Characteristics and interpretation of ground magnetic field variations from subauroral latitude to equator during SCs

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In order to confirm magnetic latitude and local time dependence of the main impulse (MI) amplitude on the ground from subauroral latitude to equator during SCs, we analyzed a large number of SC events identified by the long-term observation data with high time resolution of 1 second or 1 minute provided from the 8 stations: Yap (geomagnetic latitude, MLAT=0.38 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), Stecolny (MLAT=51.52 degree), and King Salmon (MLAT=58.09 degree). 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 8 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 of magnetic local time (MLT) dependence of SC amplitude showed negative and positive magnetic field variations in the morning (6-12 h, MLT) and afternoon (12-18 h, MLT) sectors from the subauroral to middle latitudes produced by two-cell ionospheric currents (DP 2-type currents) which are driven by the dawn-to-dusk electric field accompanying a pair of field-aligned currents (FACs). The magnetic effects of the DP 2-type currents at least expands to the low-latitude region (16.54 degree). In this region, the DL part of SC produced by the Chapman-Ferraro currents can be more dominant, but the DP part of SC contaminated 7 % of the DL one. On the other hand, at the daytime equator between 8:00 and 16:00 (MLT), the SC amplitude is considerably enhanced with its peak amplitude of 3.24 (normalized SYM-H value) around 11:00 (MLT). This enhancement is caused by intensification of the Pedersen currents around the dip equator due to the Cowling effect. Another interesting point is that the nighttime enhancement of SC amplitude is clearly found in a region from the middle latitudes to equator. The peak value tends to increase with increasing magnetic latitude except for subauroral latitude. This tendency suggests that the origin of the nighttime enhancement exists in high latitudes. From the above results, the nighttime enhancement of SC amplitude can be interpreted as the magnetic effects of the region-1 type of the FACs associated with the MI phase of SC. On the other hand, we found the nighttime depression of SC amplitude at the equator (YAP) and subauroral latitude (KSM) associated with magnetic effects of westward ionospheric currents.