Mission-Independent Analysis for Energetic Particle Data

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POINT 1 of 2: The use of **Data Interfaces** greatly simplifies multi-mission analysis and data fusion for **all kinds of science data**, not just energetic particle and field data.

The Data Interface concept is relatively new and is useful in any multi-mission analysis environment. This panel defines and describes data interfaces. The panel on the right gives an example of one application which uses data interfaces to enable multi-mission analysis of particle and field data.

Data Interfaces - descriptions and definitions

A data interface is a software API which sits over a dataset and provides access to the dataset; all access to the dataset must go through the data interface, which is implemented in a thin software layer.

A data interface enables multi-mission analysis by providing a common way to access datasets with similar scientific content.

A data interface can serve data from a dataset stored in any conceivable format.

A data interface is not a data format, but it does require a standard set of method calls (similar to subroutine calls) which define what scientific quantities can be extracted from a particular kind of science data.

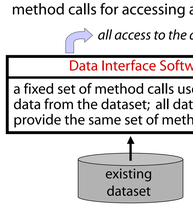
A data interface can be enhanced or extended to allow for development of mission specific tools for instrument teams, for example.

A data interface separates analysis tool development from data reader software.

A data interface can be implemented in a language independent way using existing techniques (i.e., Grid technology or web services).

Data interfaces can contribute to LWS data system development because they define a standardized way to access existing or new datasets. Any conceivable distributed analysis architecture can benefit from lower level components which enable unified data access through data interfaces.

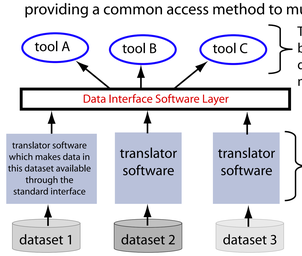
a. A data interface defines a standard set of subroutines or method calls for accessing a particular kind of science data.



The interface layer defines a software API for accessing a specific kind of science data.

Note that this approach shifts the data definition away from file static file formats and moves it into a software layer, which is more flexible.

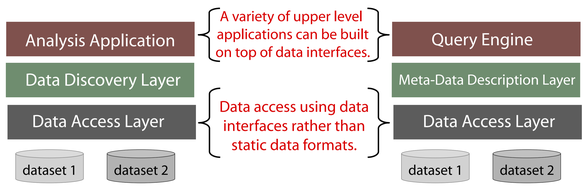
b. Data interfaces enable multi-mission analysis by providing a common access method to multiple datasets.



The same tools can be used to analyze data from different missions.

Mission specific software reads data from a static dataset and makes it available through the methods of the interface.

c. Data interfaces as fundamental components in the lower layers of a data system design will be useful building blocks for any conceivable architecture chosen for the larger, conglomerate system.



d. Common questions about data interfaces.

Question: How can you expect the community to come up with a standard access method for science data?

Response: Standard access through a ***data format*** has never worked, but if you want multi-mission inter operability, you must standardize somewhere, and rather than do this in the data format, do it in a ***software layer***, which has much more flexibility.

Question: How long does it take to write the implementation software for a data interface? Who writes this software?

Response: For simple ephemeris and magnetic field data, it takes less than one day. For particle data, it can take anywhere from 1 to 3 months. It would require a programmer who knows about both the data interface definition and the dataset and/or instrument specific details.

POINT 2 of 2: Effective web-based analysis tools for multi-mission particle and field data have been developed and deployed using the **Data Interface** concept. For the first time, the highest time-resolution energetic particle data for several important missions is now available on the web.

The data and analysis tools described below are available on-line at `http://sd-www.jhuapl.edu/MIDL`

To utilize the data interface concept for particle and field data, the following three steps were taken:

STEP 1 - Data interfaces have been defined for the following kinds of data:

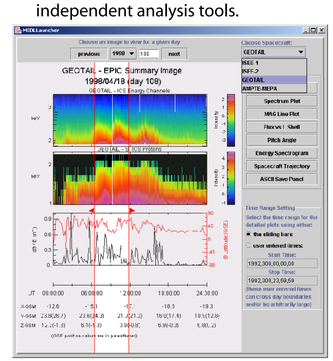
Energetic Particle Data	Magnetic Field Data	Spacecraft Ephemeris
mission independent access to the *highest time resolution data*, including directional information	provides high time resolution measurements for Bx, By, and Bz, with uncertainties if available	provides spacecraft X, Y, and Z position in relevant coordinate system

STEP 2 - Software implementations (i.e., the datasets specific translator software shown above the datasets in box "b" on the left panel) for these three interfaces have been written for the following 4 missions:

GEOTAIL/EPIC, AMPTE/MEPA, ISEE-1, ISEE-2

STEP 3 - Web-based analysis tools were created based solely on the APIs in the data interfaces. These tools analyze and display the particle, field and ephemeris data for all of the above missions.

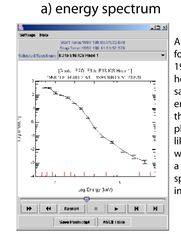
The main application links the interface implementations with the mission-independent analysis tools.



The current setup shows one summary image per day for each included dataset. Scrolling through these summary images provides a way to browse a dataset.

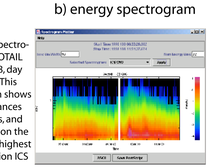
After selecting a specific time range, analysis tools can be launched to view dynamic plots, such as:
a) an energy spectrum
b) an energy spectrogram
c) a line plot of intensity
d) magnetic field values

a) energy spectrum



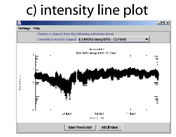
An energy spectrum for GEOTAIL/EPIC on 1998, day 108. Shown here is a 200 second sampling of ICS energy channels E3 through E16. The plot also has a "VCR-like" play panel which lets you watch a movie of the spectrum changing in time.

b) energy spectrogram



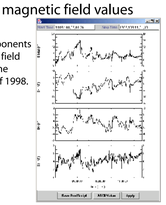
An energy spectrogram for GEOTAIL EPIC on 1998, day of year 108. This spectrogram shows CNO abundances and energies, and was created on the fly from the highest time resolution ICS data.

c) intensity line plot



A plot of particle intensity points for the E3 energy channel of ICS head 1 (out of 2 total heads) on GEOTAIL/EPIC on day 108 of 1998. The total time window (about 4 hours) was selected decided by the user before launching this particular plotting tool.

d) magnetic field values



A plot showing the three vector components of the magnetic field, along with total field strength. Measurements come from the GEOTAIL magnetometer on day 108 of 1998.

The tools are written in Java, and run inside a web browser on all major platforms.

Future Plans:
- develop more data interfaces: plasma moments, plasma waves
- include more datasets: IMP-8, ACE/EPAM, Ulysses/HI-SCALE, Cassini/MIMI
- expand the analysis environment: more cross-dataset tools tools