CSI 662/ASTR769 Spring 2007
Introduction to Space Weather

Project: The Sequence of Sun-to-Earth Activities of Intense Geomagnetic Storms

Phase 1: Physical Processes on the Sun

Assignment Date: Feb. 20, 2007
Due Date: Mar. 6, 2007

Requirements

1. **Identify and describe the solar sources of the super intensive storm studied**

   A super geomagnetic storm is always driven by a fast CME originated from the Sun's corona. It takes about 20 to 40 hours for a fast CME to propagate from the Sun to the Earth, depending on the initial speed and the kinematic evolution in the interplanetary space. A fast CME is also often associated with a major flare on the Sun, associated with a strong active region.

   You are required to identify the source CME, source flare and surface source region responsive for the storm. You may refer to http://solar.gmu.edu/research/cme_storm/index.html for the source identification.

   With the source identified, please study and provide the following information

   - One magnetogram image (e..g, SOHO/MDI) indicating the surface source region. Briefly describe the source region.
   - One coronal image (e.g., SOHO/EIT) taken at the time during the eruption. Describe what you see, and indicate the eruption feature in the image (e.g., flaring, dimming)
   - One coronagraph image (e.g., SOHO/LASCO C2 or C3 image) taken at one time during the eruption. Describe what you see, and indicate the location of the CME in the image.

   Note that you may need to use screen capture to extract appropriate images from mpeg movies often provided online.

2. **CME timing: estimate CME onset time based on measurement by LASCO C2/C3**
   LASCO C2 and C3 have fields of view of 2-6 Rs, and 4-30 Rs, respectively (measured from disk center). Though a CME first appears in the C2 field of view (>2 Rs), it is initiated in an earlier time in the lower corona close to the Sun's surface. Based on the height-time measurement in the LASCO, estimate the CME onset time at the surface of the Sun using linear extrapolation method, assuming (1) CME is

initiated at the surface (or at 1 Rs) and (2) CME is instantly initiated and has a constant speed in the inner corona below the C2 occulting disk. The height-time measurement data for CMEs are available at http://cdaw.gsfc.nasa.gov/CME_list/. (for the H-T data file, click on the link in the second column in the monthly event table). In the H-T file, the first three columns indicate the CME height, date and time, respectively. You could do the extrapolation using any software, e.g., IDL, Excel, and Mathematics. A graphic plot of the data points and linear extrapolation are welcome but not required.

3. **CME kinetic energy, velocity and transit time to the Earth**
    - Assuming the mass of this CME is 10^{16} gram, calculate the kinetic energy of this CME
    - Assuming the true radial velocity along the line of sight is the same as the observed projected velocity, calculate the transit time (in unit of hour) of this CME from the Sun to the Earth (distance of 1AU), and estimate the impact time (time and day, in UT format)

Useful links

Major storm list with some solar and geo-space data:
http://solar.gmu.edu/meetings/cdaw/Data_master_table.html

Major storm list with source region identification:
http://solar.gmu.edu/research/cme_storm/index.html

Online CME Catalog by GSFC/NRL
http://cdaw.gsfc.nasa.gov/CME_list/

SOHO LASCO/EIT site by NRL
http://lasco-www.nrl.navy.mil/lasco.html

SOHO MDI data
http://soi.stanford.edu/data/