STEREO and the Virtual Heliospheric Observatory

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http://vho.nasa.gov
Scientific Quest is Changing

- **Past** – In-depth single spacecraft studies
- **Future** – Study multi-spacecraft / multi-instrument local and remote sensing measurements
- **STEREO**
  - Multi spacecraft platform with remote and in-situ instruments
  - Addresses large-scale heliospheric structures so it would uniquely benefit from other platforms
Battle of WITS

- **W**: Where to find data?
- **I**: Integration of data from various sources is often difficult.
- **T**: Tools are needed to work with the data.
- **S**: Scientific perspective introduces additional questions:
  - Integration of distant heliospheric observations
  - Time-space propagation (what is a match?)
  - Integration of remote and in-situ measurements
Why Virtual Observatories?

- Many datasets with large volumes
- Data sites distributed worldwide
- Stored in a variety of formats
- Accessible through a wide variety of interfaces
What is the goal of the VHO?

- Science based discovery of heliospheric data
- Unified, yet simple, environment to access all heliospheric data sets and tools
- Provide rapid community access to the highest quality processed data
VHO Design

- Existing data providers plus new Metadata descriptions of data and data products
- SPASE dictionary
- Data Synchronization
VHO Design

Addition of VHO Middleware

Metadata synced to VHO
VHO Design
Initial VHO Data Participants
8 Spacecraft - 13 Data Sets

ACE
- Magnetometer
- SWEPAM

IMP 8
- Magnetometer

Genesis
- Mag. Field Proxy
- 3D Moments

SOHO
- Celias instrument

Helios 1 and 2
- Magnetometer
- Plasma instrument

WIND
- MFI
- SWE
- ELPD
- PLSP

Mars Global Surveyor
- Solar Wind Pressure Proxy
Addition of Instruments and Spacecraft
Total: 12 Spacecraft - 30 Data Sets

**Messenger**
- MAG
- EPPS

**Ulysses**
- VHM (mag field)
- BAI (ions)
- BAE (electrons)

**Voyager**
- MAG

**STEREO**
- IMPACT - PLASTIC
Data Synchronization

- WIND 3DP processing requires most recent and highest quality MFI data

- Automated synchronization makes archiving requirements easier
Current Types of VHO searches

Science driven data searches:

- **Time**
  - Date/Time
  - Bartel Rotation
  - HGI
  - Spatial Region

- **Space**
  - GSE
  - GSM
  - Particles/Moments

- **Measurement**
  - Magnetometers
  - SW Plasma
  - Particles/Moments

Other:
- Event Lists

Spatial Region search allows for keyword search examples:
- Bow Shock to ~60 Re, L1, Inner Heliosphere (< 0.8 AU)
- Mid Heliosphere (0.8 AU to 5 AU), Outer Heliosphere (> 5 AU)

Note: solar wind data only, magnetospheric data removed
VHO Searches

- Complex Queries: find data when multiple conditions are true
- Find other heliospheric data sets to use along with STEREO
## Spectrum of Users

<table>
<thead>
<tr>
<th>Web Based Interface</th>
<th>Public Tools</th>
<th>Application Programming Interface (API)</th>
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</thead>
<tbody>
<tr>
<td><strong>CoSEC, ACE Science Center</strong></td>
<td>• Access all types of searches and services from VHO web page</td>
<td>• Access VHO from your own software</td>
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<tr>
<td><strong>• Easy access</strong></td>
<td>• CoSEC Client software being written to access VHO</td>
<td><strong>• Complete flexibility</strong></td>
</tr>
<tr>
<td><strong>• Fixed Interface</strong></td>
<td>• More advanced and community provided</td>
<td><strong>• Steep learning curve</strong></td>
</tr>
<tr>
<td></td>
<td>• Dependant on tool providers</td>
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Services and Tools

- **Services offer automated data processing:**
  1. Coordinate Transformations - 12 coordinate systems
  2. Ascii Subsetting - subset a few hours from file
  - CoSEC interface offers ability to use services outside of VHO
  - Examples of how to use through API/CoSEC
  - Example of how to interface with SSCWeb
  - Metadata standardization for services
STEREO Related Functionality

- Collaborating with VSO team to set up cross VO queries
  - STEREO data users will not have to go to both VSO and VHO to get STEREO data
- Future Services
  - Merging multi-spacecraft time series data and solar images into one file
  - Backtracing to get solar images
Summary

- Prototype available at http://vho.nasa.gov
- Encourage community input on services and methods used in services
  - SW propagation methods
  - Means of combining in-situ and remote data
- Encourage input regarding models and their integration into virtual observatories