

Magnetic Field Line Rendering Package for SolarSoft

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OVERVIEW

We announce a new SolarSoftWare (SSW) package for IDL, named `pfss`, that enables the user to trace magnetic field lines through the solar corona and render them as a "hairy sun" image. The package utilizes an online database of coronal magnetic field models, in which the field is sampled on a 1° grid at a six-hour cadence from Jul 1996 to the present. The database is updated daily. The user can interactively browse the database using a GUI-based interface, or use a command-line interface for more involved tasks.

The coronal magnetic field models used by the software are based on evolving full-sun Carrington maps of the photospheric magnetic field, into which SOHO/MDI magnetograms are directly inserted when available. The coronal magnetic field is then deduced by extrapolating the photospheric field upward via the potential-field source-surface (PFSS) approximation, in which the field in the coronal volume is assumed potential between the photosphere and a spherical source surface located at radius of $2.5 R_{\text{sun}}$. The modeled magnetic field is forced to become purely radial at the source surface, approximating the dynamic effect of the solar wind on the magnetic field of the high corona.

While the coronal magnetic field is not expected to be potential everywhere, we have found decent agreement on a qualitative basis between the PFSS modeled fields and coronal loops as seen in EUV and soft x-ray images. Such models are also currently used to forecast the velocity and polarity of the quiescent solar wind in interplanetary space (see <http://www.lmsal.com/forecast>). In the future, we expect that the software will utilize more physically realistic coronal magnetic field models as they become available, and as they become capable of computing the coronal magnetic field on a real-time basis.

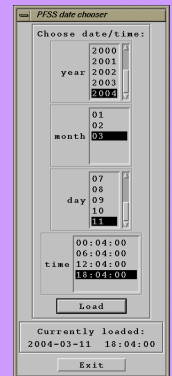
USING THE GUI

The first step is to start SSWIDL, load the PFSS package, and start the viewer, by typing on the IDL command line:

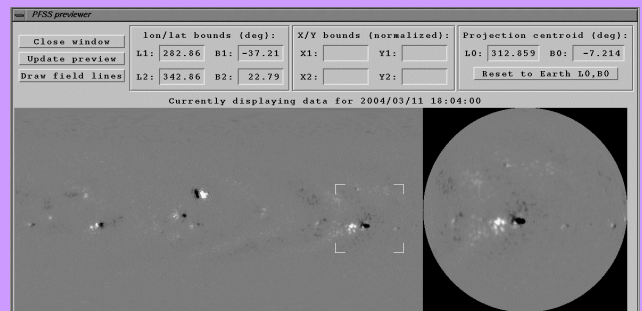
```
IDL> ssw_path,/pfss
IDL> pfss_viewer
```

The *PFSS date chooser* window (shown at right) should appear shortly. Before opening the window, the software queries the database for a list of all available dates and times.

At this point the user is prompted to select the year, month, day, and time of interest. Upon clicking the *Load* button, the GUI will download the selected IDL save file from the database (if it is not already local) and restore it. The file contains the magnetic field at each point in the corona, sampled horizontally every 1° . These files are 35 MB in size, and thus may take some time to download. After the save file is loaded, the viewer will launch the *PFSS previewer* window (shown below), containing the surface magnetic field map displayed both in rectangular (Carrington) coordinates and as an orthographic projection as viewed from earth.

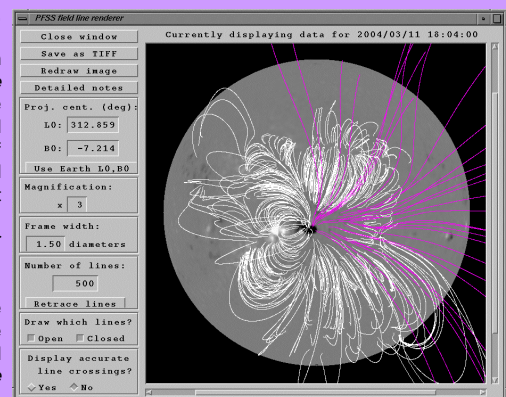


In the *PFSS previewer* window, the user chooses the surface coordinates from which coronal magnetic field lines will be traced. The default region is 60° -square bounding box, whose corners are shown in white in the figure at right.



The user may modify the bounding box either by typing in new values for $L1$, $L2$, $B1$, and $B2$, or by clicking and dragging the corners of the bounding box to their desired locations.

After the bounding box is chosen, clicking on the bounding box is chosen, clicking on the *Draw field lines* button will compute the trajectories of 100 random field lines and launch the *PFSS field line renderer* window (shown at right). In the display area, the field lines are displayed on top of an orthographic projection of the surface magnetic field map. Closed lines are drawn in white, and lines that reach the source surface are drawn in green or magenta, depending on their polarity.



At this point, the user can fine-tune the rendering by adjusting any or all of the options to the left of the display area, and re-render by pressing the *Redraw image* button. The finished product can be saved by pressing the *Save as TIFF* button.

The command-line interface allows the user to further customize the rendering. Users can specify the field-line starting points (rather than having them chosen at random), retrieve the path of each field line in coordinate space, create a map object of the rendering, and save the rendering in any standard format. Image details such as the field-line thickness, background color, or color map can also be customized. Full documentation is provided with each routine. The image at left was generated using the script `pfss_sample1.pro` (included in the package), and shows the coronal field on 4 Apr 2003 from a point inclined 30° north of the equator. The script may be used as a template.

