SPEDAS Tutorial
Mini-GEM 2017, New Orleans LA
Agenda

SPEDAS Tutorial

Opening remarks

SPEDAS development status
New features, plugins, and tools

Live demo: HAPI, new DSCOVR and SECS plugins, ISEE 3d tool

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 2.1 is now undergoing QA testing, and should be released in late December 2017 or early January 2018.
  - 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.
DSCOVR 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)

\[ \text{trg} = \text{timerange}(['2017-02-18/03:00:00','2017-02-18/15:00:00']) \]

\[
\text{dsc\_overview}, \text{trange}=\text{trg} \quad ; \text{Overview for a given timerange}
\]

\[
\text{dsc\_overview\_mag}, \text{trange}=\text{trg} \quad ; \text{Overview of Magnetometer data}
\]

\[
\text{dsc\_overview\_fc}, \text{trange}=\text{trg} \quad ; \text{Overview of Faraday Cup data}
\]
SECS ASI Mosaic plot
(projects/secs/examples/secs_mosaic_plot_crib)
• SPEDAS 2.00 was released in June 2017:
  • SPEDAS 2.00 includes the new ISEE 3D tool for visualizing particle distributions
  • SPEDAS 2.00 supports the new Heliophysics API
  • Many load routines have been updated to work with data sources that enforce HTTPS-only downloads (e.g. CDAWeb, NOAA, LASP, etc)

• SPEDAS 2.00 includes GUI tools for loading data for any mission supported by CDAWEB; support for loading various geomagnetic indices, and an interface to the GEOPACK magnetic field modelling library.
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)
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’
• With a few clicks of the button the user can load, analyze, and plot data.
• Interactive Capabilities
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:
   \[
   \text{calc,}'"\text{tha_pos_re}" = "\text{tha_state_pos}$/6374.4'\\
   \]

2: Natural log of total esa density:
   \[
   \text{calc,}'"\text{tha_density_log}" = \ln("\text{tha_peir_density}"+"\text{tha_psif_density}"")\\
   \]

3: Average magnetic pressure:
   \[
   \text{calc,}'\text{Pb_avg} = \text{mean}(0.01*\text{total}("\text{tha_fgs_dsl}"^2,2)/25.132741)\\
   \]

Additional examples can be found in general/examples/crib_calc.pro
Data Analysis

Available Data

Active Data

Common Functions

Data Processing

Loaded Data

Active Data

g15_H_enp_1 [2014-07-23] 2014-07-23/00:00:00 to 2014-07-24/00:00:00

g15_H_enp_1 [2014-07-24] 2014-07-23/00:00:00 to 2014-07-24/00:00:00

Clear Active  Done

(2014-T2-12/07:24:18) 10: Bad Selection, Please try again

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

SPEDAS Tutorial  Slide – 18  New Orleans, LA -- December 2017
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
### Load Data panel (MMS plugin tab)

The Load Data panel allows users to select and load data from various sources. Here are the key components:

**MMS Data Selection:**
- **Start Time:** 2007-03-23/00:00:00
- **Stop Time:** 2007-03-24/00:00:00
- **Use Single Day:** Checkmark for single day selection
- **Instrument Type:** FGM
- **Probe:**
  - MMS 1
  - MMS 2
  - MMS 3
  - MMS 4
- **Data Rate:**
  - L2
- **Level:**
  - Any
  - Best

**Data Loaded:**
- **Geomagnetic Indices**
  - Kyoto
  - WDC
  - kyoto_dst [2007-03-23/00:00:00 to 2007-03-24/00:00]

Additional options include:
- **Clear Probe**
- **Clear Rate**
- **Clear Levels**
- **Clear Type**
- **Delete All Data**

At the bottom:
- **Done**

**Status Information:**
- Message: Status information is displayed here.
Configuration settings panel (THEMIS plugin tab)

Local data directory: c:/data/themis/
Remote data directory: http://themis.ssl.berkeley.edu/data/themis/
Download Data: 
- Automatically
- Use Local Data Only
Update Files: 
- Update if Newer
- Use Local Data Only
Load into GUI: 
- Load data
- Download Files
Verbose (higher value = more comments): 2

Save To File  Cancel  Reset to Default

Status information is displayed here.

Done
IUGONET, OMNI, Field Data

crib_iugonet_20120122sc.pro

Yoshimasa Tanaka
• SPEDAS Development Roadmap

  • SPEDAS 2.00 was released in June 2017; SPEDAS 2.1 expected in late December 2017 or early January 2018

  • Future SPEDAS versions will include expanded support (including a GUI panel) for downloading via the new Heliophysics API

  • 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.

  • We are looking into the possibility of porting some SPEDAS capabilities to Python

  • We intend to develop some tools that would allow for exporting and importing data and metadata between SPEDAS and Autoplot
• 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](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).
Introduction:
- You Tube Channel
- SPEDAS video
- Introductory Examples
- Screen shots
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