Simplifying Space Physics Data Analysis with SciQLop: A Comprehensive Toolkit for In-Situ Measurements

Streamline Your Data Discovery, Retrieval, and Analysis Workflow

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With the **SCI**entific **Q**t application for **L**earning from **O**bservations of **Pl**asmas (**SciQLop**), analyzing space physics data is made easier. The project aims to solve the technical challenges involved in retrieving and interpreting data from remote servers, which can be daunting for students or newcomers. Even analyzing data from a single instrument on a given mission can raise some technical difficulties such as finding where to get them, how to get them and sometimes how to read them. These challenges can compound when building complex machine learning pipelines involving multiple instruments and even multiple spacecraft missions. The SciQLop project removes these technical difficulties while maintaining high performance, allowing scientists to focus on their data analysis.

Speasy : Making Space Physics Data Access Easy

Speasy is an open-source Python package that streamlines the discovery and retrieval of space physics data from remote servers. By providing a user-friendly API, Speasy removes the technical complexities involved in finding and downloading data from sources such as **CDAWeb**, **SSCWeb**, **CSA**, and **AMDA**, making it easier for researchers and students to focus on data analysis.

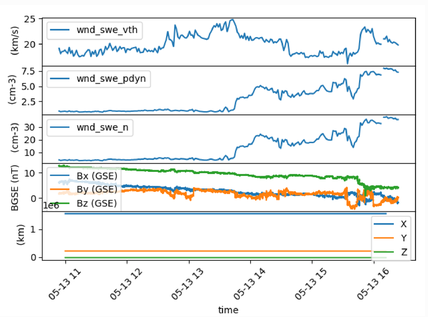
Key features:

- Really simple and user friendly API:

  With just one function, **get_data(what, [when])**, you can retrieve any combination of data products and time ranges. This makes it easy to access the specific data you need for your analysis, without having to navigate complex server structures or learn multiple APIs.

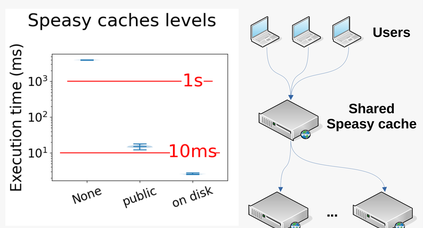
```
[8]: products = [
         spz.inventories.tree.amda.Parameters.Wind.SWE.wnd_swe_kp.wnd_swe_vth,
         spz.inventories.tree.amda.Parameters.Wind.SWE.wnd_swe_kp.wnd_swe_pdyn,
         spz.inventories.tree.amda.Parameters.Wind.SWE.wnd_swe_kp.wnd_swe_n,
         spz.inventories.tree.cda.Wind.WIND.MFI.WI_H2_MFI.BGSE,
         spz.inventories.tree.ssc.Trajectories.wind,
     ]

     data_several_dates: List[List[SpeasyVariable]] = spz.get_data(
         products,
         spz.inventories.tree.amda.TimeTables.SharedTimeTables.SOLAR_WIND.Magnetic_Clouds
     )

     for i in range(5):
         #fig = plt.figure(figsize=(20, 6))
         fig = plt.figure()
         gs = fig.add_gridspec(5, hspace=0)
         axes = gs.subplots(sharex=True, sharey=False)
         for j in range(5):
             data_several_dates[j][i].plot(ax=axes[j])
         plt.tight_layout()
     plt.show()
```

Figure 12



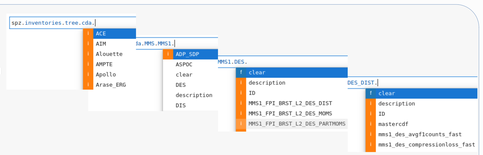
- Efficient multi-layer caching mechanism

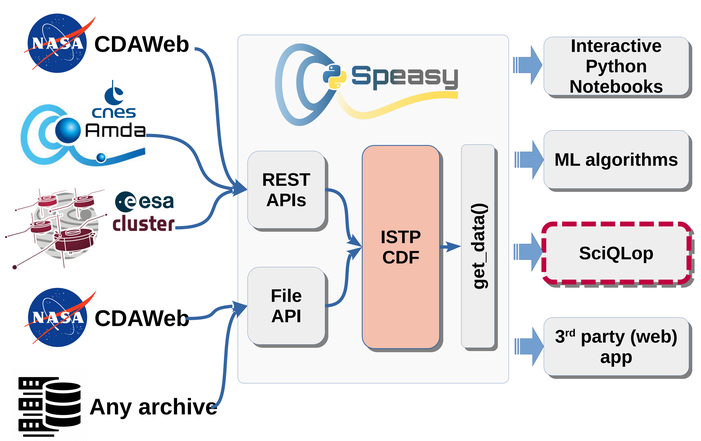
  With two levels of caching - one on disk and one on a shared server that runs Speasy - the package can quickly access previously requested data without having to make slow requests to remote servers like AMDA or CDAWeb. This not only saves time but also reduces the load on the remote servers.



- Dynamic remote servers inventory:

  Speasy builds a dynamic inventory of accessible remote servers, providing users with a comprehensive list of available products. With runtime Python completion, users can easily navigate and discover products on remote servers without the need for extensive documentation or complex queries. This simplifies the discovery process and reduces the time required to find the relevant data, making it an efficient and user-friendly feature.





SciQLop: A Fast and User-Friendly GUI for Space Physics Data Analysis

The SciQLop GUI app is a fast and extensible data analysis tool written in Python using PySide. Built with the aim of simplifying the analysis of in-situ space physics measurements, this app utilizes Speasy to access data from remote servers. In addition to its speed and simplicity, the app is also designed to be highly extensible, with an embedded IPython kernel and JupyterLab for easy integration with other Python tools and libraries.

Key features:

- Simple and user-friendly interface:

  The user-friendly GUI of SciQLop is designed to be both fast and easy to use, making it accessible to scientists with varying levels of technical proficiency. It employs drag and drop extensively for user interactions, and ensures that plots can be zoomed in/out and panned quickly and smoothly.

- JupyterLab integration:

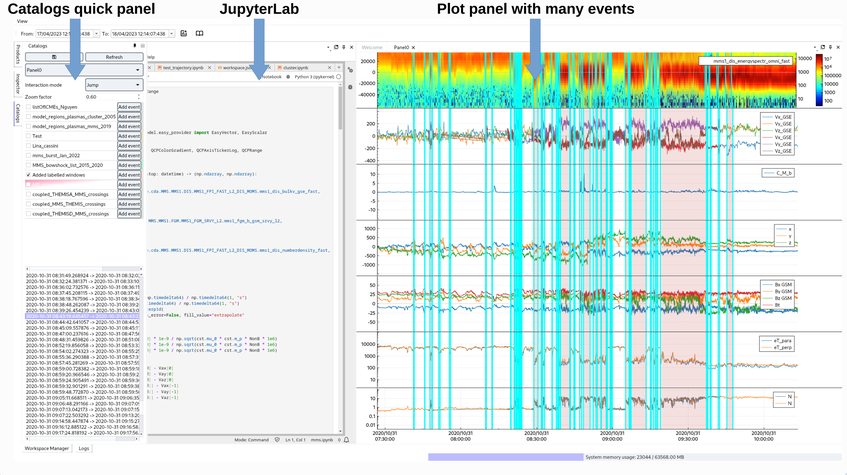
  Scientists can interact with SciQLop API from Jupyter Notebooks to quickly build custom plot panels and custom products while benefiting from both SciQLop responsive UI and Python rich ecosystem.

Planed features:

- "Virtual products":

  With Sciqlop, scientists can quickly create their own virtual products by combining various data sources and algorithms using just a few lines of Python code. These virtual products can then be easily visualized and analyzed within the app.

- Catalogs features: SciQLop will include catalogs online sharing and live co-edition.
- "Marketplace": SciQLop will allow to browse, discover and fetch Notebooks or extensions from online community repositories.



Scientific publications using Speasy

Subion-Scale Turbulence Driven by Magnetic Reconnection

D. Manzini, F. Sahraoui, and F. Califano
Phys. Rev. Lett. 130, 205201 – Published 19 May 2023

Global environmental constraints on magnetic reconnection at the magnetopause from in-situ measurements

B Michotte De Welle, N Aunai, B Lavraud, V Génot, G Nguyen, A Ghisalberti, A Jeandet, Roch Smets
First published: 16 February 2024

The Helicity Sign of Flux Transfer Event Flux Ropes and Its Relationship to the Guide Field and Hall Physics in Magnetic Reconnection at the Magnetopause

S. Dahani, R. Kieokaew, V. Génot, B. Lavraud, Y. Chen, B. Michotte de Welle, N. Aunai, G. Tóth, P. A. Cassak, N. Fargette, R. C. Fear, A. Marchaudon, D. Gershman, B. Giles, R. Torbert, J. Burch
First published: 26 October 2022

Global Three-Dimensional Draping of Magnetic Field Lines in Earth's Magnetosheath From In-Situ Spacecraft Measurements

B. Michotte de Welle, N. Aunai, G. Nguyen, B. Lavraud, V. Génot, A. Jeandet, R. Smets
First published: 08 December 2022