CSI 769/ASTR769 Spring 2008
Solar and Heliospheric Physics

Project: Potential Field Source Surface Model of Solar Corona

Assignment date: Feb. 11, 2008
Due date: Feb. 28, 2008

1. Introduction

Solar corona is composed of highly magnetized plasma. It is believed that magnetic field in the corona plays the vital role in determining the structure of the corona, contributing to the incessant heating, and producing intermittent energetic activities such as CMEs and flares. In this project, you are required to calculate the coronal magnetic filed using the so called potential field source surface model (PFSS), which is regarded to be the first-order approximation of the magnetic field in the corona.

2. **Requirements**

(1). Event selection. You are required to calculate the global solar corona on the day of Nov. 4, 2004, during which at least two halo CMEs occurred and produced a super geomagnetic storm on Nov. 8, 2004. During the declining phase of the solar cycle, the inferred solar corona shall not be as complicated as that during the solar maximum, thus permits a better understanding of the calculated model result.

(2). Input data. One MDI magnetogram image on Nov. 4, 2004, and the corresponding Carrington synoptic image providing the global lower boundary magnetic field before and after. You need to take a stripe of MDI image (within +/- 20 degree from the central meridian) and imbed this stripe into the synoptic image in order to obtain the best possible boundary condition. The data are available at the MDI website at Stanford University. You are encouraged to use the synoptic image with the highest spatial resolution.

(3). PFSS computational models. You are free to choose one of the existing PFSS models or develop your own PFSS model, to implement the project. The output shall be a 3-D array holding the vector B, either (Bx, By, Bz) or (Br, Bθ, Bφ). The source surface is at least 2.5 Rs (solar radius). See section 3 for details on models.

(4) Visualization. You are responsible for choosing visualization tools to show case the 3-D result. At the minimum, you should be able to show the following images: (1) global coronal image as seen from the Earth (front-view), (2) global coronal image as seen from the north pole (top view), (3) a detailed view of coronal field line from NOAA AR0696. You are free to choose the number and locations of footpoints where the field lines are traced out into the corona. Closed and open field lines shall be marked in different colors.

3. Resources on PFSS computational models

(1) Computational models. While you are open to any models, you could choose one of the following two model packages, which are well implemented in IDL and the source codes are easily available.

(a). PFSS model created by Dr. DeRosa from LMSL. The model is available in $SSW/packages/pfss. The entry point of looking into this model is ../pfss/idl/pfss/pfss_sample1.pro.

(b). PFSS model developed by Dr. Zhao from Stanford University. The access to the model package will be provided separately.

(2) "Blind" Run on CCMC models. There are currently four coronal models provided in the NASA Community Coordinated Modeling Center (CCMC) (at http://ccmc.gsfc.nasa.gov/models/models_at_glance.php). You are able to request a model run based on the boundary condition that you specify, and model results will be returned to you. However, you are not able to access the source code and modify the processing. For this project, you are required to request a test model run from one of the CCMC models, and compare the result with that you get from the open models that you will be working on (as described in 3.1).

4. Submission

You need to submit a succinct project paper with the following components. (1) Model description. You need to describe your PFSS model, showing the main functions that characterize the model, the analytic/numerical methods solving the equations, and the key coefficients calculated. (2) Briefly explain the data and the usage of the data, (3) Model results. Show your model results as described in 2.4, and briefly discuss or justify what you find, (4) Model run using one CCMC solar coronal model, and compare CCME test result with your model result.