



SPDF

Annual Report from Space Physics Data Facility (SPDF)

<https://spdf.gsfc.nasa.gov>

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International Heliophysics Data Environment Alliance (IHDEA) Meeting

ESAC, Spain

17 October 2024

Heliophysics Missions



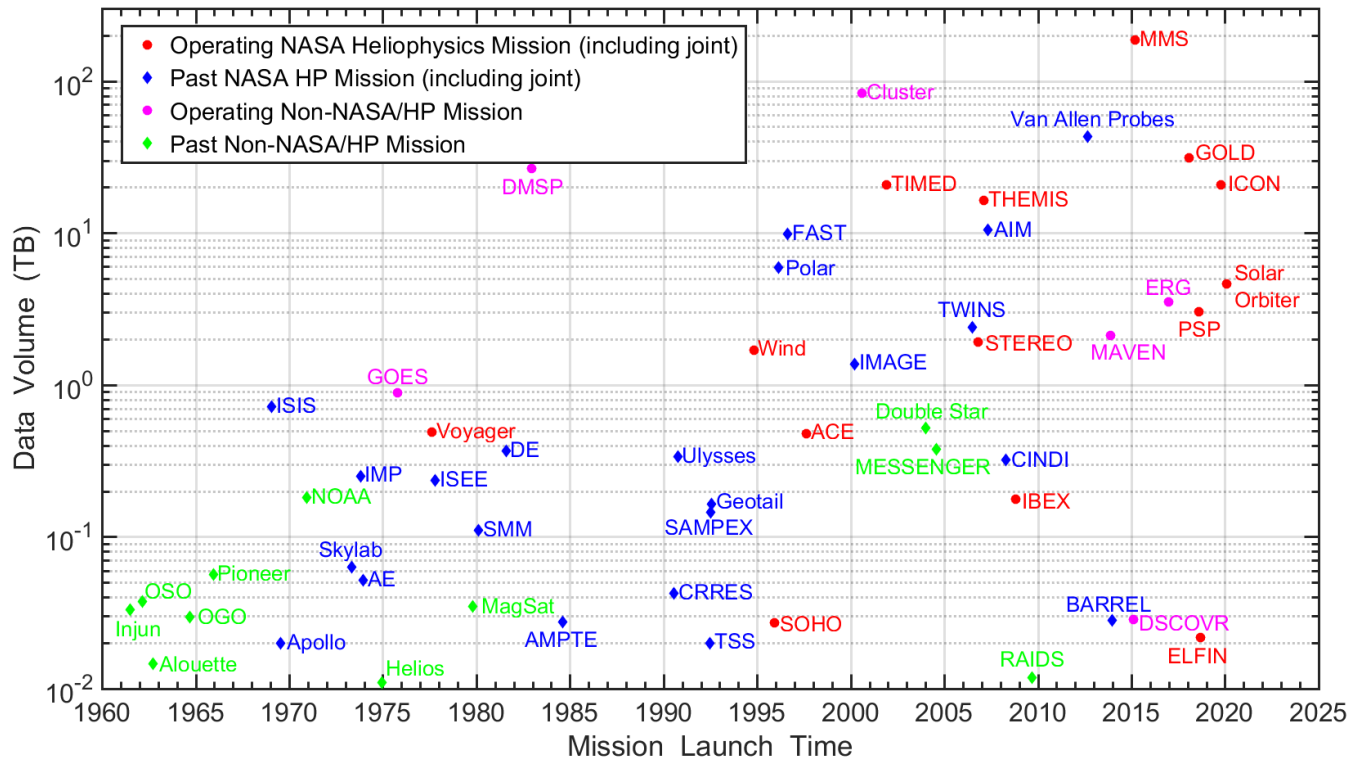
Introduction

- ❑ SPDF team include 10 curation scientists (mostly part time, covering a wide range of heliophysics domains) and 13 technical and development staff
- ❑ Established in 1990s, SPDF is now the **active and final archive of non-solar or space physics data** (mostly in situ data) from NASA Heliophysics missions, including joint missions with other US or foreign agencies, to enable correlative and collaborative research across discipline and mission boundaries
- ❑ SPDF also archives other data **relevant to NASA Heliophysics Science Objectives** (often per the request of missions/projects)
 - Related data from planetary missions (e.g., MAVEN, New Horizons)
 - Heliophysics data from satellites of NOAA, DoD, or other agencies (e.g., GOES, DMSP)
 - Ground-based magnetometers, aurora cameras, radars, etc., which are funded by NSF or other agencies (the majority are archived at relevant facilities other than SPDF)
- ❑ Besides local archival, data are backed up in Iron Mountain and NCCS on premises

Mission Data Volume Archived at SPDF

SPDF data holdings span 100+ missions over 65 years

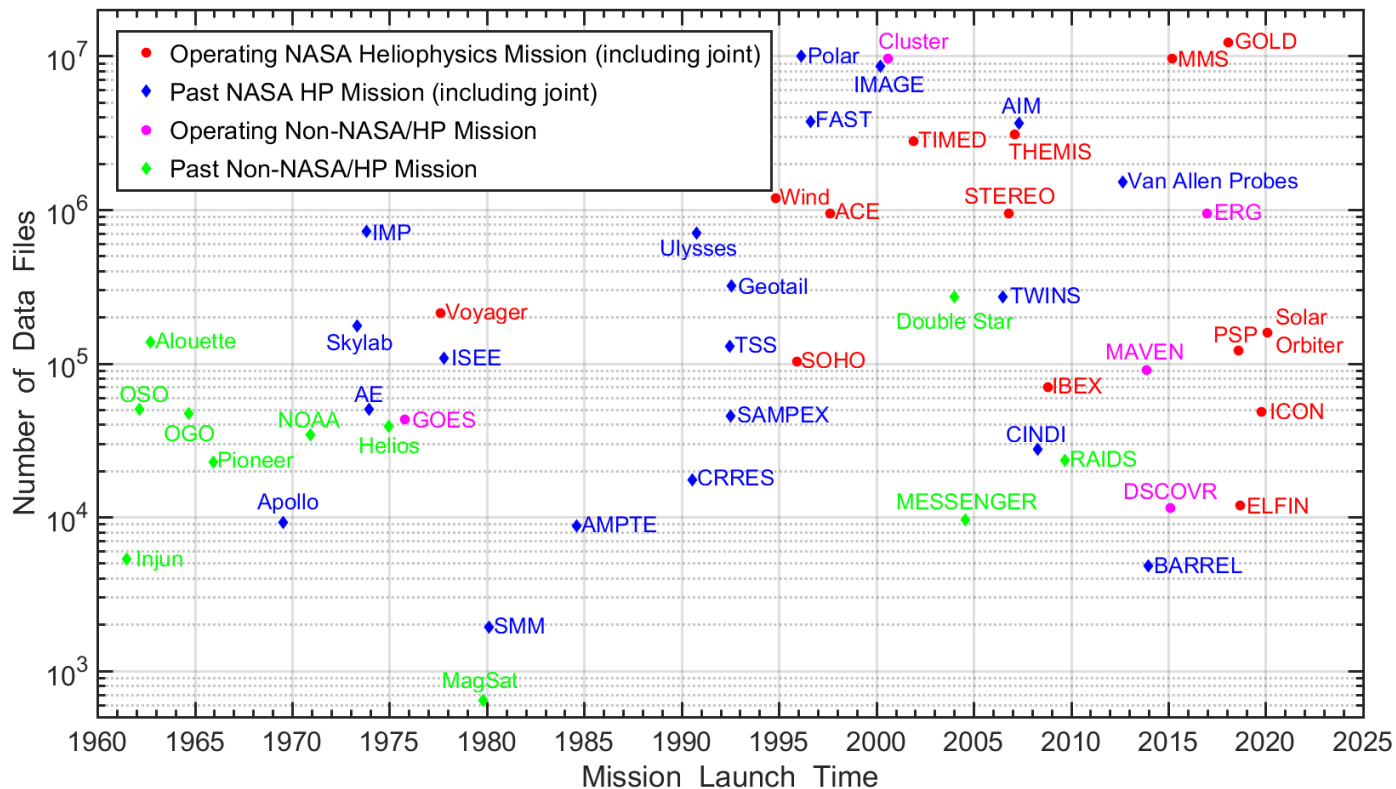
Covering **from the Sun to the local interstellar medium** including magnetosphere – ionosphere – thermosphere – mesosphere (M-ITM) of Earth and other applicable planets



File Numbers of Mission Data Archived at SPDF

~3000 CDF datasets, ~5000 non-CDF datasets, ~100M files, ~600 TB data

Guidelines for data delivery: https://spdf.gsfc.nasa.gov/archive_newdata_reqt.html



SPDF's Science-Enabling Services

❑ Coordinated Data Analysis Web (CDAWeb)

- Data access through web browser, API, IDL, Python
- Interface for browsing, correlating, and displaying data (audio and movie for special cases) from 60+ missions or mission groups and multiple instruments
- *Inventory plot and usage statistics* for mission data

❑ Satellite Situation Center (SSC)

- Data access through web browser, API
- ~160 missions, orbit/ground track displays and queries
- Coordinate transformation tools

❑ OMNI Web (including COHO Web)

- Solar wind plasma, magnetic field, and energetic particle data at the nose of Earth's bow shock and other locations of the heliosphere
- Interface for plotting, filtering, and statistical analysis

❑ Critical Infrastructures for the **Heliophysics Data Environment**

- Common Data Format (CDF): self-describing science file format (cdf.gsfc.nasa.gov)
- International Solar-Terrestrial Physics (ISTP) Metadata Standards for CDF (NetCDF) data including global and variable attributes
- Heliophysics Data Portal: discipline-wide data inventory and access service

SPDF Data Archiving in the Past Year

- ✓ Automated ingestion pipeline for > 75 missions out of over 160 missions for a total of ~4,000 datasets and ~600 TB (ingestion and usage logs in <https://cdaweb.gsfc.nasa.gov/publiclogs/>)
- ✓ Recent average monthly data ingestion rate: ~0.7 million files, ~14 TB data
- ✓ Assisting Phase F of AIM and ICON missions to finalize their data archiving
- ✓ Added new datasets from GOLD, PSP, Solar Orbiter, MMS, IBEX, DMSP, and other missions
- ✓ Added new missions: **BioSentinel**, **Endurance**, **AWE** (in progress)
- ✓ Continuing the population of OMNI, COHO, SSC databases

Update of Cluster & Solar Orbiter Data

- **Cluster:** 771 CDF datasets and some canned graphics files, 11M files, 86 TB
 - In the past 3 years, Pertti Makela combed through 1960 datasets from Cluster Science Archive (CSA) with the help of Harri Laakso, and selected 771 to be archived at SPDF based on their science use, excluding datasets without metadata or of limited interest like engineering
 - New ingestion scripts for CDF datasets were set in addition to the previous ones that SPDF has been getting for years from CSA and other sources
 - Many datasets still in CDAWeb test site
 - Majority: variable **VALIDMIN/MAX** values are not defined to be applied across the dataset, but rather for a given file → Pertti is running software across each dataset to determine the correct values and adding them to CDAWeb master CDFs
 - Other issues with the FILLVAL value and other important attributes
 - Once these items are corrected and the display types are set up, the datasets will be moved to public CDAWeb
- **Solar Orbiter:** SPDF ingested from GSFC's mirroring site of Solar Orbiter Archive, 0.17M data files, 5 TB
 - 101 datasets in public CDAWeb, master CDFs were changed earlier this year for some datasets due to changes of variables
 - 13 datasets in test CDAWeb because of issues such as frequent changes of dimension size for variables

CDF Status and Recent Development

- ❑ CDF 3.9.1 C-library to be released soon with improved buffer overflow warnings and compression functions, updated zlib, and better support for very long attribute and variable names
- ❑ Continued CDF support and general development, with added features
- ❑ Improving documentation, beginner's guides, adding to Wikipedia CDF entry
- ❑ Establishing Steering Committee for ISTP Metadata Guidelines, standardizing ISTP Metadata Guidelines with version control and governance at https://github.com/IHDE-Alliance/ISTP_metadata
- ❑ Updated CDFML and its corresponding JSON representation with cdf.xsd to use more specific datatypes (e.g., xs:dateTime, xs:integer, xs:float, etc.) instead of just xs:string
- ❑ Investigated multi-thread support in CDF C library but the performance was worse due to maintaining the locks during read/write operations, so not released
- ❑ External groups have written CDF libraries in C++, JavaScript

*Robert Candey's
talk tomorrow*

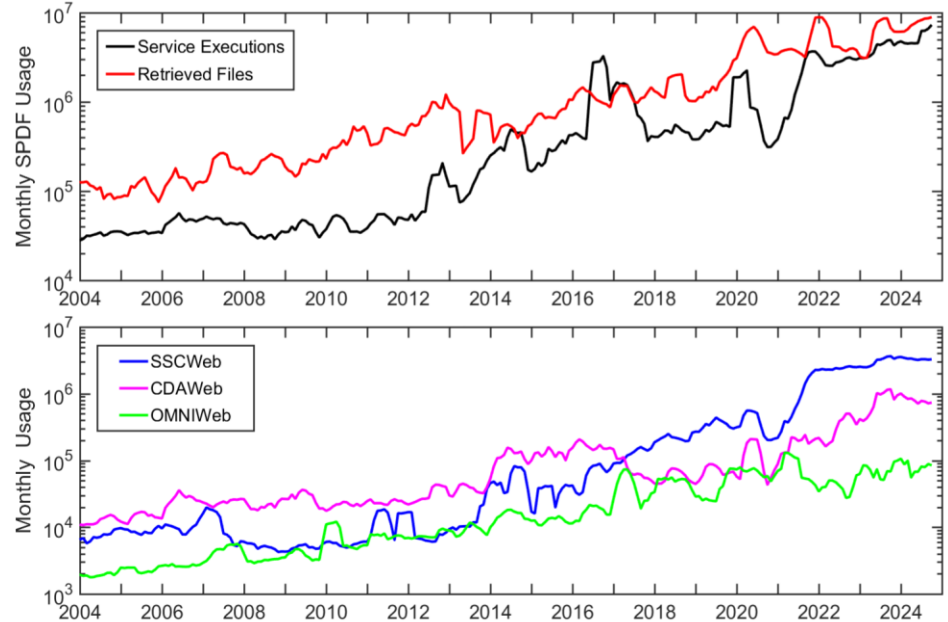
CDF Plans

- ❖ Releasing **new CDF website** with quick-start guides and more responsive design
- ❖ Releasing new ISTP metadata editor (SKTeditor) in JavaScript, adding Space Physics Archive Research and Extract (SPASE) metadata creation
- ❖ Supporting CDFs in cloud object storage
- ❖ Defining CDF MIME type and international standard
- ❖ Apache 2 license in place of current custom license
- ❖ Adding support for CDF to command line NetCDF tools, such as NCO, NCAR, ANTS, NCtools
- ❖ CDF gap checker to write filename, variable name, begin and end time, number of records, and any gaps greater than a certain amount (G-good, M-missing, F-fill, R-outside range, B-backward time)
- ❖ Adding CDF support to Octave, Gnu Data Language (GDL), Excel, Ruby, C++, WebWinds, LinkWinds, Opendap, SWIG.org

*Eric Grimes's
talk tomorrow*

SPDF Other Activities in the Past Year

- Released **new SPDF website** following US Government web design system (USWDS) in late 2023
- Released Plot Walk and JavaScript-based 4D Orbit Viewer
- Working on new SSC and CDF websites
- Copying science level data from SPDF/CDAWeb to HelioCloud, supported HDRL outreach
- Improved CDAWeb plot and display: adjustable X and Y scales, autoscale time axis for intermittent (burst mode) data



About 50% of *JGR-Space Physics* and *Space Weather* papers in 2023 acknowledged SPDF services and data
<https://spdf.gsfc.nasa.gov/Acknowledgements.html>

Development of ISTP Metadata Editor

New JavaScript based web-browser tool to help users create/update CDF datasets with ISTP and SPASE metadata



File Tools Help

Eric Grimes's talk tomorrow

Information

Global Attributes

Variable Attributes

Required

Project [[Project](#)]

LWS>Living With a Star

Source / Spacecraft Name [[Source_name](#)]

PSP>Parker Solar Probe

Descriptor / Instrument Name [[Descriptor](#)]

ISOIS-EPILO>Integrated Science Investigation of the Sun, Energetic Particle Instrument Lo

Data Type [[Data_type](#)]

L2-ic>Level 2 ic

File Naming Convention

source_descriptor_datatype yyyyMMdd

PI Name [[PI_name](#)]

David McComas

PI Affiliation [[PI_affiliation](#)]

Princeton University

Discipline [[Discipline](#)]

Solar Physics>Heliospheric Physics

Space Physics>Interplanetary Studies

Recommended

Acknowledgement [[Acknowledgement](#)]

Cite McComas et al (2016), doi:10.1007/s11214-014-0059-1

Rules of Use [[Rules_of_use](#)]

See https://spp-isois.sr.unh.edu/ISOIS_Terms_of_Use.html, Cite as, "McComas et al. (2016)" a

Digital Object Identifier [[DOI](#)]

SPASE ID [[spase_DatasetResourceID](#)]

spase://VSPO/NumericalData/ParkerSolarProt

Time Resolution [[Time_resolution](#)]

1 minute to 1 hour

Generated By [[Generated_by](#)]

ISOIS SOC, University of New Hampshire

Generation Date [[Generation_date](#)]

20220129

Links

:: Data [Rules of Use](#) [Edit](#) [Trash](#)

:: Instrument paper at [Space Science Reviews](#) [Edit](#) [Trash](#)

:: Magnetic field data for pitch angle calculation courtesy of [the FIELDS team](#) [Edit](#) [Trash](#)

60+ Missions or Mission Groups →

Coordinated Data Analysis Web (CDAWeb)

<https://cdaweb.gsfc.nasa.gov/>

- **Special data source groups:** balloons, ground-based investigations, cubesats, sounding rockets, etc.
- **Enable Systems Science:** cross-mission, multi-instrument science
- Present dataset view rather than individual files
- 70% of 2744 datasets in CDAWeb have SPASE records; 57% have DOIs

• **Select zero OR more Sources**
(default = All Sources if >=1 Instrument Type is selected)

- Balloons
- Geosynchronous Investigations
- Ground-Based Investigations
- Helio Ephemeris
- OMNI (Combined 1AU IP Data; Magnetic and Solar Indices)
- Smallsats/Cubesats
- Sounding Rockets
- ACE
- AIM
- AMPTE
- ARTEMIS
- Alouette
- Apollo
- Arase (ERG)
- CNOFS
- CRRES
- Cassini
- Cluster
- DMSP
- DSCOVR

• **Select zero OR more Instrument Types**
(default = All Instrument Types if >=1 Source is selected)

- Activity Indices
- Electric Fields (space)
- Electron Precipitation Bremsstrahlung
- Energetic Particle Detector
- Engineering
- Ephemeris/Attitude/Ancillary
- Gamma and X-Rays
- Ground-Based HF-Radars
- Ground-Based Imagers
- Ground-Based Magnetometers, Riometers, Sounders
- Ground-Based VLF/ELF/ULF, Photometers
- Housekeeping
- Imaging and Remote Sensing (ITM/Earth)
- Imaging and Remote Sensing (Magnetosphere/Earth)
- Imaging and Remote Sensing (Sun)
- Magnetic Fields (Balloon)
- Magnetic Fields (space)
- Particles (space)
- Plasma and Solar Wind
- Pressure gauge (space)
- Radio and Plasma Waves (space)
- Spacecraft Potential Control
- UV Imaging Spectrograph (Space)

- AEROCUBE-6-B_DOSIMETER_L2:** Aerocube 6/Dosimeter Level 2 - J. B. Blake (The Aerospace Corporation)
[Available Time Range: 2014/06/21 14:49:56 - 2017/06/30 15:24:08] [Info](#) [Metadata](#)
- CSSWE_REPTILE_6SEC-COUNTS-L1:** CSSWE REPTile level1 6sec Counts and Position - Xinlin Li (University of Colorado at Boulder)
[Available Time Range: 2012/09/14 00:28:03 - 2014/08/20 20:27:56] [Info](#) [Metadata](#)
- CSSWE_REPTILE_6SEC-FLUX-L2:** CSSWE REPTile level2 6sec flux and Position - Xinlin Li (University of Colorado at Boulder)
[Available Time Range: 2012/09/14 00:28:03 - 2014/08/20 20:27:56] [Info](#) [Metadata](#)
- ELA_L1_STATE_PRED:** ELFIN-A state file, contains predictive position, velocity, and attitude - V. Angelopoulos (UCLA, IGPP/EPSS)
[Available Time Range: 2018/09/17 00:00:00 - 2022/09/17 23:59:59] [Info](#) [Metadata](#)

CDAWeb Data Explorer

- Time interval is automatically set by the last available day of the selected dataset(s)
- Remove spikes or filter coarse noise
- **Plot data availability**
- Adjust X and Y lengths for plotting
- **Auto scale time axis for finding discrete bursts or events**
- Overlay vector components of selected variables, or selected variables that are identical among multiple datasets
- Output a subset or a superset of datasets in CDF, ASCII/CSV, JSON
- Create **audio** and **movie** files for selected variables

Select start and stop times from which to GET or PLOT data:

Start time (YYYY/MM/DD HH:MM:SS.mmm):

Stop time (YYYY/MM/DD HH:MM:SS.mmm):

Compute uniformly spaced binned data for scalar/vector/spectrogram data (not available with noise filtering)

Use spike removal to filter data without binning (not available with noise filtering)(Warning: Experimental !!).

Select an activity:

Data Availability Chart : Generate a chart showing when data is available for the selected data set(s) and time range (Select > 1day).

Plot Data : select one or more variables from list below and press submit.

Also create PS and PDF best quality outputs (all plot types except images and plasmagrams).
Many panels per dataset are allowed but <=4 panels optimal for standard Y-axis height and single page display.

Use coarse noise filtering to remove values outside 3 deviations from mean of all values in the plotted time interval.

Change the X-axis width for time-series and spectrogram PNG plots (NEW default=3). NEW

Change the Y-axis height for time-series and spectrogram plots (NEW default=2). NEW

Autoscale time axis (useful for finding discrete bursts/events). NEW

Combine all time-series and spectrogram plots, for all requested datasets, into one plot file.

Plot overlay options.

Overlay vector components of selected variables.

Overlay selected variables or variable components that are identical among the datasets chosen
(Supported constellations: MMS, Van Allen Probes (RBSP), THEMIS, Cluster, and GOES).

List Data (ASCII/CSV): select one or more variables from list below and press submit. (Works best for < 31 days)

Download original files : press submit button to retrieve list of files. (Max. 200 days - use [HTTPS site](#) for larger requests)

Create V3.9 CDFs for download: select one or more variables from the list below and press submit. NEW

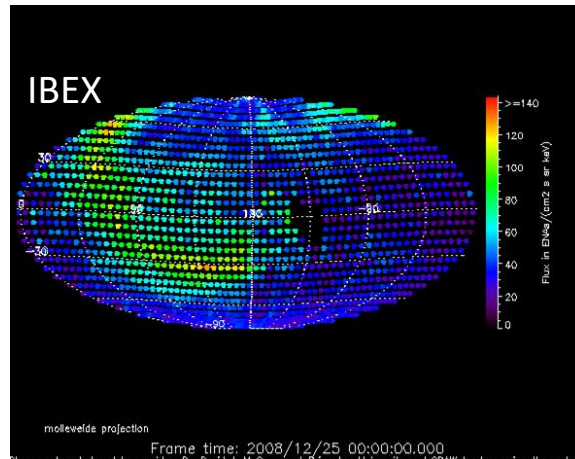
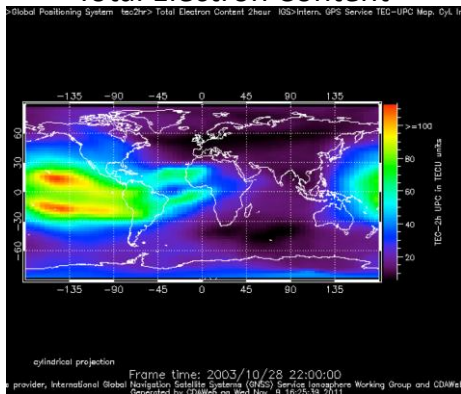
Create **audio files** based on data from selected variables. [More information about audification.](#)

Note: [CDF patch](#) required for reading Version 3.9 CDFs in IDL or MATLAB.
Get [CDFX](#) - IDL GUI plotting/listing toolkit software. To be used with either the daily or "created" CDF files available above.

Pressing the "Submit" button will spawn a new window/tab in order to support the new "Previous" and "Next" functions.

GPS International GNSS Service Total Electron Content

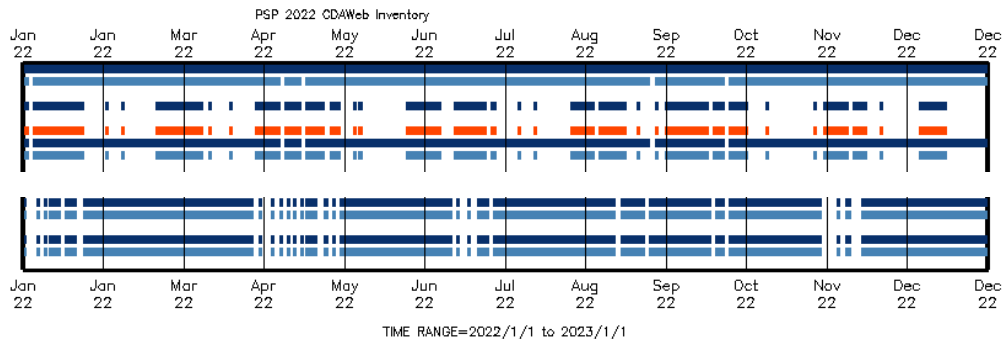
Example
Parameter
Displays
in CDAWeb



More at <https://cdaweb.gsfc.nasa.gov/about.html>

Inventory
Plot for
Mission
Datasets

```
PSP_C0H01HR_MERGED_MAG_PLASMA
PSP_FLD_I2_AEB
PSP_FLD_I2_DFB_AC_BPF_DV12HG
PSP_FLD_I2_DFB_AC_BPF_DV34HG
PSP_FLD_I2_DFB_AC_BPF_SCMULFHG
PSP_FLD_I2_DFB_AC_BPF_SCMULFHG
PSP_FLD_I2_DFB_AC_SPEC_DV12HG
PSP_FLD_I2_DFB_AC_SPEC_DV34HG
PSP_FLD_I2_DFB_AC_SPEC_SCMULFHG
...
PSP_SWP_SPL_SF00_L3_MOM
PSP_SWP_SPL_SF00_L3_MOM_INST
PSP_SWP_SPL_SF01_L2_BDX32EX8A
PSP_SWP_SPL_SF0A_L3_MOM
PSP_SWP_SPL_SF0A_L3_MOM_INST
```



https://cdaweb.gsfc.nasa.gov/sc_inventory_plots/

Each supported dataset also provides links to IDL and Python code examples for downloading and working with the data files independently (outside of the CDAWeb system)

CDAS Web Service Client Code Examples

The following web service client code examples demonstrates how to access data from the [AEROCUBE-6-B DOSIMETER L2](#) dataset from particular programming environments.

Jupyter Notebook on Binder

The following link launches a Python Jupyter Notebook that demonstrates using the `cdasws` library to access [AEROCUBE-6-B DOSIMETER L2](#) data in a Jupyter Notebook. It is merely an example and does not show all the capabilities of the library. You should edit the code to suit your needs.

[launch binder](#)

cdasws Python Library

The following code demonstrates using the `cdasws` library to access [AEROCUBE-6-B DOSIMETER L2](#) data in Python. It is merely an example and does not show all the capabilities of the library. You should edit the code to suit your needs.

```
# Install these prerequisites once before executing the example code:
# Option 1.
#   Install CDF from https://cdf.gsfc.nasa.gov/
#   pip install -U spacepy
#   pip install -U cdasws
# Option 2.
#   pip install -U xarray
#   pip install -U cdflib
#   pip install -U cdasws

from cdasws import CdasWs
cdas = CdasWs()

# Edit the following vars, time variables, and printing to suit your
environment
# (spacepy or cdflib) and needs.
vars =
['alt', 'lat', 'lon', 'XYZ_GEO', 'dos11', 'dos1m', 'dos1rate', 'dos21', 'dos2m'
```

cdasws IDL Library

The following code demonstrates using the `cdasws` library to access [AEROCUBE-6-B DOSIMETER L2](#) data in IDL. It is merely an example and does not show all the capabilities of the library. You should edit the code to suit your needs.

```
compile_opt idl2
savFilename = filepath('spdfcdas.sav', /tmp)
oUrl = obj_new('IDLnetUrl')
; For IDL installations with old root certificates
oUrl->setProperty, SSL_VERIFY_PEER=0
savFilename = oUrl->get(filename=savFilename,
url='https://cdaweb.gsfc.nasa.gov/WebServices/REST/spdfcdas.sav')
restore, savFilename

; Edit the following vars and time variables to suit your needs.
vars =
['alt', 'lat', 'lon', 'XYZ_GEO', 'dos11', 'dos1m', 'dos1rate', 'dos21', 'dos2m', 'dos2rat
e', 'dos31', 'dos3m', 'dos3rate', 'flag', 'Sample_Rate', 'Lm_IGRF', 'Bmag_IGRF', 'MLT_IG
RF', 'InvLat_IGRF', 'Lm_OPQ', 'Bmag_OPQ', 'MLT_OPQ', 'InvLat_OPQ', 'Loss_Cone_Type', 'B
xyz_GEO', 'Beq', 'I', 'K', 'K_Z', 'Lstar', 'Lstar_Z', 'Hmin', 'Hmin_Z', 'Loss_Cone_Near',
'Loss_Cone_Far', 'B100N', 'LAT100N', 'LON100N', 'B100S', 'LAT100S', 'LON100S', 'Alpha',
'Alpha_X', 'Alpha_Y', 'Alpha_Eq', 'Beta', 'Beta_X', 'Beta_Y', 'Phi_B', 'OmegaxYZ_GEO', '
B_spin', 'Spin_Sum', 'Dist_In_Track', 'Lag_In_Track', 'Dist_Cross_Track_Horiz', 'Dist
_Cross_Track_Vert', 'Dist_Total', 'alt_10Hz', 'lat_10Hz', 'lon_10Hz', 'dos11_10Hz', 'd
os1m_10Hz', 'dos1rate_10Hz', 'dos21_10Hz', 'dos2m_10Hz', 'dos2rate_10Hz', 'dos31_10Hz
', 'dos3m_10Hz', 'dos3rate_10Hz', 'flag_10Hz', 'Subcom_10Hz', 'Lm_OPQ_10Hz', 'Bmag_OPQ
_10Hz', 'MLT_OPQ_10Hz', 'InvLat_OPQ_10Hz', 'Loss_Cone_Type_10Hz', 'K_Z_10Hz', 'Lstar_
Z_10Hz', 'Hmin_Z_10Hz', 'Alpha_10Hz', 'Beta_10Hz', 'Dist_In_Track_10Hz', 'Lag_In_Trac
```

[Copy code to clipboard](#) [Download code](#)

More information about using this library is available from the following:

- IDL library description [cdasws](#)
- Jupyter IDL [notebook example](#)
- Application Programming Interface description [API](#)

Alternative data access methods https://cdaweb.gsfc.nasa.gov/alternative_access_methods.html

Update of Webpages

Linking SPDF Services with Missions

https://spdf.gsfc.nasa.gov/data_orbits.html (Partial Screenshot Below)

Click an **SPDF service name** to check mark (✓) the spacecraft whose data are available.

Click a **spacecraft name** to check mark (✓) the SPDF services with its data.

See [Info for New Users](#) for more information about these data services.

160+ missions

Go to Service's Home Page Show Source Info * = Orbit/Trajectory Data Only

DATA SERVICES:	SOURCE SPACECRAFT:	Explorer	Landsat	San Marco	OTHER DATA SOURCES:
<p>✓ CDAWeb </p> <p>High-resolution, current space physics data with graphics and listings from many missions.</p> <p>➤ OMNIWeb Plus </p> <p>Hourly-averaged solar wind magnetic field and plasma, etc.</p> <p>✓ GIWALK </p> <p>Browse pregenerated data and orbit plots</p> <p>✓ SPDF FTPS Site </p> <p>Read FTP to FTPS information.</p> <p>✓ SPDF HTTPS Site </p>	<p>ACE </p> <p>Active* </p> <p>Aerocube </p> <p>Aeros </p> <p>AIM </p> <p>Akebono* </p> <p>Alouette1 </p> <p>Alouette2 </p> <p>AMPTE </p> <p>APEX-MAIN* </p> <p>Apollo </p> <p>Aqua </p> <p>Ariel-4 </p> <p>Arase (ERG) </p> <p>ARCAD </p> <p>ARTEMIS </p> <p>ASTRID II* </p> <p>AE </p> <p>Aura </p> <p>Aureol2 </p> <p>BARREL </p> <p>BepiColombo </p> <p>BioSentinel </p>	<p>FAST </p> <p>FIREBIRD* </p> <p>Formosat </p> <p>Freja* </p> <p>Galileo* </p> <p>Gateway* </p> <p>GCOM W1 </p> <p>Genesis </p> <p>Geotail </p> <p>Giotto* </p> <p>GOCE </p> <p>GOES18 </p> <p>GOES19 </p> <p>GOLD </p> <p>GPS </p> <p>GMS 3 </p> <p>GRACE* </p> <p>Granat </p> <p>Hawkeye </p> <p>Helios </p> <p>Hinode </p> <p>Hinotori </p> <p>IBEX </p>	<p>LANL </p> <p>LRO </p> <p>LUNA </p> <p>Magsat </p> <p>MAP </p> <p>Mariner 10 </p> <p>Mars </p> <p>MAVEN </p> <p>MESSENGER </p> <p>MGS </p> <p>Microlab 1 </p> <p>Mir* </p> <p>MMS </p> <p>MRO </p> <p>MSL </p> <p>MSX* </p> <p>Munin </p> <p>Neptune </p> <p>New Horizons </p> <p>NOAA* </p> <p>Oersted </p> <p>OGO </p> <p>Ohzora </p>	<p>Saturn </p> <p>SCATHA* </p> <p>SDO </p> <p>SET-1/DSX </p> <p>SMILE </p> <p>SNOE </p> <p>SOHO </p> <p>Solar Orbiter </p> <p>SORCE </p> <p>Spartan-A </p> <p>Spitzer </p> <p>SPORT </p> <p>Sputnik 1 </p> <p>STEREO </p> <p>Suisei </p> <p>Swarm </p> <p>Tatiana </p> <p>THEMIS </p> <p>TIMED </p> <p>TRACE </p> <p>TSS-1R </p> <p>TWINS </p> <p>UARS* </p>	<p>Planet & Comet Positions</p> <p>Ground-based</p> <p>Activity Indices</p>

ORBIT/ TRAJECTORY SERVICES:

✓ **SSCWeb Services**

Display and download trajectory

Plot Walk for Pre-Generated Plots

https://spdf.gsfc.nasa.gov/plot_walk/

Summary or quick-look plots from 20+ missions (12.5 million plots)

Plot Walk

[User Guide](#)

Date:

2024-05-12

Time:

00:00

Mission:

PSP-SOLO-STEREO-Wind CROC

Plot type:

Radio Flux

Time range:

1 day



Links:

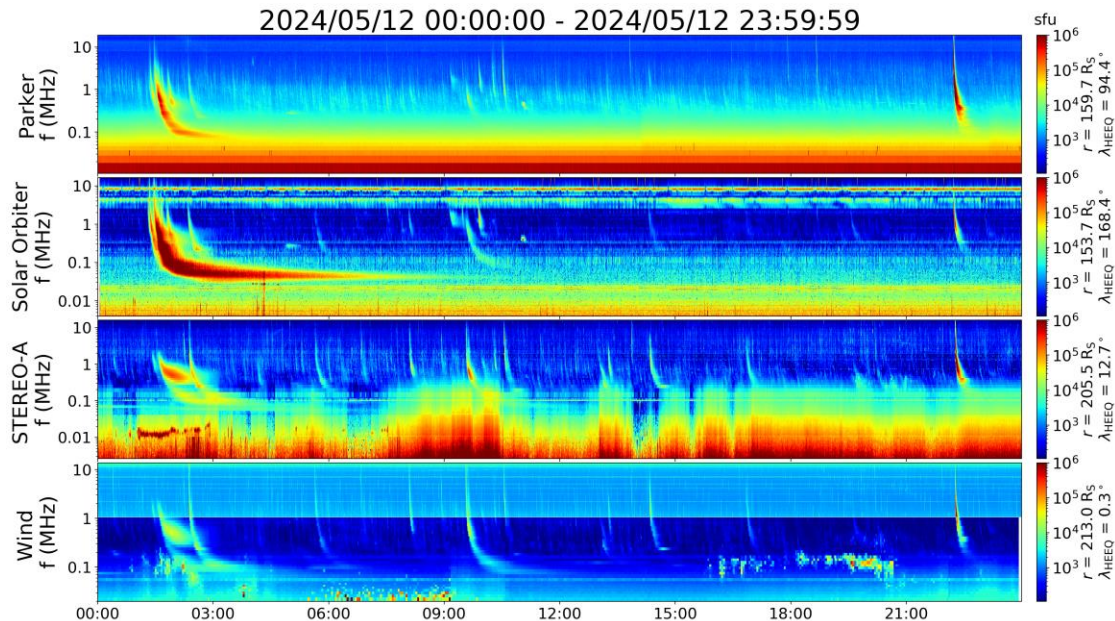
[README](#)

[Image](#)

links for
readme, PNG,
PDF, PS files

Powered by [URI Templates](#), [flatpickr](#) and [driver.js](#).


The catalog can be found [here](#).



Coordinated Radiodiagnosics of CMEs and Solar flares (CROCS) plots using radio data from PSP, Solar Orbiter, STEREO A, and Wind spacecraft

4-D Orbit Viewer (160+ Spacecraft)

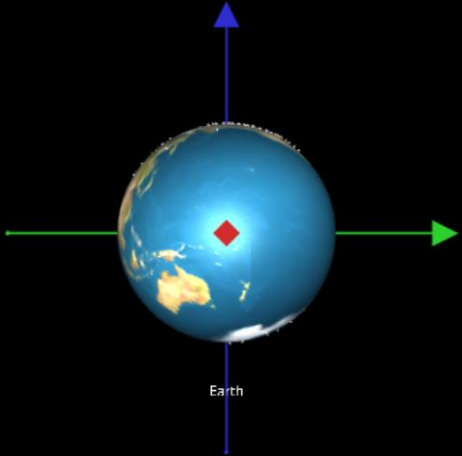
<https://sscweb.gsfc.nasa.gov/4dorbit/>

4D Orbit Viewer  SPDF

☰ ⬇️ 🖼️ ⚙️ 📏 📖 ❓ X Y Z

- ⊕ Earth
- ☾ Moon
- ☉ Sun
- ♿ Mercury
- ♀ Venus
- ♂ Mars
- ♃ Lagrange Point 1

Earth



Earth

Start ▶️ Loop ❓ Speed: 1 x

2024 Oct 13 00:00:00 **2024 Oct 13 00:00:00** 2024 Oct 14 00:00:00

ⓑ ⓓ Ⓜ ⓎⓏ ⓍⓏ ⓍⓎ ⓏⓏ

4-D Orbit Viewer: Time and Spacecraft Selection

The interface displays a 3D visualization of Earth with several spacecraft orbits. A blue box labeled "Display Orbits" points to the orbit lines. The spacecraft are color-coded: Cluster-1 (grey), Cluster-2 (orange), DMSP-18 (pink), GOLD (green), and MMS 2 (purple). The GOLD spacecraft is highlighted with a green oval. The interface includes a top navigation bar with icons for home, download, image, settings, zoom, bookmark, and help. The main panel is divided into a control sidebar on the left and a main display area on the right. The control sidebar includes time selection fields, observatory filters, and a spacecraft selection table. The main display area shows the Earth, orbits, and a table of spacecraft positions in Earth Radii (Re) in GSE coordinates. A timeline at the bottom shows the current time as 2024 May 13 00:39:48 and the end time as 2024 May 16 00:00:00.

Select start of display interval:
2024-05-09 00:00:00
Start Time : May 09 2024 00:00:00

Select end of display interval:
2024-05-16 00:00:00
End Time : May 16 2024 00:00:00

Select observatories:
All Available Selected

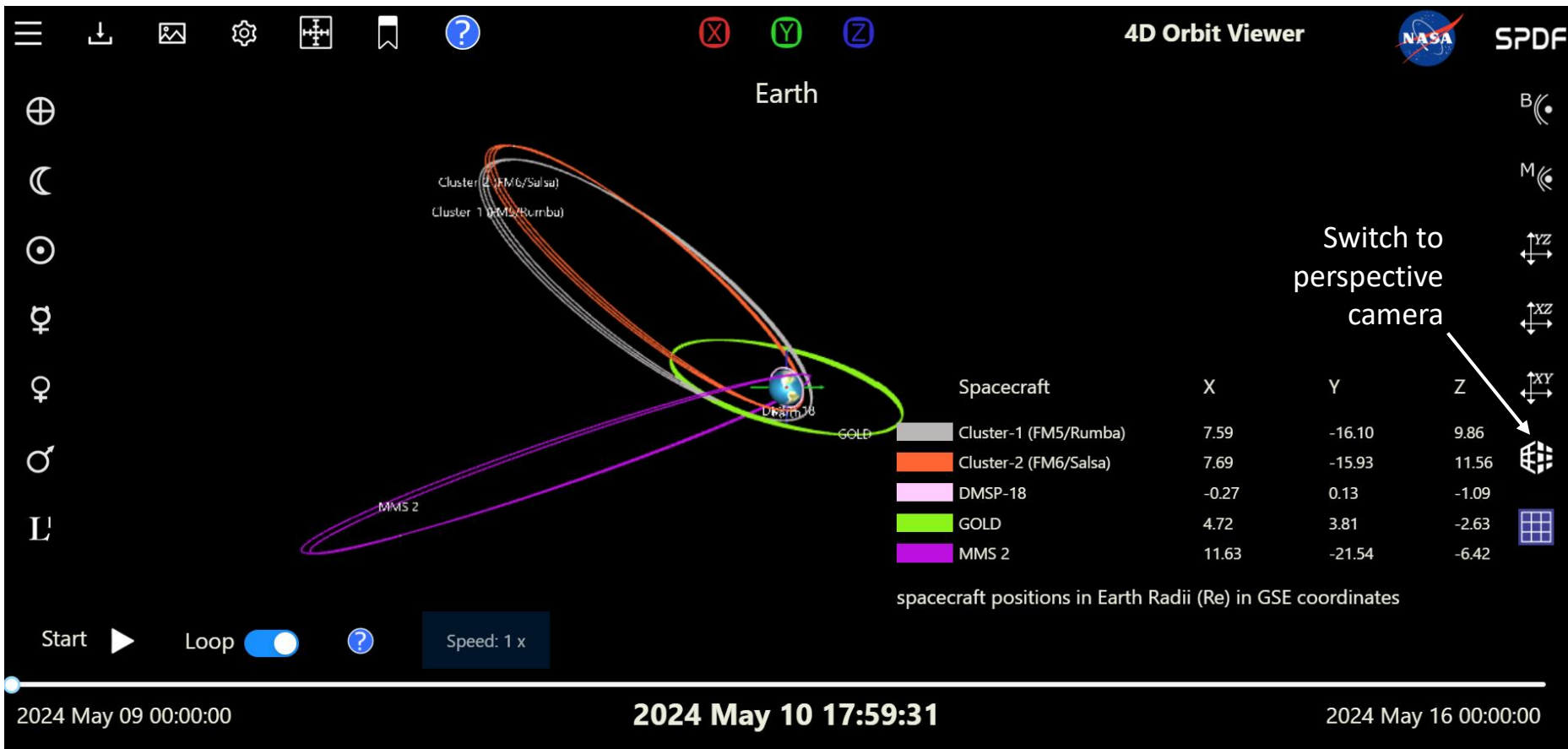
Name	Color	Shape
<input checked="" type="checkbox"/> Cluster-1 (FM5/Rumba)		cube v
<input checked="" type="checkbox"/> Cluster-2 (FM6/Salsa)		sphere v

Spacecraft	X	Y	Z
Cluster-1 (FM5/Rumba)	6.88	-16.44	10.02
Cluster-2 (FM6/Salsa)	6.98	-16.25	11.71
DMSP-18	0.53	0.89	-0.44
GOLD	-4.90	4.40	0.53
MMS 2	4.68	-25.96	-9.16

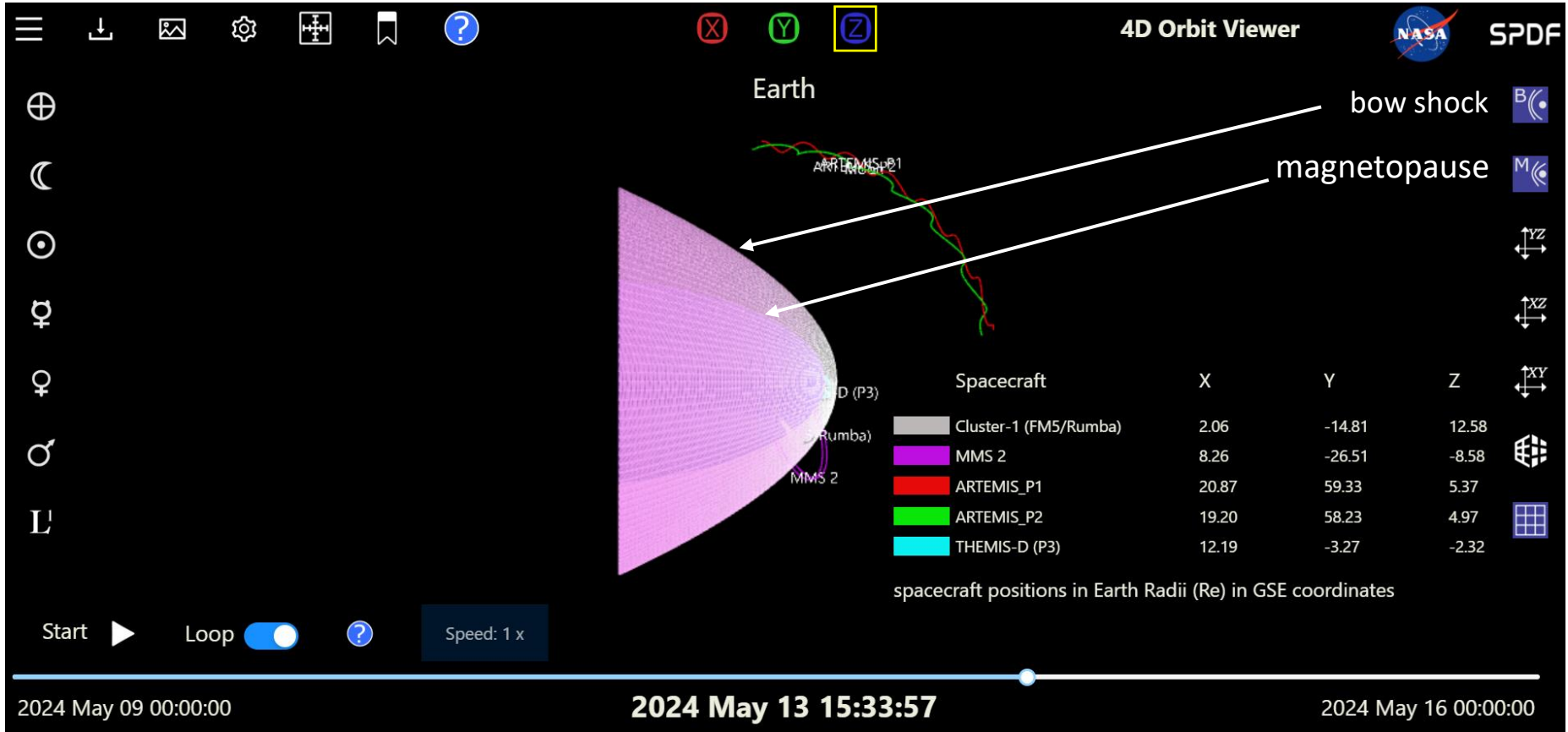
spacecraft positions in Earth Radii (Re) in GSE coordinates

2024 May 13 00:39:48 2024 May 16 00:00:00

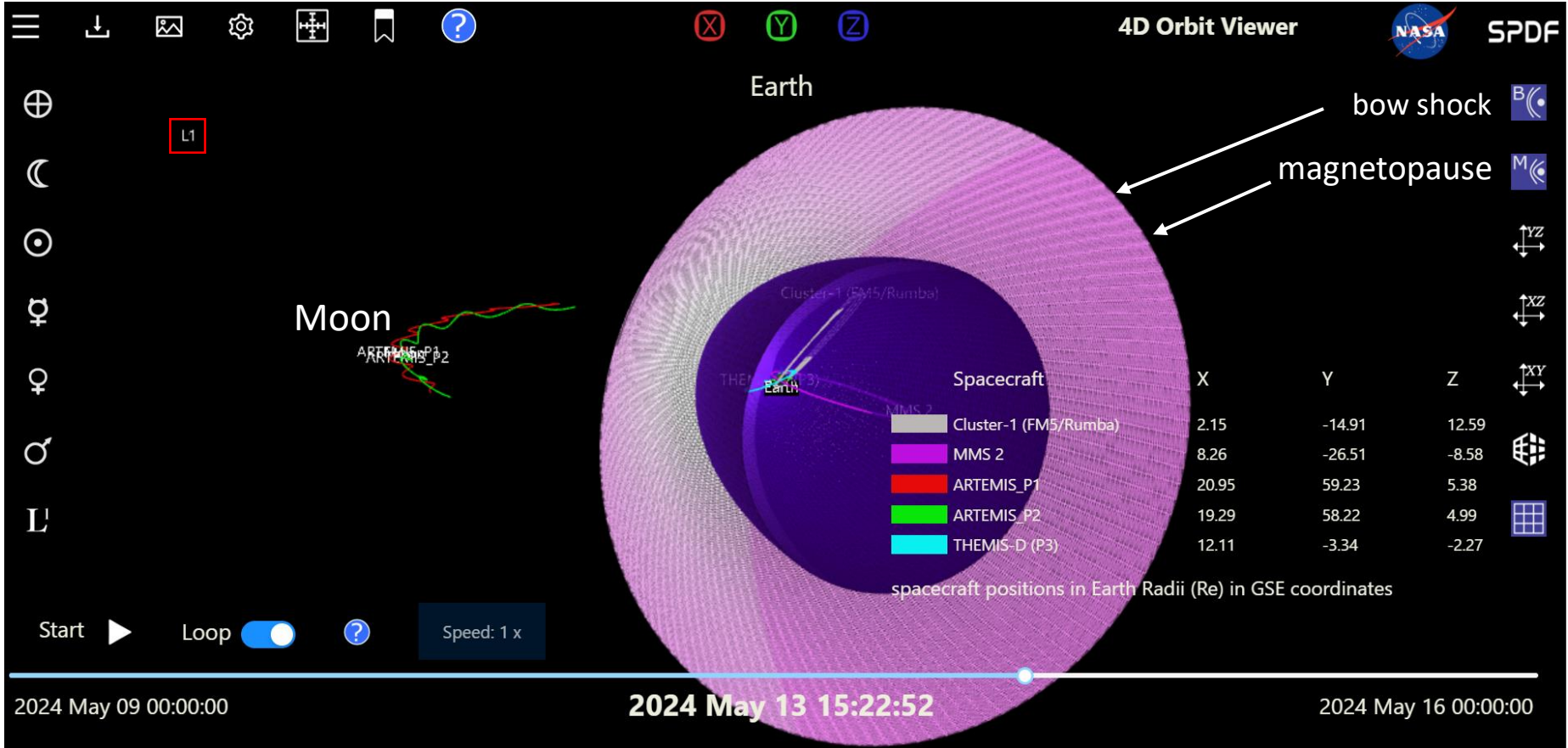
4-D Orbit Viewer: Different Perspectives



4-D Orbit Viewer: Bow Shock and Magnetopause



4-D Orbit Viewer: Rotation of Coordinates



4-D Orbit Viewer: Bookmark the URL

The screenshot shows the 4-D Orbit Viewer interface. A white dialog box is centered on the screen, containing the following text:

Copy URL to Recreate Display to Clipboard

<https://sscweb.gsfc.nasa.gov/4dorbit/?start=20240509T000000Z&stop=20240516T000000Z&spacecraft=cluster1;cluster2;dmspf18;gold;mms2>

Buttons: Cancel, Copy

The background interface includes a top toolbar with icons for menu, download, image, settings, zoom, and help. The main display shows Earth with several spacecraft orbits (Cluster-1, Cluster-2, DMSP-18, GOLD, MMS 2) and their current positions. A table on the right lists the spacecraft and their coordinates in Earth Radii (Re) in GSE coordinates.

Spacecraft	X	Y	Z
Cluster-1 (FM5/Rumba)	-2.22	-6.29	8.38
Cluster-2 (FM6/Salsa)	-1.42	-5.68	7.71
DMSP-18	0.38	0.03	1.07
GOLD	6.22	0.51	-2.19
MMS 2	7.23	-26.13	-9.18

spacecraft positions in Earth Radii (Re) in GSE coordinates

At the bottom, there is a playback control bar with 'Start', 'Loop', and 'Speed: 1 x' buttons. The time display shows '2024 May 09 00:00:00' on the left, '2024 May 09 15:37:40' in the center, and '2024 May 16 00:00:00' on the right.

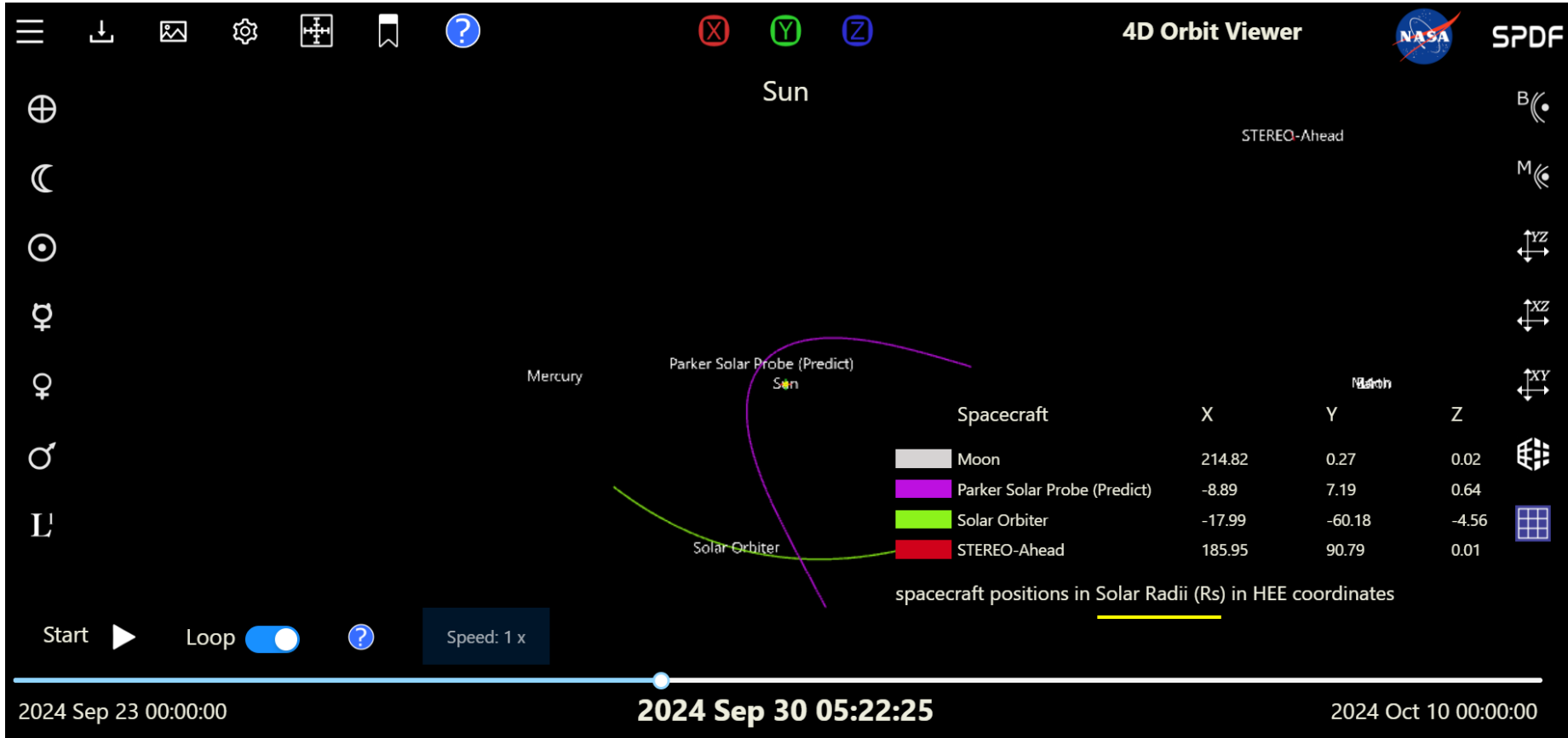
4-D Orbit Viewer: Different Coordinates

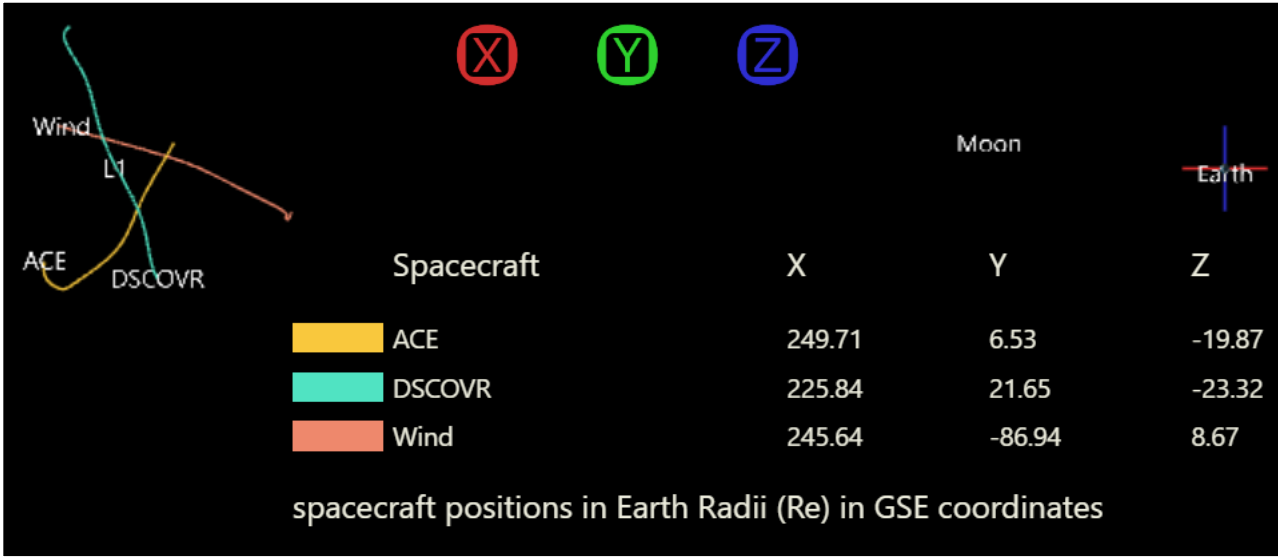
The screenshot displays the '4-D Orbit Viewer' application interface. A central dialog box titled 'Select A Coordinate System' is open, showing two categories of coordinate systems:

- Geocentric Coordinate Systems**
 - GSE** Geocentric Solar Ecliptic
 - GEI** Geocentric Equatorial Inertial
 - J2000** Geocentric Equatorial Inertial for epoch J2000.0
 - GSM** Geocentric Solar Magnetospheric system
 - SM** Solar Magnetic coordinates
 - GEO** Geographic coordinate system
- Heliocentric Coordinate Systems**
 - HAE** Heliocentric Aries Ecliptic
 - HEE** Heliocentric Earth Ecliptic

The background interface includes a top toolbar with icons for menu, download, image, settings, and a coordinate system icon (indicated by a white arrow). The left sidebar contains icons for Earth, Moon, Sun, Venus, Mars, and Jupiter. The bottom timeline shows a date range from '2024 Oct 13 00:00:00' to '2024 Oct 14 00:00:00' with 'Start' and 'Loop' controls. The top right corner features the 'NASA' logo and 'SPDF' text. The right sidebar contains icons for 'B/C', 'M/C', 'YZ', 'XZ', 'XY', a cube, and a grid.

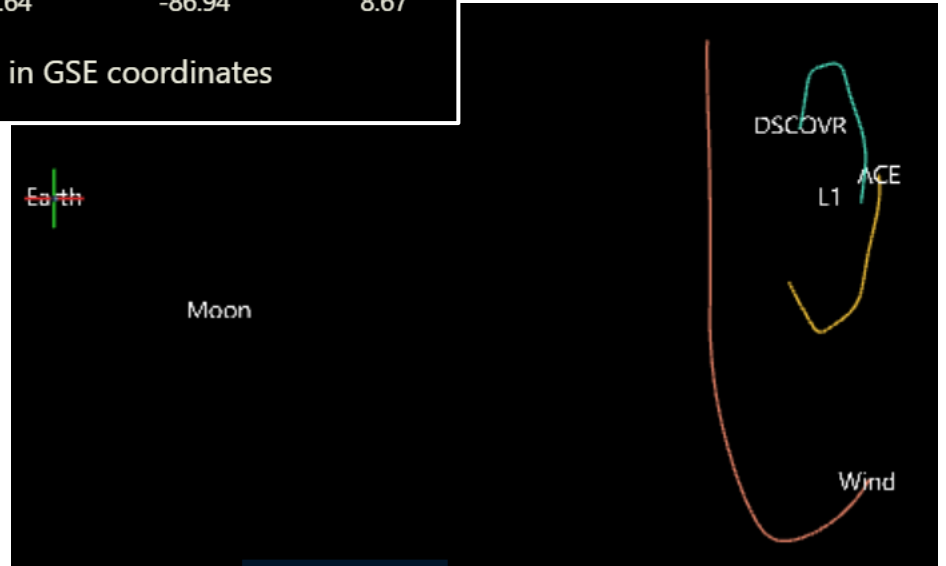
4-D Orbit Viewer: Heliocentric Coordinates





Centered at L1
Along Y axis

Centered at L1
Along Z axis



SPDF Plans

- Data archiving and service for the **upcoming new missions** (EZIE, IMAP, TRACERS, Carruthers)
- Higher-resolution orbit data for SSC
- Improving SPDF documentation and the archival of mission documents
- Standardizing ISTP Metadata Guidelines with version control, etc.
- Releasing new SKTeditor in JavaScript, including defining SPASE metadata at the same time as defining the internal metadata and structure of the CDF/NetCDF dataset
- Adding more planetary coordinates and simulated physical boundaries (e.g., magnetopause) to the new 4D Orbit Viewer
- Releasing new SSC and CDF websites following USWDS, with quick start guides and tutorials
- Designing new OMNI Web and CDAWeb sites
- Making web services for event lists of burst mode data or science events, using CDAWeb and SSCWeb to find previous/next burst or event and better serve them
- HTML5/JavaScript-based browser interface for CDAWeb/SSCWeb, building on the 4D orbit viewer, expanded to add interactive data plotting and sonification tied to the orbit display, perhaps with data glyphs along the orbits as well (using JSON output from CDAWeb and SSC web services)

Backup

Alternative Data Access Methods

https://cdaweb.gsfc.nasa.gov/alternative_access_methods.html

- CDAWeb Browser interface for plots, listings and CDFs (both original and creation of sub/super-set CDFs)
- HTTPS access to original CDFs
 - Master CDFS (binary)
 - SkeletonTables (ascii)
- (FTPS required) FTPS access to original data CDFs
- REST Web Services interface and example use.
- SOAP Web Services interface and example use.
- Python CDAS web services package and ai.cdas package.
- Scripts to keep up-to-date on data files for particular datasets:
 - Example Perl code
 - Periodically download the [CDAWeb HTTPS listing file](#) and compare with a previous file (then download the differences). See Bash shell script below.
- IDL software - reads CDFs and selected Netcdfs, plots, lists and creates subset/superset CDFs (the software that underlies CDAWeb).
 - [CDAWlib readme and example code.](#)
 - [Direct link to CDAWlib software.](#)
- Extremely easy to use IDL software that provides direct access to CDAWeb held data files.
- CREADER : Load data from CDAWeb directly into IDL 7.1+ with specified variables, and optional spike editing and binning and interpolation that produce uniform time series at a chosen time resolution.
- SPEDAS : Space Physics Environment Data Analysis Software - IDL-based plotting, analysis, and data downloading tools.
- pySPEDAS : Python implementation of many SPEDAS plotting, analysis, and downloading tools.
- Autoplot.org (**non-NASA**) interface to public CDAWeb database
- HAPI streaming protocol using HAPI IDL, Python, and other clients from [CDAWeb HAPI](#).

Spacecraft Situation Center (SSC) Conjunction Query

Spacecraft/Time Range Selection

[Spacecraft Availability & Time Ranges](#)

Satellites	Time Range
<ul style="list-style-type: none"> ACE Active AE-C AE-D AE-E AEROCUBE-6A AEROCUBE-6B AIM Akebono Alouette1 Alouette2 APEX-MAIN Aqua Arase (ERG) ARIEL-4 ARTEMIS_P1 ARTEMIS_P1 (6-year Predict) ARTEMIS_P2 ARTEMIS_P2 (6-year Predict) ASTRID II 	<p>Valid Date/Time Formats:</p> <p>Date yyyy ddd yyyy/mm/dd yyyy-mmm-dd hh.hhhh</p> <p>Time (Optional) hh:mm:ss hh:mm</p> <hr/> <p>Start Time (inclusive) <input type="text" value="2023 200"/></p> <hr/> <p>Stop Time (inclusive) <input type="text" value="2023 202"/></p> <hr/> <p>Query Conjunction Condition Type</p> <p><input checked="" type="radio"/> Ground Station <input type="radio"/> Lead Satellite <input type="radio"/> Region</p>

Satellite Combination
<input checked="" type="radio"/> All satellites <input type="radio"/> At least <input type="text" value="1"/> satellite(s)

Example Using THEMIS Mission

https://sscweb.gsfc.nasa.gov/examples/THEMIS_queries/

[themis_conjunction2](#) Magnetic conjunction of THEMIS-5 (lead satellite) with at least 3 other THEMIS

[themis_fast2](#) Magnetic conjunction of at least 2 THEMIS satellites with FAST (lead satellite)

[themis_goes11a](#) Magnetic conjunction of at least two satellites (THEMIS 1-5, GOES 13) with GOES 11

[themis_goes13a](#) Magnetic conjunction of at least two satellites (THEMIS 1-5, GOES 11) with GOES 13

[themis_ground_stations1](#) Magnetic conjunction of at least 2 THEMIS satellites with one of 4 THEMIS ground stations during 2008 doy=1-5

OMNI Web

<https://omniweb.gsfc.nasa.gov/>

OMNIWeb Plus
SPDF • Goddard Space Flight Center

Paths to Magnetic field, Plasma, Energetic particle data relevant to heliospheric studies and resident at Goddard's Space Physics Data Facility.

- OMNI data (spacecraft-interspersed, near-Earth solar wind data)
 - Low resolution OMNIWeb (1-hour, 1 and 27 days, yearly, 1963 - current)
 - High resolution OMNIWeb (1-min, 5-min, 1981 - current)
- Spacecraft-specific data sets (near 1 AU, including near-Earth)
 - ACE
 - Geotail
 - IMP-8, IMP6&7
 - Wind
 - Explorer 33&35, Genesis, ISEE 3, Prognosz, SOHO, GOES
 - Moon Related Spacecraft
 - DSCOVR
- Deep space data
 - COHOWeb-formatted hourly solar wind field, plasma and proton fluxes**
 - Pioneer
 - Ulysses
 - Voyager
 - Cassini, Helios, Mariner, STEREO
- Interfaces for comparing multi-source data
 - Merged Magnetic field and Plasma 1-min
 - Magnetic field
 - Plasma
 - Energetic particle fluxes
 - Multi-source spectra of energetic particle fluxes (MSSP)
 - IMP8/CPME, GOES and ACE/SIS proton fluxes, 1-hour

[Heliocentric Trajectories for Selected Spacecraft, Planets, and Comets](#)

- 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 energetic particle fluxes in other locations of the heliosphere, especially useful for planetary studies and heliospheric model validation
- Interface for plotting, filtering, and downloading the data