The Heliophysics API (HAPI)
Facilitating Access to Personal Spaceweather Station Data

William Engelke[1], Travis Atkison[1]

[1]University of Alabama

Abstract

One of the major enhancements being developed for the Personal Space Weather Network System is our implementation of the Heliophysics Application Programming Interface. This interface is being developed with help from Dr. Robert Weigel of George Mason University to make HamSCI data more accessible to researchers. In the first version of the PSWS system, users have been able to download individual files to analysis, but this can be labor intensive and time-consuming if a lot of files are needed. The current NSF-funded effort will make the data more easily accessible to users by leveraging Python libraries that make data access transparent, such as hapiclient, hapiplot, hdpws, And SwarmPAL. This poster gives an overview of what will be included and how you will be able to use it.

Introduction

The Personal Space Weather System Network collects spectrum and magnetometer data continuously, doing a daily upload of one "observation" (24 hours of data) daily at or shortly after 00:00 UTC from each active station. So far, this has resulted in a collection of over 140,000 observations (typically 75 to 100 files per day). Here we see the first 8 from a given day.

Data rate	Center Frequency	Station	Instrument	Size (MB)	File/Observation		Plot Start (UTC)	End (UTC)
10	—	WA9TKK	Grape1	0.2745	OBS2026-02-26T00-00	●	2026-02-26 00:00:00	2026-02-26 00:10:00
10	—	AA6BD	AA6BDGrape1	34.1749	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-26 00:00:00
10	—	N6RFM/5	Grape v1.12	34.1752	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-26 00:00:00
10	—	N5BRG-Grape1	Grape1-01-Ch0-N...	30.8857	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-26 00:00:00
10	—	WA9TKK	Grape1	34.1750	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-26 00:00:00
10	—	N5BRG-Grape1-MAG1	Grape1-02-Ch1-E...	30.8857	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-26 00:00:00
10	—	K4BSE	Grape-RF	34.1617	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-25 23:59:00
10	—	N0000011	Grape_V1_12	34.1617	OBS2026-02-25T00-00	●	2026-02-25 00:00:00	2026-02-25 23:59:00

Scientists can download these one by one for their own local analysis. However, as analysis has become more sophisticated, this one-by-one approach has become burdensome. An effort is underway to make data access easier, faster, and in conformance with standards so that data analysis packages (typically Python) can more efficiently use the data.

With help from George Mason University, we are implementing the Heliophysics API, which is a time series download and streaming format specification. From the web site hapi-server.org:

"The Heliophysics Data Application Programmer's Interface (HAPI) specification is a **time series** download and streaming format specification. It was originally developed for Heliophysics data, but the specification applies to any time series served from an API. A 1-page summary is given in HAPIOnePager.pdf. A more detailed overview is given in the JGR article Weigel et al., 2021[1] and the presentation by Vandegriff et al. (pdf | YouTube video). The HAPI specification was recommended by COSPAR in 2018 as the common data access API for space science and space weather data."[2]

Accessing data on a HAPI server

Every HAPI server provides a set of functions such as:
/catalog: Returns a list of all datasets available on the server, including a unique identifier for each dataset.
/info: Provides metadata for a specific dataset, including parameter names, types, units, and temporal coverage.
/data: Streams time series data for a specific dataset and time range (using time.min and time.max), supporting CSV, binary, or JSON formats.
/capabilities: Lists the server's supported output formats and protocol version.
/about: Provides information about the server, such as the provider, contact information, and a description of the served data

Getting started: Test to see if a server supports HAPI:
https://servername/hapi e.g., https://cdaweb.gsfc.nasa.gov/hapi
Typical result:
HAPI Server
This server supports the HAPI 2.0 specification for delivery of time series data. The server consists of the following 4 REST-like endpoints that will respond to HTTP GET requests.
capabilities endpoint (/capabilities) describes the capabilities of the server; this lists the output formats this server can emit (csv, json and binary)
catalog endpoint (/catalog) lists the datasets that are available; each dataset is associated with a unique id
info endpoint (/info) (example) provides a description for a dataset of a given id; the description defines the parameters in every dataset record
data endpoint (/data) (example) streams data content for a dataset of a given id; the streaming request must have time bounds (specified by request parameters time.min and time.max) and may indicate a subset of parameters (default is all parameters)

HAPI Data Explorer: https://hapi-server.org/servers/

You can use this for quick explorations of HAPI data: Pick a server and data type; request plot :
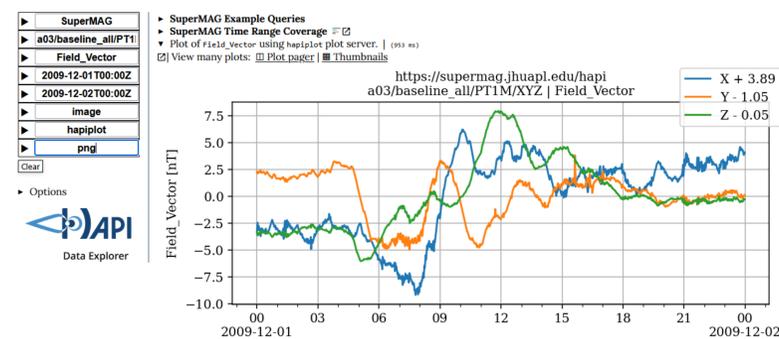
You can also write Python code to do your own analyses using Python Libraries: hapiclient, hapiplot – Example:

```
from hapiclient import hapi
from hapiplot import hapiplot
server = 'https://cdaweb.gsfc.nasa.gov/hapi'
dataset = 'OMNI2_H0_MRG1HR'
parameters = 'DST1800'
start = '2003-09-01T00:00:00'
stop = '2003-12-01T00:00:00'
opts = {'logging': True}
# Fetch data and metadata
data, meta = hapi(server, dataset, parameters, start, stop, **opts)
print(meta) # Metadata dictionary
print(data) # NumPy structured array
# Quick plot
```
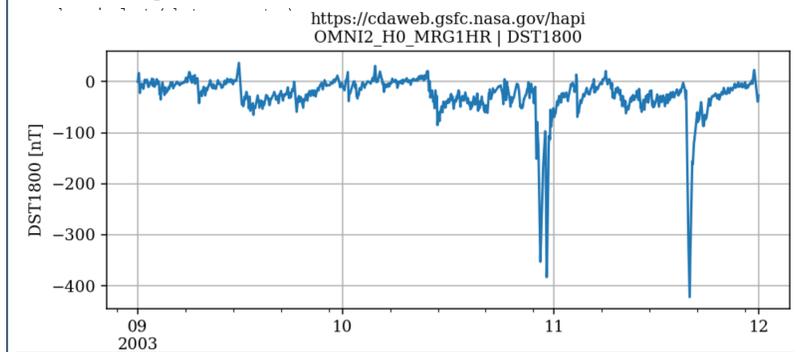

Data can be pulled from multiple data sources and aligned in time, allowing for correlation and temporal studies of heliophysics and geomagnetic data.

The Plan

The PSWS development team at University of Alabama is (with generous help from George Mason University) working on implanting a HAPI service (to run alongside of the existing PSWS web service) to make PSWS data (spectrum and magnetometer data) available. Then it will be possible to access the majority of our data using HAPI code and libraries. As with all HAPI compliant data sources, it will be possible to line up our spectral and magnetic data with measurements such as Kp and satellite data.

References

1. Weigel, R. S., Vandegriff, J., Faden, J., King, T., Roberts, D. A., Harris, B., ... & Martinez, B. (2021). Hapi: An API standard for accessing heliophysics time series data. *Journal of Geophysical Research: Space Physics*, *126*(12), e2021JA029534.
2. Hapi-server.org

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Your-email@domain.com

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