Data Analysis with the SolarSoft System

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Abstract. The SolarSoftWare (SSW) system is a set of integrated software libraries, databases and system utilities which provide a common programming and data analysis environment for solar physics. Primarily an IDL based system, SSW is a collection of common data management and analysis routines derived from the *Yohkoh* and SOHO missions, the Solar Data Analysis Center, the Astronomy libraries and other packages. The SSW environment is designed to provide a consistent look and feel at co-investigator institutions and facilitate sharing and exchange of data. The SSW system minimizes the learning curve when doing research away from the home institution or when correlating results from multiple experiments.

1. Introduction

The SolarSoftWare System (SSW) originally evolved from the Solar Maximum Mission and the *Yohkoh* Software data analysis system. The *Yohkoh* team required a software package to manage the data products generated by the Soft X-ray Telescope (SXT), the Hard X-ray Telescope (HXT), the Bragg Crystal Spectrometer (BCS) and the Wide-band Spectrometer (WBS). (see Ogawara *et al.* (1991) for a summary of the *Yohkoh* mission.) The goal was a system capable of complete data management ranging from level-zero reformatting to data analysis and presentation, providing a common environment for data analysis for all the experiments (Morrison *et al.*, 1991).

The *Yohkoh* Software system has since been expanded and generalized to work with experiments on the *Solar and Heliospheric Observatory* (SOHO), including the Extreme-ultraviolet Imaging Telescope (EIT), the Michelsen Doppler Imager (MDI), the Coronal Diagnostic Spectrometer (CDS) and the Large Angle Spectroscopic Coronagraph (LASCO) (see Domingo, Fleck, & Poland (1995) for a description of the SOHO mission). The success and growth of the SSW system is the result of collaboration between the science teams of the various *Yohkoh* instruments, the SOHO mission and ground-based observatories.

2. Features.

The SSW system runs as a layer on top of the IDL software package (Research Systems, Inc.), though some instrument teams integrate executables written in other languages. Some capabilities include:

- Time series analysis
- Spectral fitting
- Image and movie display
- File I/O, FITS file manipulation
- Solar limb fitting, grid overlay, coordinate transforms
- World-wide Web operations – web page generation and updates, FORM handling, CGI scripts and movie making

The system will run on any Unix and VMS based platforms supported by IDL, and has been successfully run on PCs running FreeBSD and Linux. Installation and setup are largely transparent on different platforms. The SSW system includes startup scripts which may be configured to support local variables in system setup, such as location of ancillary databases (a mixture of ground-based and satellite-based databases may be present on the system), paths to local binary executables and location of the SSW tree itself. This configuration of database management facilitates coordinated data analysis between different experiments.

The SSW system works with IDL data structures as specified in the *Yohkoh* system, and also with the SOHO FITS standard. The SSW system reads FITS headers into an IDL structure for further analysis, and non-standard FITS keywords can be easily accommodated with specialized FITS reading routines. Regeneration of legacy FITS files is unnecessary. Few restrictions are imposed on data files by IDL, as there is no unique IDL or SSW file format.

The SSW system includes routines to assist in software maintenance and allow for user-contributed software. Users may submit routines for inclusion in the master tree and these routines are automatically checked for conflicts with the system. The SSW system also has routines to update the software tree on the user's system via the Internet, and only those routines which have been updated or added since the last upgrade are downloaded from the master site. Online documentation is available for most of the SSW tools.

3. Organization

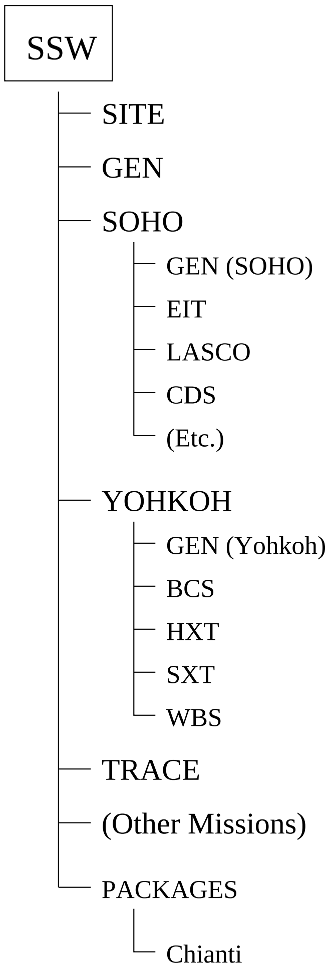

Figure 1. The layout of the SSW tree. The top level of the tree contains a site-specific branch of locally-configurable scripts, a generic branch of tools and libraries, mission-specific branches (SOHO, *Yohkoh* and TRACE in this case) with further breakdowns for experiments, plus additional branches for add-on packages that provide additional capability to IDL. The selection of missions and experiments is fully user-configurable.

A typical (though extensive) setup is suggested in figure 1. At installation time a site may select which missions and experiments are required for data analysis. Each mission will have a generic directory with tools common to that mission, plus specialized directories for instruments associated with that mission. It is not necessary to include all instruments for a particular mission. It is possible to include other packages in this directory structure. The Chianti code, presented as an example here, is an atomic database of emission lines in UV and EUV wavelengths (Dere *et al.*, 1998). Other packages are available.

4. Installation

Installation assumes IDL is already installed on the host system. Installation of the SSW system is usually accomplished over the internet, though other arrangements are possible when this option is not feasible. The user selects desired instruments and databases from an HTML form, which then creates (again via the SSW system) a shell script the user executes on the client machine. This script checks for dependencies and required disk space, then downloads the requested libraries and databases via FTP. The user is directed to the SSW web site[1] for current information and web-based forms for web-based installation.

5. Acknowledgments

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[1] `http://www.spasci.com/solarsoft/`