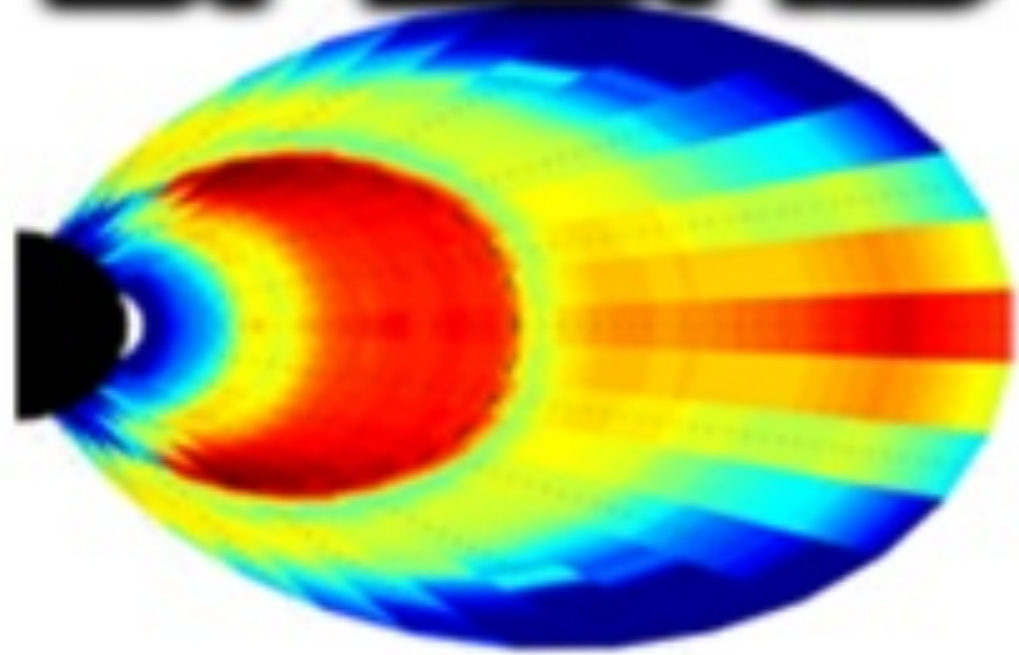


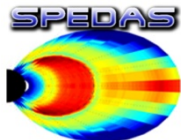


# SPEEDAS



## SPEEDAS Tutorial

GEM 2018, Santa Fe, NM



# Agenda



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## SPEDAS Tutorial

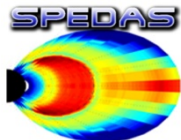
Opening remarks

SPEDAS development status

New features, plugin status updates

Live demo: HAPI, Autoplot, GUI plot templates

Q&A, discussion



# What is SPEDAS?

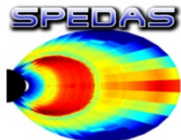


## Space Physics Environment Data Analysis Software (SPEDAS)

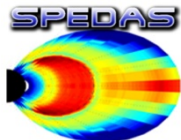
- Grass-roots data analysis software for Space Physics Community
- SPEDAS is an outgrowth of THEMIS / ARTEMIS code that has been extended to support multiple missions
- Standardizes retrieval of data from distributed repositories
- Science processing and graphics contain powerful set of legacy routines.
- The THEMIS mission is now served through the TDAS plugin

### The SPEDAS framework:

- Contains a GUI for ease of use (available through IDL VM freeware)
- Command line provides full access to IDL (paid license only)
- Works with Windows, Linux and Mac OS X.
- Is based on IDL, benefiting from platform independence and software maintenance services.



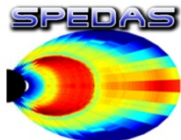
- What is the current status of SPEDAS development?
  - SPEDAS 3.0 was released in April, 2018, and includes these recently added features:
    - New plugin for Spherical Elementary Currents System (SECS) allows loading of EICS (Equivalent Ionospheric Currents) and SECA (SEC amplitudes) data, as well as plotting over THEMIS ASI mosaic maps.
    - New plugin for DSCOVR mission, including data loading, overview plots, and line plots with shaded confidence intervals.
    - Updates to ERG, IUGONET, THEMIS, and MMS plugins
    - Improved HTTPS support for digest authentication, and significant performance improvements when creating large numbers of new TPLOT variables.
    - Support for downloading data via the Heliophysics Application Program Interface (HAPI)
    - Preliminary support for exporting data from SPEDAS to Autoplot
    - Support for saving tplot variables as ISTP-compliant CDFs (tplot2cdf)



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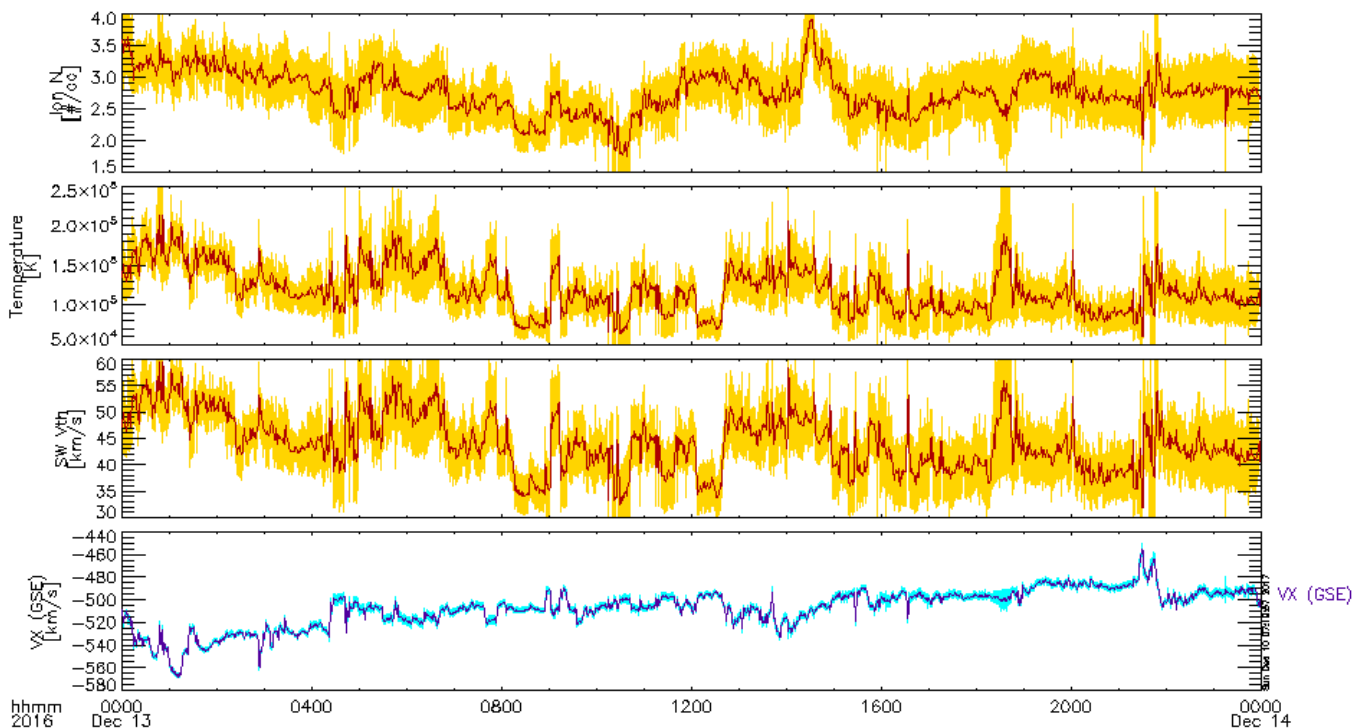
# ERG (Arase) Project

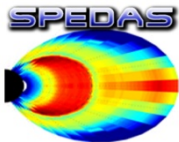
Mariko Teramoto



# DSCOVOR confidence interval plot, from projects/dscovr/examples/dsc\_crib.pro:

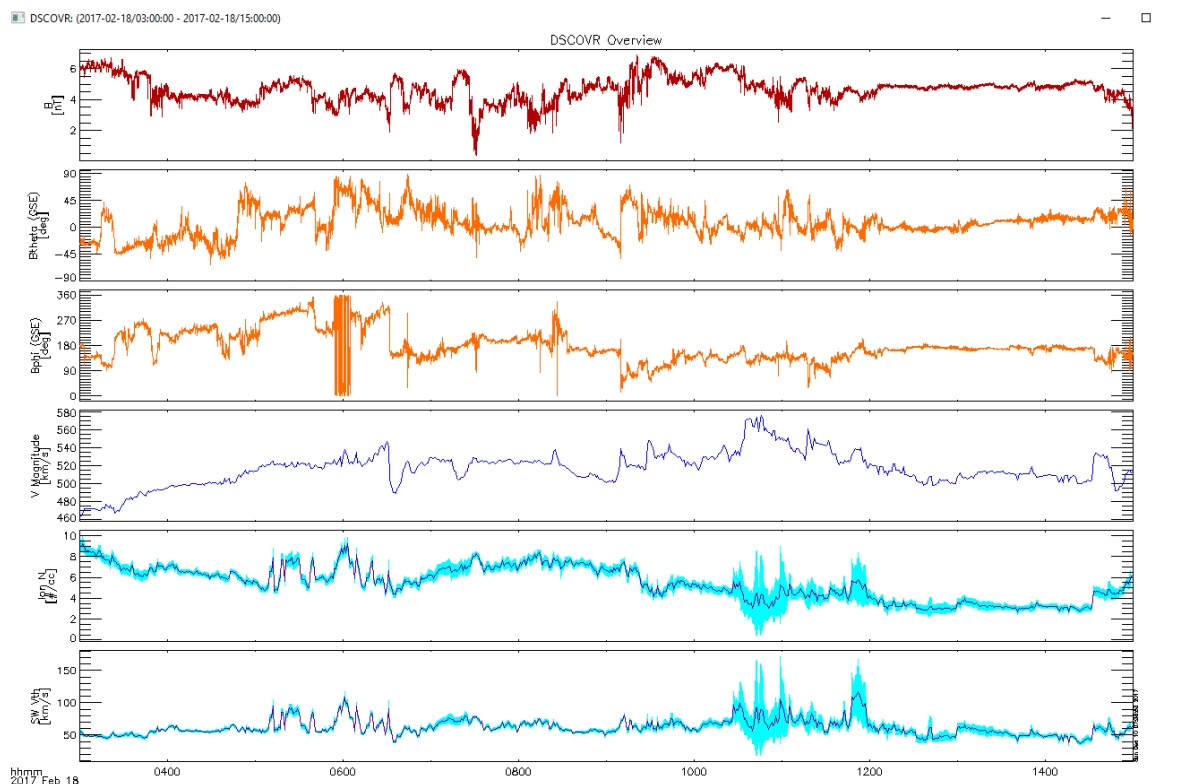
```
tplot,  
['dsc_h1_fc_Np', 'dsc_h1_fc_THERMAL_TEMP', 'dsc_h1_fc_THERMAL_SPD', 'dsc_h1_fc_V_GSE_x'] ; aka [25,26,24,27]  
dsc_dyplot
```



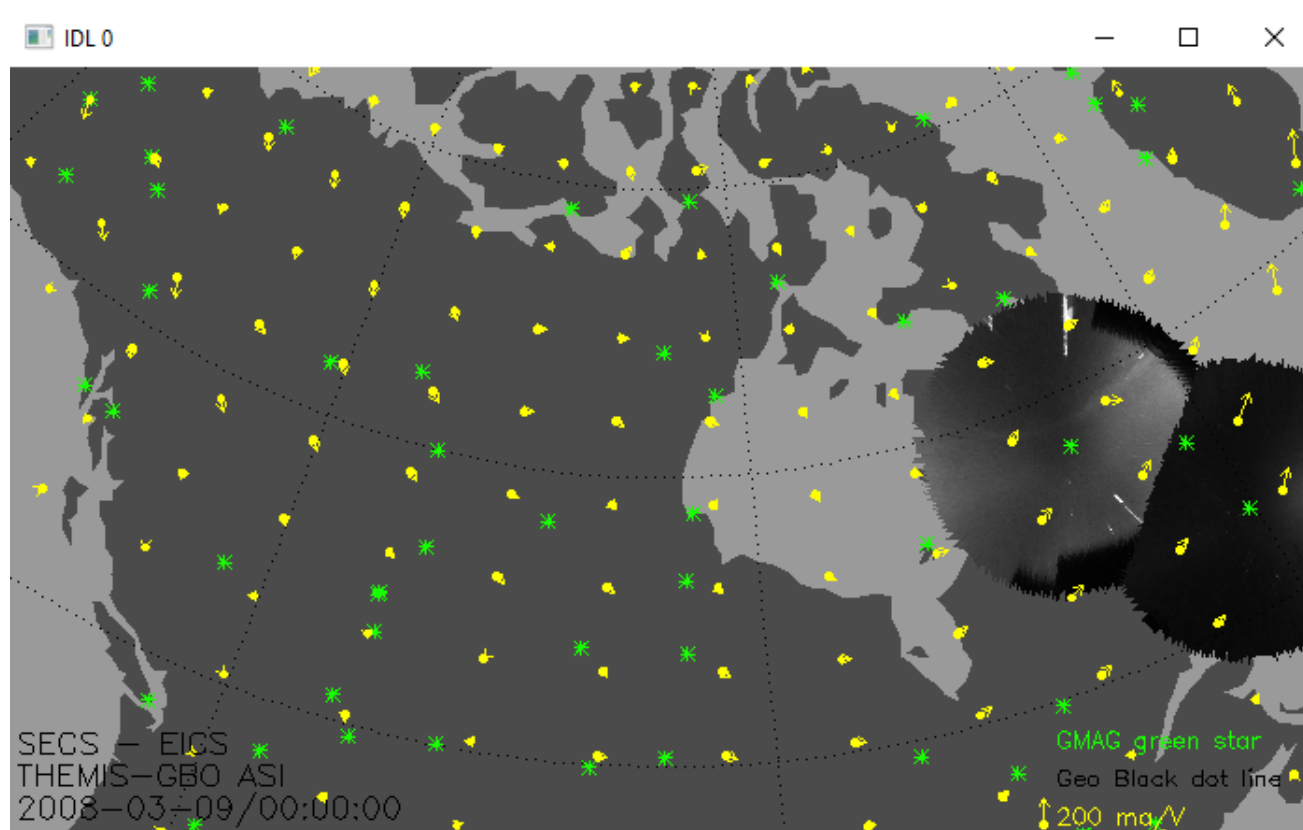


## DSCOVr overview plot (dsc\_crib.pro)

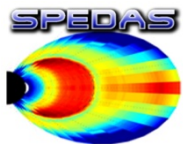
```
trg = timerange(['2017-02-18/03:00:00', '2017-02-18/15:00:00'])  
dsc_overview, trange=trg ; Overview for a given timerange  
dsc_overview_mag, trange=trg ; Overview of Magnetometer data  
dsc_overview_fc, trange=trg ; Overview of Faraday Cup  
data
```



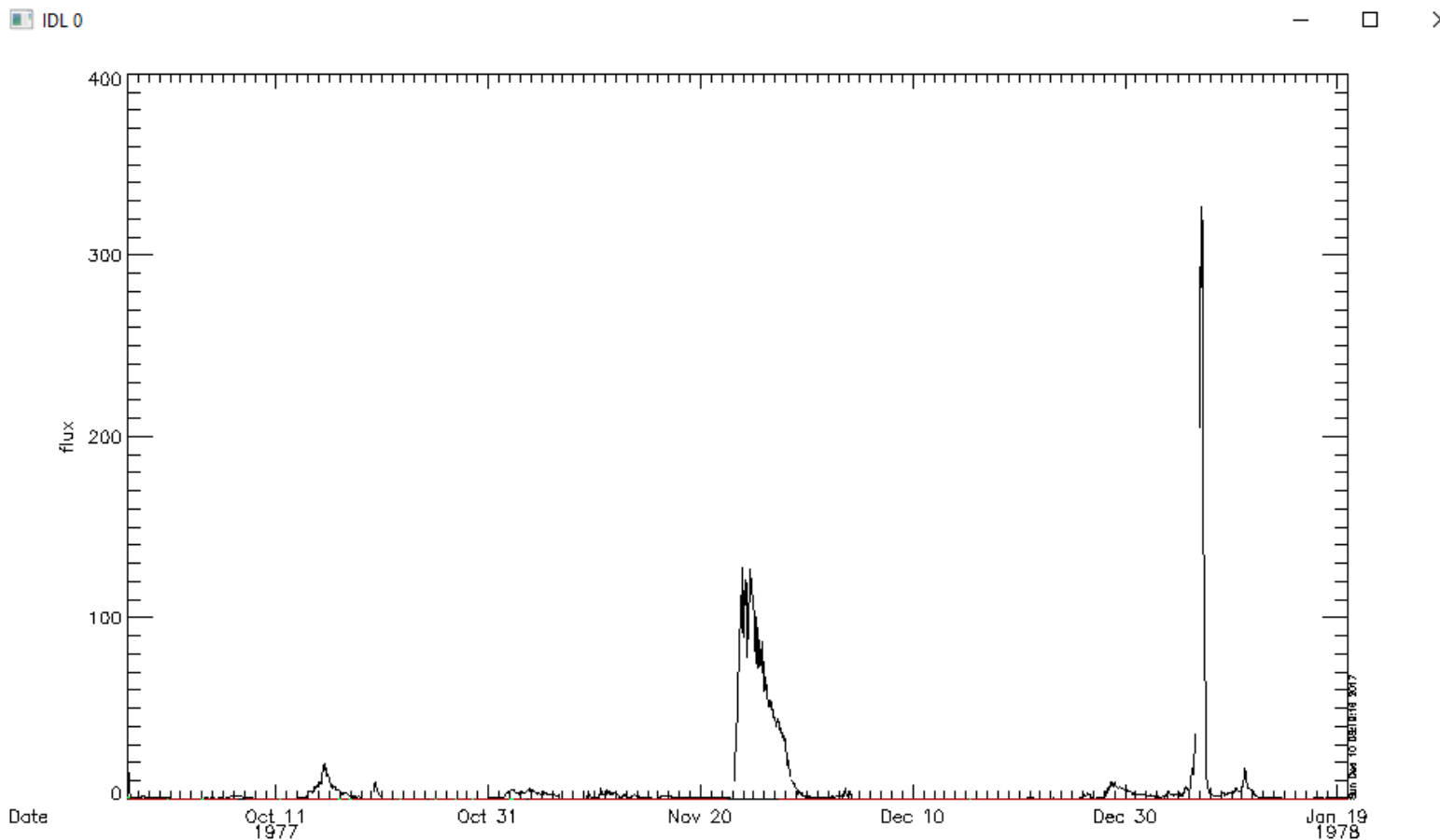
## SECS ASI Mosaic plot (projects/secs/examples/ secs\_mosaic\_plot\_crib)





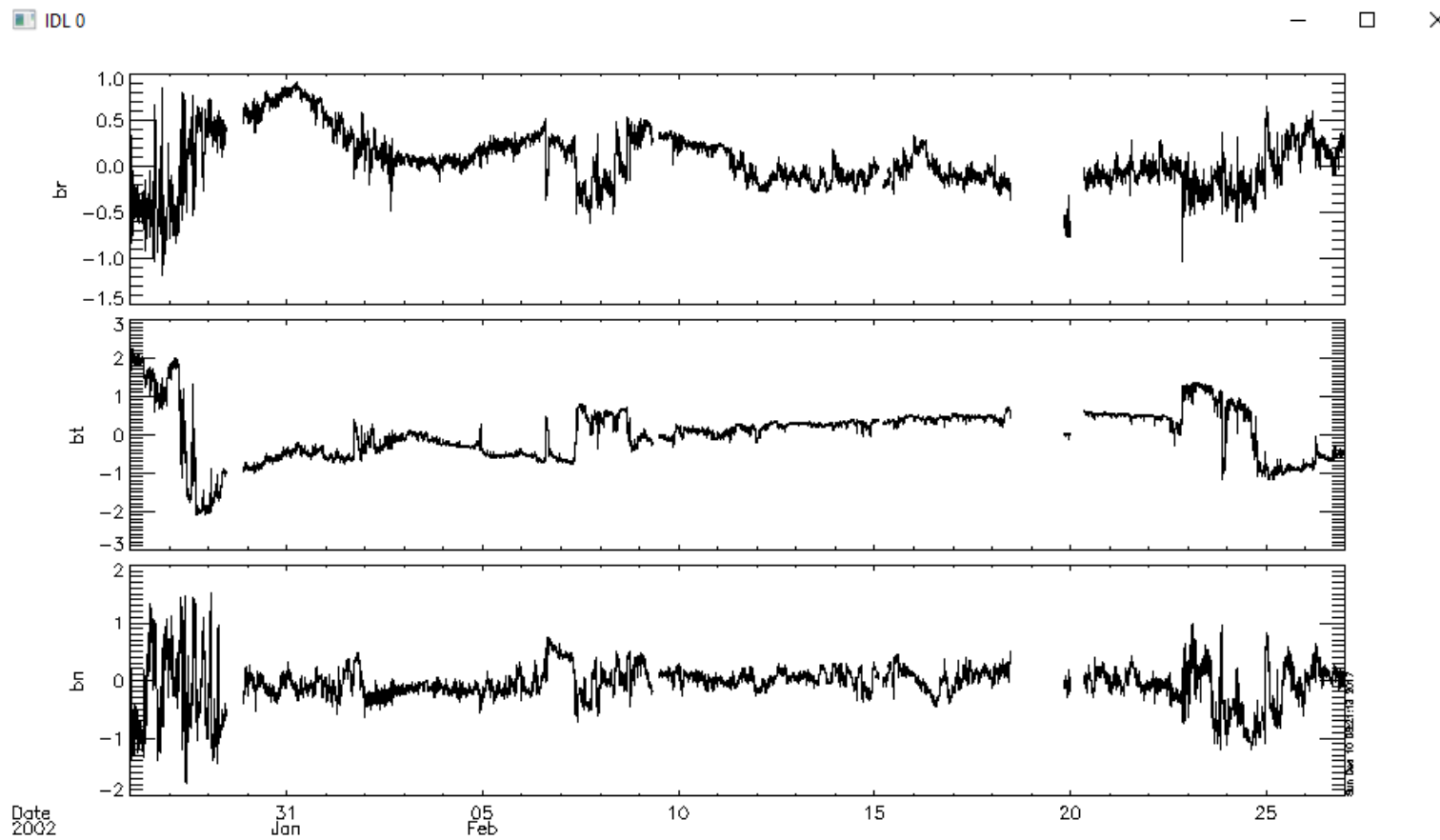


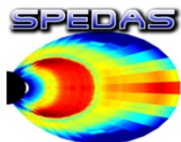
Voyager 1 proton flux via Heliophysics API (HAPI), from `idl/general/crib_hapi.pro`:



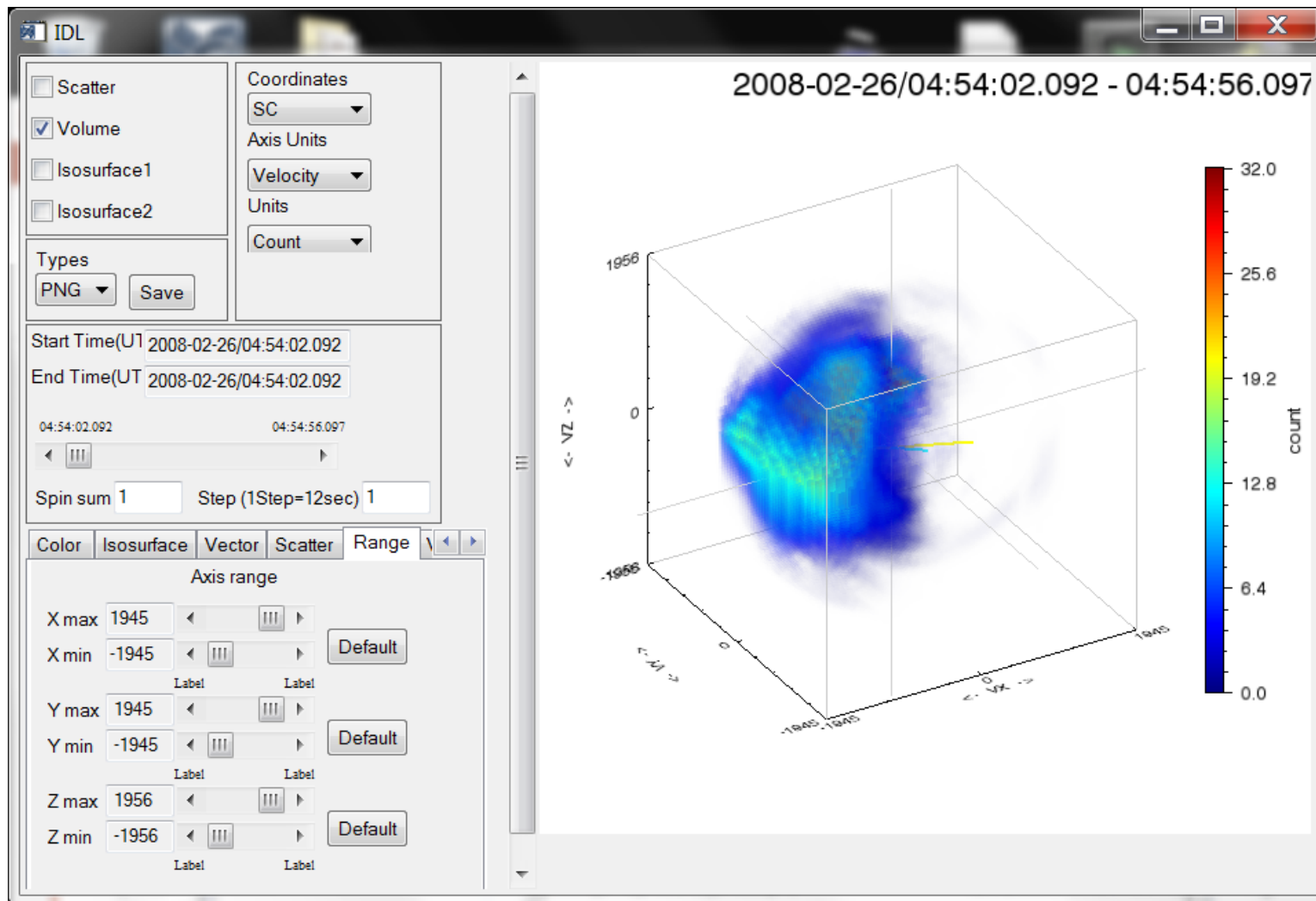


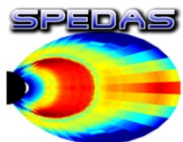
Cassini mag data via Heliophysics API (HAPI), from `idl/general/crib_hapi.pro`:





# ISEE 3D settings panel (using THEMIS data)

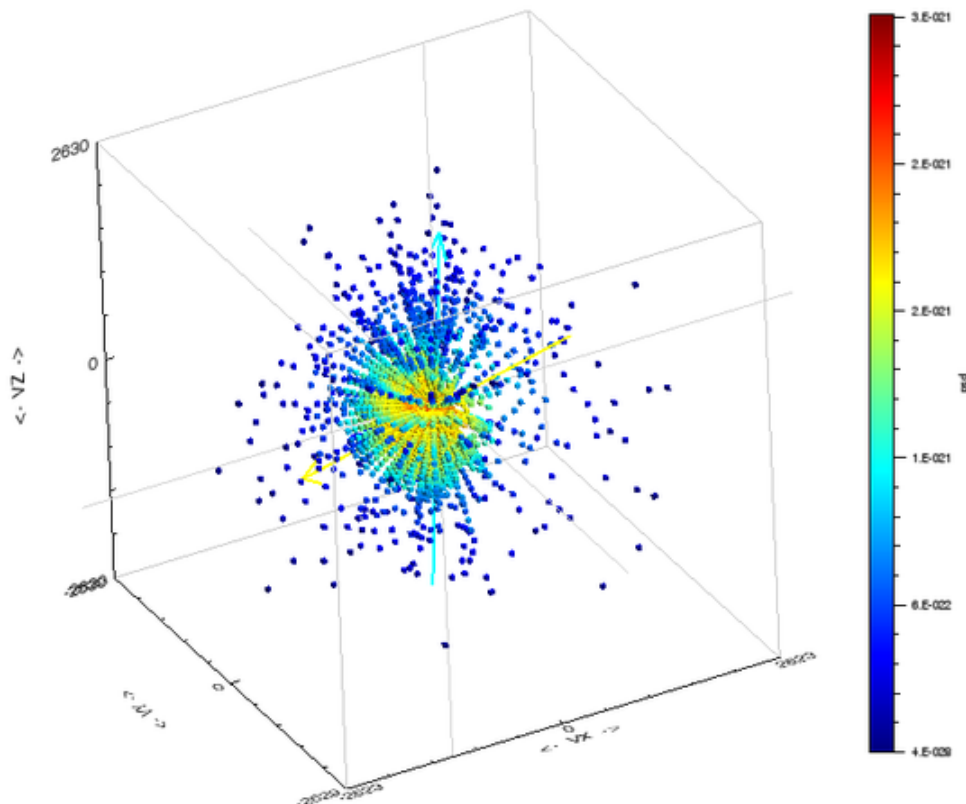


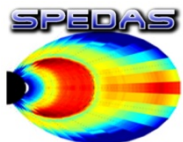


# ISEE 3D: MMS FPI ion scatter plot



2015-10-20/05:56:35.957 : velocity

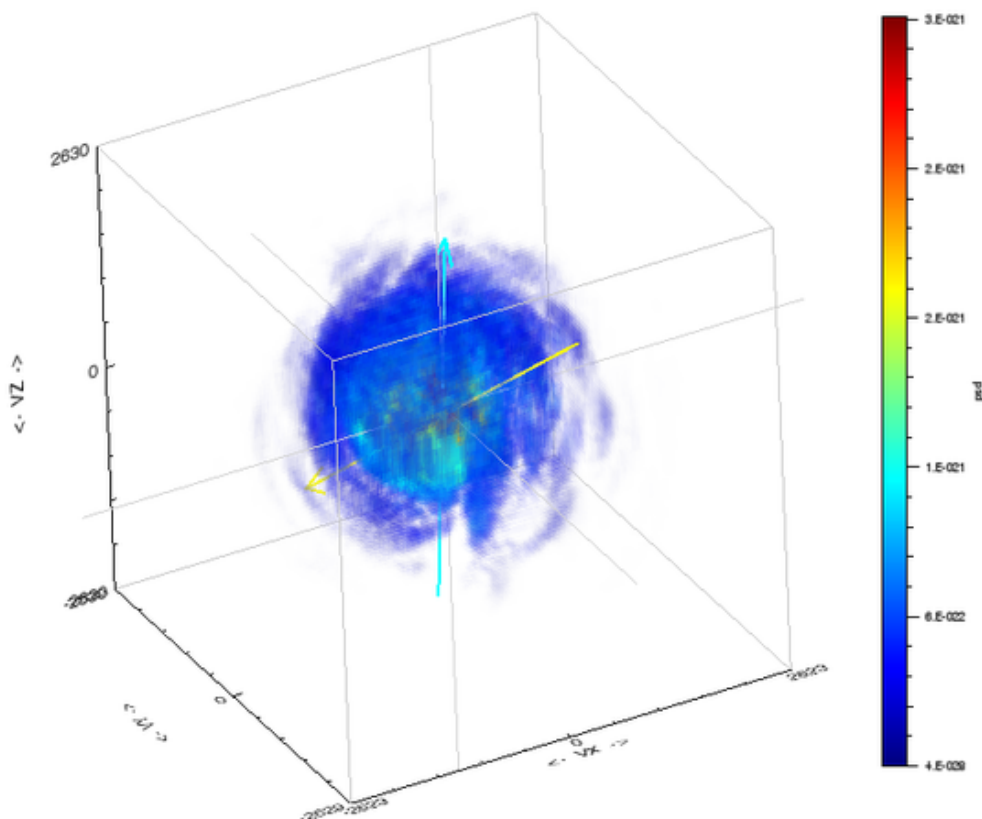


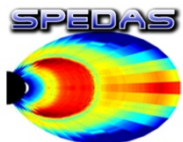


# ISEE 3D: MMS FPI ion volume plot



2015-10-20/05:56:35.957 : velocity

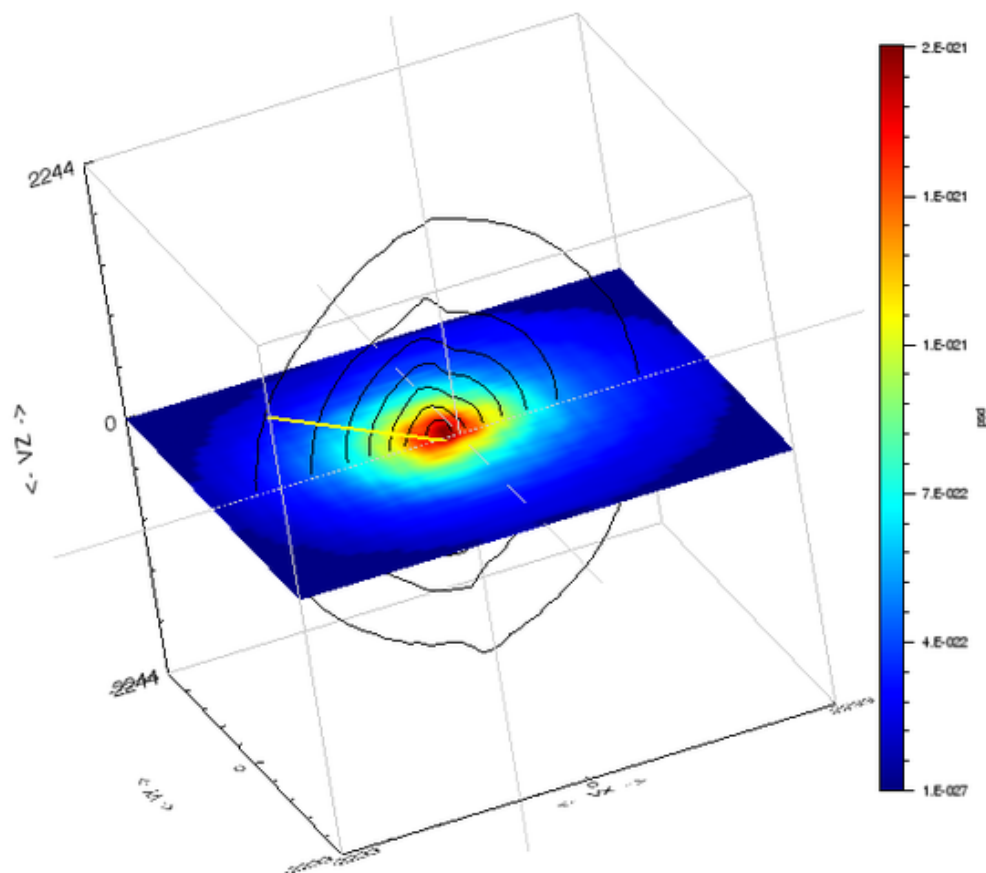


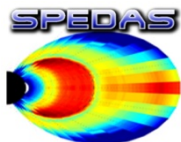


# ISEE 3D: MMS FPI ion contours



2015-08-15/12:50:03.923 - 12:50:57.923 (velocity)





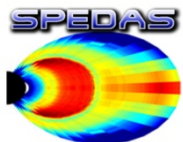
# Loading CDAWeb Data



## To Load CDAWeb Data:

- Select 'Load Data using CDAWeb' under the File menu
- Select Mission Group (i.e., TWINS, Cluster, RBSP, etc.)
- Select the Instrument Type
- Click 'Find Datasets'
- Select variable or dataset to download
- Click 'Get CDAWeb Data'

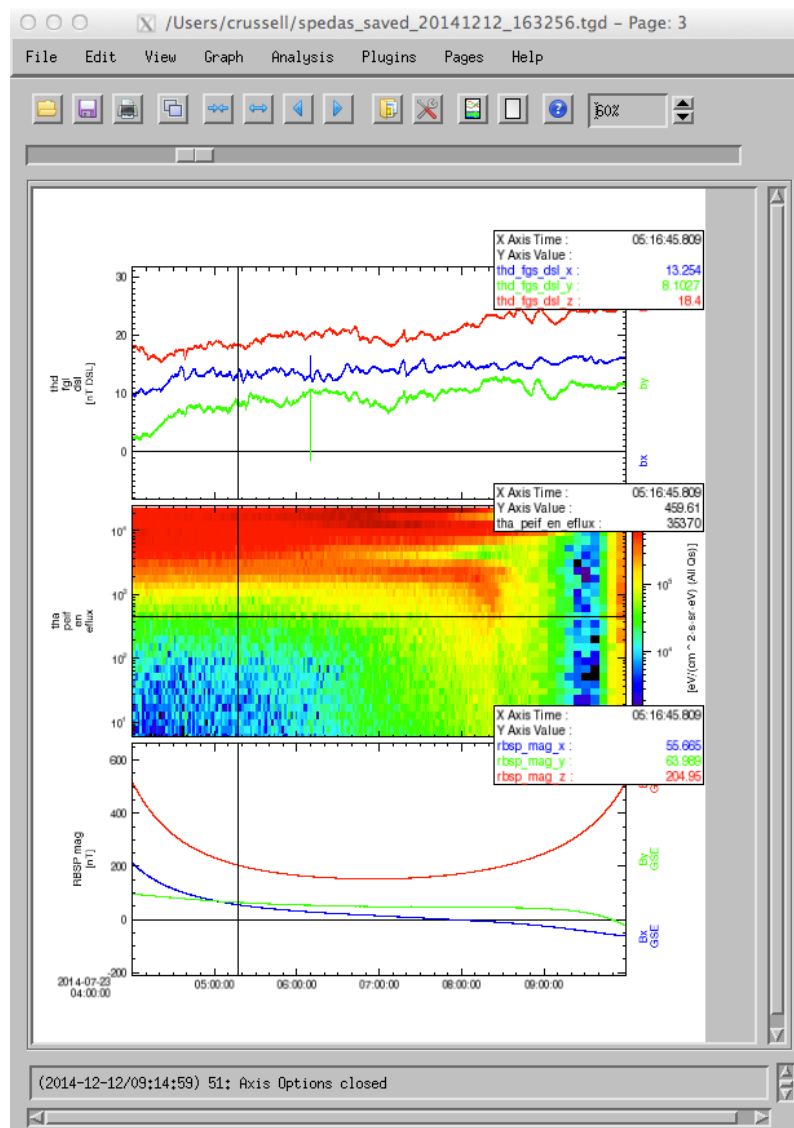




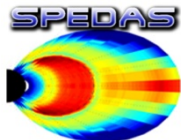
# THEMIS and RBSP Plots



- With a few clicks of the button the user can load, analyze, and plot data.
- Interactive Capabilities







# SPEDAS Mini Language



- Simple scripting language has been written in IDL.
- This language allows access to some data analysis functionality in the IDL virtual machine and eases manipulations of time series (tplot) data
- This language allows composition of statements and functions with order of operations to give significant flexibility in statement construction

## Examples:

1: Position to RE:

```
calc,"tha_pos_re" = "tha_state_pos"/6374.4'
```

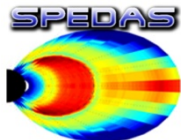
2: Natural log of total esa density:

```
calc,"tha_density_log"  
=ln("tha_peir_density"+"tha_psif_density")'
```

3: Average magnetic pressure:

```
calc,'Pb_avg = mean(0.01*total("tha_fgs_dsl"^2,2)/25.132741)'
```

Additional examples can be found in [general/examples/crib\\_calc.pro](#)



# Data Analysis



Available Data

Active Data

Loaded Data

- G15
  - FGM
    - g15\_BTSC\_1 [2014-07-2
    - g15\_BTSC\_2 [2014-07-2
    - g15\_Bsc\_1 [2014-07-23/
    - g15\_Bsc\_2 [2014-07-23/
    - g15\_Bsens\_1 [2014-07-2
    - g15\_Bsens\_2 [2014-07-2
    - g15\_HT\_1 [2014-07-23/C
    - g15\_HT\_2 [2014-07-23/C
    - g15\_H\_enp\_1 [2014-07-
    - g15\_H\_enp\_2 [2014-07-
    - g15\_H\_enp\_1\_x\_dpwrsp
    - g15\_H\_enp\_1\_y\_dpwrsp
    - g15\_H\_enp\_1\_z\_dpwrsp
  - MAGED
- POES/MetOp
  - NOAA15
  - NOAA19

Active Data

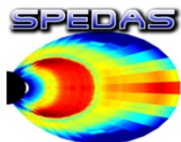
g13\_H\_enp\_1: 2014-07-23/00:00:00 to 2014-07-24/00:00:00  
g15\_H\_enp\_1: 2014-07-23/00:00:00 to 2014-07-24/00:00:00

Common Functions

- Subtract Average
- Subtract Median
- Smooth Data...
- High Pass filter...
- Block Average...
- Clip...
- Deflag...
- Degap...
- Interpolate...
- Clean Spikes...
- Time Derivative...
- Wavelet Transform...
- Power Spectrum...
- Coordinate Transform...
- Split Variable
- Join Variables...

Clear Active Done

(2014-12-12/07:24:48) 10: Bad Selection, Please try again



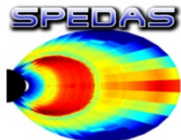
# Magnetic Field Models



- The GUI is now able to:
- Model the field at the spacecraft position
  - Trace field from position to the ionosphere and equator

The screenshot shows a software window titled "Magnetic Field Models". It contains several sections for user input and output:

- Input:** A text box containing "the\_state\_pos".
- Model Selection:** Radio buttons for "TS04", "T01", "T96", "T89", and "IGRF", with "TS04" selected.
- Solar wind parameters:** Text boxes for "IMF By (GSM)", "IMF Bz (GSM)", "Proton density", and "Proton speed".
- Magnetospheric parameters:** Text boxes for "Dst" and "W-coefficients (optional)".
- Current model parameters:** A list of parameters with their values, such as "Model: TS04", "IMF By: OMNI\_HRO\_1min\_BY\_GSM", "IMF Bz: OMNI\_HRO\_1min\_BZ\_GSM", "SW density: OMNI\_HRO\_1min\_proton\_density", "SW flow speed: OMNI\_HRO\_1min\_flow\_speed", "Dst: OMNI\_HRO\_1min\_SYM\_H", and "W coefficients: [calculate automatically]".
- Output:** Checkboxes for "Model at position", "Trace to equator", and "Trace to ionosphere", all of which are checked.
- Buttons:** "Generate", "Clear", and "Close".
- Log:** A scrollable text area at the bottom showing the message: "(2014-06-19/06:13:11) 7: Traced the\_state\_pos\_gsm to the ionosphere".



# Load Data panel (MMS plugin tab)



MMS

POES      THEMIS      THEMIS Derived Products      WIND

ACE   BARREL   ELFIN Lomo   FAST   GOES   Geomagnetic Indices   IUGONET   MAVEN\_PFP   MMS   OMNI

MMS Data Selection:

Start Time: 2007-03-23/00:00:00

Stop Time: 2007-03-24/00:00:00

Use Single Day

Instrument Type: FGM

Probe:	Data Rate:	Level:	Data Type:
MMS 1	svvy	L2	
MMS 2	brst		
MMS 3			
MMS 4			

Clear Probe   Clear Rate   Clear Levels   Clear Type

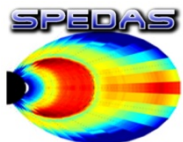
Data Loaded:

- Geomagnetic Indices
  - Kyoto
    - WDC
      - kyoto\_dst [ 2007-03-23/00:00:00 to 2007-03-24/00:00:00 ]

Delete All Data

Done

0: Status information is displayed here.



## Configuration settings panel (THEMIS plugin tab)



Configuration Settings

SPEEDAS | BARREL | GOES | Geomagnetic Indices | MAVEN\_PFP | OMNI | POES | **THEMIS** | WIND

Local data directory:

Remote data directory:

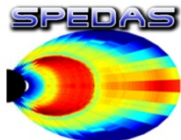
Download Data:  Automatically  Use Local Data Only

Update Files:  Update if Newer  Use Local Data Only

Load into GUI:  Load data  Download Files C

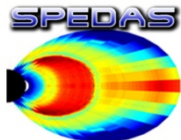
Verbose (higher value = more comments):  ▼

0: Status information is displayed here.



- ## SPEDAS Development Roadmap

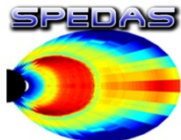
- SPEDAS 3.00 was released in April 2018; SPEDAS 3.1 expected in July 2018.
- SPEDAS 3.1 will include support for the TS07D field model implemented in the latest update to the GEOPACK library, a plugin for ICON, and a GUI interface for performing Minimum Variance Analysis.
- Our QA procedures, release schedule, and set of deliverables need a bit more flexibility to keep up with new plugins as they are released or updated.
- In future releases, we hope to expand the scope of some mission-specific tools (for example, particle moments, 2-D and 3-D visualization tools, spectrograms, pitch angle distributions) to more generic solutions that can be applied to multiple missions.
- We continue to work closely with other projects, to support integrating their software tools into SPEDAS as plugins or core capabilities.
- SPEDAS in Python: Efforts are underway to coordinate with other developers working on heliophysics packages in Python, with the goal of porting SPEDAS tools to Python



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## • SPEDAS Development Roadmap

- Currently, all crash reports and help requests are routed to the THEMIS science support address, even if the crash or problem occurs in some other plugin. Future releases should allow each plugin to define its own error handlers and reporting policy.
- We have conducted several WebEx tutorial sessions covering various capabilities of the SPEDAS software and plugins. These sessions allow us to go into far greater detail into the nuts and bolts of using SPEDAS for realistic data processing tasks.
- We will be looking into implementing more tools to support exporting data as CDFs with standard metadata (ISTP, SPASE).



## Spedas.org is now live!

SPEDAS and plugin downloads

Documentation wiki

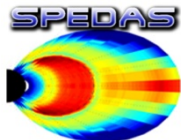
Mailing list

Blog

Google group ( <https://groups.google.com/forum/#!forum/spedas> )

We welcome plugin developers to contribute content and participate in discussions on the SPEDAS site! (Registration required for wiki and blog edit privileges; please contact Jim Lewis ([jwl@ssl.Berkeley.edu](mailto:jwl@ssl.Berkeley.edu)) to gain access).





# SPEDAS Wiki

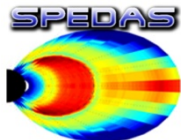


## Introduction:

- You Tube Channel
- SPEDAS video
- Introductory Examples
- Screen shots

The screenshot shows the SPEDAS Wiki main page. The browser address bar displays `spedas.org/wiki/index.php?title=Main_Page`. The page features a sidebar with navigation options like 'Main page', 'Community portal', and 'Recent changes'. The main content area includes a 'Main Page' section with a 'Contents' table of contents listing sections from 'Welcome to SPEDAS' to 'External Resources'. Below this is a 'Welcome to SPEDAS' section with a paragraph of introductory text and a bulleted list of features. A 'SPEDAS Graphical User Interface' image is shown on the right. At the bottom, an 'Introduction' section contains a list of links to YouTube videos and screenshots.

[spedas.org/wiki](http://spedas.org/wiki)



# SPEDAS Downloads



**Select:**  
1.2 Downloads  
From Main  
Page

File Edit View History Bookmarks Tools Help

Zimbra: Inbox x cindy.russell@rocketmail.c... x Google Calendar x Downloads - SPEDAS Wiki x +

spedas.org/wiki/index.php?title=Downloads

SPEDAS Wiki

Most Visited Zimbra Yahoo Maps THEMIS GMAG UCLA Bank Dictionary BBB Travelocity Spanish Weather Gmail AmEx Google Calendar GMAT User Guide

### Version 1.00, August 2014

- Source code.** This is a zip file with all the SPEDAS IDL source code. To use it you need to have IDL installed. This is the only distribution that provides full access to the command line tools. If you have used TDAS in the past, this is probably the option you should use.  
[\\* Download SPEDAS 1.00 source code \(13 MB\)](#)
- Save file.** This is suitable for users without an IDL license. It requires the IDL Virtual Machine (VM) which has to be downloaded for free from Exelis. There are limitations using the VM compared to the full IDL. This distribution only provides access to the GUI, and not the command line tools.  
[\\* Download the SPEDAS 1.00 savefile \(14 MB\)](#)
- Executable files.** These zip files contain executable files that can be run directly without installing anything else. They include a Virtual Machine (VM) version of IDL and they open the SPEDAS GUI but they do not include a command line tool, nor the SPEDAS IDL source code. They also include Geopack. (Note: If you have downloaded a zip file before Dec 5th, 2014, then you should download it again. The new version contains small fixes.)  
**IDL 8.3**
  - [\\* Download SPEDAS 1.0 Executable, Windows 64bit, IDL 8.3, Geopack 9.3 \(52 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, MacOS 64bit, IDL 8.3, Geopack 9.3 \(60 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, Linux 64bit, IDL 8.3, Geopack 9.3 \(70 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, Linux 64bit, IDL 8.3, Geopack 7.6 \(70 MB\)](#)**IDL 7.1**
  - [\\* Download SPEDAS 1.0 Executable, Windows 64bit, IDL 7.1, Geopack 9.3 \(34 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, MacOS 64bit, IDL 7.1, Geopack 9.3 \(48 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, Linux 64bit, IDL 7.1, Geopack 9.3 \(53 MB\)](#)
  - [\\* Download SPEDAS 1.0 Executable, Linux 64bit, IDL 7.1, Geopack 7.6 \(53 MB\)](#)

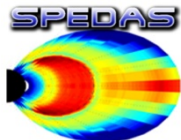
The Enhancement Lists for SPEDAS Version 1.00 can be found [here](#).

### Installation on a Mac

Newer Mac OS X versions do not include the Y11 libraries. YQuartz (Y11) has to be downloaded and installed, or IDL will not work.

Firefox automatically sends some data to Mozilla so that we can improve your experience. [Choose What I Share](#)

[spedas.org/wiki/index.php?title=Downloads](http://spedas.org/wiki/index.php?title=Downloads)



# Analyzing MMS data with SPEDAS

MMS Plug-in Tutorial Tomorrow, 1:30PM!

Anasazi Ballroom

email me: [egrimes@igpp.ucla.edu](mailto:egrimes@igpp.ucla.edu)