

Study of plasma sheet variations observed by Geotail at the time of substorm onset

Shinobu Machida[1]; Yukinaga Miyashita[2]; Akimasa Ieda[3]; Masahito Nose[4]; Daisuke Nagata[5]; Tsugunobu Nagai[6]; Takahiro Obara[7]; Yoshifumi Saito[8]; Toshifumi Mukai[9]

[1] Dept. of Geophys., Kyoto Univ.; [2] ISAS/JAXA; [3] STEL, Nagoya Univ.; [4] DACGSM, Kyoto Univ.; [5] Dept. of Geophysics, Kyoto Univ.; [6] Tokyo Institute of Technology; [7] NICT; [8] ISAS; [9] JAXA

<http://www-step.kugi.kyoto-u.ac.jp/~machida/>

In a series of our studies, we have investigated the time development of Earth's magnetosphere during substorms adopting a multi-dimensional superposed-epoch analysis to the data from the Geotail spacecraft. Time variations during substorms were obtained for such as the earthward flow velocity, northward magnetic field, total pressure, electric field, and Poynting flux toward the center of the plasma sheet etc. We could confirm various variations which relevant models of substorm are based on or predict. We further proposed a new model called Slingshot Current Relaxation model in which the Poynting flux toward the plasma sheet center enhances the $J \times B$ force, resulting in the earthward motion of highly stretched closed field lines. This flow can affect the instability responsible to the current disruption in the inner magnetosphere. This induced flow triggers the reconnection of open field lines at the edge of highly stretched closed field lines around $X = -20 R_e$.

On the basis of those results, we performed case studies of substorm events observed by Geotail when it was located at $X \sim -14 R_e$. First, the substorm which occurred at 1620 UT on April 23, 1996 was investigated. Geotail stayed in the plasma sheet at the time of the onset, observing the periodic modulation in both ion and electron fluxes with the time period of about 2 min. This flux modulation can be regarded as a precursor of the substorm. After the onset, the fluxes of both electrons and ions increase substantially and the earthward BBFs were generated. At around 1627UT, Geotail observed the slow tailward flows which are often found when the BBFs stop. It was followed weak modulations in both electron and ion fluxes.

Similar Characteristics were observed for the substorm event occurred at 1552UT on January 7, 2002 although the flux modulation just prior the onset was clearer in this event compare to the previous case. The flux modulation just after the onset is not due to the BBFs but the north-south excursion of the spacecraft through the thin current sheet. A weak flux modulation also followed to this variation similarly to the previous event.

As can be found in those examples, we can find flux modulations as a precursor of substorm onset in the plasma sheet at around $X \sim -14 R_e$.