The philosophy of user interfaces in **HELIO** and the importance of **CASSIS**

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ABSTRACT: HELIO is a European project funded under FP7 (Project No. 238969). One of its goals as a Heliospheric Virtual Observatory is to provide an easy access to many datasets scattered all over the world, in the fields of Solar physics, Heliophysics, and Planetary magnetospheres. The efficiency of such a tool is very much related to the quality of the user interface. HELIO infrastructure is based on a Service Oriented Architecture (SOA), regrouping a network of standalone components, which allows four main types of interfaces:

- HELIO Front End (HFE) is a browser-based user interface, which offers a centralized access to the HELIO main functionalities. Especially, it provides the possibility to reach data directly, or to refine selection by determination of observing characteristics, such as which instrument was observing at that time, which instrument was at this location, etc.
- Many services/components provide their own standalone graphical user interface. While one can directly access individually each of these interfaces, they can also be connected together.
- Most services also provide direct access for any tools through a public interface. A small java library, called Java API, simplifies this access by providing client stubs for services and shields the user from security, discovery and failover issues.
- Workflows capabilities are available in HELIO, allowing complex combination of queries over several services.

We want the user to be able to navigate easily, at his needs, through the various interfaces, and possibly use a specific one in order to make much-dedicated queries.

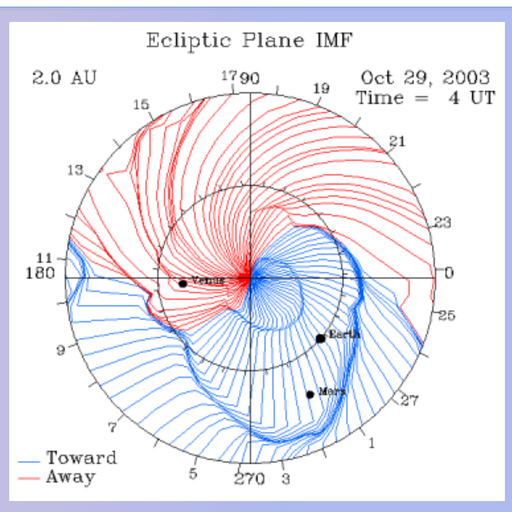
We will also emphasize the importance of the CASSIS project (Coordination Action for the integration of Solar System Infrastructure and Science) in encouraging the interoperability necessary to undertake scientific studies that span disciplinary boundaries. If related projects follow the guidelines being developed by CASSIS then using external resources with HELIO will be greatly simplified.

About HELIO

Heliophysics is a research field that explores the effects of the Sun on the Solar System; it addresses problems that span a number of existing disciplines — solar and heliospheric physics, and magnetospheric and ionospheric physics for the Earth and other planets. In order to facilitate the study of this new discipline, the **Heliophysics Integrated Observatory**, **HELIO**, will deploy a distributed network of services that will address the needs of a broad community of researchers in heliophysics. HELIO necessitates to tackle issues in a number of areas related to two basic requirements:

- Provide integrated access to data from all the domains of heliophysics that are held in archives around the world.
- Provide the means to conduct searches across the domains to identify data-sets of interest.

A major research problem is to search multiple catalogues or databases to track the development of an event when the effects of that event travel at different speeds. Heliophysical events are first observed (remotely) on the sun, and then propagate through the solar system while potentially being detected by a variety of space- and earth-based instruments. In addition, HELIO will thus integrate dedicated propagation tools that will assist users in such researches.

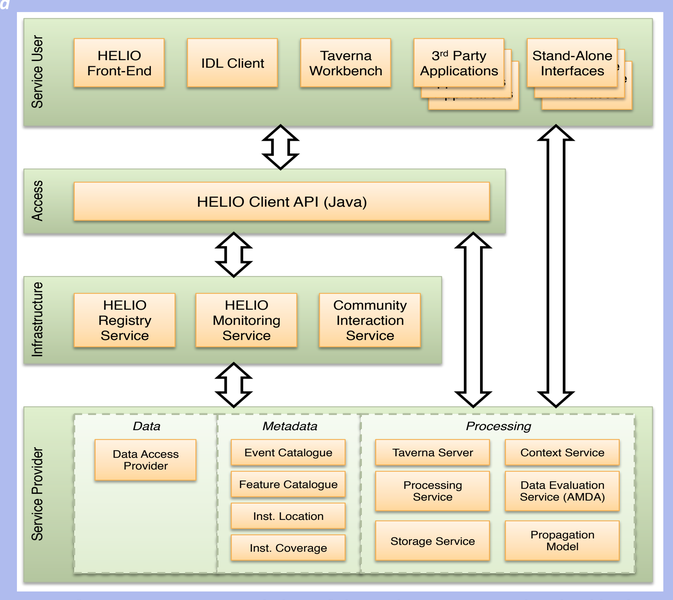


HELIO will offer specific capabilities to help users to track a propagating phenomena through the heliosphere, precising when and where associated events can be observed, and allowing to easily retrieve corresponding data.
Here, Instantaneous snapshot of propagation model for charged particles, showing distortions to the interplanetary magnetic field caused by coronal mass ejections. (Courtesy of Geophysical Institute, University of Alaska, Fairbanks, Alaska)

HELIO is being implemented with a service-oriented architecture – this basically means that capabilities that are required are split into a number of separate services. In principle, the services can be grouped into two areas: search for interesting events and phenomena; and identify, locate and retrieve observations.

Service Name	Purpose
Search Metadata	
Heliophysics Event Catalogue (HEC)	Maintain and provide access to *existing* event data from all domains
Heliophysics Feature Catalogue (HFC)	Maintain and provide access to existing feature data from all domains
MetaData Evaluation Service (MDES)	Allows the user to create an auxiliary event list based on a *newly-derived* parameter, etc.
Context Service (CXS)	Provide context information to help the user make a selection
Review suitable observations	
Instrument Capabilities Service (ICS)	Match required observation type to one or more instruments (each part of an observatory)
Instrument Location Service (ILS)	Determine the location of an instrument (part of an observatory) at a specified time
Observation Coverage Service (OCS)	Provide information on whether an instrument was making suitable observations at a specified time
Locate and Retrieve the Data	
Data Provider Access Service (DPAS)	Provide integrated access to data archives in all domains no matter how the data are stored or accessed
Enabling Services	
HELIO Registry Service (HRS)	Maintain and provide access to a registry that describes all the services available to HELIO
Community Interaction Service (CIS)	Manages interactions with the community, including authentication and usage statistics
Processing Service	Support processing on demand
Storage Service	Provide storage for user information
Ancillary Information Service (AIS)	Provide integrated access to external resources that do not conform to HELIO interface standards
Coordinate Transformation Service (CTS)	Translated between the different coordinate systems used by the communities
Semantic Mapping Service (SMS)	Maps terms used in the metadata from the different communities
HELIO Monitoring Service (HMS)	Keeps track of the status and performance of the services that the HRS knows about
Resource Usage Service (RUS)	Keeps track of usage of HELIO so that the project can provide statistics to users, providers, etc.

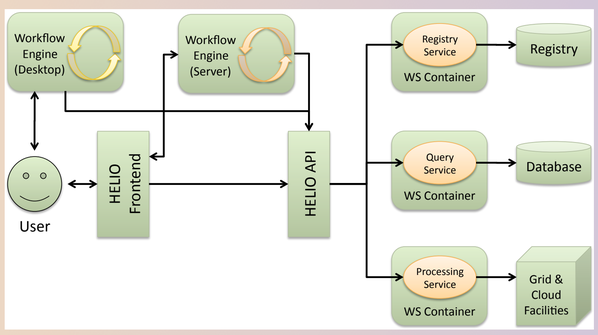
➡ For more information about HELIO, see **J. Aboudarham** talk, or visit **http://www.helio-vo.eu**



Infrastructure. Structural view of the main components involved in the HELIO infrastructure. The arrows denote communication flows.

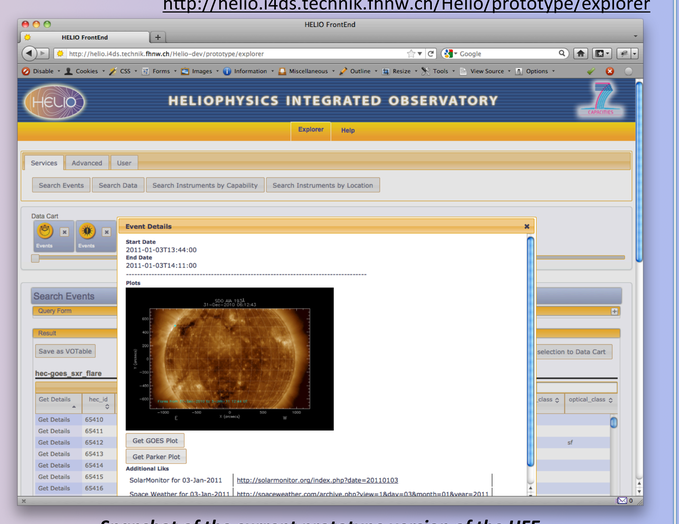
HELIO Front End

The HELIO Front End provides a centralized and user-friendly access to the HELIO network. Services usage and data processing are here done in the background, and therefore allow users to make science using the system capabilities intuitively.



Information flows in complex HELIO usage, showing how the front-end will use the sysem to access the network

http://helio.i4ds.technik.fhnw.ch/Helio/prototype/explorer

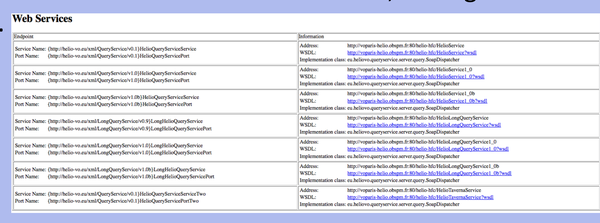


Snapshot of the current prototype version of the HFE.

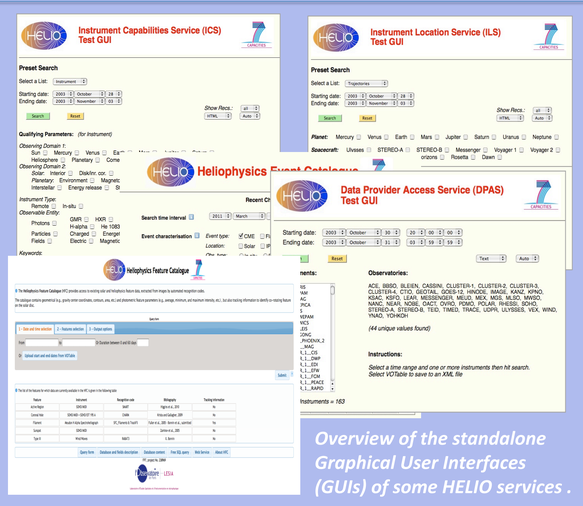
Standalone Interfaces

Most HELIO services have their own stand-alone interfaces, allowing them to be directly used over the web. It mainly concerns the database-oriented components such as the HELIO event catalogue (HEC), HELIO feature catalogue (HFC), or the Instrument Location Service (ILS).

All these services also support web service queries (HTTP-GET and SOAP) through the HELIO query interface (HQI). HQI constitutes the standard JAVA interface to communicate in the HELIO network, using Votable format.



Example of wsdl access page proposed by the HQI (here for the HFC)

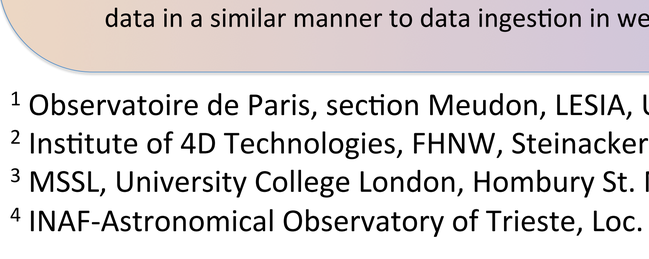


Overview of the standalone Graphical User Interfaces (GUIs) of some HELIO services .

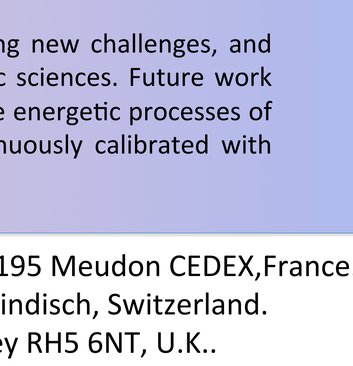
http://www.helio-vo.eu/services/service_interfaces.php

Workflows Capabilities

HELIO uses Taverna as its exemplar workflow system, as it provides a relatively simple mechanism for orchestrating multiple services into a single unit of processing. In addition to supporting the use of the Taverna Workbench, HELIO has an installation of Taverna Server which can execute workflows that have been created through the Workbench. These stored workflows are annotated with metadata that enables them to be automatically exposed to users through the HFE, enabling workflow use without the users having to install a complex piece of software like the Workbench.



The workflows are principally comprised of processing elements that access HELIO's services (especially the query interfaces) via SOAP method invocations, interleaved with extra processing elements to extract and combine results.

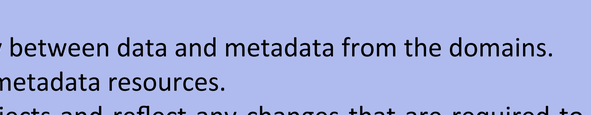


Example of Taverna workflow for querying HELIO Feature Catalogue and HELIO Feature Catalogue.

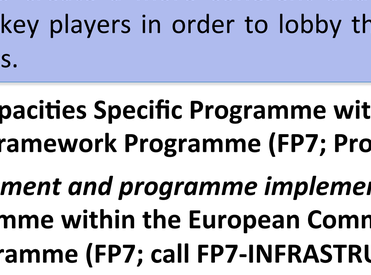
HELIO Client interfaces

HELIO API: The HELIO Application Programming Interface specifies interfaces for various client applications to connect to the HELIO infrastructure. Applications can either access services directly through their individual API (HELIO Service API) or they can connect through the central HELIO Client API. The main purpose of the HELIO Client API is to unify access to the service infrastructure. It features a user centric approach in order to make access to HELIO as simple as possible. Moreover it enhances selected services with additional functionality.

HELIO SSW: HELIO is also accessible through the Solar Software (SSW) installed with the "helio" package. It allows to handle, view, and retrieve data from HELIO services, or from solar, planets and heliospheric data providers.



This enables access to HELIO through the IDL scripting environment. With IDL, users can interactively communicate with the HELIO system, and in this way combine the HELIO capabilities with advanced data analysis tasks.



Quickview of a SOHO/MDI observation, produced using SSW HELIO package. Active regions contours are overplotted using HELIO Feature Catalogue data.

Conclusions & Future Works

The HELIO infrastructure is largely complete and key use cases are being deployed. The community consultation is pro- ceeding via a series of workshops in which the requirements of the heliophysicists are being mapped onto the services and the services are linked in dynamic workflows that execute across a back-end infrastructure that transparently uses Grid and Cloud resources. The workflows represent a key resource for the community, just as they do in other disciplines. We have been careful to reuse previous work by the Virtual Observatory and eScience communities, and we believe that our success in doing this is a mark of the progress of eScience to becoming a more mature field of research. As a result, we are able for the first time to address the whole nature of heliophysics.

Studying the heliophysics discipline in a systematic manner will bring new challenges, and methods will be developed that can be applied in other data-centric sciences. Future work will integrate the data gathered from observations with models of the energetic processes of interplanetary space, allowing for example the models to be continuously calibrated with data in a similar manner to data ingestion in weather forecasting.

About CASSIS

➡ More information about CASSIS project on **http://www.cassis-vo.eu**

Solar System science has traditionally been undertaken within a number of separate disciplines. However, like any system its aspects are inter-related and it has been difficult to address these aspects because of the lack of the integrating technology required to span the inter-disciplinary boundaries. While advances in technology means that the intrinsic differences between disciplines (manifest in differing data formats and dependencies) are beginning to be addressed, it is necessary to coordinate our efforts in order to help break down the barriers.

Within **CASSIS** we propose to take steps to move to the next level by cooperating in a number of areas. The cooperation will be in three main areas:

- We will investigate ways to improve the interoperability between data and metadata from the domains.
- We will also investigate the possibility of sharing some metadata resources.
- We will coordinate the use of standard within the projects and reflect any changes that are required to organisations like the **IVOA** and **IPDA**.

We will coordinate our dissemination activities in order to create a more coherent and comprehensive approach. As part of this activity, we will hold meetings of key players in order to lobby the case for solar system science with the decision makers and funding agencies.

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