

Towards a Unified Heliophysics Data Environment: Semantic Interoperability and Knowledge Discovery

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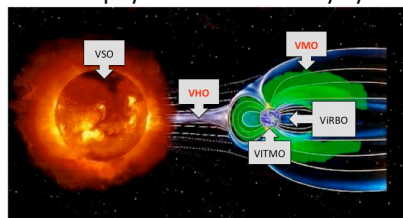
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Introduction

A prime objective of the Heliophysics Data Environment is seamless data discovery and access irrespective of storage format, access protocol, or naming convention. We demonstrate how semantics can assist in achieving this objective. Meaning is represented using a formal ontology. This abstraction of knowledge allows for more efficient machine-to-machine communication as well as more efficient human-computer interaction.

NASA Heliophysics Data Discovery Systems



VSO – Virtual Solar Observatory – Images and Remote Sensing data of the Sun
 VHO – Virtual Heliospheric Observatory – Primarily time series data from in-situ spacecraft
 VMO – Virtual Magnetospheric Observatory – Space and ground-based data from Earth's magnetic field
 VIRBO – Virtual Radiation Belt Observatory – Measurements of Earth's radiation belts
 VITMO – Virtual Ionospheric, Thermospheric, Mesospheric Observatory – Earth's upper atmosphere
 Red = Semantically Enabled System



- International effort to create a standardized metadata model
- Ontology created from XML Schema

Ontology and Instance Files

- <http://vho.nasa.gov/ontology/spase.owl>
- <http://vho.nasa.gov/ontology/vho.owl>
- <http://vho.nasa.gov/ontology/vmo.owl>

Ontology Instances



Simultaneous observations of earthward flow bursts and plasmoid ejection during magnetospheric substorms

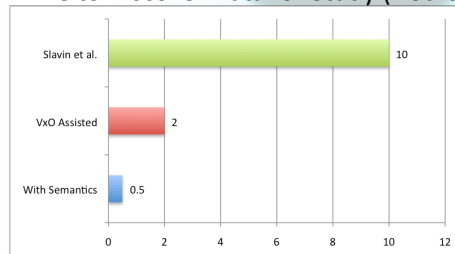
J. A. Slavin,¹ D. H. Fairfield,² R. P. Lepping,³ M. Hesse,⁴ A. Ieda,⁵ E. Tanskanen,⁶ N. Ohigami,⁷ T. Mukai,⁸ T. Nagai,⁹ H. J. Singer,¹⁰ and P. R. Sckelton¹¹

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[1] Examination of observations taken by radially aligned International Solar Terrestrial Physics spacecraft in the magnetosphere revealed clear temporal correlations between earthward flow bursts in the plasma sheet and the ejection of plasmoids. A one-dimensional model of plasma sheet flow is applied to these observations to determine the time and location for the initiation of lobe flux tube reconnection. For the single clear flow burst-plasmoid pair observed during the first substorm and the three pairs produced by the second substorm, lobe

~ 10-100 hours to identify the events

Time to Discover Data for Study (Hours)



VxO Assisted results from Merka et al. 2008

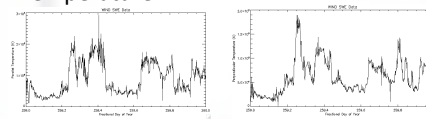
Ontology Supported Client Application

Researchers would like read disparate formats as well as map differences in parameters (e.g. units, coordinate systems) to a common baseline for interoperability.

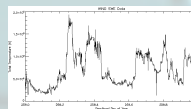
We use the Workflow Driven Ontology (WDO) (Salayandia et al., 2006) and our SPASE Ontology to define conversions between parameters, units, coordinate systems, and representations. This is in contrast to the Vandergriff and Brown (2010) method.

Example

Dataset contains parallel and perpendicular components of Temperature, but user wants total Temperature

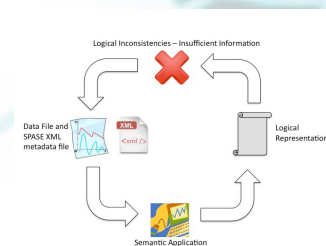


Conversion workflow is inferred from domain and WDO ontologies



Conversion applied and user gets requested data

Ontology Supported Feedback Loop



Benefits Over Existing Method

- Baseline parameters are customizable and not defined a priori
- Conversions are external to source code – shareable and extensible
- One code base can read all data sets
- Preserves Provenance