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Spatiotemporal Characteristics of the Field-Aligned Currents

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We present the first ever comprehensive statistical study of the spatiotemporal characteristics of field-aligned currents in the terrestrial magnetosphere-ionosphere system. We determine how the density, variability and scale size are coupled. The three ST 5 satellites were in a pearls-on-a-string formation making measurements of the magnetic field with variable inter-spacecraft separations ranging from a few seconds to about 10 min. More than 4700 sets of satellite passes are analyzed using a robust correlation analysis aimed at determining the variability of the FAC system as a function of scale size and satellite spacing. We find significant differences between the FAC characteristics on the dayside and on the nightside in terms of dynamics of the current systems. On the dayside it is found to be independent of IMF Bz and geomagnetic activity while the nightside indicates increased variability during disturbed conditions. The boundary separating highly and poorly correlated FACs can be fitted by a linear line for satellite separations shorter than 60 sec (dayside) and 160 sec (nightside). We interpret this as the dayside and nightside magnetospheric reconfiguration times respectively. For times exceeding this the FAC characteristics are suggested to be controlled by the solar wind (dayside) and plasma sheet (nightside) dynamics. Finally, the characteristics of FAC system with scale sizes larger than $\sim$200 km (at ionospheric altitude) appear to be stable and repeatable on time scales of the order of a minute (i.e. comparable the low-altitude orbiting satellite's traverse time across the auroral belt). In this sense, our results effectively validate the Iijima and Potemra [1978] assumption that large-scale currents with scale sizes of the Region1 and Region2 are quasi-persistently significant in the transport of energy and momentum between the magnetosphere and the ionosphere.