Statistical Investigation of Small-scale Field-aligned Currents Using Long-term Akebono Satellite Data

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Field-aligned currents (FACs) play the most important role in the magnetosphere- ionosphere coupling system. Although global characteristics of large-scale FACs such as 'Region 1' and 'Region 2' currents have been statistically shown, recent studies indicate that small-scale FACs also play a significant role in the magnetosphere-ionosphere coupling. In the present study, the global distribution and characteristics of small-scale field-aligned currents (FACs), which have a ~10-80 km-scale at the ionospheric altitude, are statistically investigated using the long-term Akebono satellite data from March 1989 to December 1996. It is found that small-scale FACs mainly appear in the dayside region of 75-82 degrees in corrected geomagnetic latitude (CGLAT) and 06-15 h in corrected geomagnetic local time (CGMLT). Small-scale FACs are enhanced on the sunlit condition (summer), that is, they have a clear seasonal variation. It is found that the seasonal variation of small-scale FACs has a tendency opposite to that of large-scale FACs. That is, the most intense large-scale FACs appear on the nighside in winter, while the most intense small-scale FACs appear on the dayside in summer. Small-scale FACs statistically appear in the downward current region of large-scale FACs where small-scale FACs are considered to be mainly carried by a large amount of (upward or downward) suprathermal electrons (with energies less than ~300 eV). Small-scale FACs also change their distributions and intensities according to the variations of solar wind parameters and altitude. Furthermore, a correlation analysis between magnetic and electric fields is performed. It is found that the E/B ratios approximately correspond to the local phase velocities of dispersive Alfven waves both on the sunlit and dark conditions, which indicates that the small-scale FACs are closely related to DAWs. As a possible generation mechanism of small-scale FACs with a scale of 10-80 km at the ionospheric altitude, the ionospheric Alfven resonator (IAR) of DAWs is suggested. In particular, IAR mechanism or standing wave structures would be effectively formed in the high conductive ionosphere on the dayside under the sunlit or summer conditions. Consequently, small-scale FACs would be enhanced in sunlit or summer conditions. It is suggested that the conditions of local plasma density and ionospheric conducitivity are the most important parameters for forming the small-scale FACs.