Interoperability for Heliophysics and Planetary Time Series Data via HAPI

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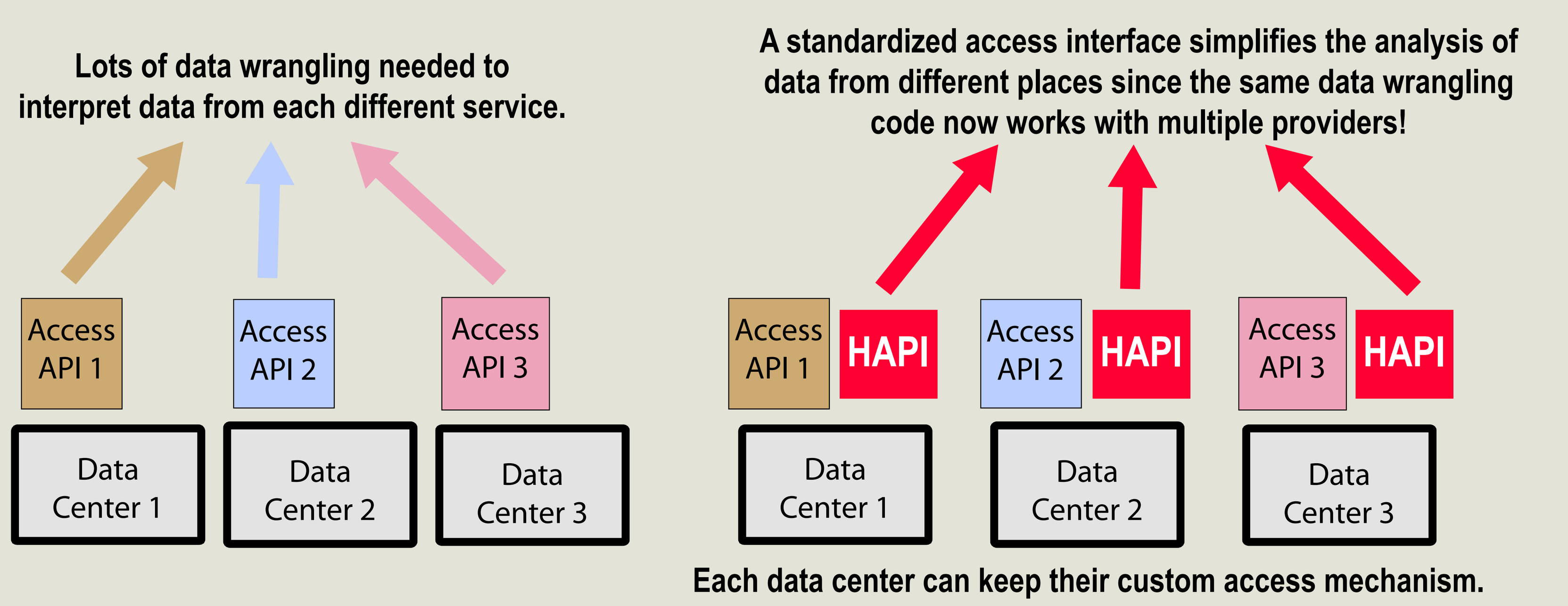
What is HAPI?

Heliophysics Application Programmer's Interface

What if your analysis tools already knew how to bring data into your workflow without any data wrangling needed by you?

HAPI is a standardized way of accessing time series data though a simple computer-to-computer interface.



What does the actual interface look like?

A HAPI server has four endpoints:

http://server/hapi/capabilities
http://server/hapi/catalog
http://server/hapi/info
http://server/hapi/data

A data request looks like this:

http://datashop.elasticbeanstalk.com/hapi/data?
id=CASSINI_LEMMS_PHA_CHANNEL_1_MIN_AVG&
time.min=2004-07-01T06:00:00.000Z&
time.max=2004-07-01T07:00:00.000Z&
include=header

Try it now!

Endpoint details.

http://server/**hapi/catalog**

Returns a JSON list of dataset identifiers from this server.

Takes no request parameters.

A human readable title for each dataset is optional.

Dataset identifiers need to be unique for any given server.


```
{
   "HAPI" : "2.0",
   "status": { "code": 1200, "message": "OK"},
   "catalog" :
   [
      {"id": "ACE_MAG",
        title:"ACE Magnetometer data"
      },
      {"id": "data/IBEX/ENA/AVG5MIN"},
      {"id": "data/CRUISE/PLS"},
      {"id": "any_identifier_here"}
   ]
}
```


The specification document.

HAPI Data Access Specification

Version 2.1.0 | Heliophysics Data and Model Consortium (HDMC) |

The most recent stable release is Version 2.1.0.

Table of Contents

Introduction

This document describes the Heliophysics Application Programmer's Interface (HAPI) specification, which is an API and streaming format specification for delivering digital time series data. The intent of HAPI is to enhance interoperability among time series data providers. The HAPI specification describes a lowest common denominator of services that any provider of time series data could implement. In fact, many providers already offer access to their data holdings through some kind of API. The hope is that this specification captures what many providers are already doing but just codifies the specific details so that providers could use the same exact API. This would make it possible to obtain time series science data content seamlessly from many sources.

This document is intended to be used by two groups of people: first by data providers who want to make

`https://github.com/hapi-server/data-specification`

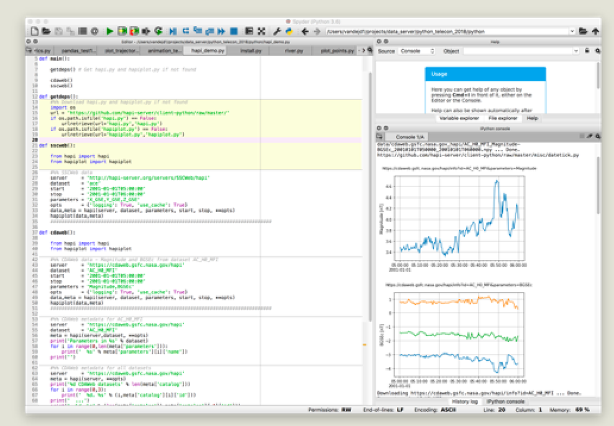
Current Implementations

A Python library is available for reading data from HAPI servers.
Several popular analysis tools know how to read HAPI data.
Multiple Heliophysics data centers are serving data using HAPI.
Tools exist to help data providers create their own HAPI servers.

Client Options (ways to read data from HAPI servers)

Python Client - create your own read routines

`https://github.com/hapi-server/client-python`

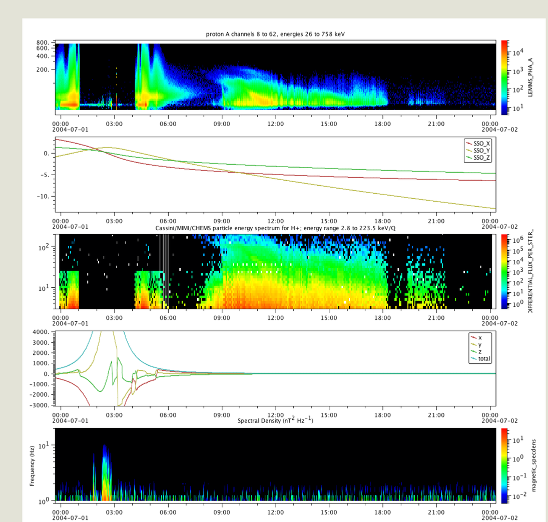


Demonstration code that reads from HAPI servers. The plotting is just for demo purposes.

A few lines of code can read an arbitrary time range into a Python data structure that will be the same for any data source.

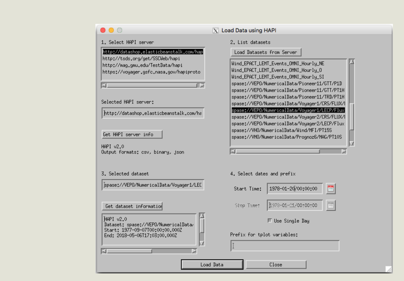
Autoplot - Java visualization tool

`http://autoplot.org`



SPEDAS - IDL suite that reads many data sources, including HAPI

`http://spedas.org`



Load data using GUI

Simple code to get HAPI data from any server.

Server Implementation Support

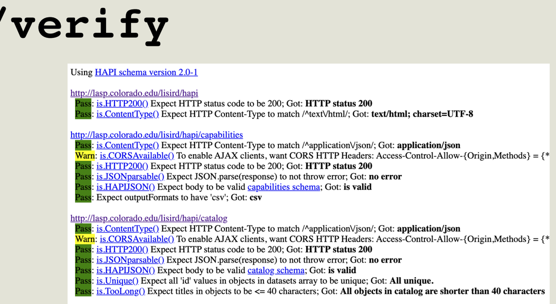
Generic Server - ready to serve your data!

Reusable server components are available that implement the HAPI protocol and read data from user-provided scripts.

`https://github.com/hapi-server/server-nodejs`

Server Verifier `http://hapi-server.org/verify`

- a mechanism for testing the validity of a server
- can be run locally or an online version is available
- has been very useful for new server developers!



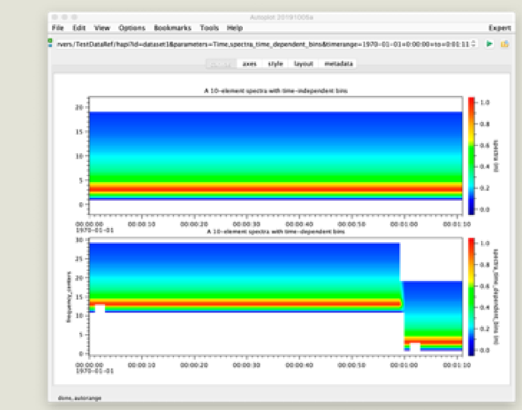
Live Data Servers `http://hapi-server.org/servers`

See list below for institutions serving data via HAPI

Recent Updates

Data with time-varying bin ranges is supported.

For many data sets, the energy ranges of frequency ranges of spectra are fixed over time. But some data sets have spectra whose bins change with time. Plotted here are two toy data sets, one with fixed bins over time and the second with bins that change near the end of the time range.




```
{   "HAPI": "3.0",
    "status": {"code": 1200, "message": "OK"},
    "startDate": "2016-01-01T00:00:00.000Z",
    "stopDate": "2016-01-31T24:00:00.000Z",
    "parameters":
      [ { "name": "Time", "type": "isotime",
          "units": "UTC", "fill": null,"length": 24 },
        { "name": "proton_spectrum","type": "double",
          "size": [16], "units": "particles/(sec ster cm^2 keV)",
          "fill": "-1e31",
          "bins": [
               { "name": "energy",  "units": "keV",
                 "ranges": "energy_ranges" } ] },
        {
          "name": "energy_ranges", "type": "double",
          "size": [16,2],
          "units": "keV", // same as proton_spectrum units
          "fill": "-1e31"
        }
     ]
}
```


For time varying bins, the bin ranges (or centers) refer not to fixed values, but to a variable who value at each time step will be used to obtain the bin ranges (or centers).

The ability to specify a units framework.

Units are specified as strings, and providers can now include a schema to indicate what units framework governs any units strings for a given dataset.

Specifying references within the JSON metadata.

If data sets have repetitive elements, they can now be explicitly linked in the metadata using a references to a common element.

For units, other options are **`astropy3`** or **`cdfunits`**

For using references in the header, notice the definitions section, and then references to elements in this section use standard JSON syntax.


```
{   "HAPI": "3.0",
    "status": {"code": 1200,"message": "OK"},
    "startDate": "2016-01-01T00:00:00.000Z",
    "stopDate": "2016-01-31T24:00:00.000Z",

    “unitsSchema” : “udunits2”


    "definitions": {
        "spectrum_units": "particles/(sec ster cm^2 keV)",
        "spectrum_centers": [15, 25, 35, 45],
        "spectrum_bins": {
            "$id": "spectrum_bins_id",
            "name": "energy",
            "units": "keV",
            "centers": [15, 25, 35, 45]
        }
    },

    "parameters": [
       {"name": "Time", "type": "isotime", "units": "UTC",
          "fill": null, "length": 24 },
       {"name": "proton_spectrum", "type": "double", "size": [4],
            "units": {
                "$ref": "#/definitions/spectrum_units"
            },
            "fill": "-1e31",
            "bins": [{
                "name": "energy",
                "units": "keV",
                "centers": {
                    "$ref": "#/definitions/spectrum_centers"
                }
            }]
        },
        {"name":"proton_spectrum2","type":"double","size": [4],
          "units": {
             "$ref": "#/definitions/spectrum_units"
           },
          "bins": [{
             "$ref": "#/definitions/spectrum_bins"
          }]
       }
    ]
}
```


To receive HAPI update emails:

send a request to: `hapi-news@hapi-server.org`

CDAWeb
Goddard Space Flight Center
https://cdaweb.gsfc.nasa.gov/hapi

Community Coordinated Modeling Center
Integrated Space Weather Analysis System
https://iswa.gsfc.nasa.gov/IswaSystemWebApp/hapi

l'Observatoire de Paris
CDPP
Plasma Physics
Data Center

esa
European Space Astronomy Centre

UCLA
PDS: Planetary Plasma Interactions Node
https://pds-ppi.igpp.ucla.edu/hapi

LASP
Laboratory for Atmospheric and Space Physics
http://lasp.colorado.edu/lisird/hapi

JOHNS HOPKINS APPLIED PHYSICS LABORATORY
Space Exploration Sector
http://datashop.elasticbeanstalk.com/hapi

GEORGE MASON UNIVERSITY
Department of Physics and Astronomy
http://hapi-server.org/servers/SSCWeb/hapi

THE UNIVERSITY OF IOWA
RADIO AND PLASMA WAVE GROUP
http://planet.physics.uiowa.edu/das/das2Server/hapi