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Structure of magnetospheric flux transfer events: Comparing Geotail observations and 2D two-fluid simulations

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We have investigated the structure of low-latitude flux transfer events (FTEs) identified from 7 years of Geotail observations, by comparison with two-dimensional two-fluid simulations. Particularly, we focus on FTEs observed earthward of the magnetopause, that is, magnetospheric FTEs. The principal signature of an FTE is a characteristic bipolar variation in the magnetic field component normal to the magnetopause (BN). First, using Geotail MGF and LEP data obtained from 1998 to 2005 we identified 385 isolated clear bipolar BN events around the dayside magnetopause. Out of the 385 events, 64 are identified as magnetospheric FTEs. Here, an event is identified as the magnetospheric FTE when the bipolar BN signature is observed along with magnetosheath-like cold-dense ions. The 64 magnetospheric FTEs were hardly observed around the subsolar region and tended to be observed when the upstream solar wind speed, observed by the ACE spacecraft, is high. These results indicate that magnetospheric FTEs tend to be observed when the ion flow in the magnetosheath is strong.

Next, to investigate the effect of the magnetosheath flow, we perform a two-dimensional two-fluid simulation modeling the magnetopause between magnetosheath-like cold-dense plasmas and magnetosphere-like hot-tenuous plasmas. A number of past simulations neglecting the effects of the magnetosheath flow have been shown that while magnetic field lines deformed by non-stationary reconnection can produce the bipolar BN variation, the deformation occurs predominantly on the magnetosheath side because of the asymmetry between the magnetosheath and magnetospheric sides. The same result was obtained in this study when there is no magntosheath flow or the magenetosheath flow is sufficiently weak. We newly found, however, that when there is strong plasma flow tangential to the magnetopause on the magnetosheath side, magnetic field lines can be deformed largely even on the magnetospheric side. The deformation on the magnetospheric side is large enough for the clear bipolar BN variation unless the flow speed is too small as compared with the Alfven speed on the magnetoshperic side. Since these numerical results are consistent with the above observational results, we conclude that low-latitude magnetospheric FTEs are generated by reconnection under the influence of strong tangential plasma flow in the magnetosheath.

In addition, the simulation results show that flow effect leaves a characteristic signature in the data on the magnetosheath side as well. We show a prediction for pair-wise observations (one in the magneotpshere and the other in the magnetosheath) such as the THEMIS spacecraft.