Seasonal dependence of diurnal variations of SC amplitude at the magnetic equator

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In order to confirm seasonal dependence of diurnal variations of SC amplitude on the ground near the magnetic equatorial regions during the main impulse (MI), we analyzed a large number of SC events identified by the long-term observation data with high time resolution of 1 second provided from the 2 stations around the magnetic equator: Yap (geomagnetic latitude, 0.38 degree), Guam (5.22 degree). We also analyzed magnetic field data obtained from the 4 stations in the middle and low latitudes: Okinawa (MLAT=16.54 degree), Kakioka (27.18 degree), Memanbetsu (35.16 degree), and St. Paratunka (45.58 degree) in order to investigate a difference of seasonal variations between in the middle latitudes and near the equatorial regions. The SC events in the present analysis have been defined as a rapid increase of the SYM-H value with more than 5 nT and time variation of 1.5 nT min{-1} within ten minutes in the SYM-H index. Then, we identified 7556 events of SCs in a period from January 1981 to March 2008. In the present analysis, the SC amplitude obtained at the above 6 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. The results showed that the equatorial enhancement of SC amplitude in the daytime sector (7-17 h, MLT) at YAP can be clearly found in all seasons, but the maximum value of SC amplitude around 10-11 h (MLT) tends to become larger in equinox than in solstice. The peak values in spring, summer, fall and winter were 3.4 at 10 h, 2.7 at 10 h, 3.7 at 11h and 2.9 at 11 h (MLT), respectively. This feature is almost consistent with seasonal dependence of the equatorial enhancement associated with solar quiet variation at the magnetic equator previously shown by Chapman and Rao [1965]. Furthermore, an MLT range showing the value of more than 1.4 (normalized SC amplitude) tends to expand from 8-14 h (summer) to 4-17 h (equinox). This tendency suggests that ionospheric conductivity around the magnetic equator is higher around the equinox, compared to that in the solstices. However, considering seasonal variation of solar zenith angle (SZA), the conductivity enhancement in summer can not be explained by ionization rate variation due to only the SZA effect at the altitude of E-region. On the other hand, in the predawn (2-5 h, MLT) and dusk (16-22 h, MLT) sectors, the SC amplitude tends to be smallest in summer. This implies that the westward current flowing at the nighttime equatorial ionosphere tends to be more enhanced in this period. Also at GAM (5.22 degrees), we identified the same feature of seasonal dependence as that at YAP in an MLT range between 2:00 and 21:00. Furthermore, we found that the SC amplitude in the nighttime sector tends to be enhanced in summer, not showing the MLT profile at YAP. This tendency in the nighttime sector is a common feature of the MLT profile of SC amplitude in a wide region from low to middle latitudes. Then, the nighttime enhancement of SC amplitude can be interpreted as the magnetic effects of a pair of field-aligned currents (FACs) resembling region-1 type of FACs generated during the MI phase of SCs. The fact that the nighttime enhancement does not take place at the equator suggests that the magnetic effects due to FACs can be canceled by those of the westward ionospheric currents produced by the dawn-to-dusk electric field penetrating to the nighttime equator. From the above analysis and interpretation, it can be concluded that the seasonal variation of ionospheric conductivity in the daytime sector may significantly contribute to the effects of seasonal dependence of neutral wind flowing the magnetic equator.