Project Details

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Topic: FST #2: Coupling of the Solar Wind Plasma and Energy to the Geospace System

Project Title:
Quantifying global mass and energy transfer rates from solar wind to magnetosphere by magnetopause reconnection

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Summary:
Magnetic reconnection is widely considered as the most important mechanism for the solar wind plasma transferring into the magnetosphere. The local properties of magnetic reconnection, such as the local reconnection rate and the plasma flow around the reconnection site, have been extensively studied with both local simulations and satellite observations. However, it is difficult to measure the global consequences of the magnetopause reconnection with in situ satellite data, and such investigation largely depends on global numerical simulations. Ideal and resistive MHD models have been widely used to simulate solar wind-magnetosphere coupling. These models usually produce well-defined steady separatrices at the magnetopause, and the global reconnection rate, which is closely related to the efficiency of solar wind plasma transferring into the magnetosphere, can be calculated as the integral of the electric field along a separator line. In recent years, however, both beyond-MHD simulations and satellite data indicate that the magnetopause X-lines are usually patchy and unsteady, and the products of multiple X-line reconnection, flux transfer events (FTEs), occur frequently. Such complex reconnection structures imply the global solar wind-magnetosphere coupling efficiency needs to be revisited. However, it is difficult to apply the electric field integral method to calculate the global reconnection rate for such beyond-MHD simulations, because 1) it is not trivial to find and trace the patchy and unsteady magnetopause X-lines, and 2) it is not clear how the contribution of FTEs should be evaluated. On the other hand, traditional MHD simulations do not contain kinetic phenomena that are produced by the bow shock, and they may have a significant influence on magnetopause reconnection. _x000D_
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We propose to study the solar wind-magnetosphere coupling efficiency under different solar wind conditions and evaluate the influence of bow shock by simulating the solar wind-magnetosphere interaction with the MHD with Adaptively Embedded Particle-In-Cell (MHD-AEPIC) model, measuring the global solar wind-magnetosphere coupling efficiency with a test particle module that is coupled to the MHD-AEPIC model, and validating the global simulation results with MMS data and high-resolution one- and two-dimensional local shock simulations. Specifically, our proposed investigation will answer the following three fundamental science questions:_x000D_
1. What are the global mass and energy transferring rates by magnetopause reconnection under different solar wind conditions?_x000D_
2. What are the paths for the solar wind particles entering the magnetosphere? What is the role of FTEs in transferring plasma?_x000D_
3. How will the kinetic phenomena produced near the bow shock change the global magnetopause reconnection and plasma coupling efficiency?_x000D_
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The proposed investigation is highly relevant to the LWS FST #2: Coupling of the Solar Wind Plasma and Energy to the Geospace System", and it focuses on the FST #2 science goals of identifying the parameters controlling the transfer of energy through dayside magnetopause reconnection" and understanding the role of solar wind fluctuations in the coupling of the solar wind to the Earth".

Publication References:

no references