PLASMASHEET CONVECTION INTO THE INNER MAGNETOSPHERE DURING QUIET CONDITIONS

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Abstract

Using a newly developed algorithm for tracing particles through the magnetosphere, we reanalyze the ISEE-1 trapped ion observations of Williams and Frank /1/ as convecting plasmasheet ions. Without using any adjustable parameters in the convection model, the data was fit surprisingly well. Thus energetic particle features (1–50 keV) can be used to put strong constraints on global electric and magnetic field models.

Introduction

Electric field convection plays a very important role in transporting the "warm" ($1<E<30$ keV) plasma from the plasmasheet into the inner magnetosphere ($2<L<5$). The "Alfvén boundary" effect /2/ excludes the vast majority of plasmasheet ions, and all the plasmasheet electrons, from this inner region, producing the well defined "plasmasheet inner edge". Yet there remains a non-negligible region of phase space that can access the inner magnetosphere from the plasmasheet, and although it depends strongly on convection electric field strength, it still exists during quiet magnetospheric conditions. Since particle trajectories beginning in the tail must divert around the closed orbits of the magnetosphere, there is a region of large divergence where neighboring particles go east or west around the earth. This area of high divergence contains the trajectories of the most deeply penetrating ions, which must then originate from a very localized region in the plasmasheet. The difficulty in characterizing this region with a conventional Monte Carlo approach has precluded a study of this deeply penetrating plasmasheet contribution to the inner magnetosphere.

A second reason for the apparent oversight of this penetrating component, is the inclusion of only the convection electric field in most particle tracing codes. (The corotation electric field drift is always perpendicular to $\vec{\rho}$, and therefore does not contribute to radial convection.) This dawn-to-dusk electric field, thought to be imposed by the solar wind on the flanks of the magnetosphere, is shielded from the inner magnetosphere by the ring current. The shielding, empirically described by Volland /3/ and Stern /4/, prevents the ions from convecting very deeply past $L\sim5$ during quiet conditions. However, there are other low latitude electric fields in the ionosphere, in particular, the dynamo electric field driven by neutral winds /5/, which maps out along magnetic field lines to the inner magnetosphere $2<L<5$ /6/. Thus convection in this region is enhanced and plasmasheet ions can appear at radial distances as close as 2 R_E.

There are two characteristics of this penetrating component that should make it easy to observe experimentally. First, it has undergone a very large adiabatic acceleration as it convects from a 10 nT field to a 4000 nT field. Thus it will be energized, compressed, and the pitch angle will rotate