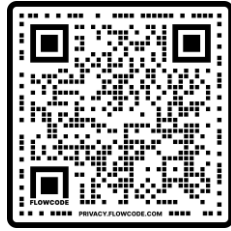




LIKED publication DOI:
10.1016/j.asr.2022.10.051



DIARieS publication DOI:
10.1016/j.asr.2022.05.012

DIARieS

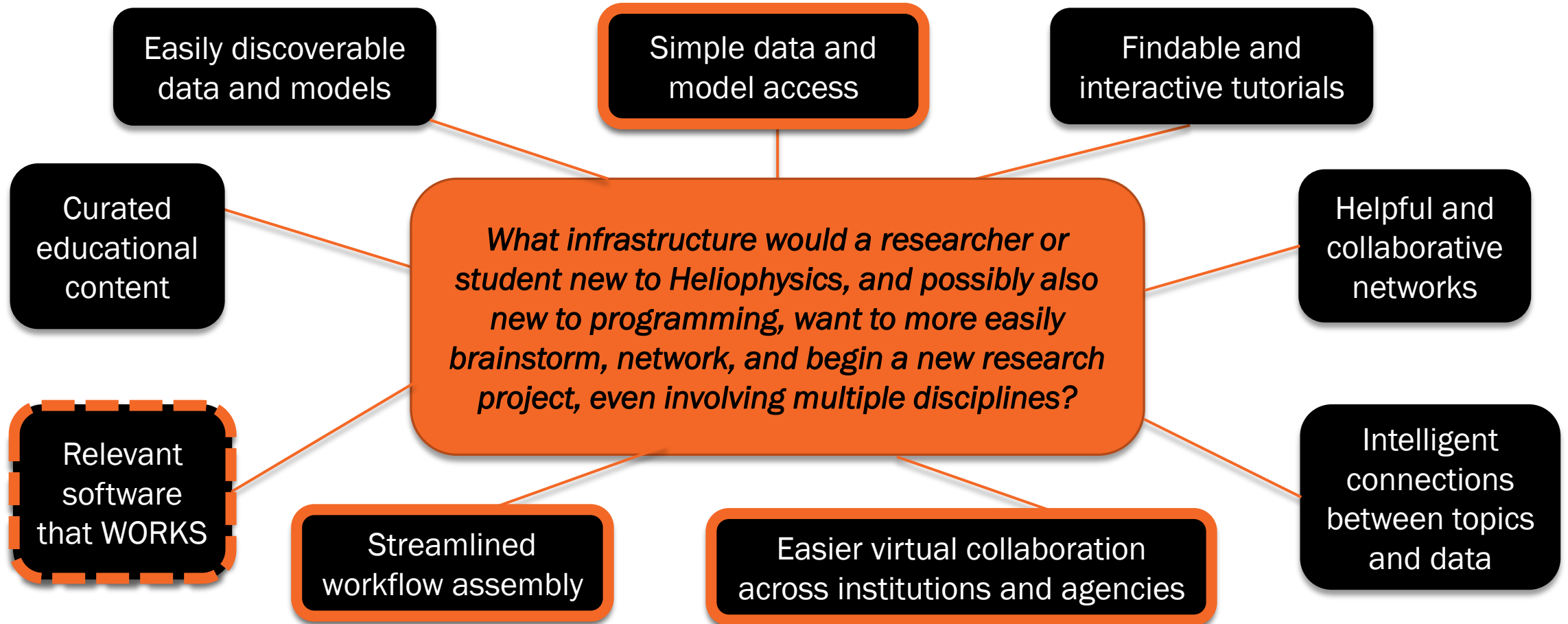
DEVELOPING A VISION FOR MATURING THE
HELIOPHYSICS INFRASTRUCTURE TOWARDS
OPEN SCIENCE

*R. Ringuette, A. Engell, O. Gerland, R. M. McGranaghan, and
B. Thompson.*

AGU 2022 Fall Meeting



Motivation



DIARieS

An ecosystem to simplify
Discovery, **I**mplementation,
Analysis, **R**eproducibility,
and **S**haring of scientific
results and environments.

A
Discovery online resource for
discovering and
implementing knowledge,
data, and infrastructure
resources.

Proposed Solution

The DIARieS Ecosystem

Discover

Search for data, catalogs, models, and software using uniform parameters:

- Discipline
- Domain
- Phenomenon
- Time Range
- Standardized Variable Name

Implement

Add the selected data, catalogs, models, and software to your ecosystem to customize your research environment **by clicking a button.**

Analyze

Perform your specialized analysis in an *automatically versioned notebook* with *built-in interactive graphics* and *high performance computing* capabilities.

Reproduce

Preserve your analysis workflow in an *automatically containerized ecosystem*, complete with all research components included.

Share

Create *customized narrated tutorials* to present your research or dashboard to the community or with colleagues with **more transparency.**

Welcome to the DIARieS Ecosystem

File Add Templates Packages Variables Citations Recording Share Help

Menu options (in above drop-down menus)

File:

- New
- Open
- Save/Save as
- Close

Add:

- **Data/Model Outputs/Catalogs**
- Software
- Widget
- Notebook
- Computing Resource

Templates:

- Template search
- Import template
- Create new template

Packages:

- None added

Variables:

- None added

Citations:

- (Pop up window with citation list and export options)

Recording:

- Create recording
- Edit recording
- View recording

Share:

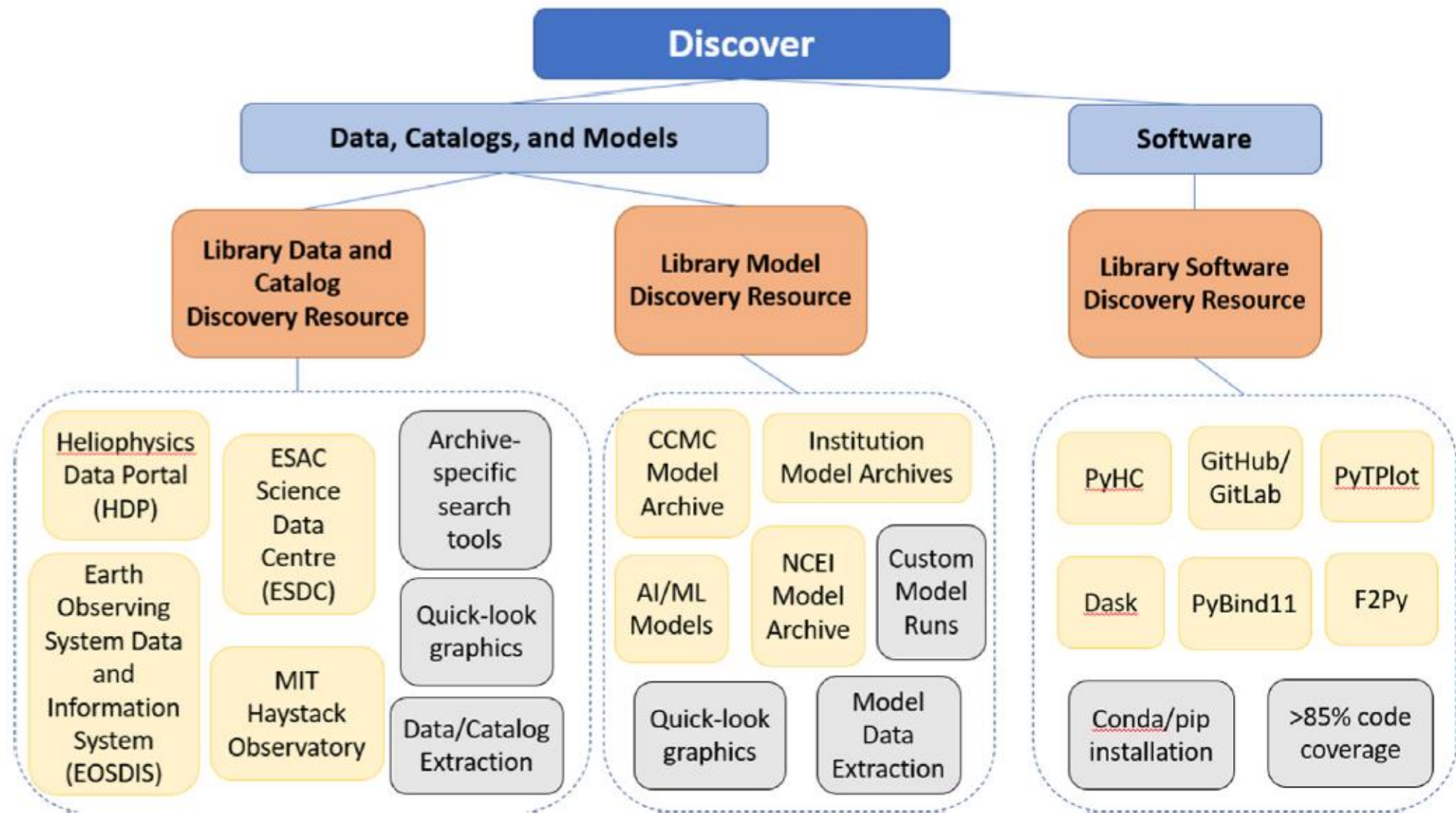
- Add/Remove authors/viewers
- Change permissions
- Create demo mode
- Publish

Help

Documentation/Help
Metadata/Properties
Remove/Update

Documentation/Help
Metadata/Properties
Remove/Change Name

Create or open a DIARieS ecosystem to get started
or click here for a narrated tutorial



- Built on LIKED – an intelligent search interface built using data science technology.
- Two sections based on type of expected mechanisms: Data and Software

DIARieS container: Data Discovery and Implementation Interface

cdaweb.gsfc.nasa.gov/cgi-bin/eval2.cgi

NASA GODDARD SPACE FLIGHT CENTER
Space Physics Data Facility

+ Goddard Home
+ NASA Home

+ SPDF HOME + MISSION DATA + MODELS at CCMC + SCIENCE ENABLED + AND MORE

+ CDAWeb Home
CDAWeb
+ FEEDBACK

Coordinated Data Analysis Web

CDAWeb Data Explorer

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

Start time (YYYY/MM/DD HH:MM:SS.mmm): 2015/11/25 04:00:00.000

Stop time (YYYY/MM/DD HH:MM:SS.mmm): 2015/11/26 04:00:00.000

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 > 1 day). **NEW**

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

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 V3.8 CDFs for download or Autoplot demonstration: select one or more variables from the list below and press submit.

Create Version 2.7.2 compatible CDFs (Default is Version 3.8)

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

Note: [CDF patch](#) required for reading Version 3.8 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.

Submit Reset

- Users first use the LIKED interface inside of DIARieS to find the desired archive (e.g. SPDF as shown here),
- Then use the search interface and mechanisms of archive to find desired data.
- DIARieS simplifies how to add that data to the analysis environment.

DIARieS container: Data Discovery and Implementation Interface

cdaweb.gsfc.nasa.gov/cgi-bin/eval3.cgi

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+ NASA Home

+ SPDF HOME + MISSION DATA + MODELS at CCMC + SCIENCE ENABLED + AND MORE

+ CDAWeb Home
CDAWeb
+ FEEDBACK

Coordinated Data Analysis Web

CNOFS_CINDIS_IVM_500MS

Download your new file (REQUIRES latest IDL/CDF_patch file from CDF): [cnofs_cindis_ivm_500ms_20151125040000_20151126034441.cdf](#)

OR

[Interactively plot this file](#) (using non-NASA software provided by [Autoplot.org](#))

NOTE: On a Mac OS X the dynamic jnlp could open as an ascii file. To fix that please follow these [instructions](#).

<< Previous time range Next time range >> **NEW**

>> Zoom IN time range << << Zoom OUT time range >> **NEW**

< Pan left Pan right > **NEW**

Return to: CDAWeb Data Explorer **NEW**

[notes and caveats](#)

NASA Official: Robert M. Candey
(301)286-6707, Robert.M.Candey@nasa.gov
Curator: Tami Kovalick
Last Modified: 5 Dec 2022

Contact SPDF: NASA-SPDF-
Support@nasa.onmicrosoft.com
+ Privacy Policy and Important Notices


Context menu options:
Open link in new tab
Open link in new window
Open link in incognito window
Add to container
Link to container
Save link as...
Copy link address
Add link to list
Inspect

Saves data to DIARieS container

Links data container to DIARieS container

DIARieS container: Data Discovery and Implementation Interface

← → ↻ cdaweb.gsfc.nasa.gov/cgi-bin/eval3.cgi

 **GODDARD SPACE FLIGHT CENTER** | [+ Goddard Home](#)

Save	Description	Units	Default Name	Enter custom name
<input type="checkbox"/>	RPA data quality flag: 0=high 9=low (https://spdf.gsfc.nasa.gov/pub/data/cnofs/cindi/QualityFlagDesc.doc)		RPAflag	
<input checked="" type="checkbox"/>	Ion density in cm-3	cm-3	ionDensity	rho_ion
<input checked="" type="checkbox"/>	Ion temperature in Kelvin	K	ionTemperature	T_ion
<input checked="" type="checkbox"/>	Ion 1 (normally O+) -----> Atomic Mass Number	AMU	atomicMass_ion1	Oplus
<input checked="" type="checkbox"/>	Ion 2 (normally H+) -----> Atomic Mass Number	AMU	atomicMass_ion2	Hplus
<input type="checkbox"/>	Ion3 (normally He+) -----> Atomic Mass Number	AMU	atomicMass_ion3	
<input type="checkbox"/>	Ion4 -----> Atomic Mass Number	AMU	atomicMass_ion4	
<input type="checkbox"/>	Ion 5 -----> Atomic Mass Number	AMU	atomicMass_ion5	
<input checked="" type="checkbox"/>	UT in seconds	s	time	
<input checked="" type="checkbox"/>	Geographic latitude in degrees	deg	glat	
<input checked="" type="checkbox"/>	Geographic longitude in degrees	deg	glon	
<input checked="" type="checkbox"/>	Altitude in km	km	altitude	

DIARieS container: Data Discovery and Implementation Interface

← → ↻ cdaweb.gsfc.nasa.gov/cgi-bin/eval3.cgi

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+ Goddard Home
+ NASA Home

+ SPDF HOME + MISSION DATA + MODELS at CCMC + SCIENCE ENABLED + AND MORE

+ CDAWeb Home
CDAWeb
+ FEEDBACK

Coordinated Data Analysis Web

CNOFS_CINDIS_IVM_500MS

Download your new file ([REQUIRES latest IDL/CDF patch file from CDF](#)): [cnofs_cindis_ivm_500ms_20151125040000_20151126034441.cdf](#)

OR

[Interactively plot this file \(using non-NASA software\)](#)

NOTE: On a Mac OS X the dynamic jnlp could open [instructions](#).

<< Previous time range Next time range >>

>> Zoom IN time range << << Zoom OUT time range >> **NEW**

< Pan left Pan right > **NEW**

Return to: CDAWeb Data Explorer **NEW**

[notes and caveats](#)

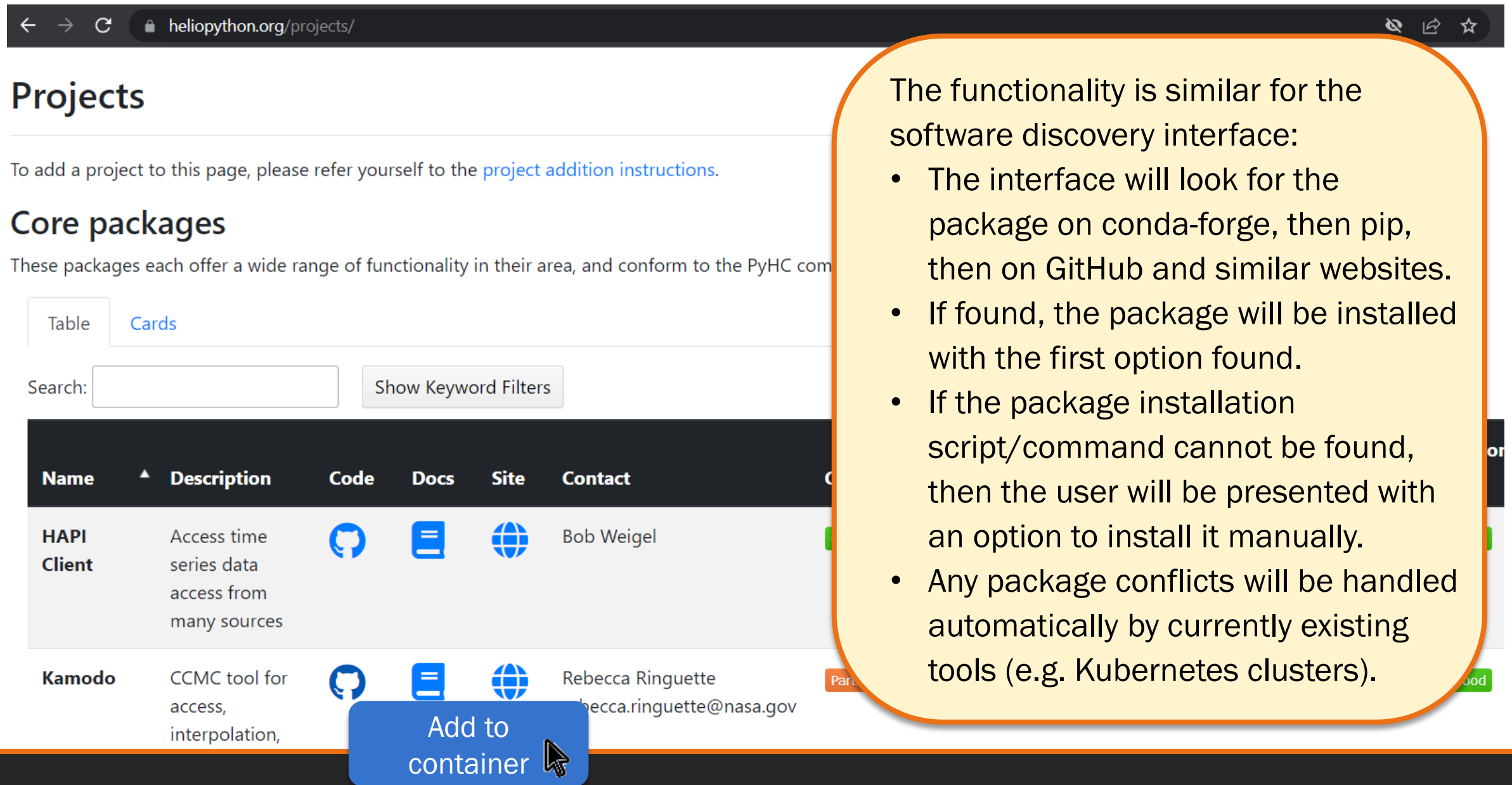
NASA Official: Robert M. Candey
(301)286-6707, Robert.M.Candey@nasa.gov
Curator: Tami Kovalick
Last Modified: 6 Dec 2022

Contact SPDF: NASA-SPDF-
Support@nasa.onmicrosoft.com
+ Privacy Policy and Important Notices

When data is added to the container...

- A link for each variable is added to the variable list,
- And the proper citation is added to the container's citation list.
- The link in the variable list links to three items:
 - Documentation/Help
 - Metadata/Properties
 - Remove/Change Name Options

DIARieS container: Software Discovery and Implementation Interface



The screenshot shows the 'Projects' page on heliopython.org. The page has a search bar and a 'Show Keyword Filters' button. Below the search bar is a table of projects. The first project is 'HAPI Client' by Bob Weigel, and the second is 'Kamodo' by Rebecca Ringuette. A blue button labeled 'Add to container' is overlaid on the bottom of the table. A callout box on the right explains the software discovery interface.

Projects







To add a project to this page, please refer yourself to the [project addition instructions](#).

Core packages

These packages each offer a wide range of functionality in their area, and conform to the PyHC com

Table **Cards**

Search: Show Keyword Filters

Name	Description	Code	Docs	Site	Contact
HAPI Client	Access time series data access from many sources				Bob Weigel
Kamodo	CCMC tool for access, interpolation,				Rebecca Ringuette becca.ringuette@nasa.gov

Add to container

The functionality is similar for the software discovery interface:

- The interface will look for the package on conda-forge, then pip, then on GitHub and similar websites.
- If found, the package will be installed with the first option found.
- If the package installation script/command cannot be found, then the user will be presented with an option to install it manually.
- Any package conflicts will be handled automatically by currently existing tools (e.g. Kubernetes clusters).

DIARieS container: Software Discovery and Implementation Interface

← → ↻ heliopython.org/projects/ 🔍 📄 ☆

Projects







To add a project to this page, please refer yourself to the [project addition instructions](#).

Core packages

These packages each offer a wide range of functionality in their area, and conform to the PyHC comm

Table **Cards**

Search:

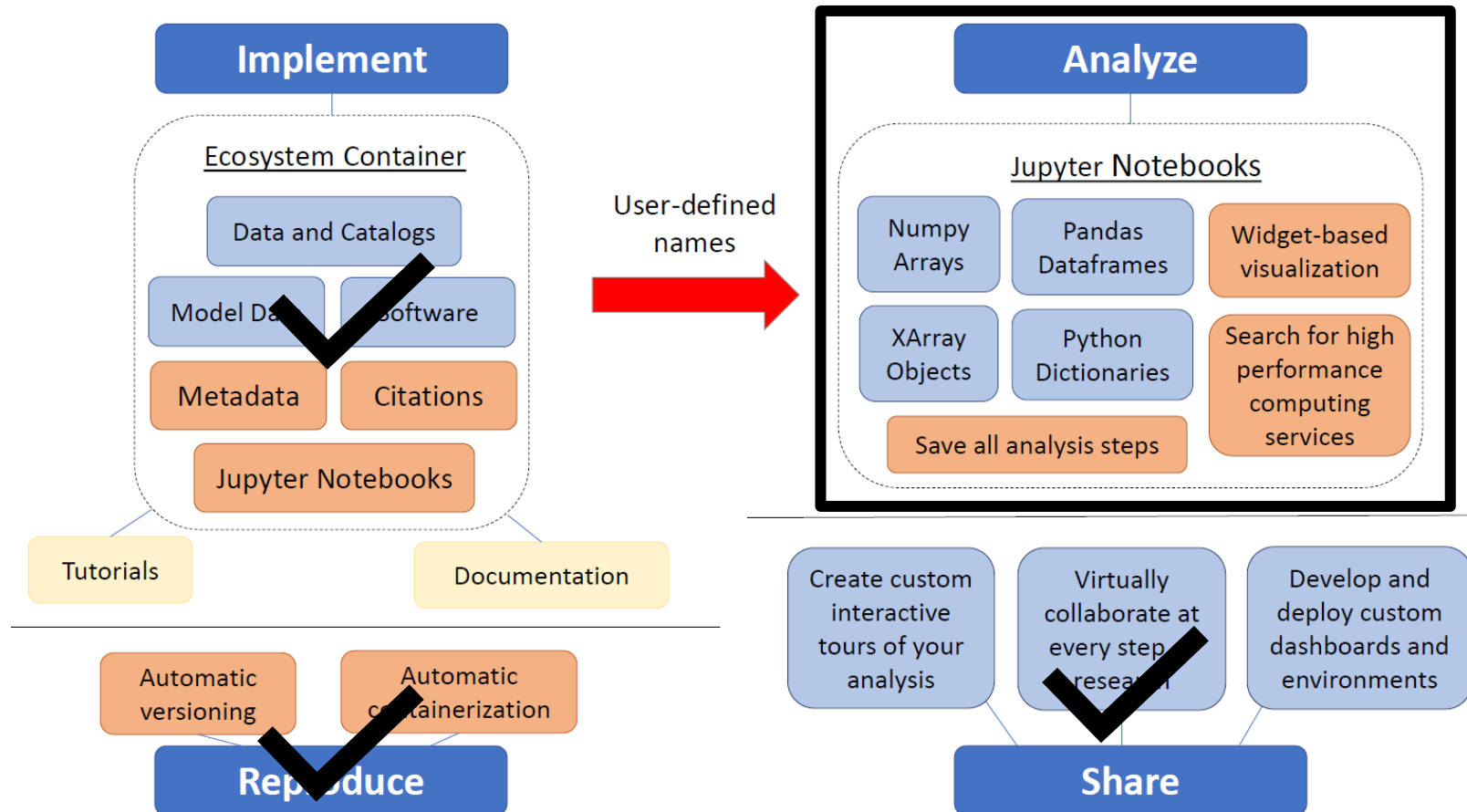
Name	Description	Code	Docs	Site	Contact	Co
HAPI Client	Access time series data access from many sources				Bob Weigel	Good
Kamodo	CCMC tool for access, interpolation,				Rebecca Ringuette rebecca.ringuette@nasa.gov	Partially Good

Package Added

When software is added to the container...

- A link for each package, named with the package name, is added to the package list,
- And the proper citation is added to the container's citation list.
- The link in the package list links to three items:
 - Documentation/Help
 - Metadata/Properties
 - Remove/Update Options

DIARieS: Simplifying AIR



(AIR = Accessibility, Interoperability, and Reproducibility)

Welcome to the DIARieS Ecosystem

File Add Templates Packages Variables Citations Recording Share Help

Menu options (in above drop-down menus)

File:

- New
- Open
- Save/Save as
- Close

Add:

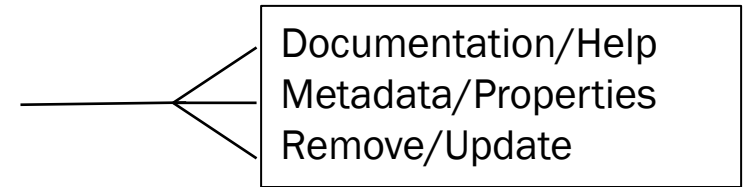
- Data/Model Outputs/Catalogs
- Software
- **Widget**
- Notebook
- Computing Resource

Templates:

- Template search
- Import template
- Create new template

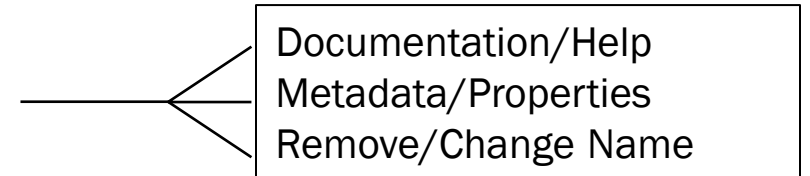
Packages:

- cdflib
- Xarray
- Kamodo
- ...



Variables:

- rho_ion
- T_ion
- Oplus
- time
- ...



Citations:

- (Pop up window with citation list and export options)

Recording:

- Create recording
- Edit recording
- View recording

DIARieS container: Analysis Interface

Widget Library

Search: _____

- Kamodo visualization
- CDF visualization
- PlasmaPy function library
- pysat data retrieval
- Kamodo model data interface
- SpacePy SWMF tools
- SunPy data filtering
- SciPy

Loaded Widgets

Search: _____

PyHC Coordinate Converter

Choose input variables Select coordinate system

time Select variable Select units Select coordinate type

X or longitude Select variable Select units Select coordinate type

Y or latitude Select variable Select units Select coordinate type

Z, radius, or altitude Select variable Select units Select coordinate type

Choose output variables Select coordinate system

time Type new name Select units Select coordinate type

X or longitude Type new name Select units Select coordinate type

Y or latitude Type new name Select units Select coordinate type

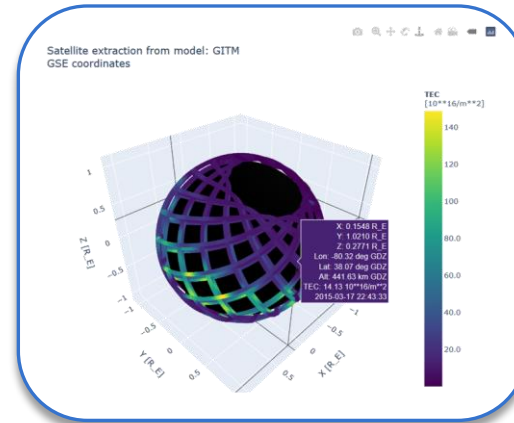
Z, radius, or altitude Type new name Select units Select coordinate type

AstroPy Unit Converter

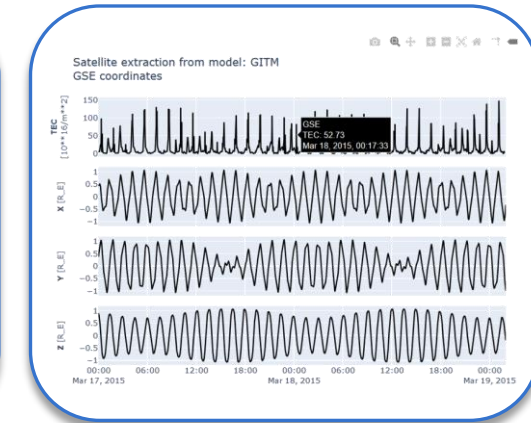
Kamodo Flythrough

Active Widgets

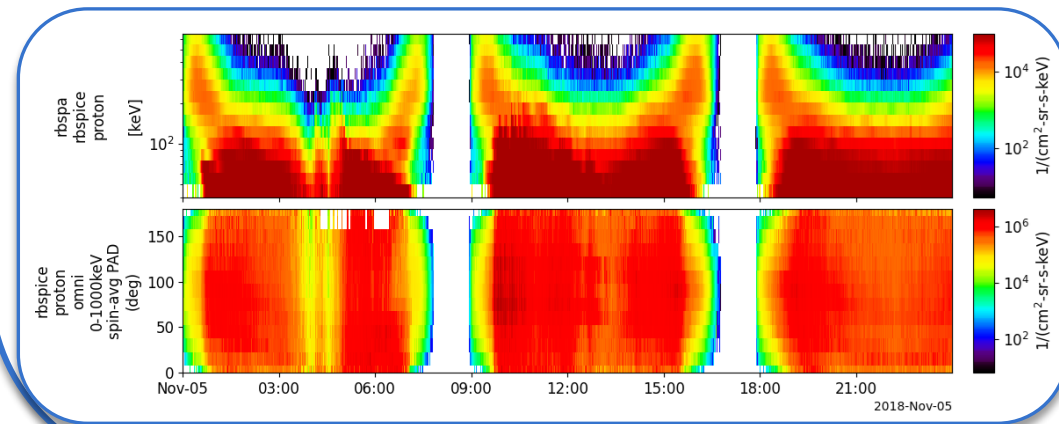
Search: _____



Kamodo 3D visualization



Kamodo 1D visualization



pySPEDAS visualization

DIARieS container: Analysis Interface

Variable Library

- rho_n
- T_ion
- X_GEO
- Y_GEO
- Z_GEO
- time.UTC
- TEC_GITM
- glat

Loaded Widgets

PyHC Coordinate Converter

Choose input variables Select coordinate system

time	Select variable	Select units	Select coordinate type
X or longitude	Select variable	Select units	Select coordinate type
Y or latitude	Select variable	Select units	Select coordinate type
Z, radius, or altitude	Select variable	Select units	Select coordinate type

Choose output variables Select coordinate system

time	Type new name	Select units	Select coordinate type
X or longitude	Type new name	Select units	Select coordinate type
Y or latitude	Type new name	Select units	Select coordinate type
Z, radius, or altitude	Type new name	Select units	Select coordinate type

Interactive Notebook

PyHC Pa... / Making_an_Executable_Paper_with_the_Python_in_Heliophysics_C... Execute access

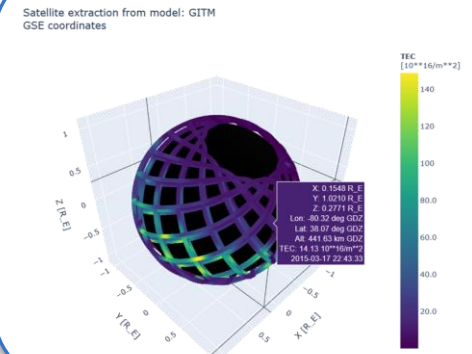
2.3.1 Perform SpacePy Calculations with MMS Data

```
def spacecraft_magnetopause_calculations(mms_mec_vars):  
    """Returns epoch,  
    pos,  
    distance between spacecraft and magnetopause  
    magnetopause's distance from Earth,  
    spacecraft's distance from Earth,  
    and solar zenith angle.  
    """  
    data = pyplot.get_data(mms_mec_vars[0])  
    pos_gsm = data.y  
    ticks = spacepy.time.Ticktock(data.times, dtype='UNIX')  
    epoch = ticks.UTC  
    c = spacepy.coordinates.Coords(pos_gsm, 'GSM', 'car', u  
    pos = c.convert('GSE', 'car').data  
  
    # Get the Shue coefficients  
    alpha = [] # Shue flaring angle  
    standoff = spacepy.empiricals.getMPstandoff(ticks, alph  
    alpha = np.array(alpha)  
  
    # Solar zenith angle of s/c position (angle with GSE +x  
    sza = np.arctan2(pos[:, 0], np.sqrt((pos[:, :2] ** 2).s  
    # Radial distance to MP along Earth-SC line (applicatio  
    mp_dist = standoff * (2. / (1 + np.cos(sza))) ** alpha  
    # Radial distance to SC  
    sc_dist = np.sqrt((pos ** 2).sum(axis=1)) / 6378  
    # How far is SC outside of MP?  
    sc_to_mp = sc_dist - mp_dist  
  
    return epoch, pos, sc_to_mp, mp_dist, sc_dist, sza
```

2.3.2 Detect Magnetopause Crossings

Since we can calculate the distance between the spacecraft and the magnetopause, we can find crossings by collecting the indices where that distance changes 0 (i.e., changes sign):

Active Widgets



Widget Help

Select a widget to see the tutorials and documentation.

Presentation Tools

Add a narration

Record a tutorial

Presentation Mode

Summary



LIKED publication DOI:
10.1016/j.asr.2022.10.051



DIARieS publication DOI:
10.1016/j.asr.2022.05.012

Heliophysics currently needs a coordinated push to make our work FAIR and efficient.

Connect
our archives
based on a
'system of
systems'
approach.

Build
on the
successes of
current
efforts and
technology.

Assemble
our various
advances
into a
streamlined
workflow

*We call on the community to work together
on this goal to launch our field into the
future.*

Choose input variables

Select coordinate system 

time

Select variable 

Select units 

Select coordinate type 

X or longitude

Select variable 

Select units 

Select coordinate type 

Y or latitude

Select variable 

Select units 

Select coordinate type 

Z, radius, or
altitude

Select variable 

Select units 

Select coordinate type 

Choose output variables

Select coordinate system 

time

Type new name

Select units 

Select coordinate type 

X or longitude

Type new name

Select units 

Select coordinate type 

Y or latitude

Type new name

Select units 

Select coordinate type 

Z, radius, or
altitude

Type new name

Select units 

Select coordinate type 