Data Analysis Enabled by the Space Physics Data Facility

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https://spdf.gsfc.nasa.gov

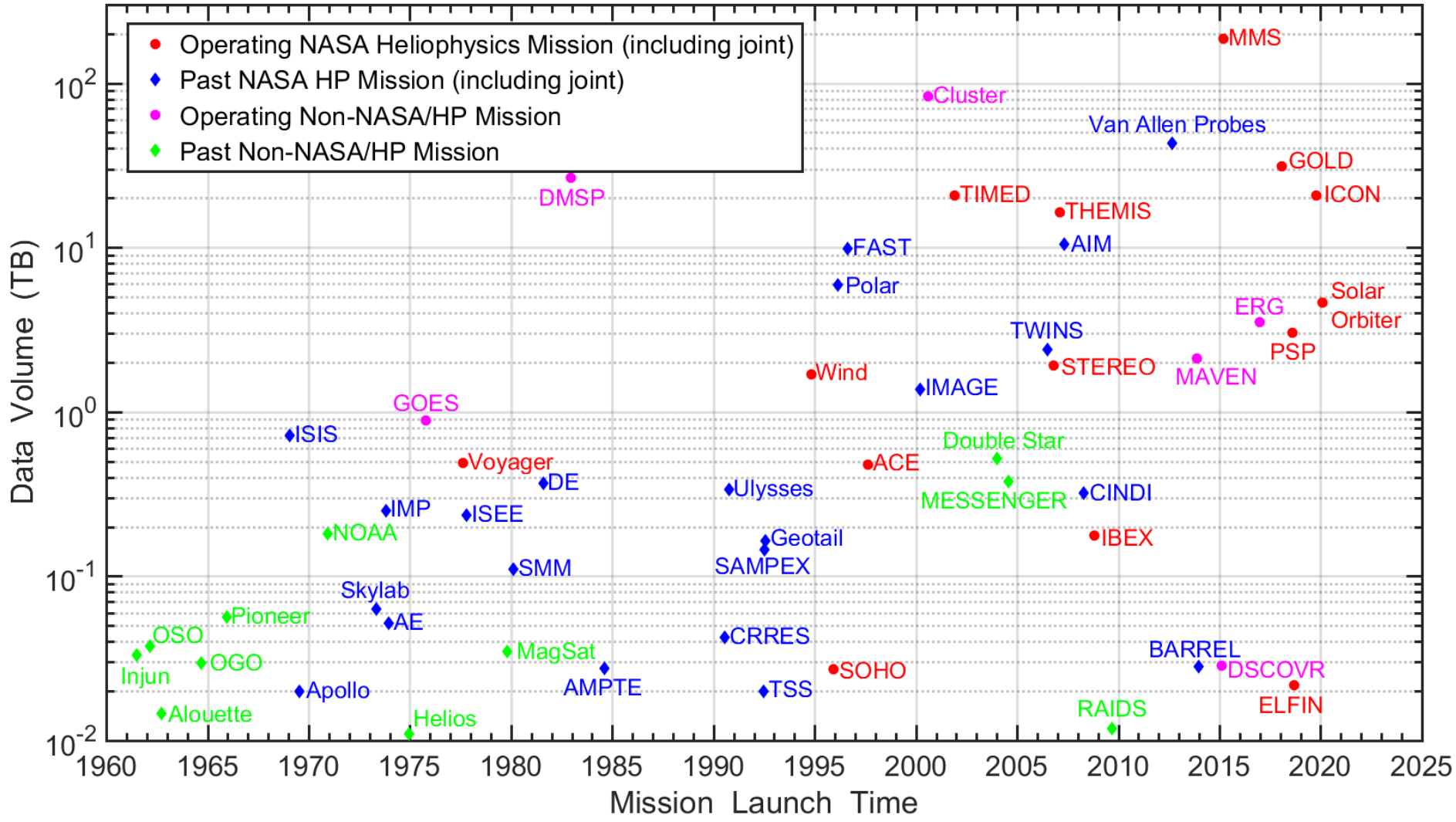
2024 Geospace Environment Modeling (GEM) Workshop

Fort Collins, CO June 28, 2024

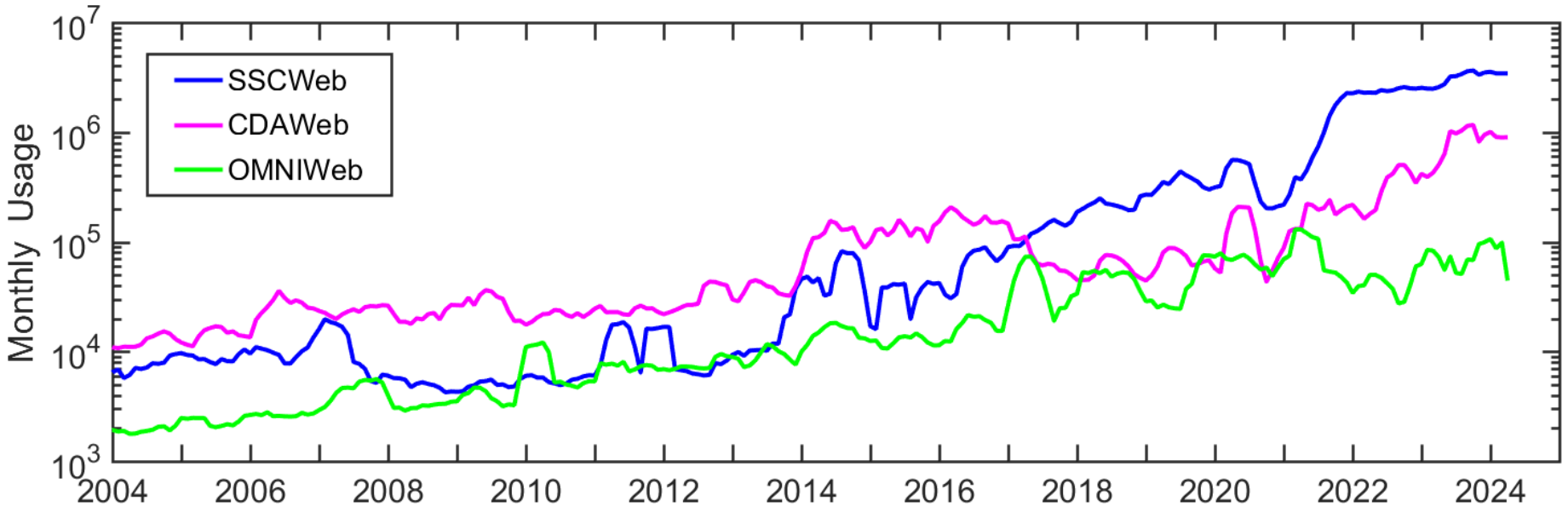
*** Largely based on a presentation give by Lan Jian at this year's TESS meeting**

Introduction of SPDF

SPDF is the active and permanent archive of space physics data from NASA missions and joint missions with other US and foreign agencies (~3000 CDF datasets, ~5000 non-CDF datasets, ~100M files)



Science-Enabling Services of SPDF



❑ **Coordinated Data Analysis Web (CDAWeb)**

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

❑ **Satellite Situation Center (SSC)**

- ~200 spacecraft, orbit/ground track displays and queries
- Coordinate transformation

❑ **OMNIWeb (including COHOWeb)**

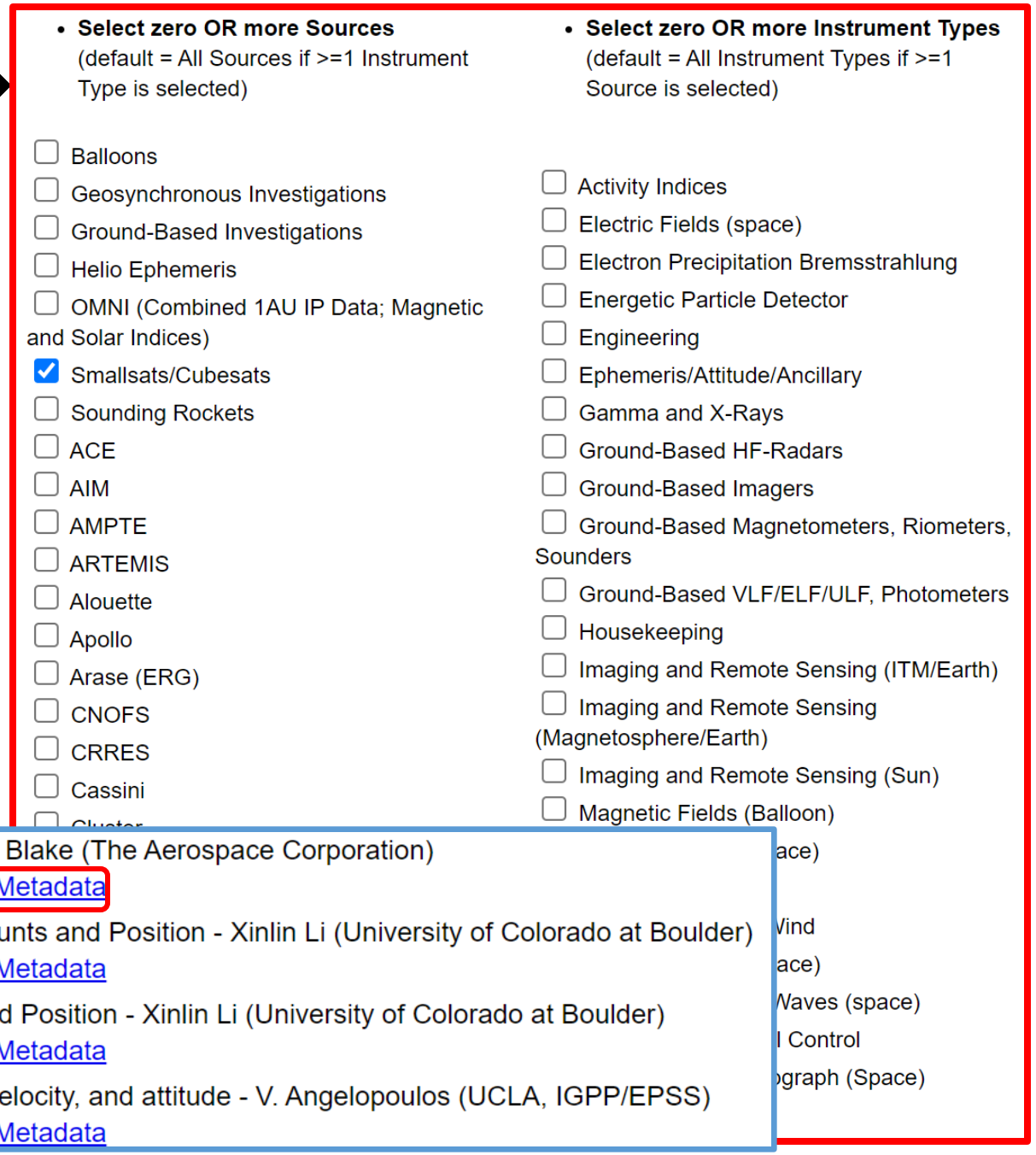
- Solar wind plasma, magnetic field, and energetic particle data at the nose of Earth's bow shock and other locations of the heliosphere
- Interface for plotting, filtering, and simple analysis

60+ Missions/Sources (Groups)

Coordinated Data Analysis Web (CDAWeb)

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

- Enable multi-mission, multi-instrument science
- Present dataset view rather than individual data files



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 print
environment
# (spacepy or cdflib) and needs.
vars =
['alt','lat','lon','XYZ_GEO','dos1l','dos1m','dos1rat
```

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','dos1l','dos1m','dos1rate','dos2l','dos2m','dos2rat
e','dos3l','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_Sun','Dist_In_Track','Lag_In_Track','Dist_Cross_Track_Horiz','Dist
_Cross_Track_Vert','Dist_Total','alt_10Hz','lat_10Hz','lon_10Hz','dos1l_10Hz','d
os1m_10Hz','dos1rate_10Hz','dos2l_10Hz','dos2m_10Hz','dos2rate_10Hz','dos3l_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

Get Dataset Information

The following code demontrates how to get information about a dataset.

In [3]:
```
#print(dataset)
datasets = cdas.get_datasets(idPattern=dataset)
ds_info = datasets[0]
#print(ds_info)
print(ds_info['Id'], ':', ds_info['Label'])
ds_time_interval = ds_info['TimeInterval']
print('Time range:', ds_time_interval['Start'], 'to',
      ds_time_interval['End'])
print('Princple Investigator:', ds_info['PiName'], ':',
      ds_info['PiAffiliation'])
print('Notes:', ds_info['Notes'])
if 'Doi' in ds_info and ds_info['Doi']:
    print('DOI:', ds_info['Doi'])
    print('DOI landing page:',
          cdas.get_doi_landing_page_url(ds_info['Doi']))
```

```
AEROCUBE-6-B_DOSIMETER_L2 : Aerocube 6/Dosimeter Level 2 - J. B. Blake (The Aerospace Corporation)
Time range: 2014-06-21T14:49:56.000Z to 2017-06-30T15:24:08.000Z
Princple Investigator: J. B. Blake : The Aerospace Corporation
Notes: https://cdaweb.gsfc.nasa.gov/misc/NotesA.html#AEROCUBE-6-B_DOSIMETER_L2
DOI: 10.48322/49dd-na02
DOI landing page: https://doi.org/10.48322/49dd-na02
```

Get An Example Time Interval

The following code gets a small example time interval.

In [4]:
```
example_interval = cdas.get_example_time_interval(dataset)
print('Example time interval:', example_interval)
```

```
Example time interval: 2017-06-30T13:24:08+00:00 2017-06-30T15:24:08+00:00
```

Get Dataset Variable Names

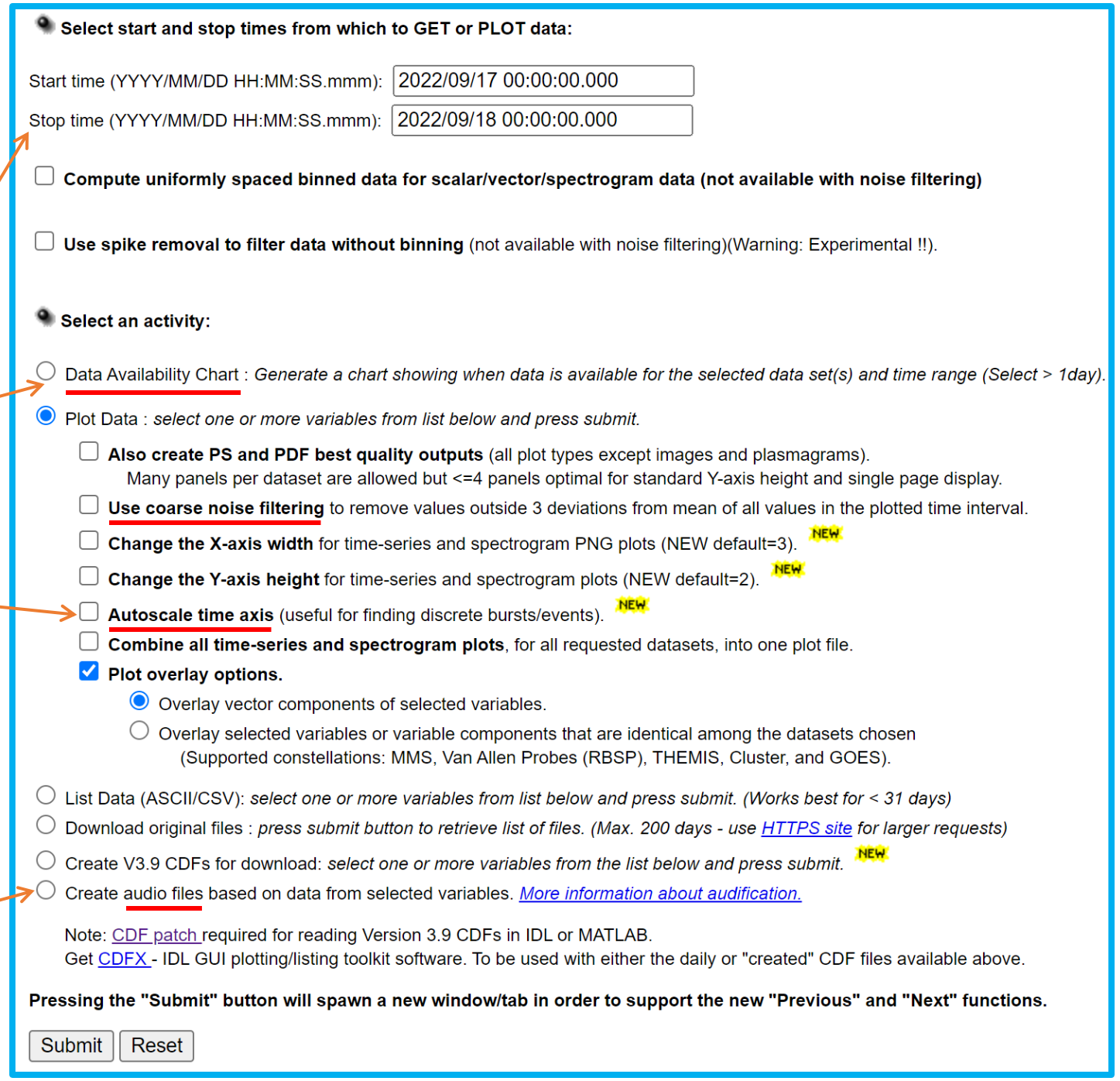
The following code demonstrates how to get a dataset's variable names.

In [5]:
```
var_names = cdas.get_variable_names(dataset)
print('Variable names:', var_names)
```

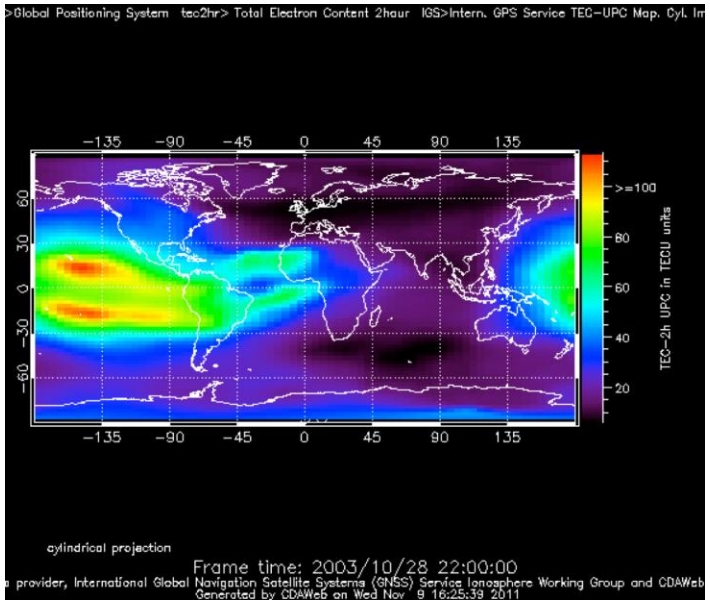
```
Variable names: ['alt', 'lat', 'lon', 'XYZ_GEO', 'dos1l', 'dos1m', 'dos1rate', 'dos2l', 'dos2m', 'dos2rate', 'dos3
l', 'dos3m', 'dos3rate', 'flag', 'Sample_Rate', 'Lm_IGRF', 'Bmag_IGRF', 'MLT_IGRF', 'InvLat_IGRF', 'Lm_OPQ', 'Bmag_
```

CDAWeb Data Explorer

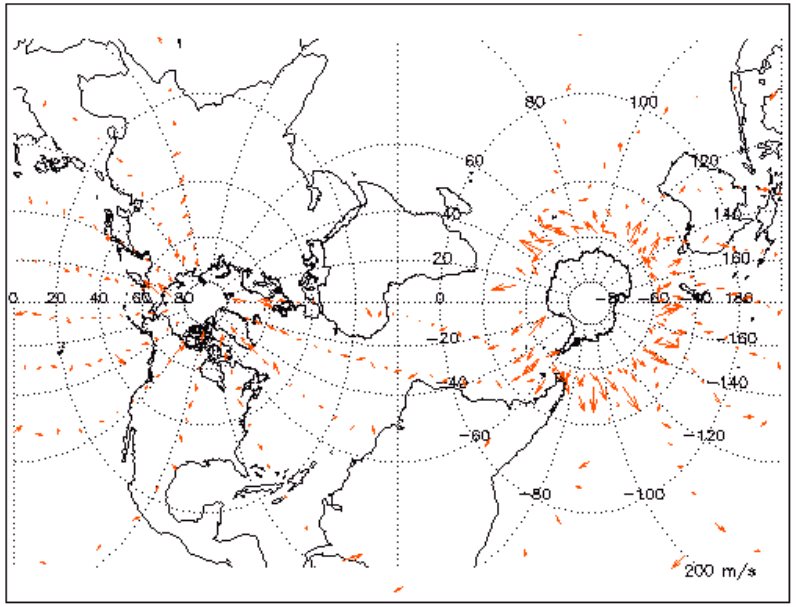
- Time interval is automatically set by the last available day of the selected dataset(s)
- Remove spikes or filter coarse noise
- **Plot data availability**
- Adjust X and Y lengths for plotting
- **Auto scale time axis for finding discrete bursts or events**
- Overlay vector components of selected 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



Parameter Displays in CDAWeb



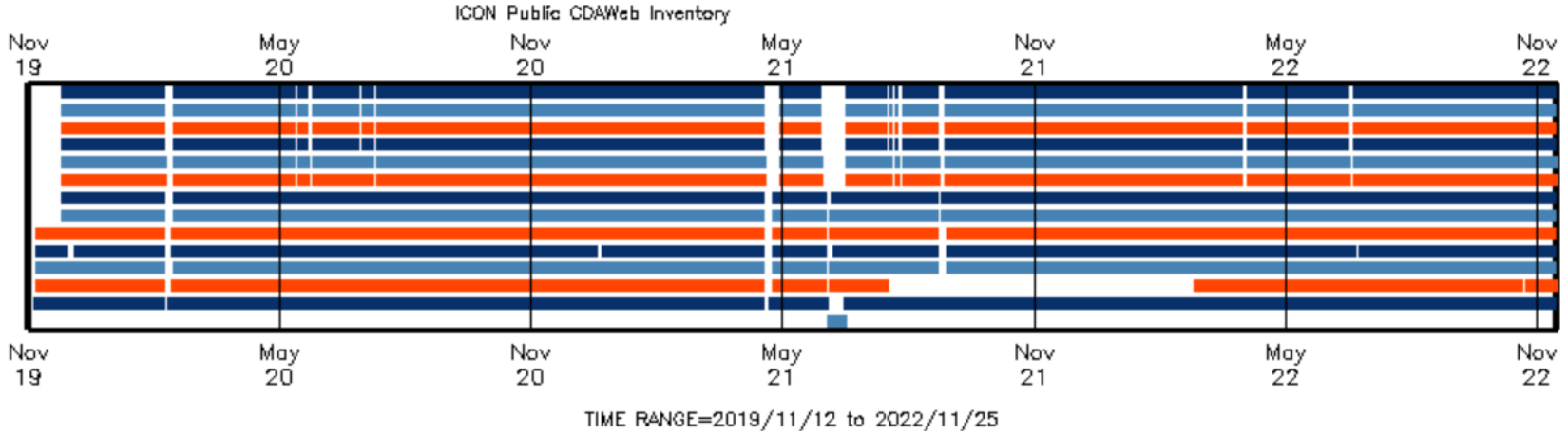
GPS International GNSS Service
Total Electron Content



TIMED/TIDI Wind Vectors Movie
Transverse Mercator Projection

Inventory Plot for Mission Datasets

ICON_L2_1_MIGHTI_A_LOS_WIND_GREEN
ICON_L2_1_MIGHTI_A_LOS_WIND_RED
ICON_L2_1_MIGHTI_B_LOS_WIND_GREEN
ICON_L2_1_MIGHTI_B_LOS_WIND_RED
ICON_L2_2_MIGHTI_VECTOR_WIND_GREEN
ICON_L2_2_MIGHTI_VECTOR_WIND_RED
ICON_L2_3_MIGHTI_A_TEMPERATURE
ICON_L2_3_MIGHTI_B_TEMPERATURE
ICON_L2_4_FUV_DAY
ICON_L2_4_FUV_DAY_LIMB
ICON_L2_5_FUV_NIGHT
ICON_L2_6_EUV
ICON_L2_7_IVM_A
ICON_L2_7_IVM_B



Plot Walk for Pre-Generated Plots

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

Summary or quick-look plots from 20+ missions (12 million plots)

Plot Walk

User Guide

Date:

2022-09-05

Time:

00:00

Mission:

AIM

Plot type:

CIPS RAA Variance (level 3a; vers

Time range:

1 day

« ‹ › »

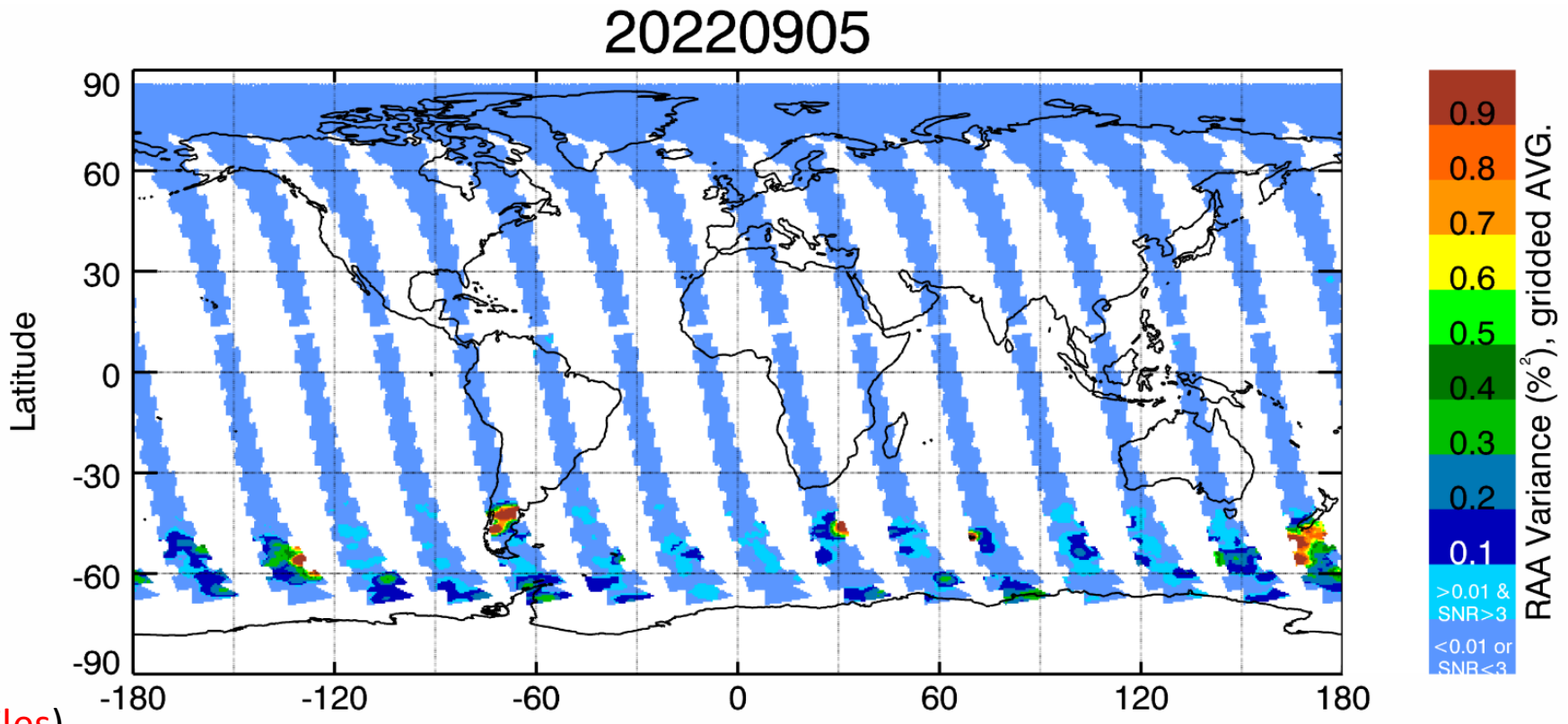
Links:

Image

(links for readme, PDF, PS files)

Powered by URI Templates, flatpickr and driver.js .

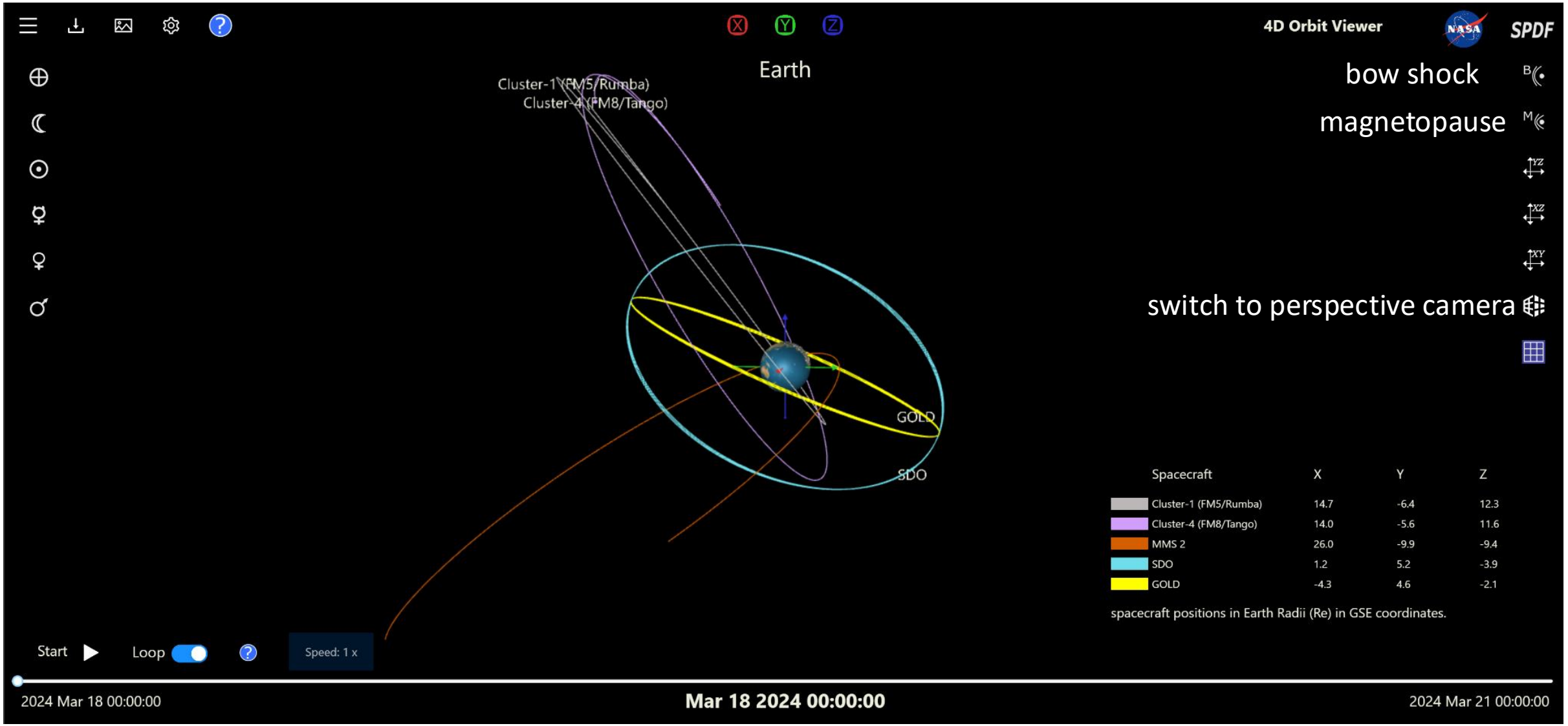
The catalog can be found here.



Rayleigh Albedo Anomaly (RAA) variance from Cloud Imaging and Particle Size instrument (CIPS) of the Aeronomy of Ice in the Mesosphere (AIM) mission

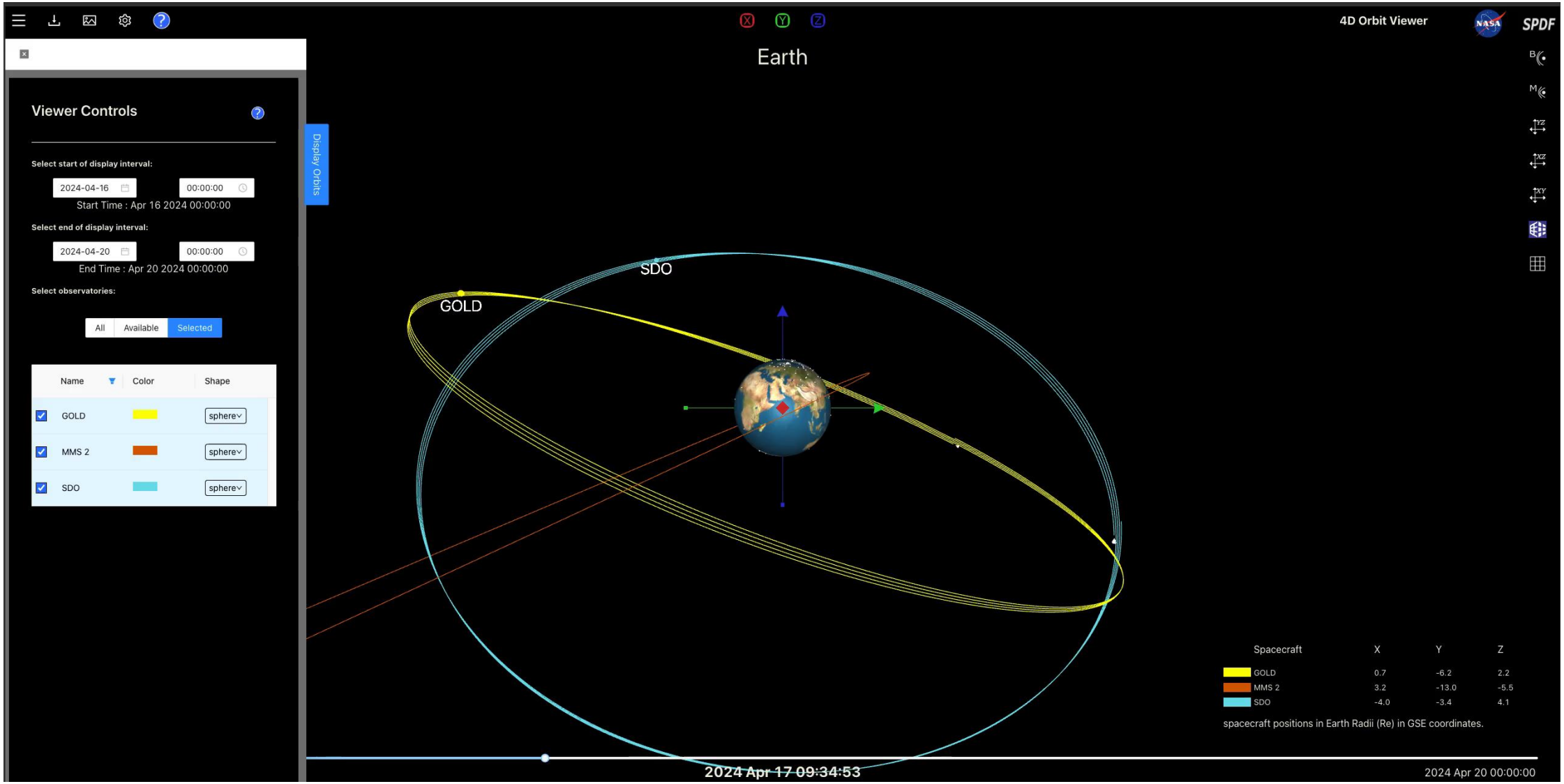
4-D Orbit Viewer (~200 Spacecraft)

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

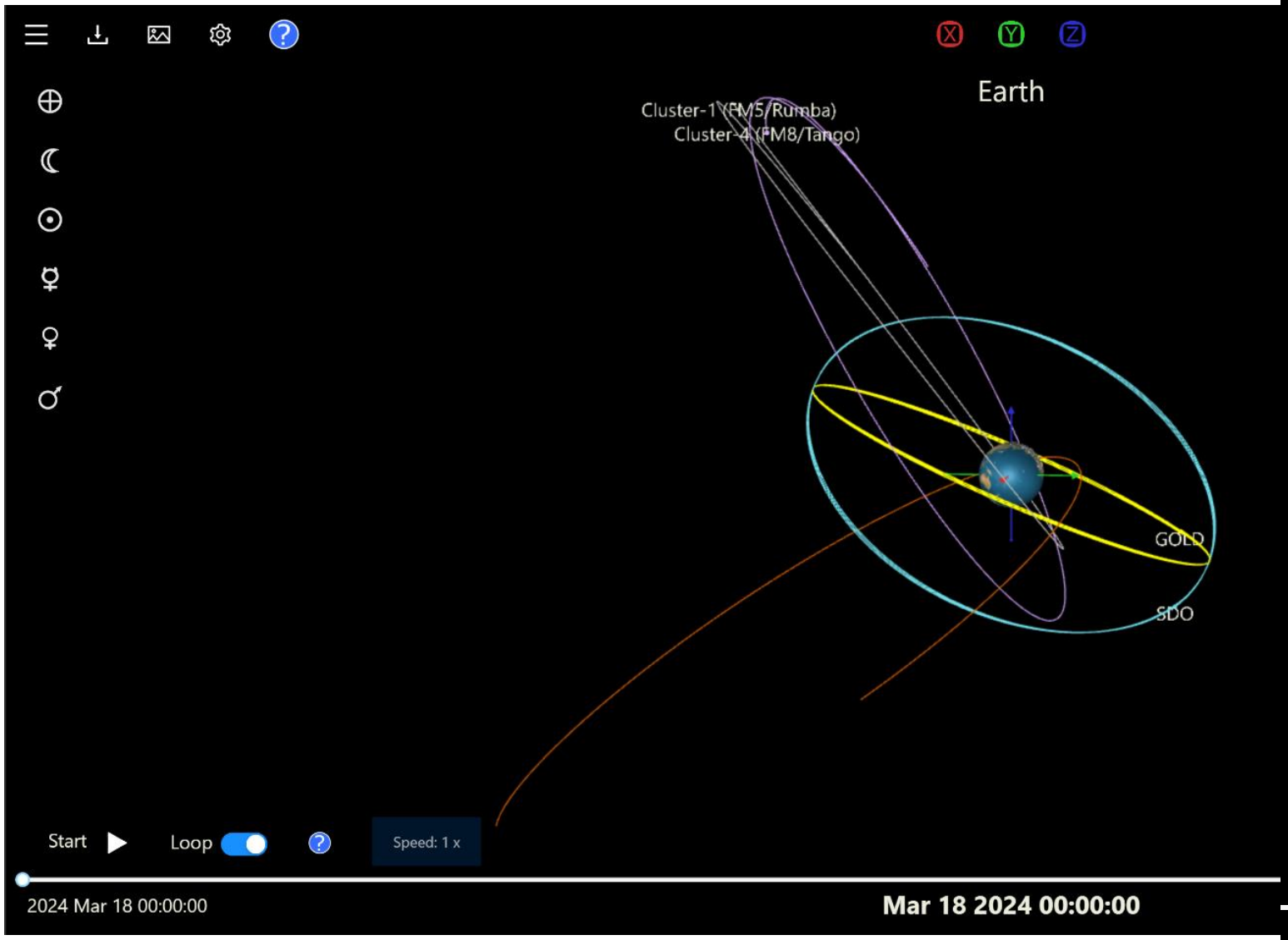


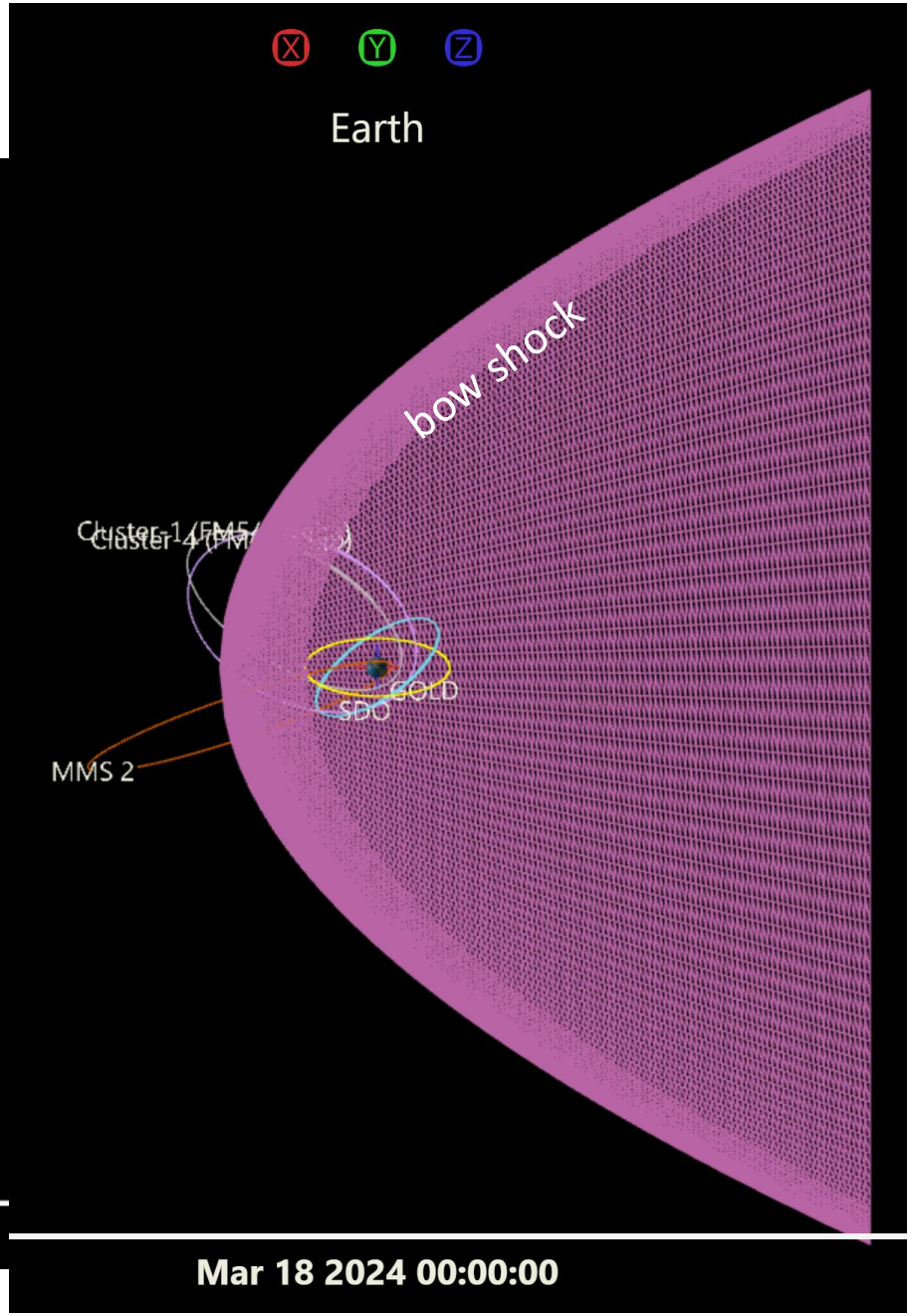
4-D Orbit Viewer (~200 Spacecraft)

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

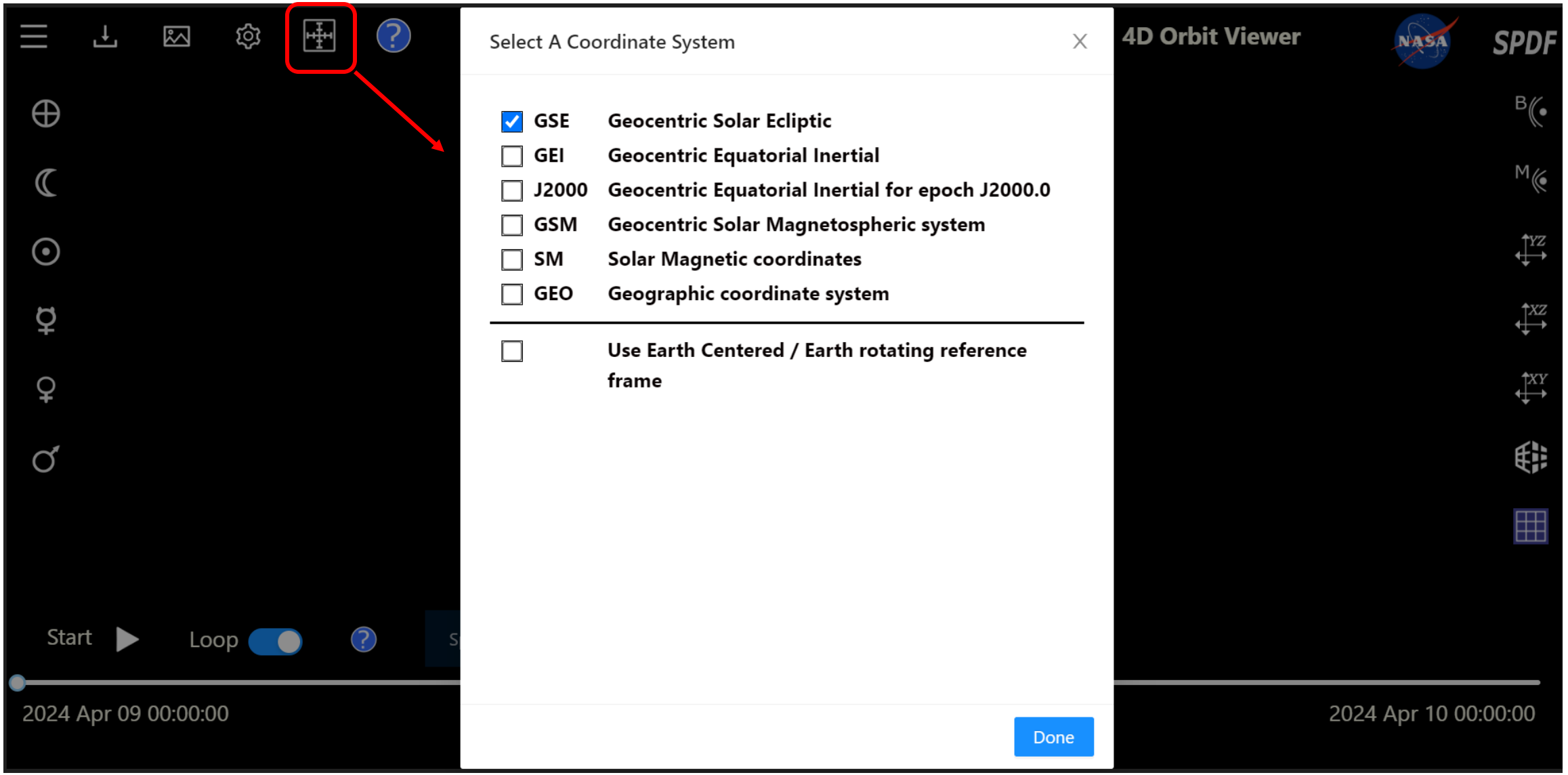


4-D Orbit Viewer





4-D Orbit Viewer: Different Coordinates



Spacecraft Situation Center Conjunction Query

Spacecraft/Time Range Selection

Spacecraft Availability & Time Ranges

Satellites	Time Range
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	**Valid Date/Time Formats:** **Date** yyyy ddd yyyy/mm/dd yyyy-mmm-dd **Time (Optional)** hh.hhhh hh:mm:ss hh:mm Start Time (inclusive) 2023 200 Stop Time (inclusive) 2023 202 **Query Conjunction Condition Type** (•) Ground Station ( ) Lead Satellite ( ) Region

Satellite Combination
(•) All satellites ( ) At least 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)

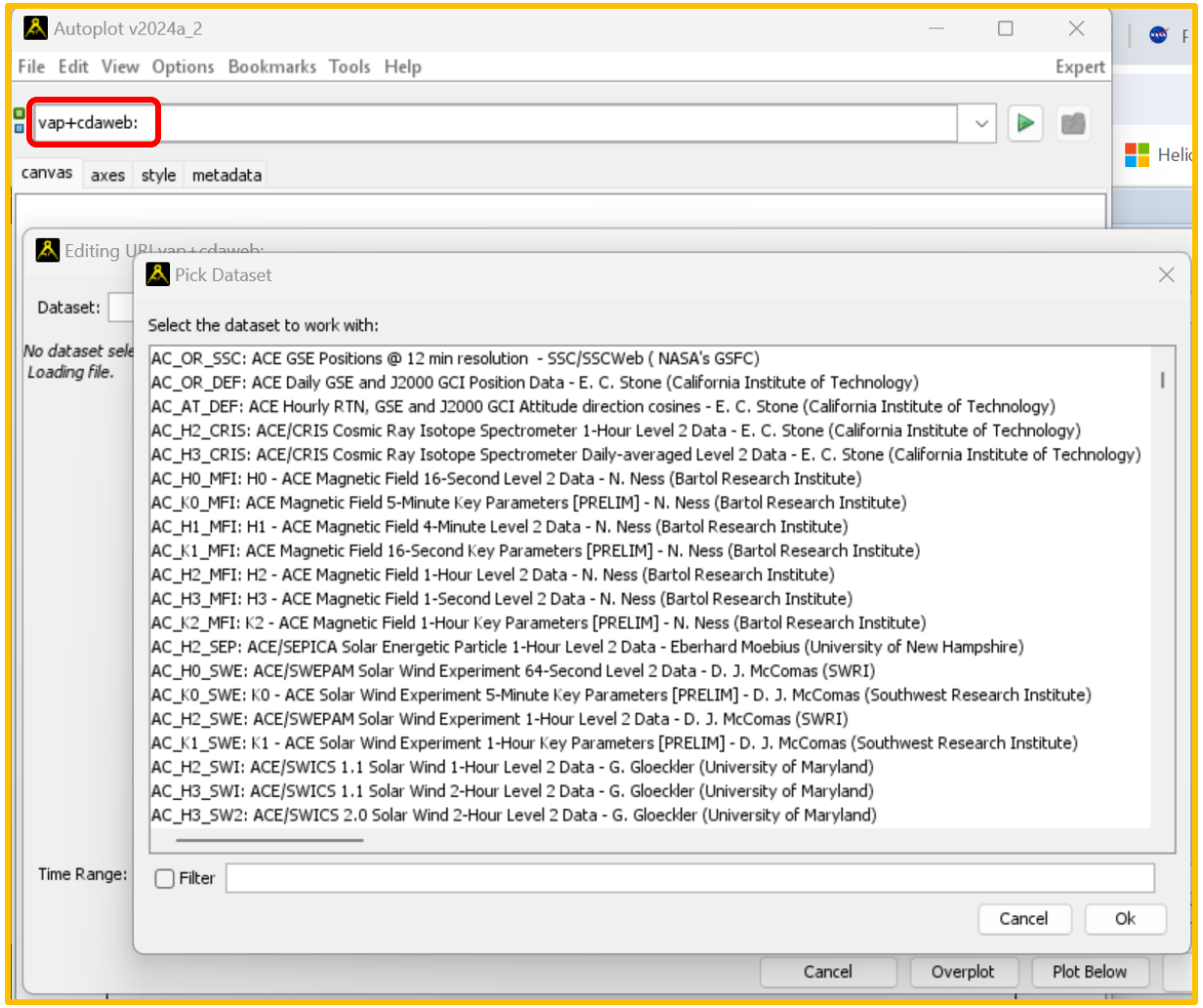
themis_goes11a Magnetic conjunction of at least two satellites (THEMIS 1-5, GOES 13) with GOES 11

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

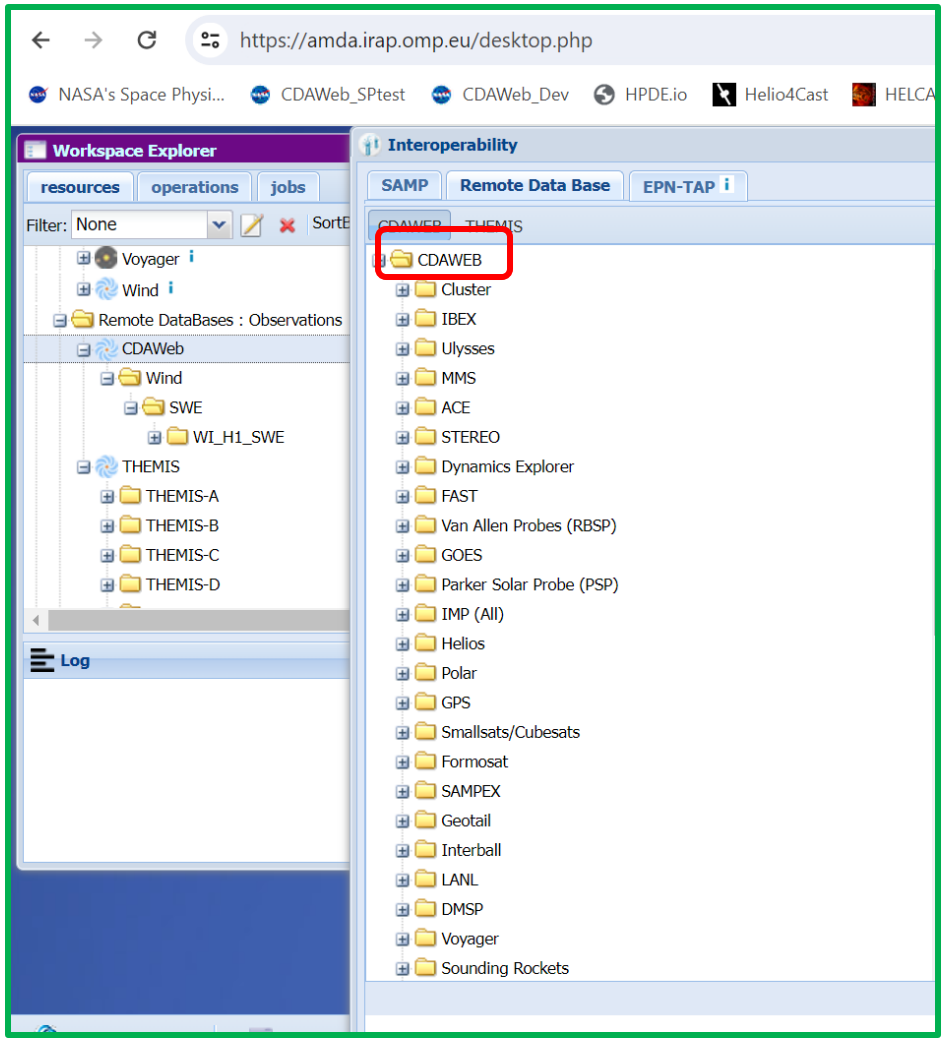
themis_ground_stations1 Magnetic conjunction of at least 2 THEMIS satellites with one of 4 THEMIS ground stations during 2008 doy=1-5

CDAWeb Datasets Are Available at HelioCloud, PySPEDAS, Autoplot, AMDA, etc.

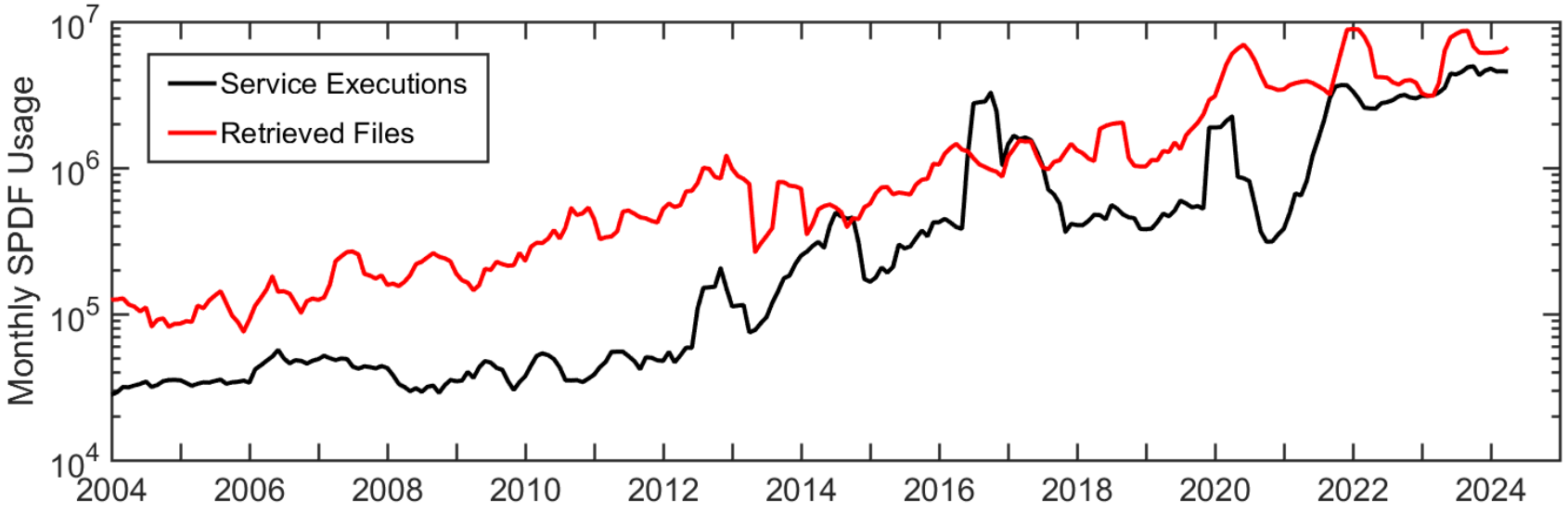
Autoplot



Automated Multi-Dataset Analysis (AMDA)



Summary



- SPDF archives and serves observational space physics data relevant to NASA heliophysics science objectives in order to promote correlative and collaborative research across discipline and mission boundaries
- SPDF provides three main science-enabling services: CDAWeb, SSCWeb, and COHOWeb
- SPDF welcomes community feedback/input to improve our services
  - Updating the ISTP metadata standards
  - Serving research generated data and plots
  - Developing more interactive data explorer (e.g., making multi-dimensional data more digestible rather than depending on heavy usage of additional software packages)