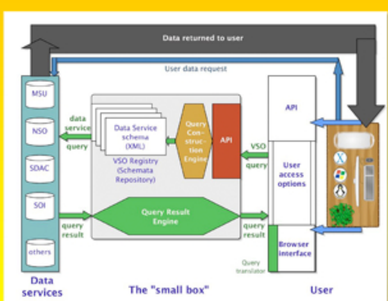
3.05 The Virtual Solar Observatory and the Heliophysics Meta-Virtual Observatory

J.B. Gurman, J.A. Hourclé, G. Dimitoglou - NASA Goddard Space Flight Center
R.S. Bogart and K. Tian - Stanford University
F. Hill, I. Suárez-Sola, and S. Wampler - National Solar Observatory
A. Davey - Southwest Research Institute
P.C. Martens, K. Yoshimura - Montana State University

ABSTRACT. The Virtual Solar Observatory (VSO) is now able to search for solar data ranging from the radio to gamma rays, obtained from space and groundbased observatories, from 26 sources at 12 data providers, and from 1915 to the present. The solar physics community can use a Web interface or an Application Programming Interface (API) that allows integrating VSO searches into other software, including other Web services. Over the next few years, this integration will be especially obvious as the NASA Heliophysics division sponsors the development of a heliophysics-wide virtual observatory (VO), based on existing VO's in heliospheric, magnetospheric, and ionospheric physics as well as the VSO. We examine some of the challenges and potential of such a "meta-VO."



Keeping it simple: the VSO design effort was tightly circumscribed, so the original design team of solar physicists and computer scientists realized the need to limit the design to the minimum necessary to do the job: provide distributed access to metadata for queries, return the metadata to the user for query refinement, and provide access to the data at the data providers' sites. All of the VSO interfaces (green arrows) are based on XML and SOAP, or HTML. Thansk to feedback at regular scientific meetings, the design included an API as well as a Web interface.

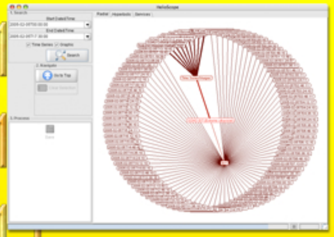
A search starts simply enough: All VSO searches are based on a time range and some combination of other parameters (physcial observables, instrument, data provider, spectral range, or combinations of these known as "nicknames" (e.g. "EUV image", "vector magnetogram").

A partly exploded time/instrument search shows all providers and instruments for search: Currently, 12 providers offer a total of 25 different data sources. More are on the way. (A fully exploded version would show each instrument in each observatory.)

Search results can include thumbnails for image data: Thumbnails are often links to full-sized images. The Graphic User Interface (GUI) used the "shopping cart" idiom common to commercial Websites.

Data delivery: Depending on the provider, data can be delivered as a URL for each file or an e-mail message indicating that a tarball is waiting for retrieval on an ftp server.

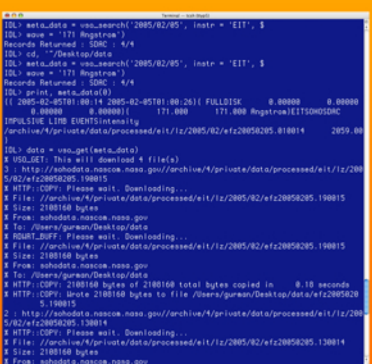
Alternate time specification: The time range(s) for a search can be determined by searching event catalogs. Currently, these include a coronal mass ejection (CME) catalog and two flare catalogs.



Using the VSO API: Users can design software to communicate with the VSO's Application Programming Interface (API). In this example from the UK's AstroGrid, the Java applet Helioscope searches the VSO for solar data and the CDAWeb for in situ data products. If the user clicks on a particular data type (here SOHO EIT), an exploded view of available files is displayed. Heliscope can be linked with the Aladin image viewer, although Aladin can not yet process raw images correctly.

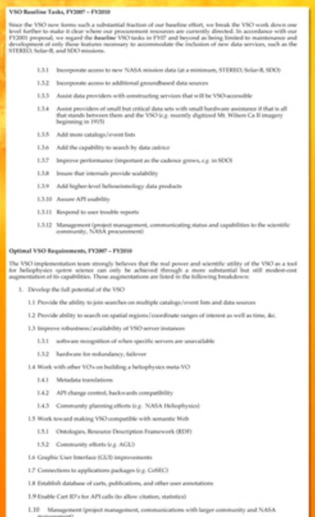
Signed up: SDO data from AIA, HMI, and EVE will be available *via* the VSO.

The STEREO Science Center (SSC) will use the VSO to enable searches; at least one STEREO PI team will have a custom VSO instance to make in-house searches easier.



IDL callable VSO: Using the VSO API and IDL™'s XML parsing capabilities, combined with IDL sockets, the VSO_SEARCH and VSO_GET functions allow an IDL user to query the VSO and download data matching user-defined metadata queries, if the files are served as URL's.

We have our work cut out for us: The NASA 2006 Senior Review of the NSSDC and Heliophysics Data and Modeling Centers directed us not only to carry out "baseline" maintenance and development, but also to move ahead with new efforts that will make the VSO more useful to both solar physicists and a wider community.



VSO Baseline Tasks, FY2007 – FY2010

Since the VSO now forms such a substantial fraction of our baseline effort, we break the VSO work down one level further to make it clear where our procurement resources are currently directed. In accordance with our FY2001 proposal, we regard the **baseline** VSO tasks in FY07 and beyond as being limited to maintenance and development of only those features necessary to accommodate the inclusion of new data services, such as the STEREO, Solar-B, and SDO missions.

1.3.1 Incorporate access to new NASA mission data (at a minimum, STEREO, Solar-B, SDO)

1.3.2 Incorporate access to additional groundbased data sources

1.3.3 Assist data providers with constructing services that will be VSO-accessible

1.3.4 Assist providers of small but critical data sets with small hardware assistance if that is all that stands between them and the VSO (*e.g.* recently digitized Mt. Wilson Ca II imagery beginning in 1915)

1.3.5 Add more catalogs/event lists

1.3.6 Add the capability to search by data cadence

1.3.7 Improve performance (important as the cadence grows, *e.g.* in SDO)

1.3.8 Insure that internals provide scalability

1.3.9 Add higher-level helioseismology data products

1.3.10 Assure API usability

1.3.11 Respond to user trouble reports

1.3.12 Management (project management, communicating status and capabilities to the scientific community, NASA procurement)

Optimal VSO Requirements, FY2007 – FY2010

The VSO implementation team strongly believes that the real power and scientific utility of the VSO as a tool for heliophysics system science can only be achieved through a more substantial but still modest-cost augmentation of its capabilities. These augmentations are listed in the following breakdown:

1. Develop the full potential of the VSO

1.1 Provide the ability to join searches on multiple catalogs/event lists and data sources

1.2 Provide ability to search on spatial regions/coordinate ranges of interest as well as time, &c.

1.3 Improve robustness/availability of VSO server instances

1.3.1 software recognition of when specific servers are unavailable

1.3.2 hardware for redundancy, failover

1.4 Work with other VO's on building a heliophysics meta-VO

1.4.1 Metadata translations

1.4.2 API change control, backwards compatibility

1.4.3 Community planning efforts (*e.g.* NASA Heliophysics)

1.5 Work toward making VSO compatible with semantic Web

1.5.1 Ontologies, Resource Description Framework (RDF)

1.5.2 Community efforts (*e.g.* AGU)

1.6 Graphic User Interface (GUI) improvements

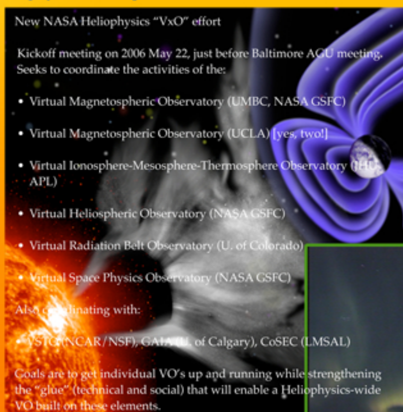
1.7 Connections to applications packages (*e.g.* CoSEC)

1.8 Establish database of carts, publications, and other user annotations

1.9 Enable Cart ID's for API calls (to allow citation, statistics)

1.10 Management (project management, communications with larger community and NASA management)

Some of the folks we'll be hanging out with over the next few years: so solar physicists can access non-solar data more easily, and space plasma physicists can get their hands do science with ours.



http://virtualsolar.org/