



VSO 2.0 and Space Weather



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The Virtual Solar Observatory (VSO) has enabled over 20 years of heliophysics data access for research and space weather applications. VSO 2.0 modernizes this platform using Python, REST APIs, and a metadata-driven architecture. This enables faster, more flexible access to near-real-time data and more powerful search and analysis capabilities.

Modernising VSO

- VSO 2.0 modernizes the platform using Python, REST APIs, and a metadata-driven architecture.
- This enables faster, more flexible access to near-real-time data and more powerful search and analysis capabilities.
- Originally developed in Perl using SOAP-based services, VSO is being re-engineered as a modern Python-based system built on REST principles.
- A strong emphasis on metadata enables advanced search capabilities, including access to data headers and support for metadata-driven analysis.
- VSO 2.0 also introduces flexible search presets for key datasets (e.g., LASCO, GONG, NRT AIA, NRT HMI), as well as user-defined queries.

Perl → Python

Modern, maintainable code aligned with current scientific and web ecosystems

SOAP → REST

Lightweight, scalable APIs enabling faster and more flexible data access

Server → Client/Server

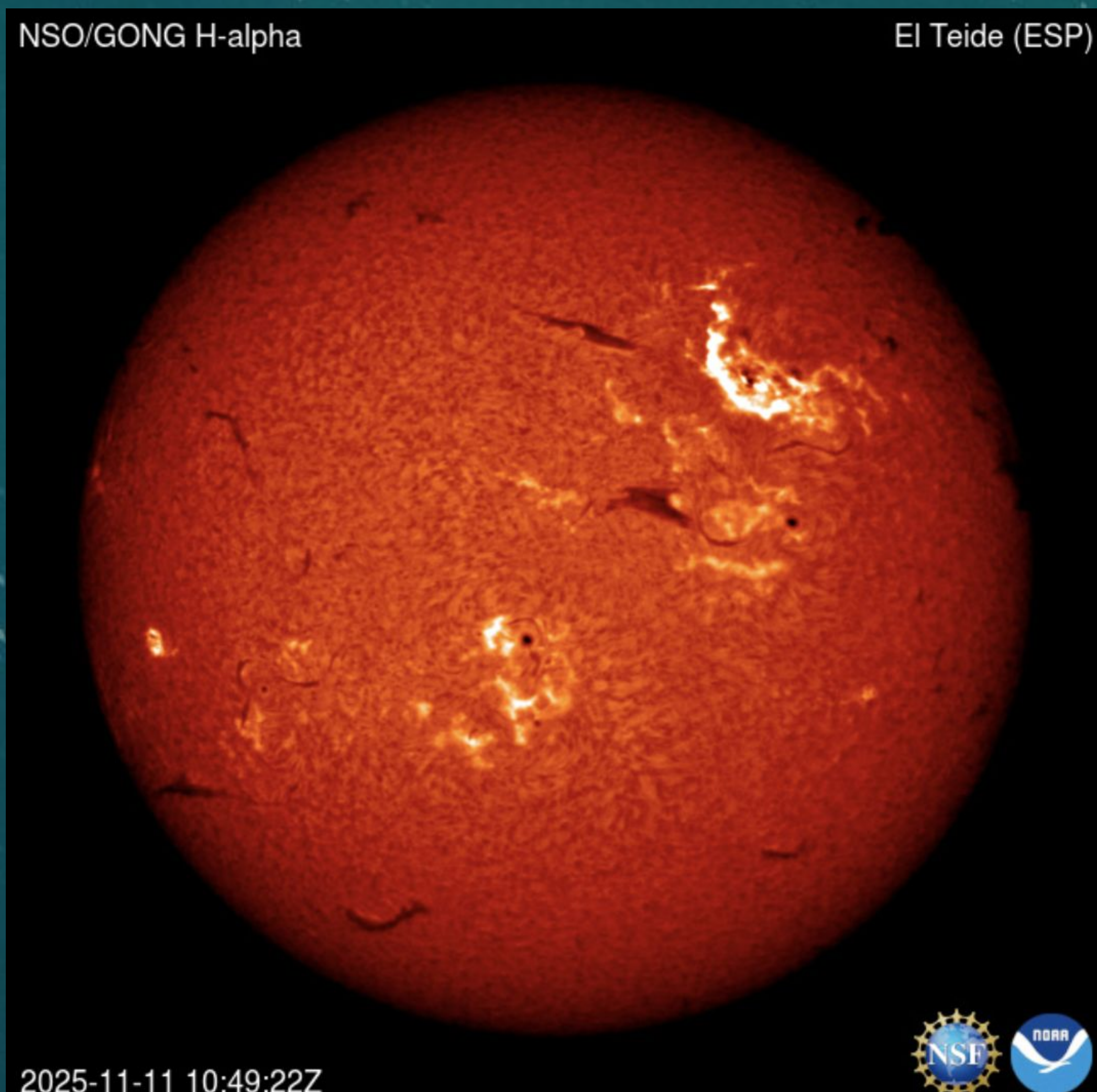
Shifts processing to the client for improved responsiveness and usability

SQL → ORM

Streamlined database interaction using Python tools like SQLAlchemy. Delegating the generation of SQL strings to an Object Relational Mapper (ORM) like Python's sqlalchemy allows for a more programmatic, streamlined way of dealing with databases and provides the ability to create far more complex queries.

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Additional Changes

Rich Metadata

VSO 2.0 captures and provides full metadata from FITS files, storing it in ¹ASDF format so data download is not required during search and filtering. This will facilitate searches on all metadata even if not included in the search interface.

¹<https://www.asdf-format.org/en/latest/overview.html>

Python's FastAPI system

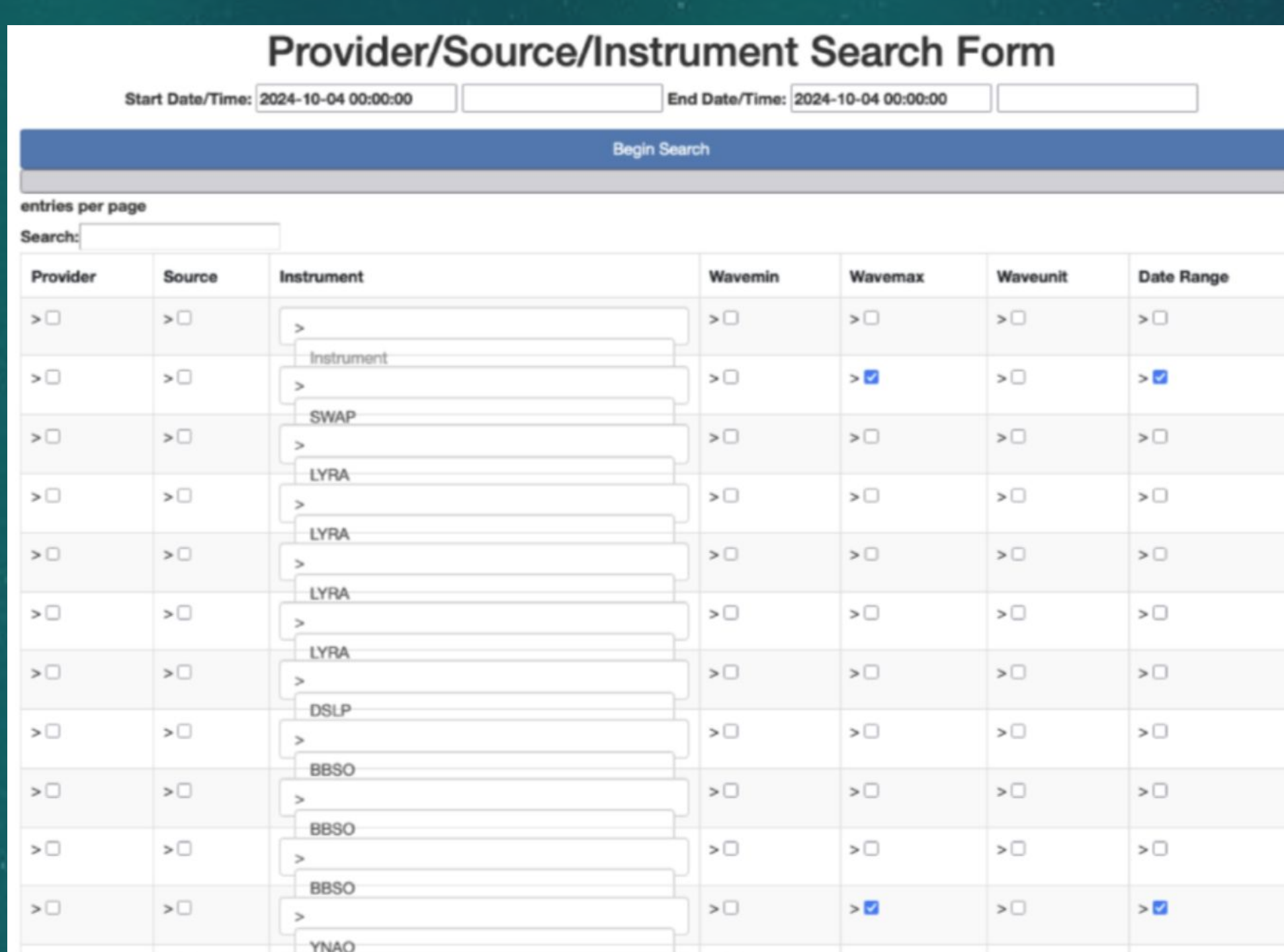
FastAPI is how VSO 2.0 exposes its data and services to users and clients in a modern, scalable way.

FastAPI enables modern REST access to data and metadata, supporting fast, scalable queries and delivery of structured results in JSON format.

Automatically generated documentation provides an interactive interface for exploring and integrating VSO services and lowers the barriers to adoption.

FastAPI is fast (async, modern Python stack) and handles many requests efficiently and will be central to providing near-real-time space weather data access.

Web Client Prototype



A prototype VSO 2.0 web interface with sub-second temporal resolution. The goal is to provide full functionality in both web and programmatic interfaces, allowing users to seamlessly switch between them.



Photo credit : Niles Oien

VSO 2.0 Benefits for Space Weather

VSO 2.0 modernizes access to heliophysics data, making it easier for the solar physics community to discover, combine, and analyze observations across instruments and datasets.

By enabling faster access, richer metadata search, and programmatic integration, it supports more flexible and efficient research workflows.

These capabilities are particularly important for applications requiring rapid access to distributed datasets, such as space weather research and forecasting.

VSO 2.0 places strong emphasis on access to space weather data, including the addition of current and new NRT resources.

We will create *search presets* which will allow easier searching for space weather data including LASCO, GONG, and near real time HMI and AIA data.

Additionally we will enable users to create their own search presets that can be executed in the web client or programmatically.

Easier Addition of new Datasets

The addition of new datasets will be MUCH easier in VSO 2.0, dramatically speeding up the time it takes to bring new resources online. Recently VSO (via SDAC) has become the primary resource for serving PUNCH data to the community. We are keen to catch up with our backlog of missions and instruments and preparing for new instruments, like Vigil which will be launched in 2031. While our previous codebase was open to the Public, there are not many new Perl programmers today, and with the implementation, we hope to invite the community to create data providers as well as the core VSO team.



Integration with Features and Events

With the current VSO we only have a weak connection with the Heliophysics event knowledgebase (²HEK). In VSO 2.0 we expect the VSO to treat HEK like another data provider which will allow us to fully integrate it into the VSO and return the features and events associated with observations.

²<https://www.lmsal.com>

Futures

We have a number of other projects planned, including integrating data and associated publications into search results.