

Sudden pressure enhancement and tailward retreat in the near-Earth plasma sheet: THEMIS observation and MHD simulation

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Plasma pressure enhancement is one of the drastic substorm-associated phenomena in the inner magnetosphere. In a substorm occurred on 1 March 2008, four of THEMIS (Time History of Events and Macroscale Interactions during Substorms) probes were almost aligned along the sun-Earth line, which was suitable for investigating spatial-temporal evolution of the near-Earth plasma sheet in a substorm. They observed a sudden increase in the plasma pressure at the inner probe (at ~ 7.2 Re), followed by the outer probes (at ~ 7.5 , ~ 8.3 , and ~ 10.4 Re), that is the high pressure region propagates tailward. Hereinafter, we call this sudden pressure enhancement (SPE). We compared the observations with simulation results of a global magnetohydrodynamics (MHD) simulation, and found a fairly good agreement between them in terms of the followings. (1) Tailward propagation of the SPE can be seen only at off-equator after the substorm onset. In the equatorial plane, an earthward propagation of the SPE precedes the tailward propagation. (2) Observations from the three inner probes show that the SPE consists of two enhancements. The first one is attributed to the convergence of bulk flow energy flux, namely flow braking. The latter one is due to the convergence of the thermal energy flux and subsequent inflation of the plasma sheet. (3) Plasma flow turned from the tailward-and-toward-the-equatorial-plane to earthward-and-away-from-the-equatorial plane near the onset from the simulation results. We discuss the spatial-temporal evolution of the plasma flow and the magnetic field during the substorm.

Keywords: substorm, THEMIS observation, Global MHD simulation, Sudden pressure enhancement