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

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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.