INSTANTANEOUS DEVELOPMENT OF GLOBAL IONOSPHERIC CURRENTS DURING GEOMAGNETIC SUDDEN COMMENCEMENTS

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The preliminary impulse (PI) of geomagnetic sudden commencements (SCs) appears as a negative impulse (PRI) at the afternoon high latitude and dayside geomagnetic equator, and a positive impulse (PPI) at morning high latitude and nightside geomagnetic equator. The temporal and spatial variations of the PI are explained by means of a magnetosphere-ionosphere current system, composed of the ionospheric Hall and Pedersen currents at high latitudes and the Pedersen current amplified by the Cowling effect at the equator. The ionospheric currents are driven by the dusk-to-dawn electric field impressed from the magnetosphere. The electric field then propagates to low latitude, driving westward/eastward currents in the day/nightside equatorial ionosphere. The propagation of the electric field is instantaneous with the temporal resolution of 10 sec, as found by Araki (PSS, 1977) using the rapid-run magnetogram. Kikuchi et al. (Nature, 1978) and Kikuchi and Araki (JATP, 1979) found that the electric field and current could be transmitted at the speed of light by the TM0 mode wave in the Earth-ionosphere waveguide. The attenuation of the TM0 mode wave is less than 15 percent for propagation from high latitude to the equator under day- and nighttime ionospheric conditions (Kikuchi, AGU Monograph, 2005). Although the observations indicate instantaneous transmission of the electric field to the equator, there remains an argument about the simultaneity of the occurrence of the PI (Chi et al., JGR, 2001; Kikuchi and Araki, JGR, 2002), probably due to rather poor time accuracy of the data and sparse observation stations at mid latitudes in the papers by Araki (PSS, 1977). To address this problem, we analyzed PI events using 1-sec sampled magnetometer data recorded at high-equatorial latitudes on both day- and nightside. The PI was found to start simultaneously with the temporal resolution of 1 sec at all latitudes and local times. The D-component deflections at mid latitudes were consistent with the Pedersen currents connecting the field-aligned currents with the equatorial PI currents. The instantaneous development of the PI currents is consistent with our scenario based on the TM0 mode wave in the Earth-ionosphere waveguide.

geomagnetic sudden commencement, global current system, Earth-ionosphere waveguide

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