Instructions for data analysis software:
- Preparation
- The IUGONET project and its products for space weather study
- Installation
- How to Use SPEDAS, part1
- How to Use SPEDAS, part2

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http://www.iugonet.org/?lang=en
The IUGONET project and hands on seminar for its data analysis software
Characteristics of Upper Atmosphere

1. Affected by various phenomena from the earth surface to the space
2. Many physical parameters
3. Various variations including solar activity are overlapped
Objectives of the IUGONET

Problem

Observational data should be quality controlled and managed by the specialists who know the observations.

For users...It was not easy to reach a necessary information, since databases are distributed in various universities and institutes.

Solution

IUGONET provides a new research platform that enables metadata extracted from ground-based observation data to be shared. In addition, IUGONET developed analysis software to access and analyze data in an integrated fashion.
The Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project aims at establishing “e-infrastructure” for researchers to effectively find, get, and analyze various kinds of upper atmospheric data spread over Japanese universities and institutes.

- To exchange ground-based observation data accumulated over 50 years since IGY (both digital and analogue data)
- To promote analyses of multi-disciplinary data, which will lead to comprehensive studies of mechanisms of long-term variations in the upper atmosphere
Schematics of the project

Kyoto Univ. Astronomical Observatories
Kyoto Univ. RISH
Kyoto Univ. DACGSM
Kyto Univ. IUGONET Information Center

International Users

Expand the system to other Geoscience community

Kyushu Univ. ICSWSE
Nagoya Univ. STEL

WDC for Cosmic Rays

NIPR
WDC for Aurora

Tohoku Univ. PPARC
WDC for geomagnetism Space Magnetism

Chairperson

Developers

Expand the system to other Geoscience community

IPRT

EISCAT Svalbard Radar

To expand the system to other Geoscience community

Kyoto Univ.

Information Center
IUGONET metadata format = SPASE + modifications

(www.spase-group.org)

What’s SPASE?

metadata format developed by international consortium to comprehensively describe research resources regarding heliospheric and magnetospheric satellite observations

- closely related to STP and upper atmosphere researches (easy to use as a base format)
- new metadata elements & words appendable (customizable according to our data)
- widely-used in VxOs (possible metadata exchange in the future)

IUGONET’s modifications

- additional words to represent non-digital archives
- additional words to represent heliospheric coordinates
- new metadata elements to describe observation location & range
IUGONET Metadata Database

- IUGONET MDB (called IUGONET Type-A) is capable of cross-searching observational data distributed across the IUGONET institutions.
- IUGONET Type-A brings a remarkable advancement in accessibility to the observational data and accelerate the interdisciplinary study.
- IUGONET Type-A provides a one-stop web services such as searching data, finding interesting events, interactively plotting the data, and leading users to more detailed analysis.
• The IUGONET Data Analysis Software (UDAS) is the plug-in software for Space Physics Environment Data Analysis System (SPEDAS), formerly known as THEMIS Data Analysis Software suite (TDAS)

• The IUGONET data (e.g., geomagnetic data, aurora data, radar data, and so forth) and many satellite mission data (THEMIS, GOES, WIND, and ACE) can be handled.

• It is possible to use many routines to visualize and analyze time series data.

• It accesses the IUGONET data through the Internet, and then the data are automatically downloaded onto the user's computer.
Outline of Loading/Plotting Data Using SPEDAS

Data can be easily plotted, for example, by only three basis commands with the SPEDAS-CUI tool.

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

If using the GUI tool, only a few simple clicks of your mouse are required to make the same plot as that created by the above command with the CUI tool.
Examples of SPEDAS visualization

- **Time series stack plot**

- **Mapping**
  
- **Correlation**

- **Wavelet**
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 Space Weather study.
ICSU - WDS
ICSU - CODATA
(International Framework)

IUGONET is a basis of a network datacenter
- Functioning like a big data center efficiently

IUGONET includes three WDC members
- NIPR(Aurora)
- Kyoto Univ(Geomagnetism)
- STEL(Cosmic Ray)
Event we analyze today

Geomagnetic storms followed by X-class flares and coronal mass ejections (CMEs) occurred on March 5-11, 2012.

From Space Weather News
http://swnews.jp/
Introduction of IUGONET Type-A
1. Access to IUGONET Type-A (http://search.iugonet.org/)

The Arase (ERG) satellite was launched at 20:00 (JST) on December 20, 2016 from Uchinoura Space Center, JAXA with an ellipse orbit (perigee: 320 km, apogee: 33,200 km, and period: 580 min). All the instruments of the Arase satellite has been recently operated and measure DC electric and magnetic field variations, plasma waves and energetic particles in the inner magnetosphere. In the first campaign observation, we operate various kinds of ground-based instruments such as the EISCAT radar, all-sky camera, EMCCD camera, induction magnetometer, riometer and related instruments near the footpoint of the orbit of the Arase satellite in order to clarify the generation and loss mechanisms of high energetic particles in Geospace and magnetosphere-ionosphere-thermosphere coupling process during geomagnetic storms and substorms.

Detailed information of this campaign: https://ergsc.isee.nagoya-u.ac.jp/mw/index.php/Campaign08/Campaign2017
How to use IUGONET Type-A

1. Set Timespan “2012/03/04 to 2012/03/10”

2. Click “Search” button
How to use IUGONET Type-A

Search Results

1. Click Plot

Search results are listed here.

- **Satellite**
  - AKEBONO
  - COSMIC

- **Ground-Based**
  - SMART (Telescope)
  - Geomagnetic Indices
  - Induction
  - PWING/PsA
  - VLF/ELF
  - VHF Radar
  - X-Band Radar

- **Instrument/Project**
  - CHAMP
  - OMI
  - MU Radar
  - GPS Receiver
  - Others

- **Observed Region**
  - CHAMP
  - OMI
  - GPS Receiver
  - Others

- **ERG Campaign**
  - COSMIC
  - Lidar
  - EA Radar
  - AWS
  - Refractor (Telescope)
  - Muon (Telescope)

- **Keyword**
  - Time Span: 2012/03/04 to 2012/03/10

- **Search Results**
  - Text
  - Plot

- **Satellite**
  - AKEBONO
    - Numerical Data: Observation data from VLF/MCA onboard Akebono
  - COSMIC
    - Numerical Data: COSMIC full spectrum inversion (FSI) data (netCDF)
    - Plot/Movie Data: Global distribution of dry air temperature at 15 km derived from the COSMIC full spectrum inversion (FSI) data (PNG)
    - Plot/Movie Data: Global distribution of dry air temperature variance in a height range of 10 - 30 km derived from the COSMIC full spectrum inversion (FSI) data (PNG)

- **Ground-Based**
  - SMART (Telescope)
    - Plot/Movie Data: Quicklook images of SMART/T3 H-alpha and continuum partial-region solar images, etc.
How to use IUGONET Type-A

Search Results

Search results are displayed with QL plots

Satellite

COSMIC

You can select a time interval from 1, 3, or 7 days for time-series data. If you select 7-days, data from 2012/03/04 to 2012/03/10 are displayed.

Ground-Based

SMART (Telescope)

No Data

Images on the last day of the selected interval are displayed (i.e., 2012/03/10 in this case)

Scroll down
How to use IUGONET Type-A

1. Click Dst index provisional
How to use IUGONET Type-A

Data Information (Metadata)

QL plot of Dst index

Set date (this is the last day of the interval)

To previous day

To next day

You can change timespan here

Scroll down
# How to use IUGONET Type-A

## Data Information (Metadata)

| Description: | The geomagnetic equatorial Dst index at 1-hr time resolution, derived at World Data Center for Geomagnetism, Kyoto University. The provisional Dst index is calculated from geomagnetic field data which were visually inspected. |
| Acknowledgement: | If the data are used in publications and presentations, the data suppliers and the WDC for Geomagnetism, Kyoto must properly be acknowledged. |
| Release Date: | 2011-02-17T00:00:00 |

| Contact (General Contact): |
| 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 |
| 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 |

| Access Information: |
| 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](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: |
| Start Date: 2012-01-01T00:00:00 |
| Stop Date: 2015-03-31T00:00:00 |

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**Scroll down**

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Acknowledgement  
Contact Person  
Access Information
How to use IUGONET Type-A

“How to plot” section shows how to plot the data by the dedicated software “IDL/SPEDAS”.

How to Plot (SPEDAS-CUI #Basic):
IDL> thm_init
THEMIS> timespan, ['2012-03-04 00:00:00', '2012-03-11 00:00:00']
THEMIS> iug_load_gmag_wdc, site='dst', level='provisional'
THEMIS> tplot, 'wdc_mag_dst_prov'

How to Plot (SPEDAS-CUI #Advanced [*Quick-Look was created with this command])
IDL> thm_init
THEMIS> timespan, ['2012-03-04 00:00:00', '2012-03-11 00:00:00']
THEMIS> iug_load_gmag_wdc, site='dst', level='provisional'
THEMIS> ylim, 'wdc_mag_dst_prov', -500, 100
THEMIS> tplot, 'wdc_mag_dst_prov'

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: '2012-03-04 00:00:00' and Stop Time: '2012-03-11 00:00:00'.
Step 6: Choose Instrument Type: 'geomagnetic_field_index'.
Step 7: Choose Data Type: 'Dst_index', Site or parameter(s)-1: 'WDC_kyoto' and parameter(s)-2: 'prov'.
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_dst_prov' and push [Line->] button.

You can plot Dst index with the SPEDAS-GUI tool according to this instruction.

CUI #Basic: SPEDAS commands minimally required to plot the data

CUI #Advanced: SPEDAS commands used to create QL plot in the metadata display page.

GUI: How to plot the data with SPEDAS-GUI.
How to use IUGONET Type-A

Interactive data plot (UDAS web)

Check the checkboxes. You can select 3 data at most.
How to use IUGONET Type-A

Interactive data plot (UDAS web)

Click Create button
How to use IUGONET Type-A

Interactive data plot (UDAS web)

Select data that you want to plot, then click “Plot”.

Select data that you want to plot,
then click “Plot”.

How to use IUGONET Type-A

Interactive data plot (UDAS web)

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Select data that you want to plot,
Installation of SPEDAS
Preparation of SPEDAS

Download of SPEDAS GUI tool

1. Access the THEMIS satellite software website

2. Scroll down to “Download” section

If you don't have an IDL license

SPEDAS is free software but if you do not have an IDL license, then you cannot use the IDL command line, and hence neither the SPEDAS command line tools. You can still use the SPEDAS GUI, and you have two options:

1. Download the SPEDAS executable (for Linux, MacOS, or Windows), or
2. Download the SPEDAS save file (for Solaris or other operating systems).

Download SPEDAS 2.00 Executables (June 2017)

For users without IDL licenses, you can use the SPEDAS 2.00 executable files for Linux, Windows, and MacOS, which allow access to the Graphical User Interface capabilities of SPEDAS, with no additional IDL license required.

- SPEDAS 2.00, Windows 64bit executable with IDL 8.5.1, CDF 3.6.4, Geopack 9.4 (~50 MB)
- SPEDAS 2.00, MacOS 64bit executable with IDL 8.5.1, CDF 3.6.4, Geopack 9.4 (~65 MB)
- SPEDAS 2.00, Linux 64bit executable with IDL 8.5.1, CDF 3.6.4, Geopack 9.4 (~65 MB)
- SPEDAS 2.00, Linux 64bit executable with IDL 3.5.1, CDF 3.6.4, Geopack 7.6 (~65 MB)

This release contains everything you need, including the IDL VM, the Geopack DLM and the CDF DLM. You just have to unzip the file and run the executable and the SPEDAS GUI will appear.

Click the proper link for your OS. The compressed executable file will be downloaded in several seconds or minutes.


[3] IDL Virtual Machine window opens on your PC, so please **click the ‘spd_gui’ button.**
Start of IDL-VM(GUI) tool

Ready?
How to Use SPEDAS
part 1

- Load data
- Plot data
- Save figure, data, and your work
Lesson: Load Dst index

1. Click this icon

Or, Select “Load Data” from “File” dropdown menu.
1. Click **IUGONET Tab**

2. Uncheck “Use Single Day”

3. Set Date and Time
   - Start Time: 2012-03-04/00:00:00
   - Stop Time: 2012-03-11/00:00:00

4. Change Instrument Type
   - geomagnetic_field_index

Note: # means that the load procedure has been developed in collaboration with the ERG Science Center.
1. Choose three parameters
   - Dst_index
   - *(all)
   - *

2. Click the arrow
GUI Basic Operation

Display of Data Use Policy

1. Click “OK”
1. Data was loaded successfully!

2. Click “Done”
Lesson: Plot data

1. Click this icon

Or, Select “Plot/Layout Options…” from “Graph” dropdown menu.
1. Select data which you want to plot: wdc_mag_dst_prov

2. Click “Line”
1. Selected variable name is added to this box

2. Click OK
PanelX(Y,Z)
X: panel serial number
Y: row index of the panel
Z: column index of the panel

You can add, remove, and edit panels with these buttons.

You can move panels and change the number of panels per page.

Lock to panel:
Lock panel axes to currently selected panel.
Try:
Load other three data

AE index
(in IUGONET tab)
Instrument: magnetometer

MAGDAS magnetometer
(in IUGONET tab)
Instrument: magnetometer
Station: HER

MAGDAS magnetometer
(in IUGONET tab)
Instrument: magnetometer
Station: ASB
1. Select IUGONET tab

2. Select magnetic_field_index

3. Select AE_index, *(all), *

4. Click arrow

5. Data is loaded
1. Select **geomagnetic_field_fluxgate**

2. Select **magdas#, asb & her, ***

3. Click arrow

4. Data is loaded

5. Click Done
Lesson:
Add Plot

Or,
Select “Plot/Layout Options…” from “Graph” dropdown menu.

1. Click this icon
1. Click Add
2. Select `wdc_mag_ae_prov_1min`
3. Click "Line"
4. Data are added
5. Click OK
GUI Basic Operation

1. Click black triangles
Try:
Plot other two data

`magdas_mag_her_1sec_hdz`

`magdas_mag_asb_1sec_hdz`
GUI Basic Operation

1. Select magdas_mag_her_1sec_hdz
2. Click Line
3. Data are added
1. Select `magdas_mag_asb_1sec_hdz`
2. Click Line
3. Data are added
4. Click OK

(GUI Basic Operation)
GUI Basic Operation
Lesson: Save plot as figure

1. Select
   File – Export To Image File

2. Select save folder

2. Input file name and select format (by extension)

3. Click “save”
Confirmation

Click “Save”
Lesson:
Save data as ascii

1. Select
File – Save Data As
1. Select data which you want to save
   magdas_mag_her_1sec_hdz_x

2. check this box

3. Select time interval
   - Start Time: 2012-03-08/00:00:00
   - End Time: 2012-03-09/23:59:59

4. check this box

5. Click Save

6. Select save folder

7. Input file name (data is saved in csv format)

8. Click “save”
An ascii data file was successfully saved!!!
Lesson: Dump your workspace

1. Select File – Save SPEDAS Document

2. Select save folder

3. Input file name

4. Click “save”

SPEDAS Document is written in XML format
How to Use SPEDAS
part 2

- Restore your work
- Manage axis
- Process and data
Lesson: Restore part1 workspace

1. Exit SPEDAS
2. Run SPEDAS again
3. Select File- Open SPEDAS Document
4. Click “Yes”
5. Select the saved tgd file.
Lesson: Remove plot

1. Select Graph – Plot/Layout Options
1. Select wdc_mag_ae_prov_1min_time -vs- wdc_mag_ae_prov_1min_4 in the right-hand panel.

2. Click “Remove”

3. Remove wdc_mag_ae_prov_1min_time -vs- wdc_mag_ae_prov_1min_3, wdc_mag_ae_prov_1min_time -vs- wdc_mag_ae_prov_1min_2, wdc_mag_aeProv_1min_time -vs- wdc_mag_ae_prov_1min_1 in the same way

4. Click OK
GUI Basic Operation

Result
Lesson:
Change X range (time scale) of the plot (1)

- Reduces X range by major tick marker
- Expands X range by major tick marker
- Shift left X range by major tick marker
- Shift right X range by major tick marker

Use these icons
Lesson:
Change X range (time scale) of the plot (2)

1. Select Graph – X Axis Options
1. Select (L) Panel 1 (1, 1) -

2. Select Fixed Range

3. Change values
   Min 2012-03-06/00:00:00.000
   Max 2012-03-11/00:00:00.000

4. Click OK
Lesson: Customize Ticks.

1. Select Major Ticks By Number or Interval.

2. Input the number into # (Number or Interval) of Minor Ticks

3. Click "Apply to All Panels", then click "OK".
1. Select your favorite format in the pull-down menu of Annotation Format.

2. If you want to change the character font, size, and color, select your favorite format in the pull-down menu here.

3. Click "Apply to All Panels", then click "OK".
Lesson: Customize Labels (of X axis)

1. Select the bottom panel number ("Panel 4")

2. Check the "Show Label" box

3. Type "Universal Time" on the Edit/Add Label

4. Click "OK"

Note: Never use "Apply to All Panels"
GUI Basic Operation

Other options.

• Page Options…
  Customize the text and layout of the page.

• Panel Options…
  Customize the title and color of each panel.

• Line Options…
  Customize the line and symbol of each plot panel.

• Legend Options…
  Customize the legend which appears when you put the mouse cursor on the plot.

• Variable Options…
  Display the values of the selected parameters under the time label.
Lesson:
Reset X range (time scale)

1. Select **X Axis Options**
1. Select **(L) Panel 1(1, 1)** -

2. Select **Auto Range**

3. Click **“OK”**
Lesson:
Processing - subtract average

1. Select
Analysis – Data Processing
1. Select data you want to process:
   - magdas_mag_asb_1sec_hdz
   - magdas_mag_her_1sec_hdz

2. Click right arrow

3. Active Data are added

4. Click Subtract Average
New variables are created.

magdas_mag_asb_1sec_hdz-d
magdas_mag_her_1sec_hdz-d

1. Click Done
Open “Plot/Layout Options”

1. Remove Panel 3 and 4

2. Select magdas_mag_her_1sec_hdz-d

3. Click line

4. Data are added

5. Then, add the other variable, magdas_mag_asb_1sec_hdz-d to panel in the same way.

6. Click OK
GUI Basic Operation

Subtracted average!
Try:
Plot Power Spectrum of magdas_mag_her_1sec_hdz_x

Hint1: Use “Data Processing” for calculating (if you will get an option dialog, use default value)

Hint2: Use “Spec” for plotting

1. Select Analysis – Data Processing
1. Click Clear Active

2. Active Data is removed
GUI Basic Operation

1. Select data
   magdas_mag_her_1sec_hdz

2. Click right arrow

3. Active Data are added

4. Click Power Spectrum

5. Click OK
1. New variables are created!

2. Click Done
1. Select `magdas_mag_her_1sec_hdz_x_dpwrspc`

2. Click Spec

3. Data are added

4. Click OK
This color bar can be customized in Graph - Z Axis Options.
Lesson:
Use Calculate (Equation editor)

1. Select
Analysis – Calculate…
Equation Editor for SPEDAS

Variable
=Your loaded data

Built-in function

Built-in Operator

Built-in Constant
Lesson:
Make an equation using the loaded variables.

1. Type variable/function/Operator/Constant directly

Note:
Enclose the variable in double quotation marks
Lesson:
Make an equation using the loaded variables.

1. Select `magdas_mag_her_1sec_hdz-d_x`
2. Click arrow
3. Variable is added

Then, try to add the offset (+200) to `magdas_mag_her_1sec_hdz-d_x`
"magdas_mag_her_1sec_hdz-d_x_ofst" = "magdas_mag_her_1sec_hdz-d_x" + 200

1. Click Run
2. A new variable is created
3. Click done
GUI Basic Operation

1. Select Panel 3 and Remove it

2. Select
   - magdas_mag_her_1sec_hdz-d_y
   - magdas_mag_her_1sec_hdz-d_x_ofst

3. Click Line

4. Data are added
1. Change the value of Row to 3
2. Panel 6 is changed to (3, 1)
3. Click OK
Offset (+200nT) was added to the H comp.
GUI Basic Operation

Try:
Expand the plot using the mouse.

By left-click and drag the mouse

A new page opens
Lesson:
Load data from CDAWeb.

1. Select
File – Load Data using CDAWeb
1. Select Mission
   OMNI(Combined …)

2. Select Instrument Type
   Magnetic fields (space)

3. Click "Find Datasets"

4. Data are listed
1. Selected data that you want to load

2. Set Date & Time

3. Click “Get CDAWeb Data”
GUI Basic Operation

Open some pop-up windows to confirm the data

1. Click “OK”

2. Click “OK”

3. Finally, click “Close” in the “CDAWeb Data Chooser” window
GUI Basic Operation

1. Select the listed all data in term
2. Click Line
3. Data are added
4. Click OK
All solar wind parameters are plotted.
For advance...

UDAS website:  http://www.iugonet.org/product/analysis.jsp

Data Analysis Software: SPEDAS
SPEDAS (Space Physics Environment Data Analysis Software) is a set of IDL (Interactive Data Language) libraries that provides an integrated analysis platform for Solar-Terrestrial Physics.
SPEDAS has useful features as follows:
1. Automatic data download without specifying the data's location
2. Data analysis without regard to the file format of the data
3. Parallel display of different types of data from many satellite and ground-based missions, including IUGONET.
4. Utilization of various analysis functions equipped in SPEDAS (e.g., frequency analysis, filtering)
5. Output into an ASCII file or image files (e.g., PNG, JPEG, GIF)
6. GUI available for those new to IDL and SPEDAS
7. SPEDAS-GUI executable on the IDL Virtual Machine without a paid IDL license.

UDAS
IUGONET has provided a plug-in software, UDAS (iUgonet Data Analysis Software), for SPEDAS. Release Note

Latest Version
s2.00.1 for SPEDAS v2.00 (zip, 1MB)

Previous Version
s1.00.1 for SPEDAS v1.00 (zip, 1MB)
3.00.3 for TDAS v8.00 (zip, 1MB)
3.00.2 for TDAS v8.00 (zip, 1MB)
3.00.1 for TDAS v8.00 (zip, 1MB)
2.01.1 for TDAS v7.01 (zip, 1MB)
2.00.2 for TDAS v7.00 (zip, 1MB)
2.00.1 for TDAS v7.00 (zip, 1MB)
1.00.1 for TDAS v6.00 (zip, 1MB)

How to use SPEDAS/UDAS
1. SPEDAS/UDAS Users Guide (PDF)
2. You can learn SPEDAS using some documents (PDF files) used in the past workshops.
SPEDAS is a grass-roots data analysis software for the Space Physics community, which was developed by scientists and programmers of the UC Berkeley's Space Sciences Laboratory, UCLA's IGPP and other contributors.