

Investigation of substorm triggering mechanism based on THEMIS data

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In this study, we show the result of superposed epoch analysis on the THEMIS probe data during the period from November, 2007 to April, 2009 by setting the origin of time axis to the substorm onset determined by Dr. Toshi Nishimura based on the THEMIS all sky imager (THEMS/ASI) data. We have restricted the time interval from $t = -100$ sec to $t = 100$ sec and the region to $-7.5 > X(\text{Re}) > -23$, and investigated various variations associated with substorm onset.

It was confirmed that earthward flows start at $t = -60$ sec in the region around $X = -14$ Re, and then they move toward the Earth. At $t = 0$, the dipolarization of the magnetic field starts at $X \sim -10$ Re, and simultaneously the magnetic reconnection starts at $X \sim -20$ Re. These variations support the validity of our Catapult Current Sheet Relaxation model for substorm onset.

Interestingly, the absolute value of dawnward plasma flow velocity $|V_y|$ decreases in the plasma sheet and the plasma sheet boundary layer during the interval $-20 < t(\text{sec}) < 20$. By analyzing individual event of $|V_y|$ decrease, it was confirmed that the plasma flows turn from the duskward convective flows ($V_y > 0$) to the dawnward flows ($V_y < 0$) on average, associated with substorm onset, so that the value of V_y once becomes to zero around $t = 0$. This variation was found to be related to the deflection of the flows when they encounter with the Earth's dipole magnetic field as they approach to the Earth, which is the same reason already known to cause the tailward flows around $X = -10$ Re when the earthward flows reach that region.

Keywords: substorm, magnetotail, magnetic reconnection, dipolarization, THEMIS probes