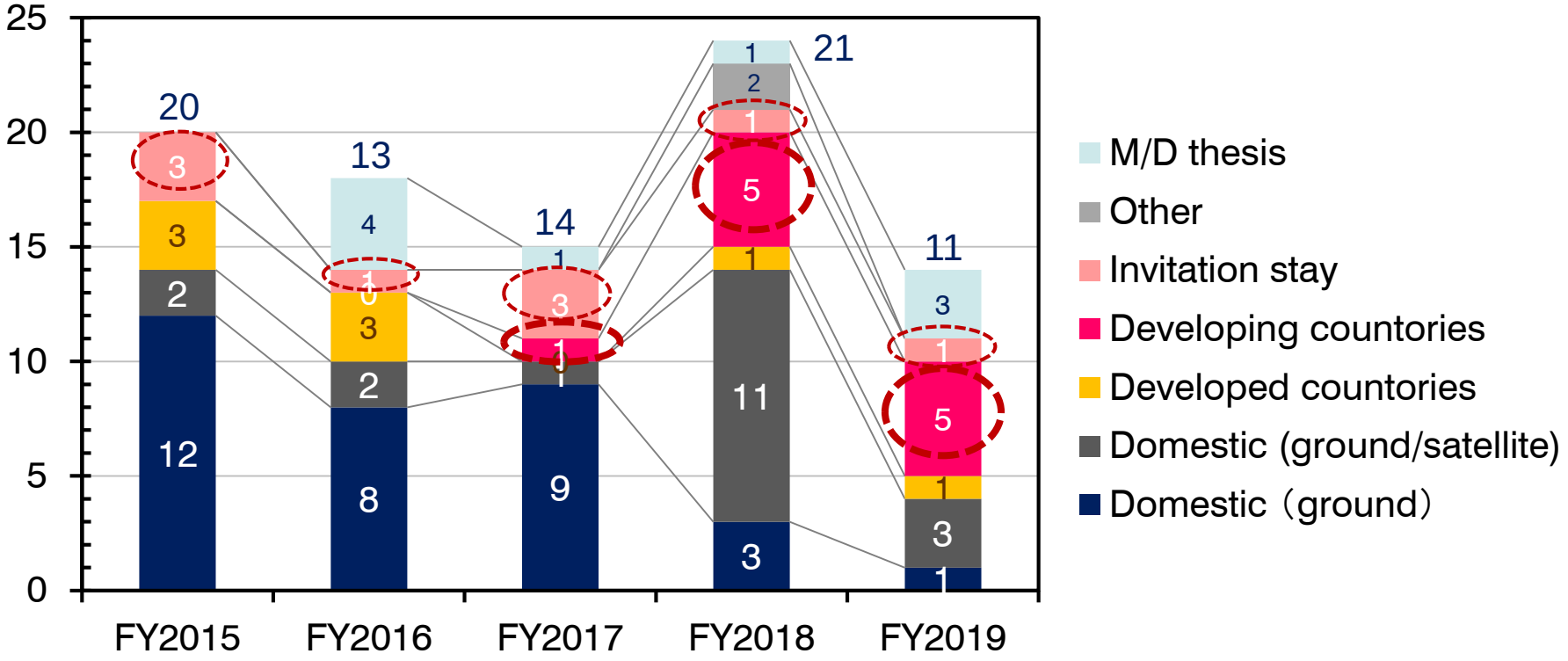
Ratio of access number from foreign countries (2016/10—2019/10)

Units (%)

USA	Indonesia	China	Germany	Russia	Turkey	Korea	France	India	Brazil
35.5	9.8	9.0	5.3	4.7	4.5	3.8	2.9	2.1	1.6

Outcome (2)

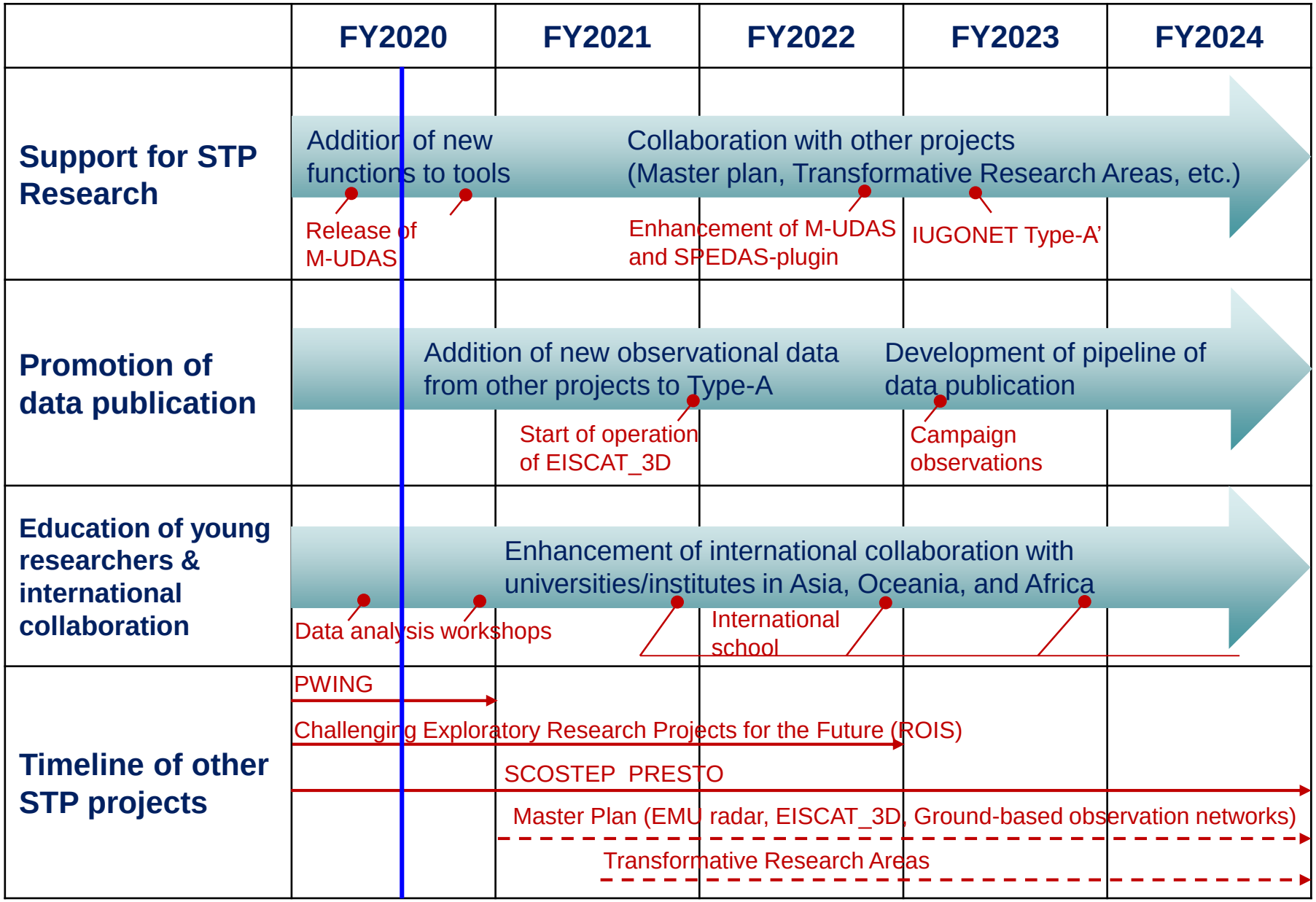
Number of papers with acknowledgements to IUGONET



List of papers whose first author is a collaborator in Indonesia (2020)

- ・Koushik, N., K. K. Kumar, C. Vineeth, G. Ramkumar, and K. V. Subrahmanyam, Meteor Radar Observations of Lunar Semidiurnal Oscillations in the Mesosphere Lower Thermosphere over Low and Equatorial Latitudes and their variability during Sudden Stratospheric Warming Events, J. Geophys. Res., 125, e2019JA027736, doi:10.1029/2019JA027736, 2020.
- ・Sridharan, S., Equatorial upper mesospheric mean winds and tidal response to strong El Niño and La Niña, J. Atmos. Sol.-Terr. Phys., 202, doi: 10.1016/j.jastp.2020.105270, 2020.
- ・Koushik, N., K. Kishore Kumar, Geetha Ramkumar, K. V. Subrahmanyam, G. Kishore Kumar, W. K. Hocking, Maosheng He, and Ralph Latteck, Planetary waves in the mesosphere lower thermosphere during stratospheric sudden warming: observations using a network of meteor radars from high to equatorial latitudes, Climate Dynamics, doi:10.1007/s00382-020-05214-5, 2020.

Future Plan


FY2020
FY2021
FY2022
FY2023
FY2024
Support for STP Research
Addition of new functions to tools
Collaboration with other projects (Master plan, Transformative Research Areas, etc.)
Release of M-UDAS
Enhancement of M-UDAS and SPEDAS-plugin
IUGONET Type-A'
Promotion of data publication
Addition of new observational data from other projects to Type-A
Development of pipeline of data publication
Start of operation of EISCAT_3D
Campaign observations
Education of young researchers & international collaboration
Enhancement of international collaboration with universities/institutes in Asia, Oceania, and Africa
Data analysis workshops
International school
Timeline of other STP projects
PWING
Challenging Exploratory Research Projects for the Future (ROIS)
SCOSTEP PRESTO
Master Plan (EMU radar, EISCAT_3D, Ground-based observation networks)
Transformative Research Areas

Conclusions

- The IUGONET project has developed the advanced tools for upper atmospheric research, such as the metadata database (IUGONET Type-A) and the integrated data analysis software (SPEDAS).
- To achieve scientific results effectively, our strategy is to connect seamlessly the research procedures using IUGONET Type-A and SPEDAS.
- We have contributed to the education for young researchers both in Japan and other countries (e.g., Indonesia, Malaysia, India, China, Nigeria) to enhance the international collaborations in the STP field.
- As a result, the number of papers whose first author is a collaborator in the developing countries is increasing.
- We are planning to continue the support for the STP researches, the promotion of data publication, and the education of young researchers.