Local time and seasonal variations of the amplitude of the main impulse (MI) of geomagnetic sudden commencements in the low-latitude and equatorial regions

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Local time and seasonal variations of the amplitude of the main impulse (MI) of geomagnetic sudden commencements (SCs) in the equatorial and low-latitude regions (geomagnetic latitude (GMLAT) range: 0 –30 degrees) has been investigated using high time resolution geomagnetic field data for the period 1996 –2009. These geomagnetic field data are provided by the Circum-Pan-Pacific-Magnetometer-Network (CPMN) [Yumoto and the CPMN Group, 2001] and National Institute of Information and Communications Technology (NICT) Space Weather Monitoring (NSWM) [Kikuchi et al., 2008]. In order to identify SC events from January 1996 to 2009, we used the SYM-H index with 1-minute time resolution archived on the web site of World Data Center for Geomagnetism, Kyoto University. In this study, total 6992 SC events were found as a sudden increase of the SYM-H index by more than 5 nT within 10 minutes 1during this period, corresponding to the solar wind dynamic pressure enhancement. The solar wind data are archived on the CDAWeb site. As a result, the local time dependence of the SC amplitude in the low-latitude region (10^{o} < GMLAT < 30^{o}) showed the semi-diurnal variation with two maxima around 10 –14 h (LT) and 22 –1 h (LT) and the two minima around 6 –9 h (LT) and 16 –19 h (LT), respectively. The peak value of the nighttime SC amplitude tended to be equal to or more than that of the daytime amplitude. The minimum value of the SC amplitude in the morning (4 –10 h, LT) tended to be smaller than in the afternoon. This morning-afternoon asymmetry in the SC amplitude is due to a magnetic effect of the two-cell ionospheric currents driven by the MI electric field. The size of the local time variation of the SC amplitude in the low-latitude regions becomes largest in the summer (May –July). During this period, the nighttime SC amplitude tended to be enhanced significantly and was larger than the daytime one. Moreover, the daytime (10 –14 h, LT) SC amplitude at OKI was enhanced significantly near the equinoxes (March and October). The seasonal variation of the SC amplitude at OKI during 10 –14 h (LT) showed a significant decrease during May –October. This depression cannot be explained only by the seasonal variation of the ionospheric conductivity. The local time variation of the SC amplitude in the equatorial region (GMLAT < 10^{o}) clearly showed the equatorial enhancement of the SC amplitude in the daytime (8 –17 h, LT). This enhancement is due to a magnetic effect of the eastward equatorial electrojet driven by a dawn-to-dusk electric field generated during the MI phase of SC. The nighttime enhancement of the SC amplitude as seen in the low-latitude region appeared also in the equatorial region (5.0^{o} < dip latitude < 20.0^{o}). This result suggests that a magnetic effect caused by a pair of FACs generated during the MI phase of SC extended near the equatorial region. The seasonal variation of the equatorial enhancement of the SC amplitude showed a significant depression by 3 –10 % in the summer (May –July), compared with that in the winter (November –January) in the northern hemisphere. The summer reduction of the SC amplitude can be seen at the GAM and MUT stations located near the dip equator. Moreover, the SC amplitude in the afternoon –evening (14 –21 h, LT) tend to decrease by 10 –30 % during March –September. This summer depression of the SC amplitude appears also at the dip equatorial stations (YAP and PON). From a comparison of the ionospheric conductivity and SC amplitude, it was shown that the decrease of the

equatorial enhancement in the morning –evening (8 –21 h, LT) cannot be explained only by the seasonal variation of the ionospheric conductivity. Therefore, the equatorial SC-MI reduction suggests a weakness of a dawn-to-dusk ionospheric electric field during the summer in the northern hemisphere.

Keywords: Geomagnetic sudden commencement, Seasonal variation, Local time variation, Ionospheric conductivity, Equatorial region, Ionospheric electric field