CSI 662/ASTR769 Spring 2007
Introduction to Space Weather

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

Phase 3: Processes in the magnetosphere

Assignment Date: April 10, 2007
Due Date: April 17, 2007

An ICME and its associated shock have profound effects in the magnetosphere. The purpose of this phase of the project is to demonstrate these effects. The solar wind data you gathered in Phase-2 is used as the necessary input.

Requirements

1. **The shift of magnetopause**

   Calculate the positions of the magnetopause (1) just before the arrival of the shock, and (2) just after the shock front. How large is the shift of the magnetopause?

   You may need to use the Prolss (6.75) formula (page 333) to do the calculation, which is

$$L_{mp} = \sqrt[6]{\frac{2B^2_{00}}{\mu_0 K m_H n u^2_{sw}}}$$

2. **Solar wind energy input into the magnetosphere**

   The famous ε formula is often used to estimate the solar wind energy input into the magnetosphere. One variant of it is the following, which calculates the input power

$$\varepsilon = uB_s L^2 R^2_E (erg / \sec)$$

   where u is the solar wind speed, Bs southern oriented magnetic field, L shell number (taken L=7), and R_E Earth radius.

   (1) calculate the power at the moment with the highest Bs during the ICME/shock sheath period
   (2) calculate the total energy input into the magnetospheric system, assuming the power calculated in (1) continuously lasting for 10 hours

3. **Ring current enhancement of current and energy**

   (1) use the observed magnetic disturbance based on Dst index to calculate the ring current enhancement at the storm peak time. You may use the Prolss formula (5.65) (P.248), which is

$$\Delta B_{rc}(R_E) \approx -\frac{\mu_0}{2}\frac{\Delta I_{rc}}{LR_E}$$

You may choose L=5 as the concentrated place of the ring current.

(2) Calculate the enhancement of ring current energy at the peak time. You may use the Prolss formula (5.68) (P.249), which is

$$\Delta B = -2\Delta E_{rc} / M_E$$

Where M_E is the dipole of the geomagnetic field, $M_E=4\pi R^3_E B_{00}/\mu_0$.
Note that Prolss formulae use the MKS unit.