R006-01
Zoom meeting B ：11/1 AM1 (9:00-10:30)
9:15〜9:30

SC の PI 電流の詳細な解析結果について

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Detailed analysis of the current system in the PI phase of the Sudden Commencement

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We already reported that there are two current systems in the Preliminary Impulse (PI) phase of the Sudden Commencement (SC). One of these current systems consists of two upward/downward field-aligned currents (FAC) and the field-perpendicular current (FPC) connecting the two FACs in the magnetopause region. The longitudinal propagation of this current is slow. FACs of this current system appear in the higher latitude in the ionosphere (type H current system). The other current system has ionospheric FAC and the magnetosheath current as well as the cross-magnetopause current. This system shifts in the longitudinal direction faster than the type H current system. FACs of this current system appear in the lower latitude in the ionosphere (type L current system). The characteristic ground magnetic variation of the PI, that is to say, longer duration of the PI geomagnetic variation and time delay of the peak of the PI geomagnetic variation in the higher latitudes, can be explained by the simultaneous occurrence of the two PI current systems. Furthermore, we also reported that 1) the cross-magnetopause current of the type L current system is driven by the acceleration of the magnetosheath plasmas associated with a sudden increase of the solar wind dynamic pressure and 2) convergence/divergence of the FPC invokes the FPC-FAC conversion of the type H current system in the magnetopause region.

In the talk, we stress the following three points that have not been treated previously.

1) The simultaneous occurrence of the two current systems does not completely explain the time delay of the peak of the PI current system because the time delay is detected in the latitude region of the type L current system. Detailed analysis of the type L current system reveals that the cross-magnetopause current of the type L current system in the higher-latitude side bents toward the noon direction in the outer magnetopause region. Thus, the peak FAC in the ionosphere appears in a longitude deviated from the longitude corresponding to the front of the solar wind impulse in the magnetosheath toward noon. On the other hand, the type L current system goes almost straight to the ionosphere.

2) We need to investigate the detailed process of the FPC-FAC conversion along the current lines of both current systems. The conversion is derived by the spatially non-uniform distribution of magnetic field intensity and plasma density (the Alfven speed) and magnetic field curvature. In addition, the displacement current of the Alfven wave also contributes to the FPC-FAC conversion in the lower magnetosphere near the ionosphere. The transition of high-beta plasma in the outer magnetosphere to the low-beta one in the inner magnetosphere does not play a role in the FPC-FAC conversion for the PI current system.

3) It is important to manifest how the latitude of the PI current in the ionosphere is determined because no papers are discussing how the latitude of the PI current is determined. Fujita et al. (2003) briefly mentioned that the PI appears in the latitude of the plasmapause because the FPC-FAC conversion of the PI current system occurs in the region of the steep spatial gradient of the Alfven speed. So, the PI current should have existed in the plasmapause latitude. But the simulation does not prove this estimation. The simulation reveals that the highest latitude of the PI current is located in the magnetopause latitude (the type H current). is located near the magnetopause latitude. In addition, as for the type L current system, the cross-magnetopause current (FPC) is gradually converted to the FAC due to the non-uniform distribution of the Alfven speed in the outer magnetosphere. The latitude of the PI current in the ionosphere is higher than the latitude of the plasmapause.

Fujita, S., T. Tanaka, T. Kikuchi, K. Fujimoto, K. Hosokawa, and M. Itonaga (2003), A numerical simulation of the geomagnetic sudden commencement: 1. Generation of the field-aligned current associated with the preliminary impulse, J. Geophys. Res., 108(A12), 1416, doi:10.1029/2002JA009407.