CDAWeb and Other SPDF Services

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Space Physics Data Facility (SPDF)
<https://spdf.gsfc.nasa.gov>
Heliophysics Science Division (Code 670)
NASA Goddard Space Flight Center

Third IHDEA meeting 2019 Oct.17

Infrastructure for the Heliophysics Data Environment

- **Heliophysics Data Portal (HDP)**
  - HDP is a world-wide inventory of public Heliophysics-relevant data
  - SPDF also uses HDP as our high-level dataset inventory
- **CDF (Common Data Format) and SPDF Metadata Guidelines**
  - **Self-describing** data format for storing/using scalar and multi-dimensional data in a platform- and discipline-independent fashion.
  - **Self-documenting** through use of global and variable “attributes”, both to the meaning/use of data and dependencies among variables
  - **Associated** ISTP/SPDF structuring and metadata **guidelines** are critical to Heliophysics usability and are applicable beyond data in CDF
- **APIs to SPDF system capabilities and data**
  - External software and services can leverage SPDF data/services (such as AMDA, Autoplot, IDL, Python libraries)

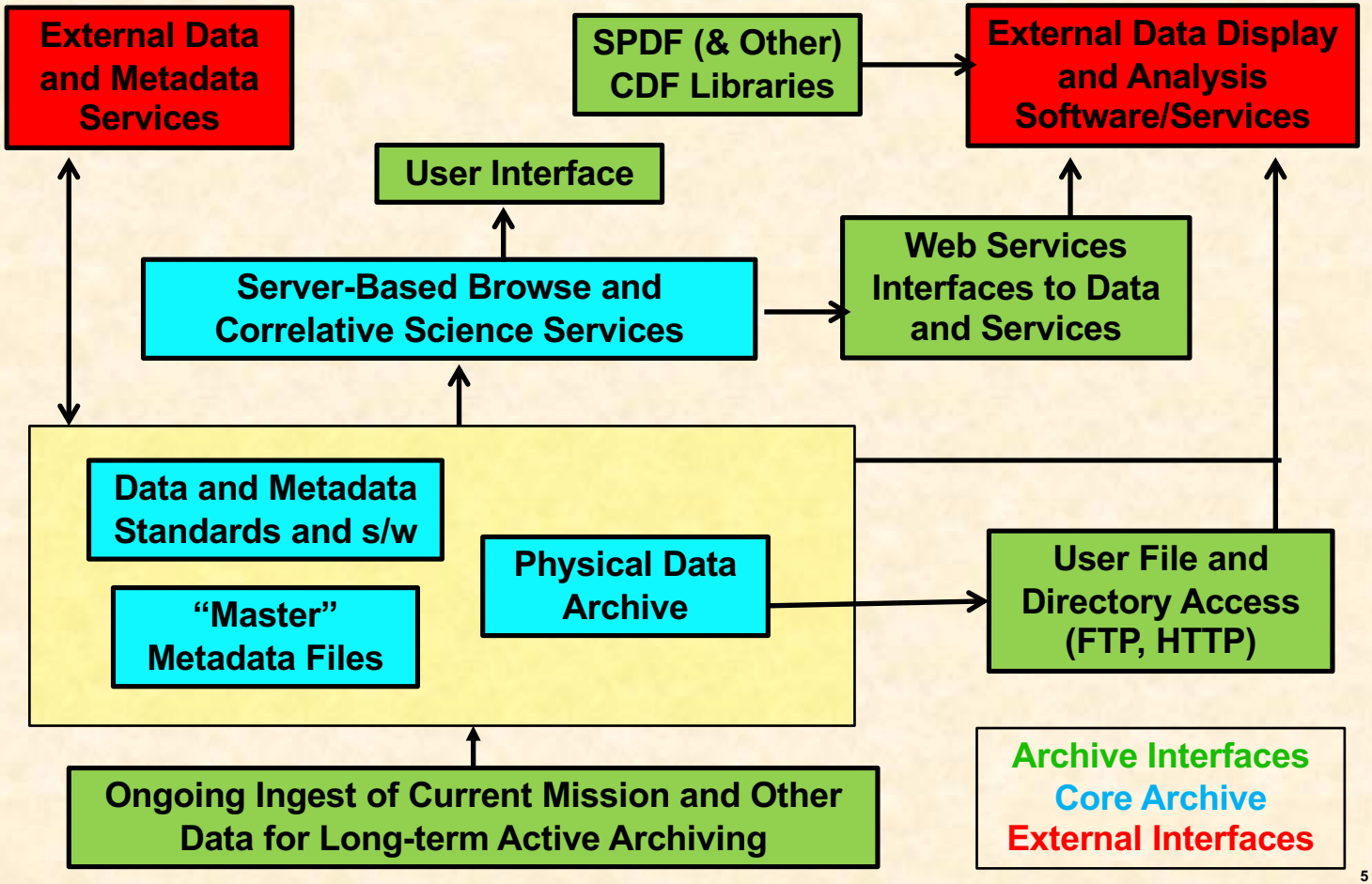
SPDF Services

- **Archive** for non-solar NASA Heliophysics science data and many other missions
- **CDAWeb** browse, correlations and display, simple interface
- **SSCWeb** orbit/ground track data/displays and conjunction queries, 4D viewer
- **OMNI Database / OMNIweb-Plus** (baseline solar wind data at Earth)
- **Heliophysics Data Portal (HDP)** SPASE-based inventory of public Heliophysics-relevant data
- **CDF** self-describing scientific data format
- **SKTeditor** for creating and testing **ISTP/SPDF Guidelines** metadata (CDF/netCDF)
- **Master** CDF/netCDF concept uses file with no data to add/over-ride metadata in datasets
- **Web services** for CDF/netCDF data in CDAWeb, SSC orbits, OMNIweb, HDP; use REST versions, many language examples
  - https://cdaweb.sci.gsfc.nasa.gov/WebServices/REST/ (same for SSCweb)
- SPDF cited in a third of JGR Blue articles

SPDF Services

- **Multi-instrument, multi-mission Heliophysics science**
  (1) Specific mission/instrument data **in context** of other missions/data
  (2) Specific mission/instrument data **as enriching context** for other data
  (3) Ancillary services & software (orbits, data standards, special products)
- **CDAWeb** (browse, correlations and display, simple interface)
  - Plot, list, subset, and download data in CDF or ASCII format
  - Primary SPDF data service for currently active mission data
  - Presents dataset view rather than individual data files
- **SSCWeb** (orbit/ground track displays and queries)
  - Plot, list orbits of multiple spacecraft in a variety of coordinate systems; query for satellite-satellite and satellite-ground station conjunction. Includes most heliospheric satellites and many ground stations.
  - **4D Orbit Viewer:** Interactive 4D animation of orbits
- **OMNI Database / OMNIweb-Plus** (baseline solar wind data at Earth)
  - Solar wind magnetic field & plasma parameters mapped to Earth's bowshock
  - Based on a large volume of quality-controlled satellite measurements (November 1963 ->) plus interface for plotting, filtering, downloading the data

Standards Underpinning SPDF Data, Products and Services



SPDF Data Access

All data files (not just CDFs and netCDFs)

- Through FTP and HTTP spdf.gsfc.nasa.gov/pub/

For data in CDFs or netCDFs with sufficient metadata:

- CDAWeb data browser for plots, lists (text, CSV, JSON), CDFs
- CDAS Web Services (REST/SOAP) cdaweb.gsfc.nasa.gov/WebServices/
- In IDL cdaweb.gsfc.nasa.gov/WebServices/REST/CdasIdlLibrary.html using CDAWlib IDL library routines spdf.gsfc.nasa.gov/CDAWlib.html
- Within Autoplot autoplot.org/help#CDAWeb
- HAPI interface to CDAWeb holdings cdaweb.gsfc.nasa.gov/hapi
  - Not all data can be sent via HAPI

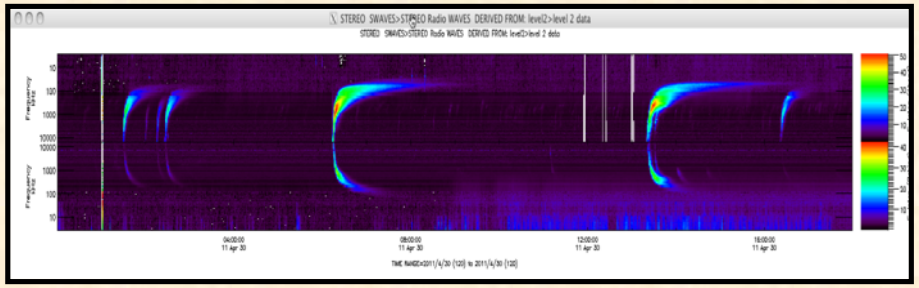
CDAS REST example (CDF fastest but other formats also)

- Get a CDF file containing the variables Magnitude and BGSEc data from the AC_H2_MFI dataset in the time range of 2009-06-01T00:00:00 to 2009-06-03T00:00:00
- https://cdaweb.gsfc.nasa.gov/WS/cdasr/1/dataviews/sp_phys/datasets/AC_H2_MFI/data/20090601T000000Z,20090603T000000Z/Magnitude,BGSEc?format=cdf

“Fill My (IDL) Array” with Data from CDAWeb

- Load specific CDAWeb data into an IDL structure using
  - @compile_cdaweb
  - spdfgetdata
- GUI to select/load/display data from CDAWeb in IDL
  - spdfcdawebchooser

```
IDL>
data
 = spdfgetdata('STEREO_LEVEL2_SWAVES',
['avg_intens_ahead', 'avg_intens_behind'],
['2011-04-30T00:00:00.000Z', '2011-04-30T18:00:00.000Z'])
```



Directly Read Data from CDAWeb into IDL

```
timename='jul_day'    ;name of time variable -- Julian days
start_time = '1998-06-10T00:00:00.0Z'  ;start time
stop_time  = '1998-06-10T23:59:59.0Z'  ;stop time
dt_sec=10.0 ;sec -- bin size in seconds

dataset_id='WI_H0_MFI'    ; CDAWeb dataset ID
vars=[ 'B3F1=Bmag3', 'B3GSE=Bx3,By3,Bz3']   ; CDAWeb variable names with locally assigned names
cdaweb_get_bin, dataset_id,vars,start_time,
                stop_time,dt_sec,time_name=timename
dataset_id='WI_PM_3DP'
vars=[ 'P_DENS=np3', 'P_VELS=Vxp3,Vyp3,Vzp3',  'P_TEMP=Tp3', 'A_DENS=na3',  $
          'A_VELS=Vxa3,Vya3,Vza3', 'A_TEMP=Ta3']
cdaweb_get_bin, dataset_id,vars,start_time,
        stop_time,dt_sec,time_name=timename,/autobad
```

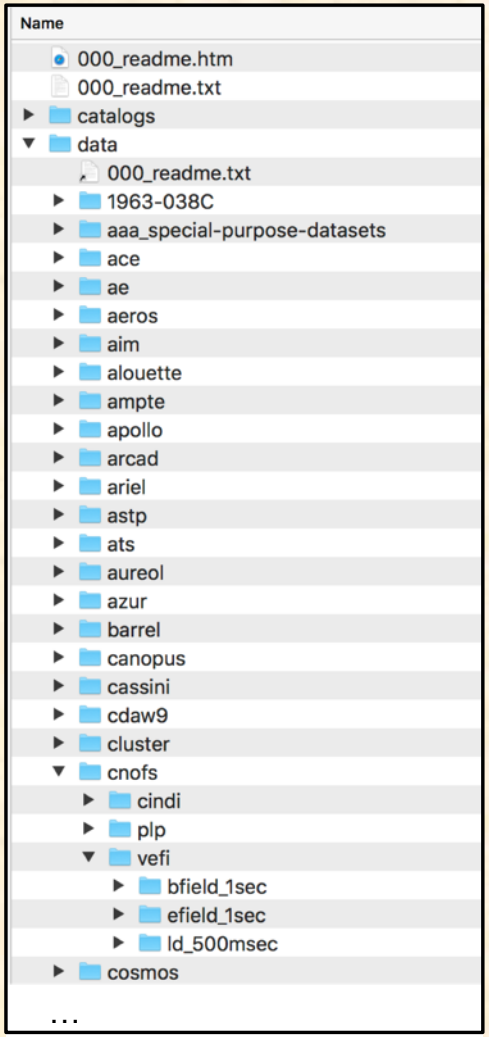
No more writing code for every dataset.

The Internet functions as a local, easy to use hard drive.

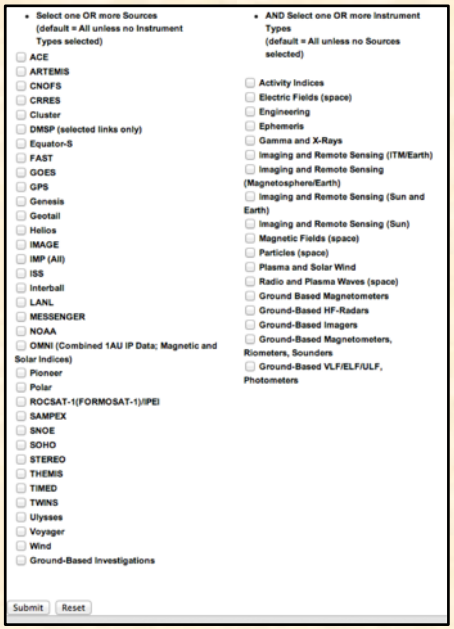
“HAPI” will generalize this to accessing “everything.”

VSO does the same for Solar Data

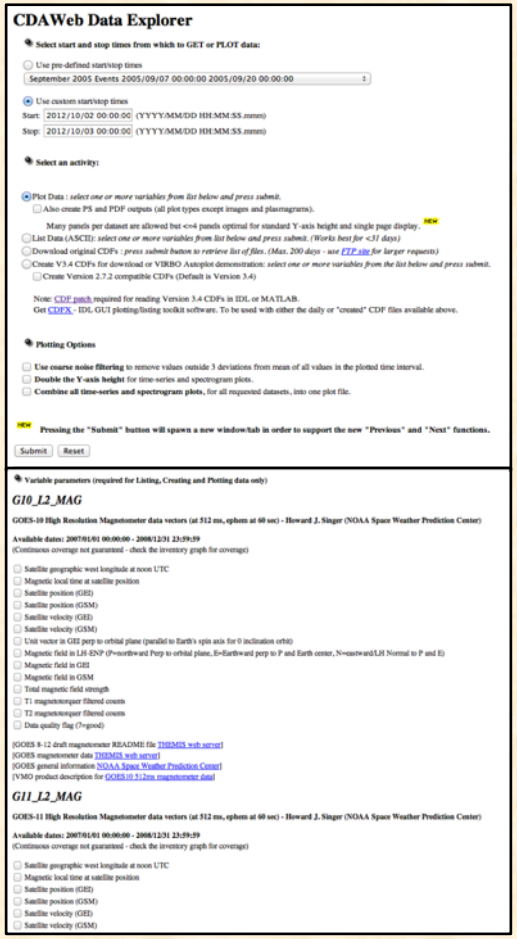
SPDF FTP/HTTPS Directories



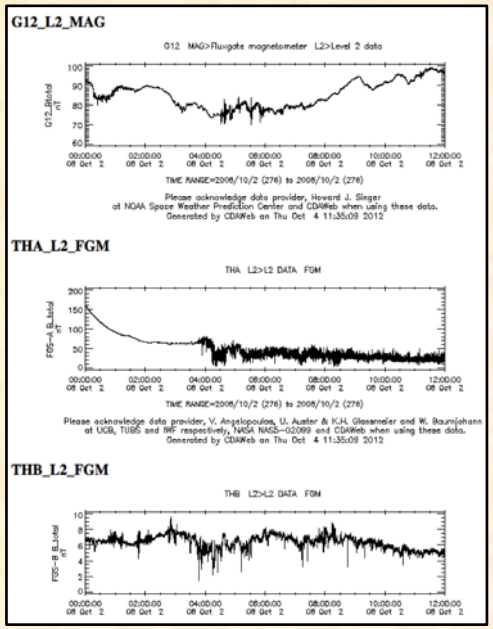
CDAWeb Interface: Simplicity and Multiple Missions



Missions and Instrument Types



Variables

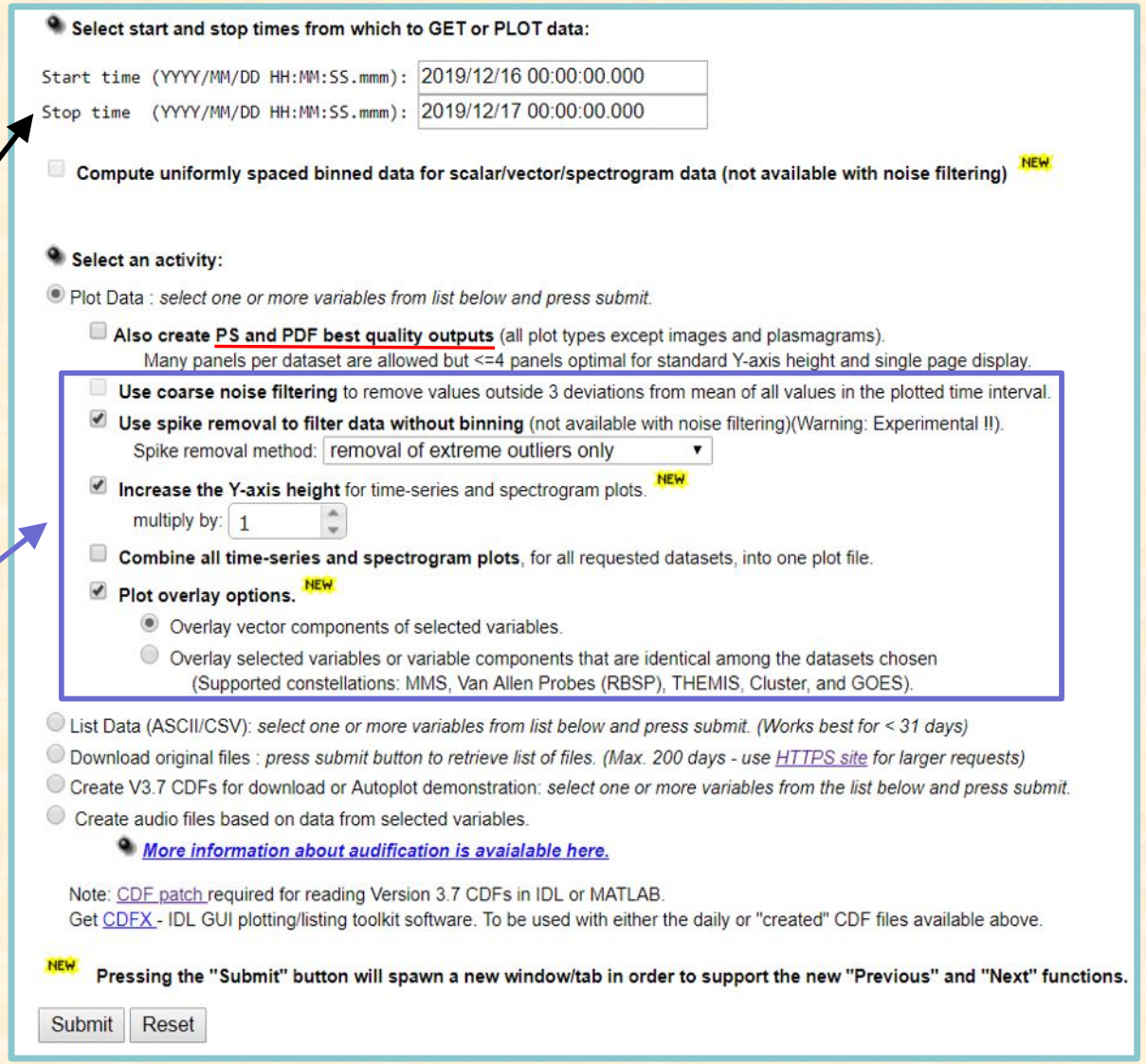


Sample Plots: also can produce ASCII listings and CDF downloads

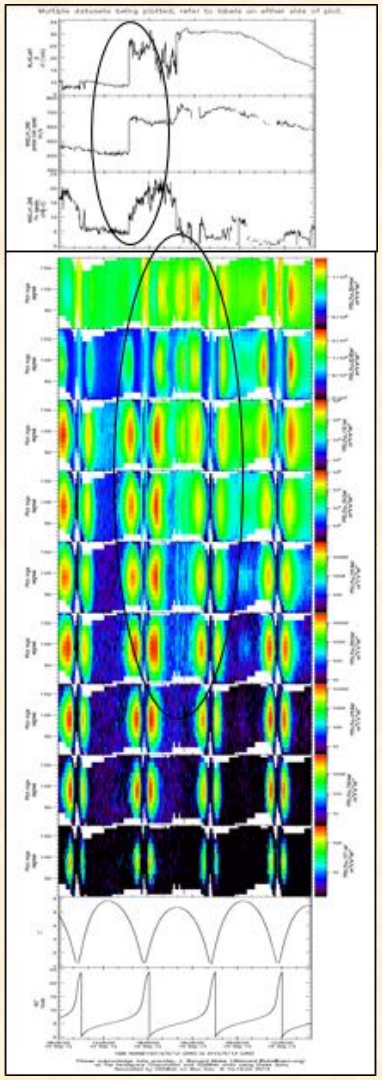
CDAWeb Data Explorer

Automatically set by the last available day of the selected data

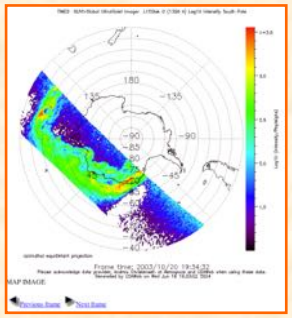
Options:
noise filtering,
spike removal,
overlay plotting



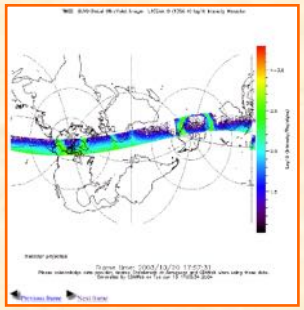
Parameter Display Options in CDAWeb



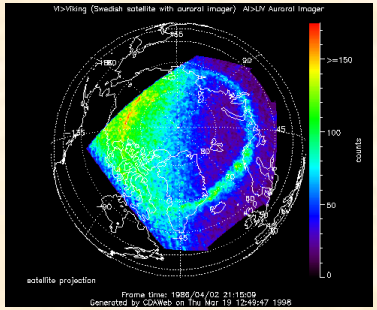
WIND MFI & SWE and Van Allen Probe A ECT & MagEIS



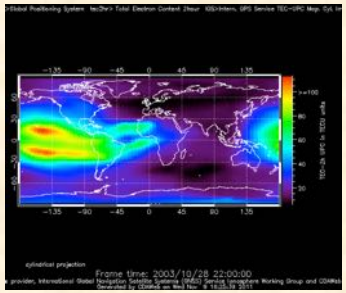
TIMED/GUVI/1356 Å Polar Projection



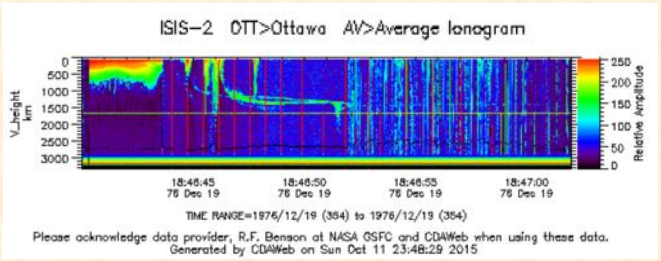
TIMED GUVI/1356 Å Transverse Mercator Projection



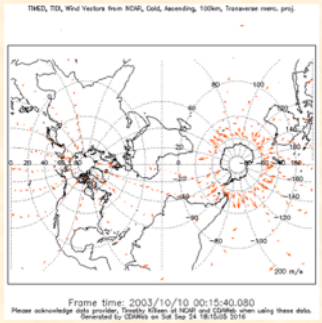
Viking(Sweden)/UV Imager/ North Pole



GPS/IGS/TEC



ISIS-2 Topside Sounder Ionogram



TIMED/TIDI/Wind Vectors Movie/Transverse Mercator Projection

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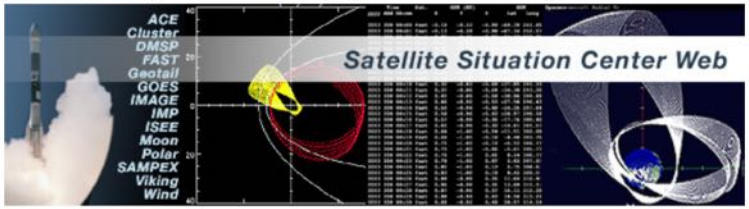
+ Space Physics models at CCMC
+ IGRF/DGRF and CGM coordinate transformations
+ Products and information
+ Data Format Translations

Additional Resources
+ Usage Statistics
+ NEW! Key parameter and orbit plots produced by the THEMIS & PWG projects



SATELLITE SITUATION CENTER (SSCWeb) SYSTEM AND SERVICES

SPDF News & Announcements
MMS Definitive and Predictive data available in the system.

Graphics

+ Locator Graphics
  The Locator graphics component provides the ability to plot the orbits of multiple spacecraft. In addition to orbit plots, mapped and time series plots can also be generated.(THEMIS Saved Examples) NEW!
+ 4-D Orbit Viewer
  This application provides the user with the capability to select spacecraft(s) and time ranges of interest, and see their orbits represented as an interactive 4-D animation.

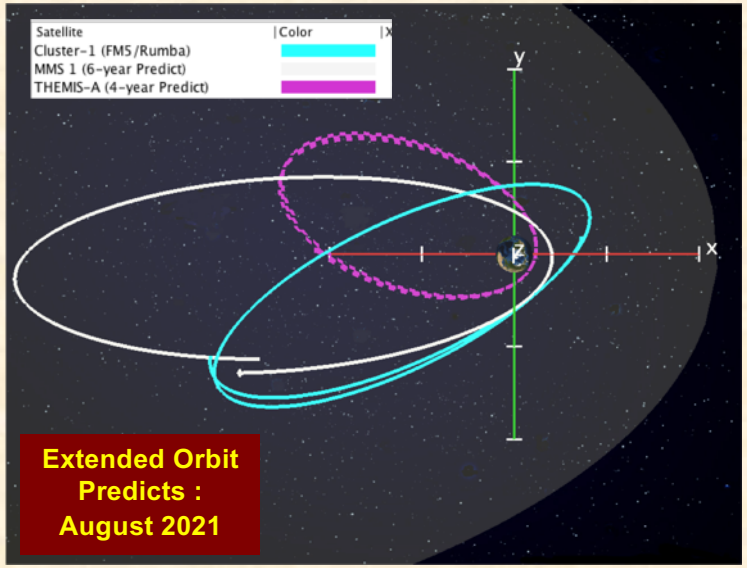
Listings

+ Locator Tabular
  The Locator component provides tabular information. As tabular output, the spacecraft's coordinate location can be listed in a variety of coordinate systems, as well as other location related items. (THEMIS Saved Examples) NEW!
+ Query
  The Query component provides two query matching options: magnetospheric region occupancy and magnetic field line tracing. The region query lists the entry and exit times during which specified satellite(s) were in particular magnetospheric regions. The trace query identifies periods when one or more spacecraft are on the same magnetic flux tube of force, or periods when one or more spacecraft occupy a field line which traces down to a specified ground station.(THEMIS Saved Examples) NEW!
+ Coordinate Calculator

Curator: Tami Kovalick
NASA Official: Robert McGuire
(301)286-7794, Robert.E.McGuire@nasa.gov

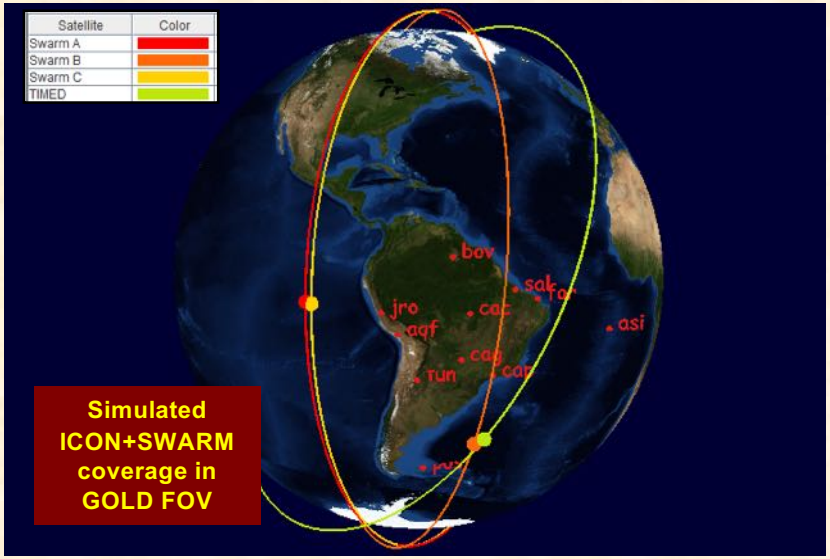
Last Modified: 10/24/2016

SSCWeb and the 4-D Orbit Viewer



4D Orbit Viewer uses SSCWeb webservices API to access S/C database (CDF)

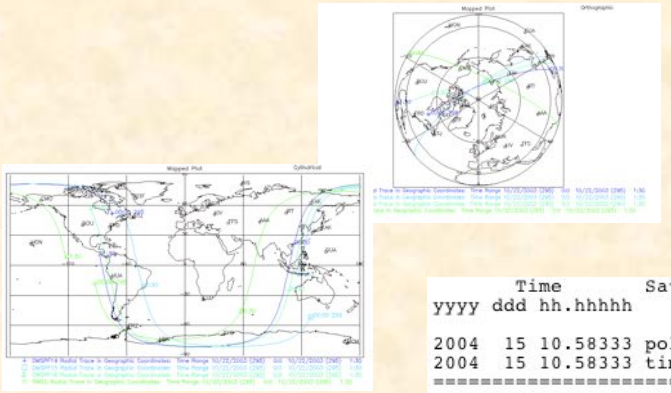
SSCweb also computes radial and magnetic field line conjunctions between satellites and satellite to ground station



SSCWeb

Multi-satellite and/or satellite - ground station magnetic conjunctions

Orbit plots for TIMED and DMSP 14, 15, 16 in a Polar or Cylindrical Projection. Ground station 3-letter codes included.

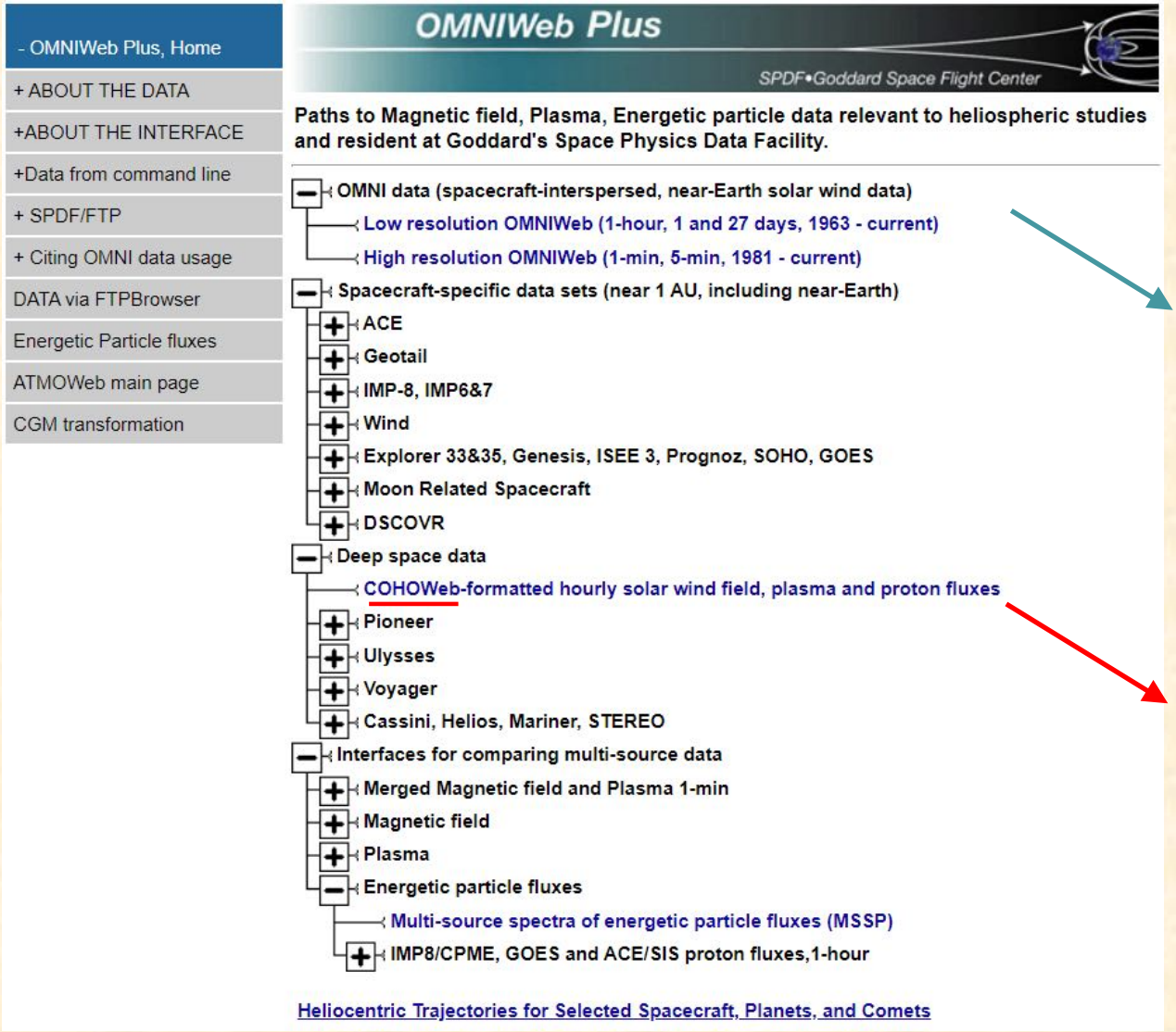


Listing of times when the magnetic footpoints of TIMED, DMSP 13, 14, 15 or 16 crossed the Arecibo ground station.

Time yyyy ddd hh.hhhhh	Sat.	GEO Lat	GEO Long	Radius (km)	Trace GEO Lat	Trace GEO Long	ArcLen (km)	Ground Stations:
2003 292 0.01667	dmspf16	-32.78	304.10	7230	19.60	294.66	8199	Arecibo
2003 292 0.03333		-29.31	303.11	7230	17.01	294.61	6898	Arecibo
2003 292 0.23333	dmspf16	12.51	293.05	7229	19.05	291.77	1097	Arecibo
2003 292 0.31667	dmspf14	-32.87	297.28	7221	17.44	290.81	7650	Arecibo
2003 292 1.23333	dmspf15	-28.26	306.59	7219	17.71	296.86	6875	Arecibo
2003 292 1.41667	dmspf15	10.19	297.54	7219	17.57	295.85	1173	Arecibo
2003 292 9.41667	timed	-35.35	296.89	7004	17.40	290.50	8028	Arecibo
2003 292 9.63333	dmspf13	-28.67	306.75	7233	18.11	296.85	7045	Arecibo
2003 292 11.13333	dmspf13	12.61	291.12	7228	19.03	289.98	1084	Arecibo
2003 292 11.36667	dmspf16	-31.39	302.55	7229	18.10	293.97	7538	Arecibo
2003 292 11.66667	dmspf14	-33.90	295.55	7227	17.79	289.73	7937	Arecibo
2003 292 12.53333	dmspf15	-29.56	307.38	7221	18.82	297.08	7377	Arecibo
2003 292 14.03333	dmspf15	11.53	291.65	7221	18.18	290.46	1101	Arecibo
2003 292 22.28333	dmspf13	11.54	300.06	7217	18.76	298.24	1160	Arecibo
2003 292 23.81667	dmspf16	-29.87	306.48	7231	18.70	296.49	7409	Arecibo

Listing of times of magnetic conjunction between TIMED and Doublestar 1, or DMSP 15 or 16.

Time yyyy ddd hh.hhhhh	Satellite	GEO Lat	GEO Long	Radius (km)	Trace GEO Lat	Trace GEO Long	ArcLen (km)	Lead Sat. Dist.	Lead Sat. Name
2004 15 10.58333	polar	13.96	76.64	38152	69.34	73.69	41635	34567	timed
2004 15 10.58333	timed	68.49	76.85	6992	69.13	77.44	539		
2004 16 0.53333	doublestar1	-28.18	165.25	38715	-58.65	151.85	34985	32959	timed
2004 16 0.53333	timed	-58.42	151.78	7003	-58.85	151.19	544		
2004 16 6.08333	dmspf15	74.37	195.14	7205	75.16	196.12	754	239	timed
2004 16 6.08333	timed	73.96	192.34	6992	74.57	192.98	539		
2004 16 22.25000	dmspf16	74.43	291.52	7215	74.79	290.13	759	239	timed
2004 16 22.25000	timed	73.81	290.53	6992	74.07	289.54	535		



OMNIWeb Plus

- OMNI Data: Database of solar wind magnetic field and plasma parameters mapped to the nose of the Earth's bow shock
- Based on a large volume of quality-controlled satellite measurements (since Nov. 1963)
- **COHOWeb**: Solar wind field, plasma, and proton fluxes in other locations of heliosphere, especially useful for planetary studies and heliospheric model validation
- Interface for plotting, filtering, and downloading the data

https://spdf.sci.gsfc.nasa.gov/pub/catalogs/all.xml

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- <description short="ACE Cosmic Ray Isotope Spectrometer"/> </instrument>
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