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An Introduction to Solar Soft

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These lecture notes are intended only for distribution to participants

An introduction to *SolarSoft*

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Outline

- What Solarsoft is, its purpose and aims
- Structure of the SolarSoft Tree (SSW)
- The role of the SolarSoft DataBase (SSWDB)
- How the SolarSoft environment is configured and invoked

- Generalized data analysis techniques
- How and where to get help
- Practical session - ask if there are particular things you want to know!!

What is SolarSoft

- ***SolarSoft*** is a set of integrated software libraries, data bases, and system utilities which provides a "common" programming and data analysis environment for the Solar Physics community.

- The **SolarSoftWare (SSW)** system is built from libraries developed for Yohkoh, SoHO and TRACE, and the SDAC and Astronomy libraries. It draws upon contributions from many members of those projects.

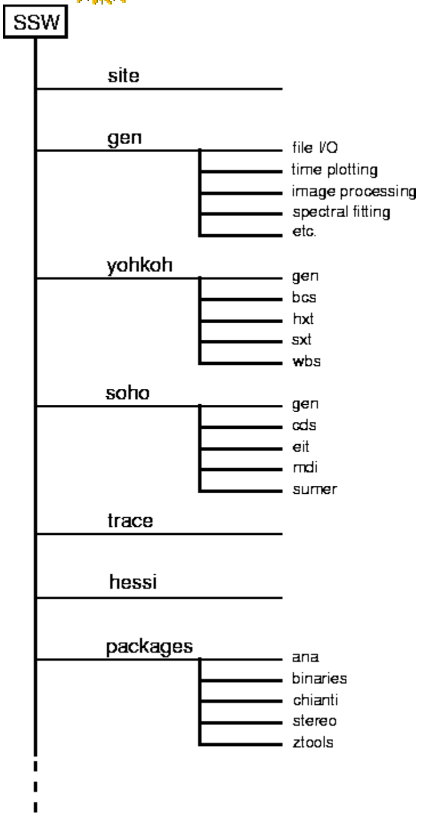
- **SSW** is primarily an **IDL** based system, although some instrument teams can and do integrate executables written in other languages.

- The **SSW** environment provides a consistent look and feel at various CoI institutions (Yohkoh, SoHO, etc.). This facilitates the sharing and exchange data and minimize the time taken to "come up-to-speed" when doing research away from your home institute.

Aims of SolarSoft

- **Promote the use of standards that will facilitate coordinated data analysis**
  - Suggested standards make many powerful routines immediately available for the analysis of new data sets.
- **Provide a hardware and site independent analysis system**
  - Fundamental shared software is written in a largely hardware-independent and site-configuration independent form. The **SSW** setup utilities support local configuration files that tailor the user's environment.
- **Provide a large reusable software library**
  - The software library represents an evolutionary system tracing back to SMM, through Yohkoh and SOHO.
- **Provide easy access to supporting ancillary data bases**
  - Access to supporting data sets from ground-based and satellite-based solar observatories are provided in consistent formats to facilitate coordinated analysis.
- **Provide integrated access to other IDL packages**
  - When IDL libraries are identified that would provide a useful extension to **SSW** capabilities, they are integrated into the tree.

The SolarSoft Tree


SSW
site
gen
file I/O
time plotting
image processing
spectral fitting
etc.
yohkoh
gen
bcs
hxt
sxt
wbs
soho
gen
cds
eit
mdi
sumer
trace
hessi
packages
ana
binaries
chianti
stereo
ztools

- The ***SolarSoft*** tree consists of many branches with a similar structure
- Branch for each mission, etc
  - SOHO, TRACE…
  - Also branches for ground based

  Observations: optical & radio
- ***$SSW/gen*** contains a reusable library of many general purpose routines
- Configuration of ***SolarSoft*** to your site is with file under the ***$SSW/site*** directory

Re-usable Software Library

- The re-usable software library represents an evolutionary system dating back to SMM. It developed through Yohkoh and SOHO, and now incorporates routines related to TRACE and other solar observatories.
- Amongst the many common tasks already included are file I/O, system access, IDL structure manipulation, data display, etc.. Spacecraft and instrument specific routines are dealt with in other, separate branches.
- ***Existing library capabilities include:***
  - Time series analysis, time conversions, time series plotting (UTPLOT)
  - Spectral fitting
  - Image and Image cube manipulation and display (including movies)
  - Solar image data routines (limb fitting, grid overlay, co-ordinate transformations, co-alignment...)
  - File I/O (generic binary, ASCII, FITS...)
  - IDL data manipulation (structure, string, array, mathematics...)
  - WWW related routines

Other Branches of the Tree

Other branches support, or are planned for the following instruments

- **Current and Past Spacecraft:**
  - SoHO: CDS EIT MDI SUMER LASCO (1996)
  - Yohkoh: BCS HXT SXT WBS (1991)
  - TRACE: Trace (1998)
  - KORONAS-ReSIK (2001)
  - HESSI (2001)
  - GOES-SXI (2001)
  - Others: GOES, CGRO, Spartan, SMM
  - Virtual Observatories (EGSO, VSO, CoSEC)
- **Future Spacecraft:**
  - Solar-B (2006)
  - STEREO (2006)
  - SDO (2008)
- **Packages:**
  - chianti, xpex, xray, etc.
  - ANA, binaries

Structure of the branches

- **The branches are similar in form:**
  - gen (includes the re-usable library)
  - missions with single or multiple instruments (e.g. TRACE; SoHO)
    - *mission/gen*
    - *mission/instrument* (e.g. soho/cds)
  - packages
  - **site**
- **Each branch has *standard* directories:**
  - doc
  - response (calibration information)
  - **idl** (can include many sub-directories)
  - **setup** (defines configuration for a branch)

- The **IDL path** is assembled from the sub-directories in the **idl** directories of the selected branches
- The **setup directories** contain files key to the function of ***SolarSoft*** - these define the location required instrument and ancillary data.
  - The files have names like: setup.*mission*_env and setup.*instrument*_env

Configuring SSW

- The setup files contain environment variables in the Unix C-shell format:

```
setenv  DIR_SXT_SDC $SSWDB/ydb/sdc
setenv  DIR_SXT_CAL $SSW/sxt/response
```

- The setup files at ssw, mission and instrument level should define almost everything needed to configure the SSW environment for an installation.
- If any instrument or ancillary files are stored in non-standard places, include setup files with the appropriate name in the **site** setup directory. ***Do not make modifications within the tree.***
- The setup files are executed in strict hierarchy:
  - $SSW/site/setup/setup.ssw_paths
  - $SSW/gen/setup/setup.mission.env
  - $SSW/site/setup/setup.mission.env
  - $SSW/mission/xxx/setup.xxx
  - $SSW/site/setup/setup.xxx

This is not as complex as it seems. It is not a fatal mistake if an environment variables are defined in the wrong place, so long as the overall order of execution has the desired effect. Also, a ***simple installation may require few changes***

The SSWDB Tree

- The ***SolarSoftWare Database*** tree (**SSWDB**) contains ancillary data provided by the experiment teams. It has a similar outline structure to the **SSW** tree – there are branches for each mission, and sub-branches for some instruments.

- The **Yohkoh** branch ($ydb)
  - Combines all datasets at mission level.
  - Some data sets are general (e.g spacecraft attitude)
  - Others are instrument specific (e.g. SXT CCD data)
  - ***Catalogues*** in form of instruments observing logs
  - Includes supporting datasets from other sources
- The **SoHO** branch is split by instrument
  - Some instruments store more than others
  - Catalogs for CDS and EIT, MDI must be generated
- The **TRACE** branch ($tdb)
  - Includes a ***catalogue***

Installation of SSW and SSWDB

- **The master copies of *SolarSoft* and SSWDB are maintained at the Goddard Space Flight Center (GSFC).** Software and ancillary data from instrument groups around the world are are mirrored into the SSW and SSWDB trees for general distribution.
- ***SolarSoft* can be installed using a web page in the SSWDOC pages**. This generates an installation package that is mailed to the user. On execution this will create directories, and copy and unpack tar files containing the requested software branches.
  - **Only install the branches that are needed**
  - Always get gen and packages/binaries
  - For some instrument, other things are installed automatically
    - HESSI always gets packages/spex and /xray
  - ***Updates by mirror*** (Perl script running FTP)

- **Required parts of the *SolarSoft DataBase* can also be installed using a web page in the SSWDOC pages**. Usually, you only need ancillary files for a short interval either side of a dataset under study. (Note: the is interface is still under development)

Invoking SolarSoft

- The environment variable **SSW must have been defined**. Installed tree is then open to you.
- Environment variable **SSW_INSTR** defines the selection of instrument branches that will be used to create the desired SolarSoft environment.
- If you are using ancillary data, **SSWDB** needs to have been defined.

- In Unix and Linux, this is defined ***outside*** IDL with the command setssw. IDL is then started with the command sswidl.Thus:

```
setssw sxt eit cds
sswidl
```

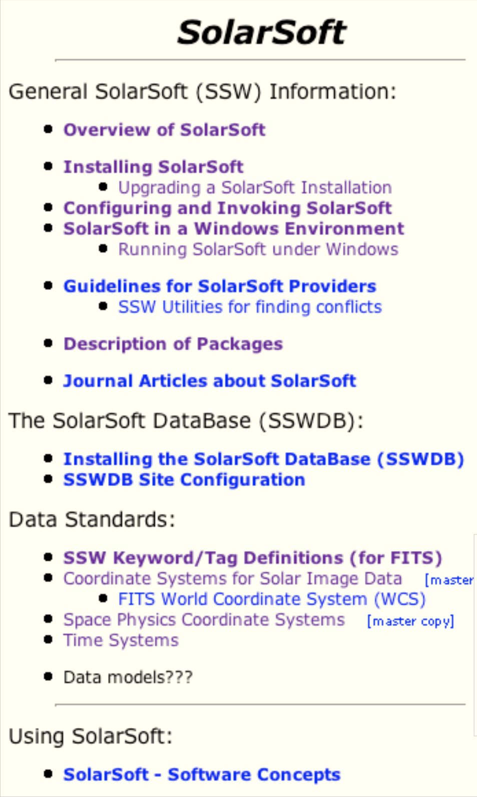
- For Windows, the selection is done ***within*** IDL, using the command setssw_windows (e.g. setssw_windows,/sxt). IDL is invoked using a .bat file that defines SSW before it calls IDL.

- The **IDL_STARTUP** routines allow the user to run some procedures when IDL is invoked.

How to get help - I

- There are many documents on the Web that can provide assistance for SolarSoft
- An integrated set of documentation, SSWDOC, including SolarSoft documents and user guides, is provided. To access it, open **`index.html`** in the sswdoc tree

How to get help - I



SolarSoft

General SolarSoft (SSW) Information:

- Overview of SolarSoft
- Installing SolarSoft
  - Upgrading a SolarSoft Installation
- Configuring and Invoking SolarSoft
- SolarSoft in a Windows Environment
  - Running SolarSoft under Windows
- Guidelines for SolarSoft Providers
  - SSW Utilities for finding conflicts
- Description of Packages
- Journal Articles about SolarSoft

The SolarSoft DataBase (SSWDB):

- Installing the SolarSoft DataBase (SSWDB)
- SSWDB Site Configuration

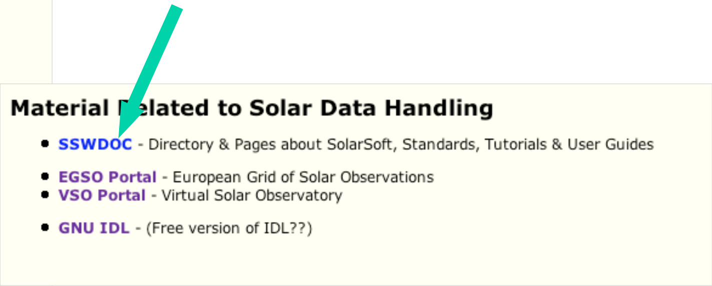
Data Standards:

- SSW Keyword/Tag Definitions (for FITS)
- Coordinate Systems for Solar Image Data [master
  - FITS World Coordinate System (WCS)
- Space Physics Coordinate Systems [master copy]
- Time Systems
- Data models???

Using SolarSoft:

- SolarSoft - Software Concepts

- There are many documents on the Web that can provide assistance for SolarSoft
- An integrated documentation set, SSWDOC, is provided – this includes SolarSoft documents and user guides. To access it, open **`index.html`** in the sswdoc tree and then select **`sswdoc`**



Material Related to Solar Data Handling

- SSWDOC - Directory & Pages about SolarSoft, Standards, Tutorials & User Guides
- EGSO Portal - European Grid of Solar Observations
- VSO Portal - Virtual Solar Observatory
- GNU IDL - (Free version of IDL??)

Data Analysis with SolarSoft

- **How to look at data in a generic manner**
  - Not all instruments are the same
  - Structure of analysis software define by the instrument teams
  - Routines in the gen branch try to cope with the differences in structure of the data and naming conventions
  - ***Lack of rigid rules is one of the strengths of SolarSoft; also a problem***

- **Combining data from several instruments**
  - Overlay images
  - Compare time series of data or derived parameters

Steps in Processing Data

- For each instrument the steps involved in accessing the data are very similar:
  - Locate the data and/ or **catalogue** for the instrument for the required time interval
  - **Access the catalogue** or data roadmap (index) to find the modes run during this interval
  - Make a selection of the modes
  - Read the data and index information for the selected modes

- Review the data by displaying it – *images, spectra, light-curves*

- **Calibrate the data**
- **Derive physical parameters**

- **Compare with data sets** from other instruments

Locate the instrument data

- Whereas the SSW and SSWDB trees combine elements from many missions and instruments, the instrument data or observations are normally stored on an instrument by instrument basis.

- This is necessary because of the shear bulk of the data, e.g. Yohkoh produces 500 Mbyte/week, and TRACE produces >3 Gbytes/week.

- The data is again addressed through environment variables. For example

– Yohkoh:	YOHKOH_DATA
– TRACE:	TRACE_I1_DIR
– MDI:	MDI_MAGS
– EIT:	EIT_LZ
– CDS:	CDS_FITS_ROOT (at MSSL)

- The data is often organized under such environment variables in sub-directories divided by weeks, months, or some other useful quantity.
- Search software identifies correct files by date range

Data and index structures

- Once you have located you data, it needs to be read in

- Many different **file formats** are used - the ***format is defined by the experiment team who also provide the read routines***
- The size of some datasets makes ***some form of selection essential***, and may necessitate special processing in some cases. In some cases this is defined by the instrument team.

- The read routines often returns a **index structure**. If so, there are many generic routines available that allow selection of the data by:
  - **mode** (e.g. channel, filter)
  - **time** (absolute time or cadence)
  - **pointing**
  - **match the times of other data**

- If you want to look at the contents of a structure

```
help,/st,structure_name
```

Selecting a data subset

- The routine **struct_where** is a generalized filter that works on index or catalogue structures. The selection is made according to filters supplied in a configuration file or string array. For example:

```
ss = struct_where(index,conf_file=file)
ss = struct_where(index,test_array=array)
```

- Filters are of the form:

```
<TAG> <OPERATOR> <VALUE>
```

- For example, a configuration file to select **TRACE** data might contain:

```
NAXIS1 = 512,1024
WAVE_LEN = 171,195,284            XCEN=600.~800.
IMG_MIN > 1.
IMG_AVG > 100 && IMG_MAX < 4096
```

- To select a series of images at a pre-defined cadence, use **grid_data**. To select images at a particular time, use **tim2dset**. For example:

```
ss = grid_data(index, min=5)
 and
ss = tim2dset(index, tref)
```

Some useful Library routines

Too many routines go into detail - look at the help pages in SSWDOC for guidance on techniques to analyse a particular dataset.

To look at the time history of data, look at:

utplot

If you are interested in comparing images from different instrument, over and expended interval, look at:

Map Objects

See the Zarro description

ssw_track_fov

track field of view over time

How to get help - II

Within **SSWIDL**, several useful procedures are available to provide help:

xdoc, *’routine_name’*
doc_library, *’routine_name’*
allow the user to search for routines and examine them (or just the document header)

chkarg, *’routine_name’*
returns the call parameters of a routine

sswloc, *’search_string’*
*Lists **names** of routines in the **SolarSoft tree** that match the search string. Note: sswloc also work at the Unix shell level as “sswloc ‘search_string’”*

pr_path
returns the current IDL path
pr_env [,/*search_string*]
allows the user to examine what environment variables defined

More information and Tutorials

- SolarSoft - Software Concepts

- Tutorials:
  - Finding/reading FITS data, plotting maps, etc.
  - Techniques for dealing with 3D datasets
  - EIT, MDI, Mapping and SSW Techniques
  - TRACE, SXT, MDI, and SSW Techniques