

Cluster observation of plasma flow reversal in the magnetotail during a substorm

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We investigate in detail a reversal of plasma flow from tailward to earthward detected by Cluster at the downstream distance of $\sim 19 R_E$ in the midnight sector of the magnetotail on 22 August 2001. This flow reversal was accompanied by a sign reversal of the B_z component and occurred during the late substorm expansion phase as revealed by simultaneous global view of auroral activity from IMAGE. We examine the associated Hall current system signature, current density, electric field, Lorentz force, and current dissipation/dynamo term, the last two parameters being new features that have not been studied previously for plasma flow reversals. It is found that (1) there was no clear quadrupole Hall current system signature organized by the flow reversal time, (2) the x -component of the Lorentz force did not change sign while the other two did, (3) the timing sequence of flow reversal from the Cluster configuration did not match tailward motion of a single plasma flow source, (4) the electric field was occasionally downward, producing a dynamo effect, and (5) the electric field was occasionally larger at the high-latitude plasma sheet than near the neutral sheet. These observations are consistent with the current disruption model for substorms in which these disturbances are due to shifting dominance of multiple current disruption sites and turbulence at the observing location.