ViSBARD

(Front-end to a Space Physics Virtual Observatory)

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The Visual System for Browsing, Analysis, and Retrieval of Data (ViSBARD), which has been funded by NASA's Applied Information Systems Research Program, is intended to be the front-end user application for a Virtual Space Physics Observatory (VSPO). The other components will be the many Government and University data repositories around the US and the world, such as the NSSDC, and web-based links, which we call "query servers," between the front-end and the repositories. This overview describes our "beta-release" version of the front-end software.

We started with the problem of 3-D visualization of time series stored in the form of ASCII or CDF files. ViSBARD can currently be used to view orbits (all of the NSSDC's Satellite Situation Center, or SSCWeb, satellites), heliospheric data (initially all of the NSSDC's Coordinated Heliospheric Observatory, or COHO, hourly-average spacecraft orbits and data), and magnetospheric data (CDAWeb-derived CDF files and combinations of these with each other and with SSCWeb files). This data can be loaded from local files, as well as retrieved from remote repositories from within ViSBARD.

We plan on continuing to improve it and add more features, but we believe that the tools are already useful, and we want community feedback on how to proceed. As more examples of uses, ViSBARD can view and browse orbits and both scalar and vector data in 3-D for a number of spacecraft limited only by computer RAM; kinematically project points in space to produce "spatial views"; display numerical values associated with a point by clicking on it; read CDF and ASCII files according to a simple XML description of the file structure; combine data sets for a given satellite at a desired resolution; display 2-D plots to aid in browsing and analysis, and produce output data sets in an ASCII format readable by ViSBARD or other programs. The software is based on industry standards—primarily Java, XML, and C—keeping it portable. This version is for Windows, Linux, and Mac OS X. This software, along with existing data repositories and their associated software, will form the core on which we build the SPVO. We can provide the source code to those interested which will allow for community-provided features and modifications.

ViSBARD Overview

Getting started.

See the ViSBARD/ViSBARD_Quick_Start_Guide.txt file for information on installation and running on your platform. We have included all necessary XML, Java, C, and other files for the Windows & Linux versions, so you need not install other software. Macintosh policies don't allow for distribution of Java with an application – installation instructions for this are also located in the above file. The ViSBARD web page includes downloads of many of the SSCWeb orbit files at modest resolution, fairly recent versions of all the COHOWeb files, a subset of OMNIWeb variables for most of the time OMNI covers, and a number of CDAWeb files. Data may be stored anywhere on your hard disk and it is retrieved through a standard Open dialogue. If you have an internet connection, you may also browse and retrieve remote data from within ViSBARD from select repositories – see below for more details.

In addition to the overview below, we provide tutorial examples in a separate file as well as simple online help (click on "?" in the toolbar).

Loading Data.

ViSBARD can load ASCII and CDF files that reside on the local machine, as well as remotely stored data on CDAWeb, SSCWeb, and through the Virtual Space Physics Observatory (VSPO). XML files (eXtensible Markup Language text files) that we call "Resource Description Files" (RDFs) determine how files of a given type are treated. If a CDF file is being loaded that doesn't have an RDF associated with it, a message will appear asking if you would like to generate a new one. This wizard will then allow you to select which variables to import from the given class of CDF file, along with asking for some other metadata. After this is complete, that file type will be automatically recognized by ViSBARD during future loads.

To load a file, click on the "folder" button and then choose "Add Local File(s)" for locally stored data, or "Add Remote File(s)" to browse and retrieve files from remote repositories. If loading local data that spans multiple files of the same format (e.g., consecutive magnetometer data files from IMP-8), be sure to click the "Concatenate files into one resource" checkbox. If you wish to combine data from several instruments into one dataset, you must "Add" each of the files separately (or at the same time, but leaving the "Concatenate" checkbox unchecked), then combine them using the "Combine Added Resources…" button.

Once the files of interest are added, the time range may be set for all the sets being loaded or for individual sets, and you may specify the level of decimation to reduce the amount of data loaded. Otherwise, the default is to load all of the data that you have added.

The final step is to load the data into the scene using the "Load New" button. If there are any files that didn't have location data contained within them, ViSBARD will ask you if

you'd like to automatically retrieve and combine the necessary orbit data from SSCWeb. You may follow these prompts, or may choose to manually specify a local file that has the requisite data.

Some further description of RDFs and ASCII formats can be found in the Tutorial and in the Help files. However, the internal workings of RDFs are no longer necessary for CDF files, as they can be generated automatically by simply loading a file that ViSBARD does not recognize. A data import wizard will then step you through the procedure. You may also rename variables at a later date within the Resource Toolkit by selecting the data file of interest, then renaming the desired variable in the "Currently Selected Resource" subpanel.

Three-Dimensional Visualization and Analysis Tools.

ViSBARD represents each data point using a symbol consisting of "glyphs" and vectors for each data point along the orbit of the spacecraft. A central Earth (or Sun), the ecliptic plane, and (for the Earth) a red axis pointing to the Sun (+X) with bow shock and magnetopause surfaces provide context. The Earth and its magnetic pole rotate correctly according to the given time. Vectors are the usual arrows of the appropriate length and direction, and scalars can be represented by the color of a vector or glyph or by the glyph's size (Properties Mapper - "MAP" on the toolbar).

A Time Controller ("TIME" on the toolbar) enables to choose the interval to be viewed. The ends of the slider move the bounds of the interval, and clicking and holding the body of the slider scrolls in time. Buttons allow zooming in and out on the time interval. The list of file names is on the slider; you may have to vertically expand the Controller to see them well when large numbers of sets are loaded. The Animation Panel ("ANIM" on the toolbar) animates the display with selections for display and physical time intervals.

The 3-D viewing panel allows pan (right button), zoom (middle button and scroll wheel), and rotate (left button), and "shift-clicking" on a data point makes it become the center of rotation.

The Properties Mapper ("MAP" on the toolbar) panel allows the changing of glyph shape, overall size scale, and line width (for vectors) for each quantity and/or spacecraft. The maximum number of glyphs (data points) displayed is also in this panel under the "Glyph" tab. Properties may be set for each spacecraft independently or for all at once ("default"). When you get settings you like, they may be saved ("Save settings" in the File menu). Orbit plotting functionality is also included in the Properties Mapper panel.

The color palettes for each quantity can be chosen independently in the Color Panel ("COL" on the toolbar) panel. We currently have a simple means of making new palettes, but this needs improvement. The Properties Mapper has a check box for making all the glyphs for each spacecraft have a unique color, which is useful for following orbits.

Different data sets can be of different lengths and resolutions, and the number of glyphs is fixed for each dataset, so that when the time interval is changed the time resolution changes to conserve memory and keep the display interactive. The Information Panel ("PICK" on the toolbar) shows the underlying and displayed resolutions as well as values at a chosen point.

Double clicking on a point chooses it and displays the current resolution, underlying data set resolution, and data values for the given data point in the Information Panel. The values for components of positions and vectors for heliospheric set are currently in "Cartesian HGI" but will support RTN, etc. in future versions.

In addition to scaling variables with sliders, the Scaling Panel ("SCAL" on the toolbar) allows selection of a "spatial view" obtained by kinematic projection (displaying points at V*dt away from the measured point, based on a reference time). The reference time is the center of the displayed interval, and points with no velocity data are not shown.

Tsyganenko magnetic field lines, the Earth's magnetic pole, Fairfield's bow shock model, and Sibeck's magnetopause model are all adjustable under the "Mag" button, including the option to allow them to react to changing environmental conditions as specified by OMNI data.

Two-Dimensional Graphics.

A 2-D display mode can be selected with the tabs at the left of the display window. The user can quickly flip between 2- and 3-D views. The two modes are coupled, so that, for example, scaling the min and max of a variable based on the 2-D graph optimizes sizes and colors in the 3-D display. The Range Controller also works in both modes, giving more options for choosing intervals. Data gaps are shown in 2-D as missing regions, as in 3-D, but lines are interpolated across small gaps. When very few points are displayed in 2-D they are shown without connections.

A floating window allows the displaying plots of selected variables along with the 3-D image – click on the "GRAPH" icon in the toolbar.

Combine Tool.

Often many types of data, from multiple instruments, are of interest from a given spacecraft. For example, orbit, magnetic field, and plasma data may be stored in separate CDF files, but for correlation studies, as well as for convenience of display, it is useful to combine these files. We have designed a feature to combine such files using either a fixed time resolution or the resolution of one of the data sets, and with binning, decimation, or interpolation to make the sets uniform. Intervals with no data can be flagged as missing. If a dataset has very different resolution from the others associated

with it (for example, minor ion data has much lower resolution than magnetometer data), then it may not make sense to combine it with the others. It can be loaded independently and will display on the orbit at appropriate points. The combined data may be saved as an ASCII file readable by ViSBARD or other programs.

This combine tool can be found within the Resource Loading Toolkit (tan folder in toolbar) under "Combine Added Resources."

Saving Data.

Currently the only allowed output format is ASCII with a specific header (see Tutorial).

ViSBARD can also save your session, allowing you to restore your workspace exactly as you left it when you restart. Find it under File|Save Session.

Hardcopy output for ViSBARD is available via the "File|Save 3-D Snapshot" menu option. It outputs an image in a screen capture-like way, grabbing the 3-D window at its current resolution. Animations can also be captured in the Animation Panel. See the online help for more information.

Conclusion.

The ViSBARD work will continue, and will include the ability to automatically generate RDFs from unknown data, implementing a calculator to visualize derived quantities, including routines for coordinate transformations, importation of space weather models, and making refinements in the current capabilities. Of course, the ability to analyze local files will always remain an option.

Feedback

We hope you find ViSBARD useful as it is, but we are also interested in feedback on:

- crashes,
- features that you like or wish were there,
- open-source contributions of improvements or new features,
- other useful software that we could learn from or incorporate,
- data repositories that you have or know of that we could link to, and
- ideas for the SPVO.

Please send your comments to aaron.roberts@nasa.gov.