# Two current systems in the preliminary phase of the Sudden Commencement

Shigeru Fujita[1,2]
[1]*Meteorological College*
[2]*National Institute of Polar Research*

The geomagnetic variations associated with Sudden Commencement (SC) observed in the morning and afternoon sides in the high latitude region show that, at higher latitudes, the duration of the geomagnetic variations of the Preliminary Impulse (PI) becomes longer and the maximum displacement time delays. The mechanism of these characteristic behaviors was studied using global MHD simulation. From the simulation results, it was found that the ionospheric FAC region on the lower latitude side of the PI phase moves at a higher speed from the dayside to the night side, but the movement speed on the higher latitude side is slow. Therefore, it can be seen that the duration of the geomagnetic variations is shorter at lower latitudes, and the time showing the maximum displacement delays toward high latitudes. Furthermore, the magnetospheric current system connected to the FAC in the PI period was analyzed, and the difference in the current system depending on the latitude was investigated, as shown in Figure 1. First, it was found that the FAC on the lower latitude side crossed the magnetopause and was further connected to the magnetosheath current. The region where the current crosses the magnetopause is at the front of the sudden increase in the solar wind's dynamic pressure. There, the solar wind on the upstream side of the front decelerates in the downstream direction. Therefore, the inertial current flows to the direction across the magnetopause. This current bridges the magnetospheric current and the magnetosheath current. Thus, the FAC's longitudinal shift in the lower latitudes is related to propagating the solar wind shock in the magnetosheath to the nightside. Next, let us consider the FAC shift in the higher latitude region. The inertial current flowing in the front of the SC bends toward the sun in the magnetosphere. On the other hand, around noon, the magnetopause is pushed inward by the increase in solar wind pressure that causes SC, so the plasma also has an inward speed. This speed slows down toward the Earth, so the inertia current flows in the dawn-to-dusk direction. On the afternoon side, this dawn-to-dusk current collides with the sunward current flowing from the front of the SC. Thus, it causes divergence of inertial current (convergence on the morning side). As a result, the perpendicular current is converted into the field-aligned current. Since the moving speed of the inertial current divergence/convergence is slower than the solar wind speed, the longitude moving speed of the high latitude FAC is slow. Thus, the longitudinal speed of the FAC distribution during the PI period is related to the speed of the solar wind at low latitudes and is slower at low latitudes.   The PI current system reported by Fujita et al. [2003] is an intermediate between the Type L current system and the Type H current system.

**References**

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.

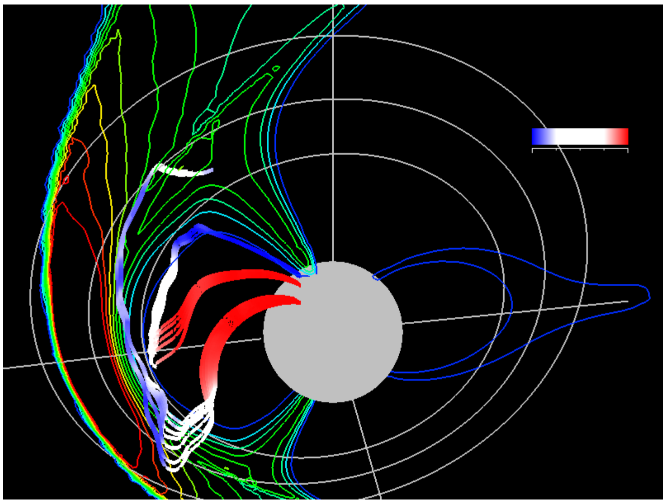

Figure 1. Snapshots of two electric current systems in the PI phase at t=5.6min. The color of the electric current lines denotes $J_{\parallel}/|J|$. If the current is parallel or anti-parallel to the magnetic field line, $J_{\parallel}/|J|$ becomes +1 or -1, respectively, and the color of the current line becomes red or blue, respectively. If the current is perpendicular to the magnetic field, the color of the current line is white. The pressure in the noon-midnight meridian is shown with color line contours. The Type H current system starting on the higher-latitude side of the PI-FAC region bridges between two PI-FAC regions in the prenoon side and the post-noon side. The Type L current system on the lower-latitude side connects the downward FAC and the electric current in the magnetosheath via the perpendicular current across the magnetopause.