Ion dynamics associated with Alfven wave in the near-Earth magnetotail: Two-dimensional global-scale hybrid simulation

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Ion dynamics in the near Earth magnetotail region is examined during periods of fast Earthward flow with a two-dimensional (2-D) global-scale hybrid simulation that the ions are treated as fully kinetic particles in a global scale context, while the electrons are assumed to be a massless fluid. The simulation shows:

Alfven waves are found to be generated at x˜-10RE where the strong earthward flow is arrested by the dipole field. The Alfven waves propagate earthward along field lines toward the polar regions in both the southern and northern hemispheres. Reflection of Alfven waves by the polar ionosphere is also observed. During the dipolarization period, new Alfven waves are continuously generated at the dipolarization front, and thus the wave region expands tailward from ˜-9 RE to -18 RE to high latitudes. Accompanying the dipolarization, strong turbulences in plasma density and magnetic field are also present near the equator.

The ion velocity distributions associated with these shear Alfven waves appear non-gyrotropic distribution. The non-gyrotropic distributions occur in both the high-latitude region of dipole field and the plasma sheet boundary layer during the plasma sheet thinning and dipolarization. The ion distribution contains a colder population and a partial-ring shaped population in the perpendicular plane. This beam contains the ions that are originated in the lobe, stream along the field lines in the plasma sheet boundary layer and plasma sheet. This kind of ion distribution is found everywhere in the simulated plasma sheet boundary layer.

The correlation between the non-gyrotropic distributions and Alfven waves suggest a causal connection between the two.