Lessons 7 and 8: IUGONET data analysis for promotion of atmospheric science

Institute for Space-Earth Environmental Research (ISEE), Nagoya University
1. Introduction
   - An overview of the IUGONET project
   - Characteristics of IUGONET Type-A and SPEDAS

2. How to use IUGONET Type-A
   - Access to IUGONET Type-A
   - How to search the data information you want to know
     (ex. Equatorial Atmosphere Radar, MF/Meter radar, …)
   - Exercise (15 – 20 minutes)

3. How to use SPEDAS with an aid of IUGONET Type-A
   - Installation of SPEDAS to your own PC
   - Data load, plot, save of image and postscript files, advanced data analysis
     (average, filter, FFT, wavelet etc)
   - Exercise (30 minutes) (ex. EAR/MU, MF/meteor, radiosonde, …)

4. Summary and conclusion
   - Future plan of the IUGONET project (international collaboration, SPEDAS for MATLAB)
1.1 Structure of the Earth’s atmosphere

- **Upper atmosphere**
  - Thermosphere
  - Ionosphere
  - Mesosphere
  - Stratosphere
  - Troposphere

**Height [km]**

**Temperature [K]**

**Electron density [m⁻³]**

**Observation instruments**
- satellite
- aurora
- ground-based observation
- lidar
- optical imager
- magnetometer
- radar
- radiosonde
- meteors
- PMC
- PSC

**Solar min.**
**Solar max.**

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1. Introduction
The upper atmosphere are influenced by both solar activity and atmospheric waves propagating upward from the lower atmosphere. To understand the generation mechanism of upper atmospheric variations, we need to perform an integrated analysis with different types of atmospheric observation data.
1. Introduction

1.3 Global observation network

- 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

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

- Hida Observatory
  - Solar Magnetic Activity Research Telescope
  - SuperDARN Hokkaido HF radar

- SuperDARN Radar

- Peru Ica University
  - MST radar
  - MF/meteor radar
  - MAGDAS magnetometer
  - FM - CW radar
  - OMTI imager
  - WDC magnetometer
  - Magnetic Equator
  (IGRF2005, Height 100km)
Various kinds of ground-based observation data taken by different techniques cover a wide region from both the poles to equator and from the troposphere to solar surface.
1. Introduction

1.5 Major problems of openness of observation data

Each research group has its own observation database.

Most observation data are used only in a particular institute or domain, and some data remain undisclosed.

Much time and troublesome procedures are required for external researchers to access databases of observation data.

Interdisciplinary research requiring various observation data is inhibited.
1.6 The IUGONET project and its objectives

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
In order to promote an interdisciplinary study of coupling processes in solar-terrestrial system, we need to establish a database of data information (metadata) on ground-based observation data for cross-search and to develop an integrated data analysis tool.

[Hayashi+, 2013]
1. Introduction

1.8 IUGONET products (IUGONET Type-A and UDAS)

IUGONET web-service
To cross-search various kinds of ground-based solar and earth’s atmospheric observation data.

iUgonet Data Analysis Software (UDAS)
Integrated data analysis tool to handle various kinds of observation data provided by the IUGONET institutes.

http://search.iugonet.org

http://www.iugonet.org/product/analysis.jsp
1.9 Structure of IUGONET Type-A

A: Top window
   A-1: Text
   A-2: Map

B: List of search results
   B-1: Text
   B-2: Thumbnail

C: Detailed search results

D: Plot maker

Pop-up window
Move the parent window
UDAS web

http://search.iugonet.org
1. Introduction

1.10 What can you learn from IUGONET Type-A?

- Basic information of observation data you want to know
  Observation site, method (instrument), period, observed region, data format, data policy, person
  → These become basic material when you write scientific paper.

- Quick look (QL) plot of observation data related to category and keywords
  → The Q plots displayed in IUGONET Type-A has a common time interval of 1, 3, and 7 days for the data you can plot with SPEDAS.
  Because their time axes are the same, you can easily compare different types of observation data (ex. neutral wind, solar wind, geomagnetic field) and may find new relationship between the phenomena observed in the different atmospheric layers.

- How to create time-series plots of observation data with SPEDAS
  → You can easily make several line or contour plots of solar and atmospheric data at anytime and anywhere by yourself.
1. Introduction

1.11 Analysis software: SPEDAS

- 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.
1. Introduction

1.12 Characteristics of SPEDAS

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

1. Set a time period
   timespan, ‘yyyy-mm-dd’

2. Load *** data
   iug_load_***

3. Plot the loaded data
   tplot, +++

In case of the GUI tool, only a few simple clicks of your mouse are required to procedure the same plot as that created by the above command with the CUI tool.
1. Introduction

1.13 Datasets to handle with SPEDAS

**Satellite**
- ACE, DISCOVER, WIND
  - Interplanetary
- ERG, FAST, GOES, MMS, RBSP, THEMIS
  - Magnetosphere
- ICON, POES  - Ionosphere
- COSMIC, CHAMP  - Atmosphere
- MAVEN  - Mars

**Ground/Model**
- ERG, IUGONET
  - Solar telescope, Radar, Imager, Ionosonde, Magnetometer, AWS, Riometer, SuperDARN, GPS, Kyushu GCM

**Space**
- Sun
- Integrated data analysis
- Space observatories

**Earth’s atmosphere**
- IUGONET observatories
1. Introduction

1.14 Example of data plot with SPEDAS
1. Introduction

1.15 Executable file of SPEDAS-GUI

We built the SPEDAS executive file working on **IDL Virtual Machine**. You can use the SPEDAS (with only GUI) without any IDL licenses. You can get the executable file from the SPEDAS website.

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 here are the 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 the SPEDAS executables, Version 3.1.1 (October 2018, minor refresh)

Note: In January 2019, we created new executable files (spedas version 3.1.1). However, the only change is the correction to the names. For users without IDL licenses, you can use the SPEDAS 3.1.1 executable files for Linux, Windows, and MacOS, which is required.

- **spedas 3.1.1**, Windows 64bit executable with IDL 8.5.1, CDF 8.3.8.1, Geopack 19.5 (35 MB)
- **spedas 3.1.1**, MacOS 64bit executable with IDL 8.5.1, CDF 8.3.8.1, Geopack 19.5 (35 MB)
- **spedas 3.1.1**, Linux 64bit executable with IDL 8.5.1, CDF 8.3.8.1, Geopack 19.5 (35 MB)
- **spedas 3.1.1**, Linux 64bit executable with IDL 8.5.1, CDF 8.3.8.1, Geopack 19.5 (35 MB) - includes Geopack 7.8

This release contains everything you need, including the IDL VM, the Geopack DLM and the CDF DLM. You just have to install it on your system.

Download the SPEDAS save file, Version 3.1.1 (October 2018, minor refresh)

Note: In January 2019, we created a new save file (spedas version 3.1.1). However, the only change is the correction to the names. The SPEDAS save file requires the run-time IDL Virtual Machine (VM) which has to be downloaded for free from here:

- **spedas 3.1.1**, IDL Savefile (20 MB)

To run SPEDAS using the IDL virtual machine,
1. start the IDL virtual machine executable
2. click through the splash screen to get to the file selection dialog
3. navigate to the SPEDAS installation
4. go into the thm gui new directory and click on thm gui svw

For details, please visit the main page of the SPEDAS GUI. From this point, you should be able to load data and execute data analysis through the GUI.

Section 2
How to use a database of data information for solar and atmospheric data (IUGONET Type-A)
2. How to use IUGONET Type-A

2.1 Access to IUGONET Type-A (http://search.iugonet.org)

Please access IUGONET Type-A from Internet browser with your own PC.
2. How to use IUGONET Type-A

2.2 Search data on the top window (list search)

You can restrict the search results by selecting the related instrument/project or inputting the keyword related to the data you want to know.
2. How to use IUGONET Type-A

2.2 Search data on the top window (map search)

The default is selected all the instruments. If you specify them, you exclude the check “All” and include the check for each instrument you want to know.

When you click the Cherry Blossoms, you can see brief information of the observation data.

You go to the detailed search page if you click the title of information of data.
2. How to use IUGONET Type-A

2.3 Search results (text)

You can exchange text into QL plot displays. If you click “Plot”, you can find the QL plots of each dataset.

List of the search results you want to know. If you click the title of each dataset, you go to the detailed search page.
2. How to use IUGONET Type-A

2.4 Search results (plot)

You can select three kinds of time range (1, 3, and 7 days). The default is 7 days.

Temperature profile obtained from the COSMIC RO data.

The start time of the QL plots corresponds to that of timespan you specify.

Solar surface image obtained from the solar terescope.
2. How to use IUGONET Type-A

2.4 Search results (plot) (specify EAR)

If you click the check box of “EA Radar” and click “search” button, the QL plots of FAI and lower stratosphere and troposphere data taken by EAR appear as shown in the left figure.

If you click the title of dataset, you go to the detailed search result.
2. How to use IUGONET Type-A

2.5 Detailed search results

From the detailed search results, you can know valuable information of the data you want to know.

You can change the start time of QL plot and time intervals (1, 3, or 7 days).

Scroll down
2. How to use IUGONET Type-A

2.5 Detailed search results

Data description
This information is very helpful for writing scientific papers.

Data use policy

Contact person
From this information, you can easily contact the data PIs.

Information of instrument
This description is also very helpful for writing scientific papers.

Data location and format
You can direct access the webpage of observation data.

- **Description:** The 10-minute average observation data in the equatorial troposphere (2-30 km) taken by the equatorial atmosphere radar (EAR) at Crotobang, Indonesia (0.203E, 100.320N, 656m MSL), which has been operated in the standard observation mode of the troposphere and stratosphere. The data are stored in the netCDF file (Network Common Data Form) named (year)(month)(day).nc.
  - The netCDF file includes the range, height, time, three components of wind velocity, radial Doppler velocity, echo power, spectral width and noise level for each beam number and so on. The azimuth and zenith angles of beam 1, 2, 3, 4 and 5 are (0, 0), (0, 10), (0, 10), (10, 10) and (200, 10), respectively, in unit of degree. The value of 1.0e-10 means missing data.
- **Acknowledgement:** If you acquire EAR data, we ask that you acknowledge us in your use of the data. This may be done by including text such as EAR data provided by Research Institute for Sustainable Humanosphere of Kyoto University.

**Access Information:**
- **URL:** [http://www.rish.kyoto-u.ac.jp/ear/data/index.html](http://www.rish.kyoto-u.ac.jp/ear/data/index.html)
- **Availability:** Online
- **Access Rights:** Open
- **Format:** NetCDF

**Measurement Type:** Profile

**Time Span:**
- **Start Date:** 2001-06-20T17:00:00
- **Stop Date:** -

**Observed Region:**
- Earth.NearSurface.Atmosphere
- Earth.NearSurface.Stratosphere
- Earth.NearSurface.EquatorialRegion

**Keywords:** EARTH SCIENCE Atmosphere Atmospheric Winds Wind Profiles

**Instrument:**
- **Name:** Equatorial Atmosphere Radar (EAR)
- **Description:** The EAR is a large Doppler radar built for atmospheric observation at the equator in West Sumatra, Indonesia (0.203E, 100.320N, 656m MSL). The construction was completed in March 2001, with collaboration between RISH, Kyoto University and the National Institute of Aeronautics and Space of Indonesia (LAPAN) of Indonesia. The EAR has a circular antenna array of approximately 110 m in diameter, which consists of 563 three-element Yagis. It is an active phased array system with each Yagi driven by a solid-state transceiver module. This system configuration makes it possible to direct the antenna beam by electronic control up to 5000 times per second. The EAR transmits an intense radar wave of 47 MHz to the sky and receives extremely weak echoes scattered back by atmospheric turbulence. It can observe winds and turbulence in the altitude range from 2 km to 20 km (troposphere and lower stratosphere). It can also observe echoes from ionospheric irregularities at heights higher than 40 km.
2. How to use IUGONET Type-A

2.5 Detailed search results

Information of observatory
This information is very helpful for writing scientific papers.

Information of basic commands of SPEDAS (CUI)
Load and plot the data.

Information of advanced commands of SPEDAS
Customize the data plot, and conduct the advanced analysis.

Information of flow chart of SPEDAS (GUI)
Load, and plot the data.

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Observatory:
Name: Equatorial Atmosphere observatory at Kototabang
Description: The Equatorial Atmosphere observatory at Kototabang is located at the equator in West Sumetro, Indonesia (0.20S, 100.32E, 885m MSL). In this site, various kinds of instruments (for example, boundary layer radar (BLR), equatorial atmosphere radar (EAR) and meteor wind (MW) radar) have been installed, which measure the equatorial atmosphere including the troposphere, lower stratosphere, upper mesosphere, thermosphere and ionosphere.

Related: MetadataContact
ISH Metadata Management Group, Research Institute for Sustainable Humanosphere (RISH), Kyoto University, iugonet@ish.kyoto-u.ac.jp

Location:
ObservatoryRegion: Earth.Surface
CoordinateSystemName: WGS84
Latitude: -0.204
Longitude: 100.320

Observed Data:

How to Plot (SPEDAS-CUI #Basic):
DL> thm_init
HERMS> timespan, ['2012-03-04 00:00:00', '2012-03-11 00:00:00']
HERMS> lsmдуш_dt = troposphere
HERMS> tplot, ['lsm düş _trop_vwnd', 'lsm düş _trop_vwnd', 'lsm düş _trop_pwl1', 'lsm düş _trop_wdl1', 'lsm düş _trop_pnl1']

How to Plot (SPEDAS-CUI #Advanced /*Quick-Look was created with this command*/):
DL> thm_init
HERMS> timespan, ['2012-03-04 00:00:00', '2012-03-11 00:00:00']
HERMS> lsm düş_dt = troposphere
HERMS> ylim, 'lsm düş _trop_vwnd', 0, 20
HERMS> ylim, 'lsm düş _trop_vwnd', 0, 20
HERMS> ylim, 'lsm düş _trop_pwl1', 0, 20
HERMS> ylim, 'lsm düş _trop_wdl1', 0, 20
HERMS> ylim, 'lsm düş _trop_pnl1', 0, 20
HERMS> ylim, 'lsm düş _trop_pnl1', 0, 20
HERMS> ylim, 'lsm düş _trop_pnl1', 40, 80
HERMS> ylim, 'lsm düş _trop_pnl1', -20, 20
HERMS> ylim, 'lsm düş _trop_pnl1', 20, 20
HERMS> ylim, 'lsm düş _trop_pnl1', 2, 2
HERMS> ylim, 'lsm düş _trop_pnl1', 2, 2
HERMS> ylim, 'lsm düş _trop_pnl1', 20, 100
HERMS> ylim, 'lsm düş _trop_pnl1', 0, 5
HERMS> tplot_options, region, [0.05, 0, 1, 1]
HERMS> tplot, ['lsm düş _trop_vwnd', 'lsm düş _trop_vwnd', 'lsm düş _trop_pwl1', 'lsm düş _trop_wdl1', 'lsm düş _trop_pnl1']

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: 'Equatorial_Atmosphere_Radar'.
Step 7: Choose Data Type: 'troposphere', Site or parameter(s): 1: "(all)" and parameter(s): 2:
Step 8: 'vwnd', 'vwnd', 'vwnd', 'vwnd', 'vwnd', 'vwnd', 'vwnd', 'vwnd'.
Step 9: Push [+] button. (Please wait a few minutes).
Step 10: Push [Done] button.
Step 11: Choose [Graph] -> [Plot Layout Options].
2.6 Exercise (2.2～2.5 items)

You try to search various kinds of ground-based observation data related to equatorial atmosphere with IUGONET Type-A.

For example, automatic weather station (AWS), wind profiler radar, EAR, radiosonde etc.

If you have some time, please try to search other datasets (solar, geomagnetic field, ionospheric plasma, air glow etc.)

Time limit: 15 – 20 minutes

If you have any questions and suggestions on this exercise and IUGONET Type-A, please let me know them.
Section 3
How to use an integrated data analysis software: SPEDAS
3. How to use SPEDAS

3.0 Contents in this section

- To Learn a basic use of SPEDAS-GUI
  1. Start of the GUI tool
  2. Load data
  3. Plot loaded data
  4. Output the plot image file
  5. Save the loaded data
  6. Save the working contents
  7. Customize the plot
  8. Simple data analysis (average, filter, FFT, wavelet etc.)

- Data set
  - EAR, meteor/MF radar, radiosonde, AWS, WPR etc.
  - Various kinds of upper atmospheric data from IUGONET
3. How to use SPEDAS

3.1 Download and installation of SPEDAS GUI tool

1. Access the SPEDAS homepage


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 the SPEDAS executables, Version 3.1.1 (October 2018, minor refresh January 2019)

Note: In January 2019, we created new executable files (spedas version 3.1.1). However, the only change is the correction of a single bug in the executables, the underlying spedas code remains that of October 2018.

For users without IDL licenses, you can use the SPEDAS 3.1.1 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 3.1.1, Windows 64bit executable with IDL 8.5.1, CDF 3.6.3.1, Geonack 10.5 (78 MB)
- SPEDAS 3.1.1, MacOS 64bit executable with IDL 6.5.1, CDF 3.6.3.1, Geonack 10.5 (71 MB)
- SPEDAS 3.1.1, Linux 64bit executable with IDL 6.5.1, CDF 3.6.3.1, Geonack 10.5 (70 MB)
- SPEDAS 3.1.1, Linux 64bit executable with IDL 6.5.1, CDF 3.6.3.1, Geonack 7.6 (70 MB) - includes Geonack 7.6, for older Linux machines that have problems with Geonack 9.4

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

Download the SPEDAS save file, Version 3.1.1 (October 2018, minor refresh January 2019)

Note: In January 2019, we created a new save file (spedas version 3.1.1). However, the only change is the correction of a single bug, the underlying spedas code remains that of October 2018.

The SPEDAS save file requires the run-time IDL Virtual Machine (VM) which has to be downloaded for free from http://idl.active�.com/products/idl

- SPEDAS 3.1.1, IDL Savefile (20 MB)

To run SPEDAS using the IDL virtual machine,

1. start the IDL virtual machine executable
2. click through the splash screen to get to the file selection dialog
3. navigate to the SPEDAS installation
4. go into the thm_gui_new directory and click on thm_gui.sav

This should bring up the main screen of the SPEDAS GUI. From this point you should be able to load, plot, and analyze your data.

Further information for loading IDL save files can be found here: http://horricesgospedas.com/docs/StartingVirtualMachineApplication.html

2. Click the proper link for your OS. The compressed executable file will be downloaded in several seconds or minutes.
3. How to use SPEDAS

3.2 Start of SPEDAS GUI tool


[2] Click the executable file named ‘spedas’ stored in the directory ‘spd_gui’.

Click the executable file named ‘spedas’

[3] Because the IDL Virtual Machine window appears on your PC, you should click the icon ‘spd_gui’.

Click the icon ‘spd_gui’.
3. How to use SPEDAS

3.3 Start of SPEDAS GUI tool

Does this window appear?

If the SPEDAS GUI starts normally, this window appears immediately.
3. How to use SPEDAS

3.4 Load and plot the EAR data

You can create the plots of the EAR data through only 12 steps!

1. Start SPEDAS GUI Program.
2. Choose [Data] -> [Load Data from Plug-in].
4. Uncheck 'Use Single Day'.
5. Set Start Time: '2012-03-04 00:00:00' and Stop Time: '2012-03-11 00:00:00'.
6. Choose Instrument Type: 'Equatorial_Atmosphere_Radar'.
7. Choose Data Type: 'troposphere', Site or parameter(s)-1: '*(all)' and parameter(s)-2: 'uwnd','vwnd','wwnd','pwr1','wdt1','dpl1','pn1'.
8. Push [->] button. (Please wait a few minutes).
11. Choose 'iug_ear_trop_uwnd', 'iug_ear_trop_vwnd', 'iug_ear_trop_wwnd', 'iug_ear_trop_dpl1', 'iug_ear_trop_pwr1', 'iug_ear_trop_wdt1', 'iug_ear_trop_pn1' and push [Line-] button.
3. How to use SPEDAS

3.4 Load and plot the EAR data

Start of Load Data Window with the following method.

(1) Click the icon “Load Data”.

(2) Select “Data” → “Load Data from Plug-in”.

(1) Click the icon “Load Data”.

(2) Select “File” → “Load Data”.
3. How to use SPEDAS

3.4 Load and plot the EAR data

[5] To select the data name you want to load on the Load Data Window

(1) Click the tab “IUGONET”

(2) Enter Start/Stop Time
   【from 2012-03-04/00:00:00 to 2012-03-11/00:00:00】
   ※If you load the data during several days, you have to remove the check ”Use Single Day”.

(3) Select instrument.
   【Select ”Equatorial_Atmosphere_radar”】
3. How to use SPEDAS

3.4 Load and plot the EAR data

[5] To select the data name you want to load on the Load Data Window

(4) Select several kinds of data parameters

【Select “troposphere”, “*(all)”, and “uwnd”, “vwnd”, “wwnd”, “pwr1”, “wdt1”, “dpl1”, “pn1” 】

※If you select several parameters at the same time, you select them with +ctrl or +shift key.
3.4 Load and plot the EAR data

To select the data name you want to load on the Load Data Window:

Click this icon. After the click, the load of selected data starts.
3. How to use SPEDAS

3.4 Load and plot the EAR data

After you carefully read “Rules of Data Use” described on a new window, please click the button “OK”.

This window appears only when you loaded the data obtained from each instrument in the first time after the start of this software.

If you push the cancel button, the data load stops and you cannot go ahead of data analysis.

Click “OK”.

(2019-02-21/12:18:49) 7. Time range is longer than One Week.
3. How to use SPEDAS

3.4 Load and plot the EAR data

[7] Please confirm whether the loaded data appear in the right box “Data Loaded” or not.

Click “Done”.

Loaded data names appears in this box ”Data Loaded”.

Note: # means that the load procedure has been developed in collaboration with the ERG Science Center.
3. How to use SPEDAS

3.4 Load and plot the EAR data

You open the “Plot/Layout Options Window” with one of the two following methods:

1. Click the icon “Plot Data”.
2. Select “Graph” → “Plot/Layout Options”.

(1) Click the icon “Plot Data”.

(2) Select “Plot” → “Plot/Layout Options”.
3. How to use SPEDAS

3.4 Load and plot the EAR data

[9] To set up the layout of plot on the window “Plot/Layout Options”.

(1) Click "iug_ear_trop_uwnd".

(2) Click “Spec ->”

(3) Selected data appear in this box.

(4) Finally, you click the “OK” button, and close this window.
3. How to use SPEDAS

3.4 Load and plot the EAR data

You can change the display size of the plot.

[10] The height-time plot appears in the main window as shown in the right figure.

[11] If you add make another kind of data plot, you open the window “Plot/Layout Options” again.
3. How to use SPEDAS

3.4 Load and plot the EAR data

[11] If you add make another kind of data plot, you open the window “Plot/Layout Options” again.
3. How to use SPEDAS

3.4 Load and plot the EAR data

[12] To add the new plot data with the following procedure:

1. Click “iug_ear_trop_vwnd”.
2. Click “Spec ->”.
3. Selected data appear in this box.
4. Finally, you click the ”OK” button and close this window.
3.4 Load and plot the EAR data

If you succeed in adding another plot of meridional wind, this plot appears below that of zonal wind.

You can change the display size of the plot.
3. How to use SPEDAS

3.5 Output of plot image file

[13] In order to output the plot image file, you select “File” → “Save Page As Image File…” on the main window.

[14] Specify the file format, name and save location and click the “SAVE” button on the Save Image window.

Select “File” → “Save Page As Image File…”.

Specify the directory

Select the saved format

Input file name

Click “SAVE” button.
3. How to use SPEDAS

3.5 Output of plot image file

Conformation window

If you go back to the previous window, please click here.

Click “Save”

If you click “Options…”, another window appears like this. In this window, you can change the resolution of the image data.
3. How to use SPEDAS

3.6 Save the EAR data in ascii (text) format

[15] If you save the loaded data in ascii format, you first select “Data” → “Save Data As...” on the main window.

[16] You specify several items on the “Save Data As” window as shown in the right figure, and click the “Save” button after you check “Save as ASCII data file”.

[17] You click the “OK” button in this window.

(1) Select the data you want to save in the “Loaded Data” box.

(2) Enter the check into “Sava as ASCII data file” and change the items in this box if necessary.

(3) You click “Save” button.
3.6 Save the EAR data in ascii (text) format

1. Specify the directory where you want to save the file.
2. Input file name:
   - Click “SAVE” button.
3. When you successfully save the data in ASCII format, another window appears.
   → Click “OK” button.
3. How to use SPEDAS

3.7 Customize the data plot (change the plot time range)

If you click this icon, you can change the plot time range.

To shorten the time range.
To extend the time range.
To shift the plot time range behind.
To shift the plot time range forward.
3. How to use SPEDAS

3.7 Customize the data plot (change the plot time range)

Select Fixed Range.

Input the time value of 2012-03-05/00:00:00 and 2012-03-07/00:00:00 into the Min and Max boxes, respectively, and click the “Apply to All Panels” button.

Click “OK” button.
3.7 Customize the data plot (change the plot time range)

The time range change 7 days into 2 days.
3. How to use SPEDAS

3.7 Customize the data plot (change the time ticks)

You can freely customize the plot Tick on the Ticks tab.

Select Major Tick By Interval and change the Major Tick Every into 24 hours.

You specify the # of Minor Ticks as 24. That is, 24 Minor Ticks are represented in 1 hour.

Finally, you click "Apply to All Panels" → "OK".
3. How to use SPEDAS

3.7 Customize the data plot (change the time format)

You can change the time format on the Annotation tab.

Select "mo:day:h:m" in the pull-down menu of the Annotation Format.

Click Apply to All Panels → OK

If you want to change the character font and size, you select your favored format in the pull-down menu of Font.

Specify the character size from "Size".

Selectable format: Courier, Helvetica, Times
3. How to use SPEDAS

3.7 Customize the data plot (change x-axis label)

You can customize the time label (X axis) on the Labels tab.

Select “Panel 2” which is the bottom panel.

You enter the check into the “Show Label” box, and enter “Universal Time” on the Edit/Add Label:

Click OK

(Note that you do not click Apply to All Panels)
3. How to use SPEDAS

3.7 Customize the data plot (results)

The format of x-axis is changed.
3. How to use SPEDAS

3.7 Customize the data plot (change the color bar format)

If you want to change Panel 2, you select Panel 2.

Enter check mark in this box with mouse click.

Input the wind velocity value of -10 and 10 into the Min and Max boxes, respectively, and click the “OK” button.

Finally, you click "Apply to All Panels" → "OK".
3. How to use SPEDAS

3.7 Customize the data plot (change the color bar format)

If you want to change Panel 1, you select Panel 1.

Change the title of z-axis “dpl1!C[dB]” into “uwnd!C[m/s]”, and click the “OK” button.
3. How to use SPEDAS

3.7 Customize the data plot (change the color bar format)

The format of color bar is changed.
3.8 Time-series analysis of the EAR data

Excise 1
Running average of zonal wind in the MLT region

[1] Click Analysis
[2] Click Data Processing
Then, the Data Processing window appears.
3. How to use SPEDAS

3.8 Time-series analysis of the EAR data


[4] By clicking the right arrow, the data you want to analyze enter the Active Data box.
You can analyze the data listed in this box using several analysis functions on the right side.
3. How to use SPEDAS

3.8 Time-series analysis of the EAR data

Click “Smooth Data... on the right side.

Smooth Data Options window appears.

On this window, you specify the running average time in the unit of second. In this case, since we calculate the 1-hour running average, the smoothing resolution is 3600.

After that, you click “OK”.

The 1-hour running average for iug_ear_trop_uwnd is calculated.
3. How to use SPEDAS

3.8 Time-series analysis of the EAR data

[5] If you successfully finish calculating the running-average, you can find the calculated valuable name in both the boxes.

[6] Please click “Done” button.
3. How to use SPEDAS

3.8 Time-series analysis of the EAR data

The running-average zonal wind data are plotted with the same method shown before.
You try to analyze various kinds of ground-based and satellite observation data with SPEDAS.

For example, automatic weather station (AWS), wind profiler radar, EAR, radiosonde etc.

If you have some time, please try to search other datasets (solar, geomagnetic field, ionospheric plasma, air glow etc.)

Time limit: 15 – 20 minutes

If you have any questions and suggestions on this exercise and SPEDAS, please let me know them.
4. Summary and conclusions

➢ The IUGONET project (http://www.iugonet.org) has been establishing a IUGONET web service (IUGONET Type-A) which combines a database of data information (metadata) and data analysis software (SPEDAS).

➢ This IUGONET Type-A is useful for researchers in efficiently finding and obtaining various kinds of observation data spread across the IUGONET institutes.

➢ The IUGONET Type-A and integrated data analysis software (UDAS) will significantly facilitate the analyses of a variety of observation data, which will lead to more comprehensive studies of coupling process in solar-terrestrial system (long-term variation in the Earth’s atmospheric environment) and interdisciplinary studies using different kinds of data.

➢ The IUGONET products have been released!

IUGONET Type-A : http://search.iugonet.org/
4. Summary and conclusions

➢ In order to enhance an international use of the IUGONET products and data for non IDL users, **we have a plan to develop the data analysis software working on other platforms (for example, MATLAB,...).**

➢ In near future, we will add several kinds of geoscience data in the web service (IUGONET Type-A).

Solar surface (Ca obs.) [NAOJ], GPS-TEC [Nagoya U/NICT]

➢ Recently, we developed a UDAS EGG (UDAS Easy Guide to Generate your load routines) to provide users with the templates for IDL procedures that can load their own data into SPEDAS/IDL.

➢ If you have any feedbacks, questions, requests on the IUGONET tool, please send email to the following:

   **E-mail iugonet-contact(at)iugonet.org**

You also check the IUGONET homepage (http://www.iugonet.org)
2. IUGONET data analysis system

2.7 IUGONET data analysis software (UDAS)

< Latest plug-in tools included in SPEDAS >

Plug-in tools stored in a bleeding edge of SPEDAS (2016/10/20)

- SPEDAS contains various kinds of project plug-in tools (iugonet, erg, ace, akebono, fast, wind etc.)
- ※rbsp and stereo are stored in another directory.
- We can load and plot various kinds of satellite data which are open in CDAWeb managed by NASA.
2. IUGONET data analysis system

2.7 IUGONET data analysis software (UDAS)

< Load command of UDAS/SPEDAS >

<table>
<thead>
<tr>
<th>No.</th>
<th>Instrument Type</th>
<th>Load routines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solar images obtained by the SMART telescope</td>
<td>iug_load_smart</td>
</tr>
<tr>
<td>2</td>
<td>Solar VHF/UHF radio spectrum</td>
<td>iug_load_iprt</td>
</tr>
<tr>
<td>3</td>
<td>Jupiter’s/Solar wide band spectral data in HF-band</td>
<td>iug_load_hf_tohokuu</td>
</tr>
<tr>
<td>4</td>
<td>Automatic weather station</td>
<td>iug_loadAws_rish</td>
</tr>
<tr>
<td>5</td>
<td>Boundary layer radar</td>
<td>iug_load_blr_rish</td>
</tr>
<tr>
<td>6</td>
<td>L-band lower troposphere radar</td>
<td>iug_load_ltr_rish</td>
</tr>
<tr>
<td>7</td>
<td>EAR (ST and FAI)</td>
<td>iug_load_ear</td>
</tr>
<tr>
<td>8</td>
<td>MU radar (MST, IS, Meter/RASS/FAI)</td>
<td>iug_load_mu</td>
</tr>
<tr>
<td>9</td>
<td>Meteor radar</td>
<td>iug_load_meteor_rish</td>
</tr>
<tr>
<td>10</td>
<td>MF radar</td>
<td>iug_load_mf_rish</td>
</tr>
<tr>
<td>11</td>
<td>Wind profiler radar</td>
<td>iug_load_wpr_rish</td>
</tr>
<tr>
<td>12</td>
<td>Ionosonde (Shigaraki)</td>
<td>iug_load_ionosonde_rish</td>
</tr>
<tr>
<td>13</td>
<td>Radiosonde</td>
<td>iug_load_radiosonde_rish</td>
</tr>
</tbody>
</table>

◆ 29 kinds of load commands are available.
◆ This package includes the statistical analysis and metadata cooperate tools.
◆ We have a plan to add the load routines of all-sky imager, riometer, VLF, and GPS-RO data to UDAS.
◆ (*) means alias of load command developed in ERG-SC.
2. IUGONET data analysis system

2.7 IUGONET data analysis software (UDAS)

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<thead>
<tr>
<th>No.</th>
<th>Instrument Type</th>
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</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>SuperDARN radar (*)</td>
<td>iug_load_sdfit (*)</td>
</tr>
<tr>
<td>15</td>
<td>EISCAT radar</td>
<td>iug_load_eiscat</td>
</tr>
<tr>
<td>16</td>
<td>EISCAT radar (ion velocity/electric field)</td>
<td>iug_load_eiscat_vief</td>
</tr>
<tr>
<td>17</td>
<td>Imaging riometer at Syowa</td>
<td>iug_load_irio_nipr</td>
</tr>
<tr>
<td>18</td>
<td>Low-frequency radio transmitter observation data</td>
<td>iug_load_lfrto</td>
</tr>
<tr>
<td>19</td>
<td>Asia VLF Observation Network (AVON/VLF-B)</td>
<td>iug_load_avon_vlfb</td>
</tr>
<tr>
<td>20</td>
<td>Optical Mesosphere Thermosphere Imagers (OMTI)</td>
<td>iug_load_camera_omti_asi (*)</td>
</tr>
<tr>
<td>21</td>
<td>All sky imager</td>
<td>iug_load_asi_nipr</td>
</tr>
<tr>
<td>22</td>
<td>All sky imager keogram</td>
<td>iug_load_ask_nipr</td>
</tr>
<tr>
<td>23</td>
<td>Geomagnetic index (AE, Dst, ASY/SYM) and WDC geomagnetic field data</td>
<td>iug_load_gmag_wdc</td>
</tr>
<tr>
<td>24</td>
<td>Magnetometer network data at Syowa, Ice land and Antarctica</td>
<td>iug_load_gmag_nipr</td>
</tr>
<tr>
<td>25</td>
<td>210 Magnetic Meridian magnetometer network data (*)</td>
<td>iug_load_gmag_mm210 (*)</td>
</tr>
<tr>
<td>26</td>
<td>MAGDAS geomagnetic field data</td>
<td>iug_load_gmag_magdas_1sec (*)</td>
</tr>
<tr>
<td>27</td>
<td>STEL induction magnetometer data (*)</td>
<td>iug_load_gmag_stel_induction (*)</td>
</tr>
<tr>
<td>28</td>
<td>Syowa and Ice land induction magnetometer</td>
<td>iug_load_gmag_nipr_induction</td>
</tr>
<tr>
<td>29</td>
<td>Kyushu GCM simulation data</td>
<td>iug_load_kyushugcm</td>
</tr>
</tbody>
</table>
2. IUGONET data analysis system

2.8 Outreach activities of the IUGONET project

In order for many research communities to use the IUGONET data analysis service (IUGONET Type-A and UDAS) as an essential e-infrastructure to investigate long-term variation in the upper atmosphere, an outreach activity is very important.

- Mini-training of how to use the IUGONET MDB system and data analysis software (UDAS)

- 2011/03/27-28 : NARL, India
- 2012/08/27-30 : LAPAN, Bandung, Indonesia
- 2013/01/12 : Online lecture (RISH-LAPAN)
- 2013/02/11 : Online lecture (RISH-LAPAN)
- 2014/11/13-15 : SPL/NARL, India
- 2015/10/21-22 : LAPAN, Bandung, Indonesia

Mini-training of the IUGONET data analysis at LAPAN on Oct. 21-22, 2015
2. IUGONET data analysis system

2.8 Outreach activities of the IUGONET project

● **Online tutorial movies**
  Researchers can learn how to use IUGONET MDB and data analysis software anytime online at the IUGONET’s YouTube site.

● **Updating Web page**

● **IUGONET mailing list**
  Users registered to the IUGONET mailing list can get all the latest IUGONET-related information about new releases of UDAS and IUGONET data analysis service, workshops, and so on.

● **IUGONET pamphlet**
2. IUGONET data analysis system

2.10 Example of upper atmospheric researches

We are promoting several scientific researches in order to evaluate the IUGONET products and to introduce a good example of application of solar-terrestrial physics researches.

- **Evaluation of the IUGONET products**
  - To modify interface, and to add new functions to the IUGONET system.

- **Examples of application of solar-terrestrial physics researches**
  - To acquire researchers to use the IUGONET data analysis system for long-term variation in solar-terrestrial physics.

**Examples of upper atmospheric researches using the IUGONET products**

- Influence of solar EUV radiation on upper atmosphere based on solar image data analysis [Kyoto and Nagoya Univ.]
- Long-term variation of upper atmosphere as seen in the geomagnetic solar quiet daily variation [Kyoto and Nagoya Univ.]
- Geomagnetic field variation and ionospheric disturbance dynamo during geomagnetic storms [Kyoto and Nagoya Univ., NIPR]
- Long-term variation in the MLT winds and wave activity [Student education, Kyoto Univ.]
2. IUGONET data analysis system

2.10 Example of upper atmospheric researches

Long-term variation in the amplitude of geomagnetic field variation

○ Using the IUGONET data analysis system, we can easily handle the long-term observation data.

○ In this case, the size of geomagnetic field variation depends on solar activity.