

# **Space Physics Data Facility (SPDF)**

Robert Candey, Lan Jian

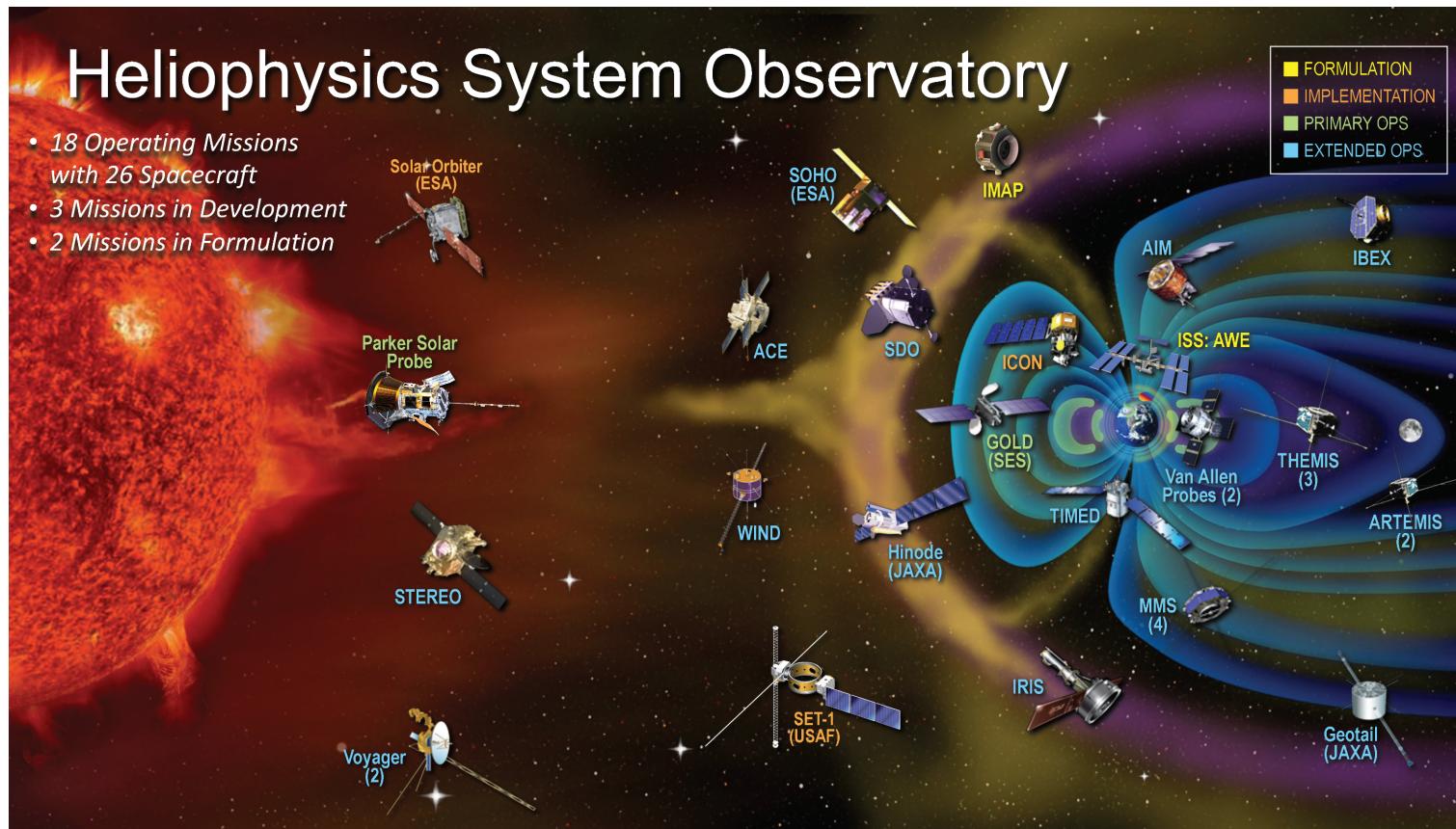
Third IHDEA Meeting

Lanham, MD

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# Introduction of SPDF

- ❖ SPDF is the active and final archive of **in situ data** from NASA heliophysics missions, including collaboration missions with other US and/or foreign agencies



# Introduction of SPDF

- ❖ SPDF is the active and final archive of **in situ data** from NASA heliophysics missions, including collaboration missions with other US and/or foreign agencies
- ❖ We also archive other data **relevant to NASA heliophysics science objectives**
  - Related data from planetary missions (e.g., MESSENGER, MAVEN, New Horizons)
  - Heliophysics data from some NOAA and DOD satellites (e.g., GOES, DSCOVR)
  - Ground-based magnetometers, aurora cameras, radars, etc., which are funded by NSF or other agencies/programs
- ❖ The data covers the space from the Sun to the local interstellar medium, including magnetosphere, ionosphere, thermosphere, and/or mesosphere (M-ITM) of Earth and other applicable planets

\* Only orbit data available

# 131 Missions Supported by SPDF

[https://spdf.gsfc.nasa.gov/data\\_orbits.html](https://spdf.gsfc.nasa.gov/data_orbits.html)

ACE	<a href="#">i</a>	Cassiope	<a href="#">i</a>	GOES	<a href="#">i</a>	LUNA	<a href="#">i</a>	Pioneer	<a href="#">i</a>	STEREO	<a href="#">i</a>
Active*	<a href="#">i</a>	Cluster	<a href="#">i</a>	GOLD	<a href="#">i</a>	Magsat	<a href="#">i</a>	Pioneer 10	<a href="#">i</a>	Suisei	<a href="#">i</a>
Aeros	<a href="#">i</a>	Cosmos 900	<a href="#">i</a>	GMS 3	<a href="#">i</a>	MAP	<a href="#">i</a>	Pioneer 11	<a href="#">i</a>	Swarm	<a href="#">i</a>
AIM	<a href="#">i</a>	C-NOFS	<a href="#">i</a>	Granat	<a href="#">i</a>	Mariner 10	<a href="#">i</a>	Pioneer Venus	<a href="#">i</a>	Tatiana	<a href="#">i</a>
Akebono*	<a href="#">i</a>	CRRES	<a href="#">i</a>	Hawkeye	<a href="#">i</a>	Mars	<a href="#">i</a>	Polar	<a href="#">i</a>	THEMIS	<a href="#">i</a>
Alouette1	<a href="#">i</a>	CSSWE	<a href="#">i</a>	Helios	<a href="#">i</a>	MAVEN	<a href="#">i</a>	Prognоз	<a href="#">i</a>	TIMED	<a href="#">i</a>
Alouette2	<a href="#">i</a>	Dawn*	<a href="#">i</a>	Hinode	<a href="#">i</a>	MESSENGER	<a href="#">i</a>	Reimei	<a href="#">i</a>	TRACE	<a href="#">i</a>
AMPTE	<a href="#">i</a>	DEMETER*	<a href="#">i</a>	Hinotori	<a href="#">i</a>	Microlab 1	<a href="#">i</a>	Rosetta*	<a href="#">i</a>	TWINS	<a href="#">i</a>
APEX-MAIN*	<a href="#">i</a>	DMSP	<a href="#">i</a>	IMAGE	<a href="#">i</a>	Mir*	<a href="#">i</a>	RHESSI	<a href="#">i</a>	UARS*	<a href="#">i</a>
Apollo	<a href="#">i</a>	Double Star*	<a href="#">i</a>	IMP 7	<a href="#">i</a>	MMS	<a href="#">i</a>	ROCSAT-1	<a href="#">i</a>	Ulysses	<a href="#">i</a>
Aqua	<a href="#">i</a>	DSCOVR	<a href="#">i</a>	IMP 8	<a href="#">i</a>	MRO	<a href="#">i</a>	SAMPEX	<a href="#">i</a>	Van Allen Probes	<a href="#">i</a>
Ariel-4	<a href="#">i</a>	DE	<a href="#">i</a>	IMP_early	<a href="#">i</a>	MSL	<a href="#">i</a>	Sakigake*	<a href="#">i</a>	Vega	<a href="#">i</a>
Arase (ERG)	<a href="#">i</a>	Equator-S	<a href="#">i</a>	Interball	<a href="#">i</a>	MSX*	<a href="#">i</a>	San Marco	<a href="#">i</a>	Venera	<a href="#">i</a>
ARCAD	<a href="#">i</a>	Explorer	<a href="#">i</a>	ISEE	<a href="#">i</a>	Munin	<a href="#">i</a>	SCATHA*	<a href="#">i</a>	Viking	<a href="#">i</a>
ARTEMIS	<a href="#">i</a>	FAST	<a href="#">i</a>	ISEE 3-ICE	<a href="#">i</a>	New Horizons	<a href="#">i</a>	SDO	<a href="#">i</a>	Voyager	<a href="#">i</a>
ASTRID II*	<a href="#">i</a>	FIREBIRD*	<a href="#">i</a>	ISIS	<a href="#">i</a>	NOAA*	<a href="#">i</a>	SMILE	<a href="#">i</a>	Voyager 1	<a href="#">i</a>
AE	<a href="#">i</a>	Freja*	<a href="#">i</a>	ISS	<a href="#">i</a>	Oersted	<a href="#">i</a>	SNOE	<a href="#">i</a>	Voyager 2	<a href="#">i</a>
Aura	<a href="#">i</a>	Galileo*	<a href="#">i</a>	Jason 2	<a href="#">i</a>	OGO	<a href="#">i</a>	SOHO	<a href="#">i</a>	Wind	<a href="#">i</a>
Aureol2	<a href="#">i</a>	GCOM W1	<a href="#">i</a>	Juno	<a href="#">i</a>	Ohzora	<a href="#">i</a>	SORCE	<a href="#">i</a>	XMM-Newton	<a href="#">i</a>
BARREL	<a href="#">i</a>	Genesis	<a href="#">i</a>	Kepler	<a href="#">i</a>	PARASOL	<a href="#">i</a>	Spartan-A	<a href="#">i</a>	Yohkoh*	<a href="#">i</a>
CALIPSO	<a href="#">i</a>	Geotail	<a href="#">i</a>	LANL	<a href="#">i</a>	Parker Solar Probe	<a href="#">i</a>	Spitzer	<a href="#">i</a>	Zond	<a href="#">i</a>
Cassini*	<a href="#">i</a>	Giotto*	<a href="#">i</a>	LRO	<a href="#">i</a>	Phobos	<a href="#">i</a>	Sputnik 1	<a href="#">i</a>		

Total: ~10,000 datasets, ~300 TB data

Recent average monthly data ingestion rate: ~0.6 million data files, ~13.7 TB data

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

**GODDARD SPACE FLIGHT CENTER**  
Space Physics Data Facility

+ Goddard Home  
+ NASA Home

## Space Physics Data Facility

+ ABOUT    + DATA & ORBITS    + ModelWeb at CCMC    + SCIENCE ENABLED    + AND MORE

**NASA's Space Physics Data Facility (SPDF)**

The SPDF is a project of the [Heliophysics Science Division \(HSD\)](#) at NASA's Goddard Space Flight Center. SPDF consists of web-based services for survey and high resolution data and trajectories. The Facility supports data from most NASA Heliophysics missions to promote correlative and collaborative research across discipline and mission boundaries. [Read More here.](#)

**Access Data & Orbit Services**

- + [Heliophysics Data Portal \(formerly VSPO\)](#)
- + [Gateway to Services](#)
- + [CDAWeb](#)
- + [CDAWeb Inside IDL](#)
- + [OMNIWeb Plus \(now including COHOWeb, ATMOWeb, FTP Browser, HelioWeb and CGM\)](#)
- + [Direct HTTP\(S\) to Data](#)
- + [Direct FTP\(S\) to Data \(FTPS required\)](#)
- + [SSCWeb](#)
- + [4D Orbit Viewer](#)
- + [GIFWalk data and orbit plots](#)

**Submit New Data to the Archive**

- + [Overview of SPDF Data Submission Guidelines and Procedures](#)
- + [Creating SPASE Data Descriptions](#)

**News & Announcements**

**NOTICE:** September 19, 2019: GOLD L1C, L1D, and L2 data files (Channel A) have been replaced with a new version in the SPDF archive. L1C and L1D data were updated to include a flat-field correction (DAY, LIM, and OCC to version 02; NI1 to version 03). L1 data are available through 8/13/2019. L2 data products were updated based on the new L1 data. TDISK, TLIMB, O2DEN, and ON2 (v02) are available through 8/13/2019. The initial release of QEUV data (v01) is available through 1/31/2019.

**August 1, 2019:** As part of Federal policy to encrypt all network connections, FTP access to the SPDF and CDAWeb data archive was changed to TLS-encrypted FTPS on July 31, 2019. Browsers and traditional command line FTP will NO LONGER CONNECT with FTP, but HTTPS access remains. For more information and alternatives, see our [FTPS Readme](#).

**Special Services**

- + [CDF/netCDF/FITS/HDF/XML/ASCII Format Translations](#)

**SPDF Web Service APIs**

- + [CDAWeb](#)
- + [SSCWeb](#)
- + [Data Format Translations](#)
- + [Heliophysics API \(HAPI\)](#)

**Software**

- + [CDF \(Common Data Format\)](#)
- + [Space Physics use of CDF](#)
- + [Data Format Translations](#)
- + [CDF SKTEditor](#)
- + [MakeCDF](#)
- + [CDAWeblib /CDFX \(IDL\)](#)
- + [ViSBARD \(visualization\)](#)

**Additional Databases**

Bobby's talk  
tomorrow

# [https://spdf.gsfc.nasa.gov/ \(cont.\)](https://spdf.gsfc.nasa.gov/)

## Access Models

- + Community Coordinated Modeling Ctr. (CCMC)
- + ModelWeb at CCMC

## Heliophysics Virtual Observatories

- + NASA's Heliophysics Data Environment
- + Heliophysics Data Portal (formerly VSPO)
- + SPASE Data Model and Dictionary
- + VEPO - Virtual Energetic Particle Observatory
- + VHO - Virtual Heliospheric Observatory
- + ViRBO - Virtual Radiation Belt Observatory
- + VITMO - Virtual ITM Observatory
- + VMO - Virtual Magnetospheric Observatory
- + VMR - Virtual Model Repository
- + VSO - Virtual Solar Observatory
- + VWO - Virtual Wave Observatory
- + More information on Data Access for New Users

NOTICE: June 25, 2019: Robert McGuire, the head of the Space Physics Data Facility (SPDF) since 1992, is retiring. He started as a National Academy of Sciences (NAS) Post-doctoral Fellow at NASA Goddard in 1976, served as the last Project Scientist for the IMP-8 mission until 2006 and was the last designated Principal Investigator of the IMP-8 Goddard Medium Energy (GME) (energetic particle) experiment. He is presently the Associate Director for Science Information Systems in the Heliophysics Science Division at Goddard.

He is being succeeded as Project Scientist for SPDF by Robert M. Candey with Lan Jian as Deputy.

NOTICE: June 25, 2019: The Canned plot visualizer interface has been updated to display MMS Quick Look Summary plots.

NOTICE: The MMS Level 2 data products are available via SPDF HTTPS and all data sets are available in CDAWeb. The range of publicly available MMS data will continue to be updated weekly.

### [New CDF Version 3.7.1 Released](#)

Common Data Format (CDF) Version 3.7.1 is now available. Updates for Perl, IDL, Matlab, and Java interfaces and the SKTeditor CDF editor are available. For further details and changes, see the [CDF release notes](#).

### [Move from HTTP to HTTPS](#)

### [Revised Definition of the Sunspot Number Index](#)

### [Relocation of Directories and Files Served by FTP by SPDF and NSSDC](#)

- + LunaSOX - Lunar Solar Origins Exploration
- + Multi-satellite Bow Shock Database
- + Multi-satellite Magnetopause Crossing Database

## Links

- + SPDF Feedback/Support
- + Heliospheric Physics Laboratory (672)
- + Heliophysics Science Division (670)
- + NSSDCA - National Space Science Data Coordinated Archive
- + Other NASA Archives

*To subscribe, send an email to  
gsfc-spdf-announcements-subscribe  
@lists.nasa.gov*

# Science-Enabling Service # 1

## Coordinated Data Analysis Web (CDAWeb)

70 Missions/Sources ➔

- Present dataset view rather than individual data files
- Plot, list, and correlate data
- Download full or a subset of data in CDF or ASCII format
- Special data sources in development
  - Cubesats: CSSWE (Colorado Student Space Weather Experiment)
  - Sounding Rockets: RENU2 (Rocket Experiment for Neutral Upwelling 2)
  - Ground-based investigations: CANOPUS, DARN, SESAME, high and low latitude chains of magnetometer stations

<ul style="list-style-type: none"><li>• Select zero OR more Sources (default = All Sources if &gt;=1 Instrument Type is selected)</li></ul>	<ul style="list-style-type: none"><li>• Select zero OR more Instrument Types (default = All Instrument Types if &gt;=1 Source is selected)</li></ul>
<ul style="list-style-type: none"><li><input type="checkbox"/> ACE</li><li><input type="checkbox"/> AMPTE</li><li><input type="checkbox"/> ARTEMIS</li><li><input type="checkbox"/> Alouette</li><li><input type="checkbox"/> Apollo</li><li><input type="checkbox"/> Arase (ERG)</li><li><input type="checkbox"/> BARREL</li><li><input type="checkbox"/> CNOFS</li><li><input type="checkbox"/> CRRES</li><li><input type="checkbox"/> Cassini</li><li><input type="checkbox"/> Cluster</li><li><input checked="" type="checkbox"/> Cubesats</li><li><input type="checkbox"/> DE</li><li><input type="checkbox"/> DMSP</li><li><input type="checkbox"/> DSCOVR</li><li><input type="checkbox"/> Dawn</li><li><input type="checkbox"/> ELFIN</li><li><input type="checkbox"/> Equator-S</li><li><input type="checkbox"/> FAST</li><li><input type="checkbox"/> GOES</li><li><input type="checkbox"/> GPS</li><li><input type="checkbox"/> Galileo</li><li><input type="checkbox"/> Genesis</li><li><input type="checkbox"/> Geotail</li></ul>	<ul style="list-style-type: none"><li><input type="checkbox"/> Activity Indices</li><li><input type="checkbox"/> Electric Fields (space)</li><li><input type="checkbox"/> Electron Precipitation Bremsstrahlung</li><li><input type="checkbox"/> Engineering</li><li><input type="checkbox"/> Ephemeris/Attitude/Ancillary</li><li><input type="checkbox"/> Gamma and X-Rays</li><li><input type="checkbox"/> Housekeeping</li><li><input type="checkbox"/> Imaging and Remote Sensing (ITM/Earth)</li><li><input type="checkbox"/> Imaging and Remote Sensing (Magnetosphere/Earth)</li><li><input type="checkbox"/> Imaging and Remote Sensing (Sun)</li><li><input type="checkbox"/> Magnetic Fields (Balloon)</li><li><input type="checkbox"/> Magnetic Fields (space)</li><li><input type="checkbox"/> Particles (space)</li><li><input type="checkbox"/> Plasma and Solar Wind</li><li><input type="checkbox"/> Pressure gauge (space)</li><li><input type="checkbox"/> Radio and Plasma Waves (space)</li><li><input type="checkbox"/> Spacecraft Potential Control</li><li><input type="checkbox"/> Ground-Based HF-Radars</li><li><input type="checkbox"/> Ground-Based Imagers</li><li><input type="checkbox"/> Ground-Based Magnetometers, Riometers, Sounders</li><li><input type="checkbox"/> Ground-Based VLF/ELF/ULF, Photometers</li></ul>

# CDAWeb Data Explorer

Automatically set by  
the last available day  
of the selected data

Options:  
noise filtering,  
spike removal,  
overlay plotting,  
making animations

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

Start time (YYYY/MM/DD HH:MM:SS.mmm): 2019/12/16 00:00:00.000  
Stop time (YYYY/MM/DD HH:MM:SS.mmm): 2019/12/17 00:00:00.000

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

Select an activity:

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.

Use spike removal to filter data without binning (not available with noise filtering)(Warning: Experimental !!). Spike removal method: removal of extreme outliers only NEW

Increase the Y-axis height for time-series and spectrogram plots. NEW  
multiply by: 1

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

Plot overlay options. NEW

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 V3.7 CDFs for download or Autoplot demonstration: select one or more variables from the list below and press submit.

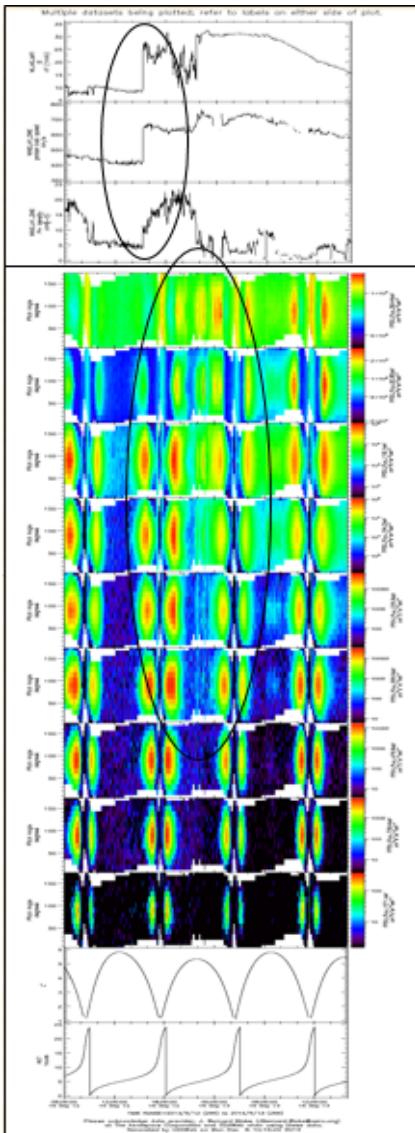
Create audio files based on data from selected variables.

[More information about audification is available here.](#)

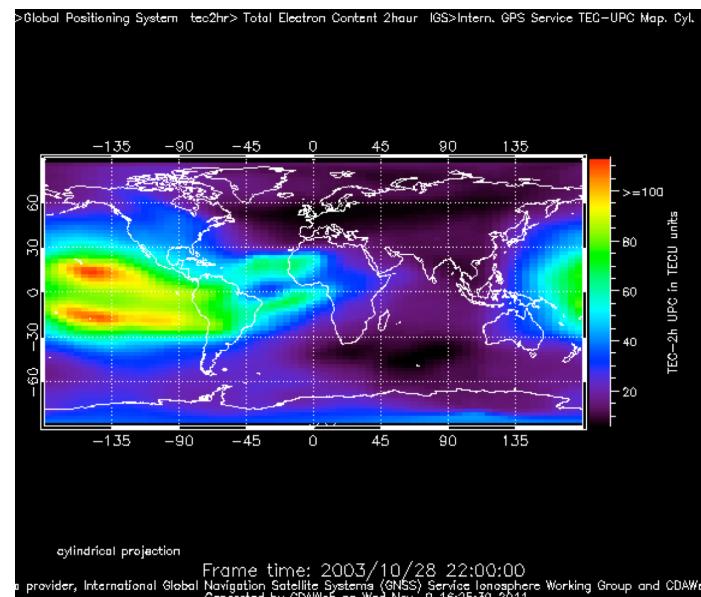
Note: [CDF\\_patch](#) required for reading Version 3.7 CDFs in IDL or MATLAB.  
Get [CDFX](#) - IDL GUI plotting/listing toolkit software. To be used with either the daily or "created" CDF files available above.

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

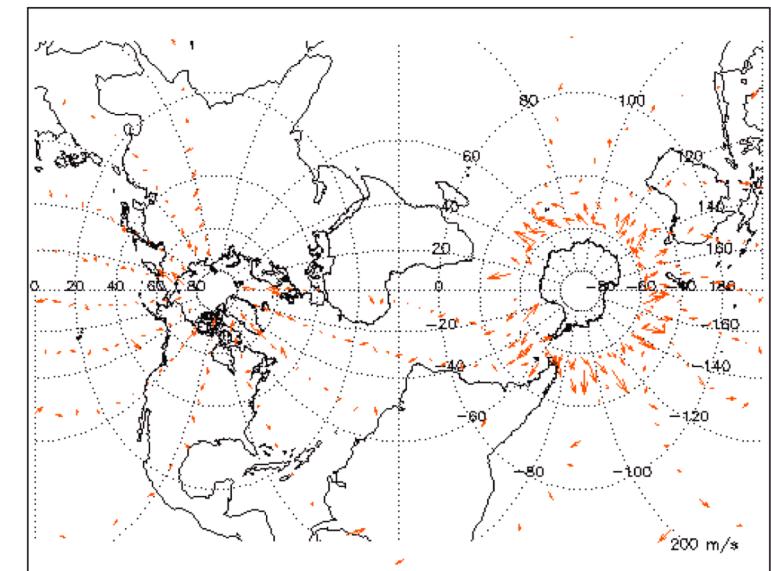
## WIND MFI & SWE Van Allen Probe A ECT & MagEIS



# Parameter Display Options in CDAWeb



GPS International GNSS Service  
Total Electron Content

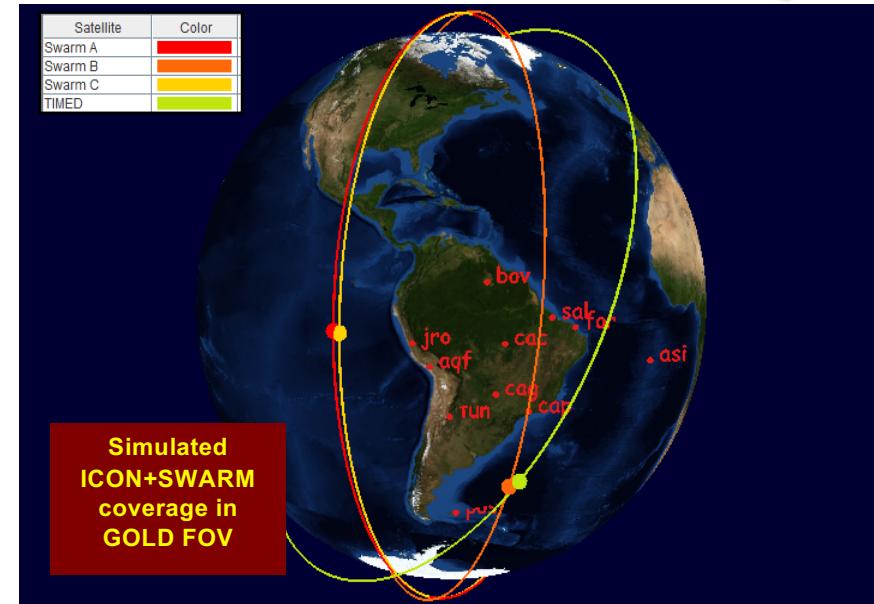
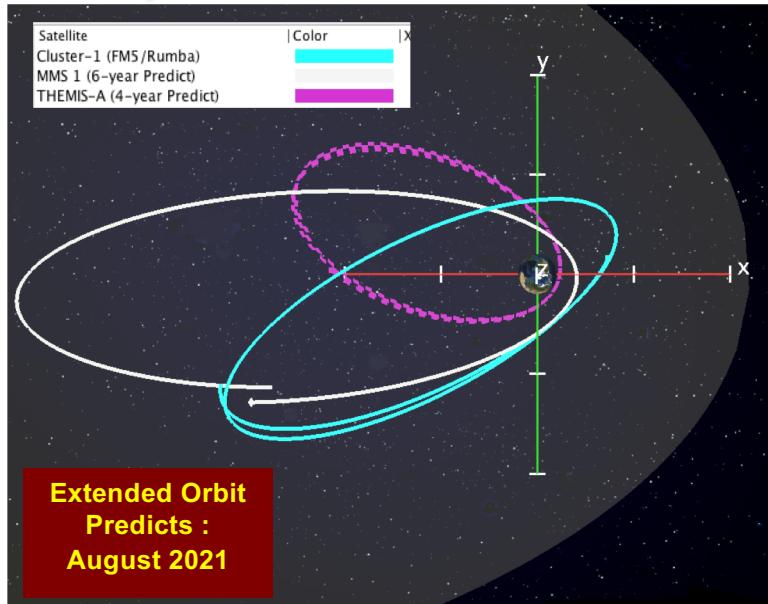


TIMED/TIDI Wind Vectors Movie  
Transverse Mercator Projection

# Science-Enabling Service # 2

## Satellite Situation Center (SSCWeb)

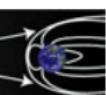
- Include most heliospheric satellites and many ground stations
- Plot and list orbits of multiple s/c in a variety of coordinate systems
- **4D Orbit Viewer:** Interactive 4D animation of orbits
- Query for satellite-satellite and satellite-ground station conjunction



- OMNIWeb Plus, Home
+ ABOUT THE DATA
+ABOUT THE INTERFACE
+Data from command line
+ SPDF/FTP
+ Citing OMNI data usage
DATA via FTPBrowser
Energetic Particle fluxes
ATMOWeb main page
CGM transformation

**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, 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, Prognoz, 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

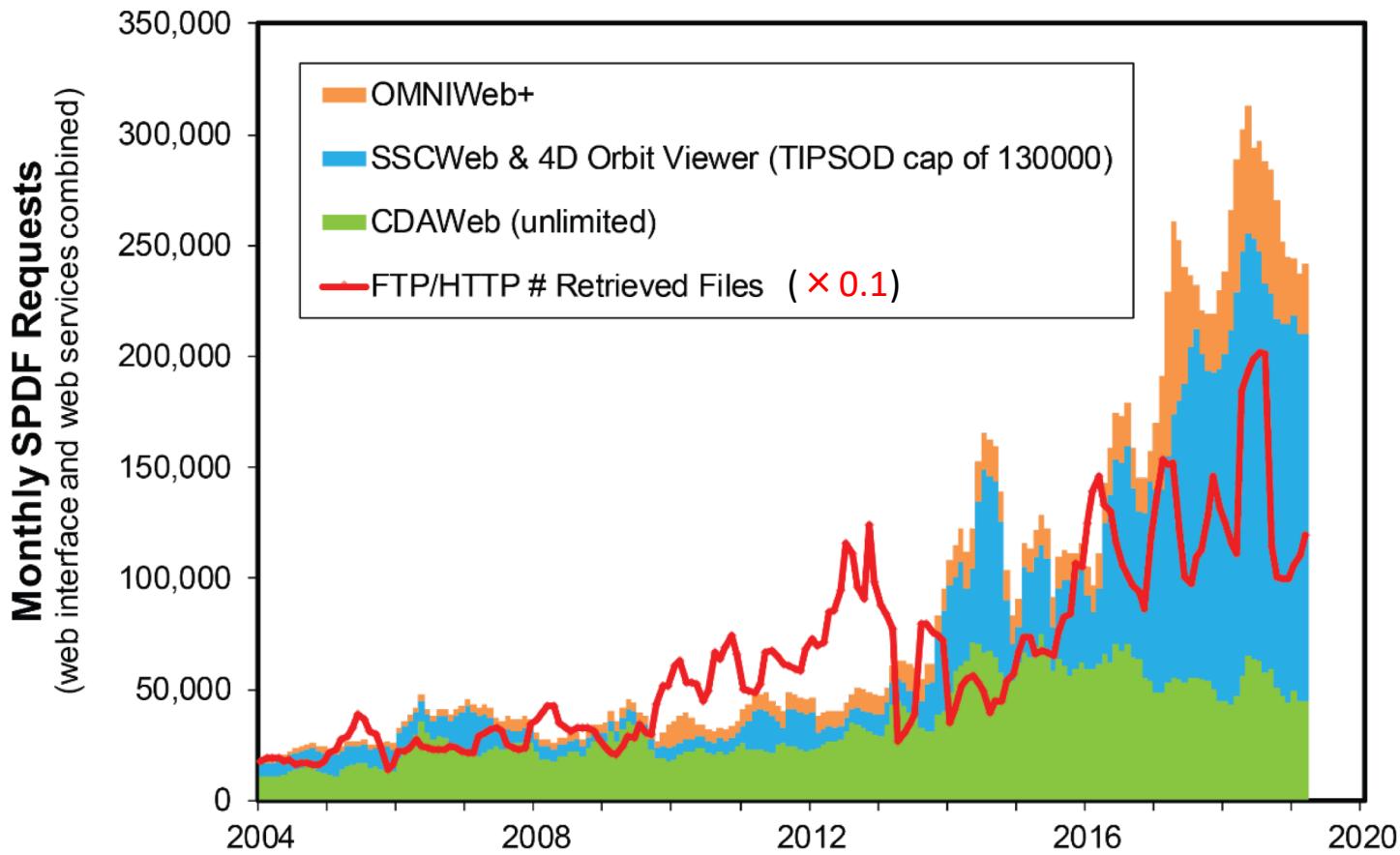
[Heliocentric Trajectories for Selected Spacecraft, Planets, and Comets](#)

# Science-Enabling Service # 3

## 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

# Extensive Use of SPDF Data & Services



- ✓ The data and services provided by SPDF have facilitated global-scale, multi-mission heliophysics science
- ✓ ~30% of papers in AGU's JGR Space Physics acknowledged SPDF services and/or data in recent years

# SPDF Group

Scientists interacting with missions and acquiring science data

+ Natalia Papitashvili  
+ Lan Jian

Retired:  
Bob McGuire



Software engineers and IT experts

Lead:  
Tami Kovalick

# Summary

- SPDF aims to find, ingest, and preserve long-term and ensure ongoing (online) useful access to in situ NASA heliophysics science data
- SPDF tracks the usage of archived data and assists mission senior reviews
- SPDF also provides three main science-enabling services
  - CDAWeb: browse, correlate, and display
  - SSCWeb: orbit/ground track displays and queries
  - OMNIWeb Plus: solar wind conditions at critical locations
- SPDF enables multi-instrument, multi-mission heliophysics science
  - Specific mission/instrument data in context of other missions/data
  - Specific mission/instrument data as enriching context for other data
  - Ancillary services & software (orbits, data standards, special products)
- SPDF helps building critical infrastructures for **heliophysics data environment**: CDF, Heliophysics Data Portal