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# Seasonal dependence of magnetic field variations from high latitude to the magnetic equator during geomagnetic sudden co

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Seasonal dependence of diurnal variation of the main impulse (MI) of geomagnetic sudden commencements (SCs) has been investigated using the long-tern geomagnetic field data with high time resolution of 1 sec within a period from 1996 to 2008 provided from the NSWM [Kikuchi et al., 2008] and CPMN [Yumoto and the CPMN group, 2001] chains and the WDC for Geomagnetism, Kyoto. In the present analysis, we used the geomagnetic field data obtained from the 12 stations: Pohnpei (geomagnetic latitude, MLAT = 0.27 degree), Yap (MLAT = 0.38 degree), Cebu (MLAT = 0.85 degree), Guam (MLAT = 5.22 degree), Okinawa (MLAT = 16.54 degree), Kakioka (MLAT = 27.18 degree), Memanbetsu (MLAT = 35.16 degree), St. Paratunka (MLAT =45.58 degree), Magadan (MLAT = 53.62 degree), Zyryanka (MLAT =59.74 degree), Chokurdakh (CHD, 70.62N, 147.89E GR, 64.81N, 212.53E GM), Kotel'nyy (KTN, 75.94N, 137.71E, 70.08N, 201.39E), and King Salmon (KSM, 58.68N, 203.35E GR, 58.09N, 258.39E, GM). In this study, the SC events have been defined as a rapid increase with its amplitude of more than 5 nT within 10 minutes in the SYM-H index. In this case, 3535 events of the magnetic field disturbance are found in a long period from January 1996 to October 2010, which has no Pi 2 signature around 10 minutes at the SC onset. Details of the analysis method have been described in the paper of Shinbori et al. [2009]. Moreover, the SC amplitude obtained at the above 12 stations has been normalized by that in the SYM-H index with latitude correction in order to minimize the different contribution of the rapid change in solar wind dynamic pressure. We also used solar wind data obtained from the IMP-8, Geotail, Wind and ACE satellites within the same period. As a result, the diurnal variation of SC amplitude in a region from the high latitude (KTN) to the middle latitude (MMB) shows a remarkable DP-2 type magnetic signature in the daytime (6-18 h) produced by the ionospheric currents. The ionospheric currents are driven by a dawn-to-dusk polar electric field carried by a pair of field-aligned currents (FACs). In the nighttime (18-06 h), the SC amplitude in the sub-auroral latitude (ZYK) to low latitude (KAK) tends to increase significantly and increases with increase of magnetic latitude. This tendency indicates that the nighttime enhancement of SC amplitude is caused by the magnetic effect of FACs. The size of the diurnal variation of SC amplitude tends to be more enhanced in the summer, compared with that in the winter. This result implies that ionospheric currents (ICs) and field-aligned currents (FACs) generated during the MI phase of SC are intensified due to the increase of ionospheric conductivity in the summer. This feature of SC current system shows the voltage generator rather than the current generator. On the other hand, the diurnal variation of SC amplitude near the equatorial region shows a remarkable equatorial enhancement in the daytime (6-18 h) with its maximum around 11 h produced by the enhanced eastward ionospheric currents due to the Cowling effect. The seasonal variation of the daytime SC amplitude showed quite a different signature from that in the middle latitudes. The remarkable feature is that the equatorial enhancement of SC amplitude tends to become relatively smaller in the summer than in the equinox or winter. This tendency suggests that the intensity of the equatorial electrojet current does not depend on only the solar zenith angle. One of the implications of the equatorial seasonal dependence is that the penetration polar electric field tends to become weak in the summer, compared with that in the winter. In future, in order to verify this feature, we will need to investigate the response of the penetration polar electric field to equatorial conductivity variation by solving the global ionospheric potential solver which uses three-dimensional ionospheric conductivity model.

Keywords: geomagnetic sudden commencement, high latitude, magnetic equator, seasonal dependence, ionospheric conductivity, voltage generator