CSI 662/ASTR769 Spring 2007
Introduction to Space Weather

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

An Overview

1. Objective

The objective of this project is to help students comprehend the space weather system that involves energy and mass flow throughout the Sun-Earth connection system. It is a comprehensive end-to-end project that addresses various physical processes and their possible cause-effect relationships in different space weather components, including the surface of the Sun, the Sun's corona, heliosphere, magnetosphere, and ionosphere.

An intense space weather event may have profound impacts on technological system. One recent example is the so called "Halloween storm" occurred in Oct. 2003. The international space station did a ground-commanded power down, and crews onboard took shelters in the service module during the peak exposure times. About 24% of the space missions turned off their instruments or took other protective actions. One Japanese satellite (ADEOS-2) is believed to have failed completely due to this storm. The NASA/ESA's SOHO satellite and the German satellite CHAMP failed temporarily. Some satellite based communication companies (TV and radio) reported several short-lived interruptions. Airlines restricted flight paths on several occasions due to degraded communications. GPS users reported degradation and outages with some applications. A power grid in southern Sweden experienced a one hour blackout.

2. **Requirements**

Students are required to observe and study a super intensive geomagnetic storm. The intensity of a geomagnetic storm is indicated by the Dst (Disturbance Storm Time) index, which measures the depression of the horizontal magnetic field on the surface of the Earth. The depression is caused by the ring current enhancement during the storm period. A super intensive storm is classified as Dst minimum < - 240 nT.

The entire study consists of 4 phases or sections, each of which has specific requirements and will be handed out separately.

Phase 1: physical processes on the Sun
Phase 2: physical processes in the heliosphere
Phase 3: physical processes in the magnetosphere
Phase 4: physical processes in the upper atmosphere and ionosphere
Phase 5: Summary (~ 2-page) and In-class presentation

Students are expected to (1) provide written documents for each phase of assignments, (2) give a short in-class presentation (~ 15 minutes) at the end of the semester.

3. Selection of Intense Geomagnetic Storms

During 1995 – 2005, there were in total 12 super intensive storms. These storms were among 88 major storms (Dst <= -100) studied in the Coordinated Data Analysis Workshop (CDAW) held at George Mason University in March 2005. A complete list of these storms is available online at http://solar.gmu.edu/meetings/cdaw/Data_master_table.html.

You are free to study any one of the 12 super intensive storms listed, as long as you do not conflict with other students. All needed data for this project are available online through various data providers. The following events are suggested, because these are well-known well studied events. A substantial amount of data for these events has been collected at the CDAW website.

* Famous Halloween storms. Double storms, one peaked at 2003/10/30 01 UT, Dst=-363, the other peaked at 2003/10/30 23:00 UT, Dst=-400 nT

*The largest storm in solar cycle 23: 2003/11/20, Dst=-472 nT

*One largest storm: 2004/11/08 Dst=-373 nT

*One recent super storm: 2005/05/15, Dst=-263 nT