Project Details

ROSES ID: NNH05ZDA001N
Selection Year: 2006
Program Element: Focused Science Topic

Topic: Solar wind plasma entry and transport in the magnetosphere

Project Title:
Solar-Wind Ion Entry into the Magnetosphere through the Magnetosheath

PI Name: Margaret Chen
PI Email: James.Chen@nrl.navy.mil
Affiliation: The Aerospace Corporation
Project Member(s):
- Lemon, Colby ; Co-I; The Aerospace Corporation
- Schulz, Michael ; Co-I; Lockheed Martin Retiree
- Lyons, Larry ; Collaborator; UCLA;
- Toffoletto, Frank Rocco; Collaborator; Rice University

Summary:
This is a proposal to investigate the physical processes that lead to the transport of solar wind ions from the magnetosheath and into the magnetosphere to form the plasma sheet. Ion distributions in the magnetosheath, tail lobes, tail flanks, and plasma sheet will thus be characterized for different Interplanetary Magnetic Field (IMF) and solar wind conditions. The study will address whether the transport of solar wind ions into the magnetosphere from different locations supply sufficient particles of different energies needed to form the quiescent and storm-time plasma sheet. The effect of changes in the solar wind population on the variance in the plasma sheet will also be examined. Our approach will be to develop and use kinetic simulations to study the relevant particle transport processes and to compare our simulation results with published observations such as from Geotail, ISEE, AMPTE, and DMSP. We will follow the full particle motion or (where appropriate) the guiding-center drifts of solar-wind ions from the magnetosheath into the magnetosphere. In the magnetosheath, we will use an analytical magnetic field model that reproduces quite well the shape of magnetosheath field lines obtained from gas-dynamic calculations. The magnetosheath electric field is proportional to the cross product of the solar-wind velocity and the magnetic field. Especially for southward IMF, the magnetosheath's magnetic field lines will reconnect with initially closed magnetospheric field lines. For the magnetospheric model, we will use the magnetically and electrically self-consistent Rice Convection Model (RCM-E) with a magnetic field boundary condition that includes the effect of a non-uniform penetration magnetic field. This magnetospheric model maintains internal force balance between the magnetospheric plasma and magnetic field. Use of the RCM-E will allow us to calculate self-consistent distributions of particle flux, plasma pressure, and current density within the magnetosphere (including the tail flanks and plasma sheet). We will study how these distributions evolve as we vary the solar-wind conditions, and we will compare the simulated results with observations. A significant outcome of this work will be a physical understanding of the relationship between properties of the solar-wind plasma (e.g., velocity and density) and the resulting plasma sheet, which is the main source for the ring current. This would provide a currently missing link for characterizing magnetic storms (and eventually accounting for variations of particle population in the inner magnetosphere) from solar-wind properties and IMF conditions. Such an achievement would be beneficial for understanding and forecasting space weather, and thus for society.

Publication References:

no references