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

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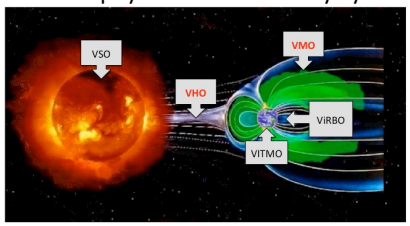
Introduction

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

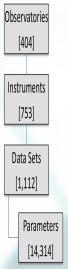
Red = Semantically Enabled System

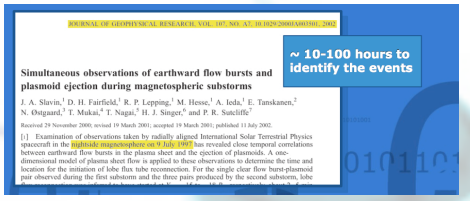
- International effort to create a standardized metadata model
- Ontology created from XML Schema

Ontology and Instance Files

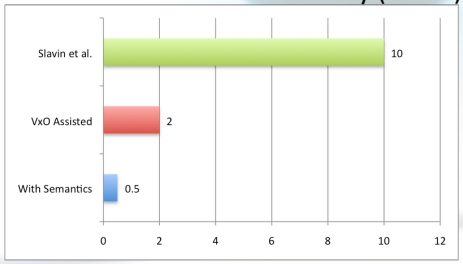
http://vho.nasa.gov/ontology/spase.owl
http://vho.nasa.gov/ontology/vho.owl
http://vho.nasa.gov/ontology/vmo.owl

Ontology Instances





Time to Discover Data for Study (Hours)



VxO Assisted results from Merka et al. 2008

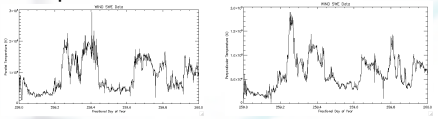
Ontology Supported Client Application

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

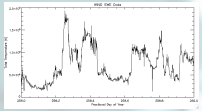
We use the Workflow Driven Ontology (WDO) (Salayandia et al., 2006) and our SPASE Ontology to define conversions between parameters, units, coordinate systems, and representations. This is in contrast to the Vandergriff and Brown (2010) method.

Example

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

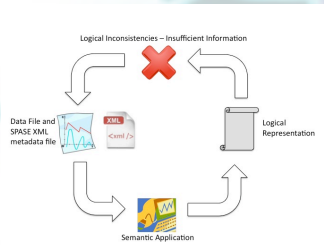


Conversion workflow is inferred from domain and WDO ontologies



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

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