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Statistical signature of the field-aligned current in the magnetotail observed by Cluster

Y. Asano (1), R. Nakamura (1), W. Baumjohann (1), T. Takada (1), A. Runov (1), T. L. Zhang (1), A. Balogh (2), B. Klecker (3) and H. Rème (4)

(1) Institut für Weltraumforschung, Österreichische Akademie der Wissenschaften, Graz, Austria, [yoshihiro.asano@oeaw.ac.at/Fax,+43-316-4120-590] (2) Imperial College, London, UK, (3) Max-Planck-Institut für extraterrestrische Physik, Garching, Germany, (4) CESR/CNRS, Toulouse, France

It is well-known that magnetotail field-aligned current shows the Region-1 type current system, namely Earthward on the dawn side and tailward on the dusk side. On the other hand, strong field-aligned current is also observed around the near-Earth neutral line. However, it has not been achieved yet to model such current systems connecting each other.

Using multi-satellite Cluster magnetic filed (FGM) data, We statistically analyzed the appearance of the field-aligned current associated with the plasma bulk velocity. We found that the field-aligned currents show different characteristics for intervals with tailward and Earthward fast flows and intervals without any fast flows.

The field-aligned current during tailward fast flows is dominantly directed tailward, which is in good agreement with the outermost current associated with the near-Earth neutral line. The field-aligned current with Earthward fast flows is mainly directed Earthward near the plasma sheet-lobe boundary. However, in the dusk side, the field-aligned current is frequently directed tailward. When no fast plasma flow is observed, current density in most cases is quite small. However, it shows a dawn/dusk asymmetry consistent with the region 1 type distribution.