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SWARM field-aligned currents during the September 2017 severe magnetic storm

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SWARM observations are used to characterize the extreme behavior of large- and small-scale field-aligned currents (FACs) during the severe magnetic storm of September 2017. The satellites crossed the pre-midnight, pre-noon, dusk and dawn sectors in both hemispheres. Evolution of the current intensities and the equatorward displacement of FACs are analyzed. The equatorward boundaries of FACs mainly follow the dynamics of ring current (as monitored in terms of the SYM-H index). The minimum latitude of the FAC boundaries is limited to 50° MLat, below which saturation occurs. The FAC densities increase dramatically at the time of the storm-time substorms occurrence. At the peak of substorm, the average FAC density reaches 3 μA/m2, while the undisturbed level is $\sim$0.1 μA/m2. The dawn–dusk asymmetry is manifested in the enhanced duskside R2 FACs in both hemispheres. The characteristics of the FAC in September 2017 are compared with the current systems of other major storms.

Filamentary high-density structures are always presented in the SWARM observations confirming that a substantial fraction of R1/R2 FACs is composed of many small-scale currents. In the pre-noon sector, the bi-polar structures (FACs of opposite polarities, 7.5 km width, adjacent to each other) dominate, while in the post-midnight sector the upward and downward FACs appear at considerably different latitudes. At the same time, the most intense paired FACs (up to $\sim$80 μA/m2) occurred just prior of the substorm onset are found exactly in the post-midnight sector. Simultaneous magnetic and plasma perturbations indicate that this structure is a current system of a mesoscale auroral arc.

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