The SciQLop Ecosystem: Open-Source Tools for Interactive Multi-Mission In-Situ Plasma Data Exploration and Analysis

Alexis Jeandet*[1], Renard Benjamin[2], Nicolas Aunai[3], Vincent Génot[4], Myriam Bouchemit[5], Bayane Michotte De Welle[6], Ambre Ghisalberti[7], Nicolas André[4], and Alexis Rouillard[4]

[1]Laboratoire de Physique des Plasmas – Observatoire de Paris, Ecole Polytechnique, Sorbonne Universite, Université Paris-Saclay, Centre National de la Recherche Scientifique – France

[2]Akkodis – akkodis – France

[3]Laboratoire de Physique des Plasmas – Observatoire de Paris, Centre National de la Recherche Scientifique, Ecole Polytechnique, Sorbonne Universite, Université Paris-Saclay – France

[4]Institut de recherche en astrophysique et planétologie – Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique, Université de Toulouse – France

[5]Institut de recherche en astrophysique et planétologie – Institut National des Sciences de l'Univers : UMR5277, Université Toulouse III - Paul Sabatier, Observatoire Midi-Pyrénées, Centre National de la Recherche Scientifique : UMR5277, Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique – France

[6]NASA Goddard Space Flight Center – États-Unis

[7]Laboratoire de Physique des Plasmas – Observatoire de Paris, Université Paris sciences et lettres, Ecole Polytechnique, Sorbonne Universite, Université Paris-Saclay, Centre National de la Recherche Scientifique : UMR7648, Centre National de la Recherche Scientifique, Sorbonne Université – France

Résumé

Our community benefits from decades of in situ measurements stored across international public archives. Exploring these databases and searching for plasma process signatures remains a bottleneck - not only due to the massive amount of data, but also its intrinsic complexity. Even accessing a single instrument raises technical hurdles: finding where to get data, how to download it, and how to read it. These compound for multi-mission studies across archives.
We present SciQLop, an open-source ecosystem of interoperable tools that removes these barriers.

Speasy provides a unified Python API to access over 65,000 products from AMDA, CDAWeb, CSA, SSCWeb, and CDPP 3DView through a single get_data() call, with transparent multi-level caching (local and shared community proxy), automatic inventory discovery with auto-completion, and native NumPy/SciPy/Pandas interoperability. It is also available in Julia.

*Intervenant

CDFpp/PyCDFpp is a modern, thread-safe C++ CDF implementation with Python bindings, achieving up to 4 GB/s read speeds - addressing the legacy NASA library's lack of thread safety and licensing issues. Combined with **PyISTP** for ISTP-compliant access, it forms the ecosystem's data I/O foundation.

SciQLop is an interactive application built on a custom C++ plotting engine (SciQLopPlots) optimized for large non-uniform datasets. Researchers can browse and label multivariate time series with fluid interaction on gigabyte-scale data. Features include drag-and-drop discovery from all supported archives, user-defined virtual products recomputed on-the-fly, graphical event cataloging (tscat), and JupyterLab integration for hybrid workflows. Upcoming: CRDT-based collaborative catalog co-editing (cocat) and a community plugin marketplace.
These tools directly serve the ATST community: multi-spacecraft comparison for plasma envelope coupling studies, rapid event identification for eruptive activity, and streamlined multi-archive access for Sun-Earth and space weather investigations. All tools are open-source, pip-installable, and supported by CDPP and Plas@Par.