Instantaneous development of ionospheric currents during the preliminary impulse of the SC

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The preliminary reverse impulse (PRI) of the geomagnetic sudden commencement (SC) appears simultaneously at the dayside geomagnetic equator and afternoon high latitude within the temporal resolution of 10 sec as found by Araki (1977). These latitude and local time features were explained by means of the DP2-type ionospheric currents driven by the dusk-to-dawn electric field impressed from the magnetosphere. Araki et al. (1985) further found that a positive impulse preceding the SC (PPI) appeared at the nightside geomagnetic equator when the PRI was observed on the dayside, implying that the dusk-to-dawn PRI electric field drove eastward currents at the nightside equator. In this paper, we examined the PRI and PPI recorded at high-equatorial latitudes with the GPS controlled high time resolution (1 sec) data, to confirm the instantaneous development of the ionospheric current from high latitude to the equator. In particular, we examined deflections in the D-component magnetic field at mid-low latitudes, to confirm magnetic effects of the Pedersen currents connecting the equatorial currents with the field-aligned currents in high latitude. We found that the onsets of the PRI and PPI at mid-equatorial latitudes were simultaneous within a few seconds. We also found that the deflections in D component were positive/negative in the afternoon/morning sectors, in agreement with the Pedersen currents flowing to/from the equator. These findings lead to a scenario that positive/negative electric potentials were transmitted to the equator instantaneously along the dusk/dawn terminators, and drove the Hall and Pedersen currents at mid latitudes and the Cowling currents along the equator. We conclude that the PRI/PPI currents were transmitted by the TM0 mode waves propagating at the speed of light in the Earth-ionosphere waveguide (Kikuchi et al., 1978; Kikuchi and Araki, 1979).

References

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