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Analysis of field-aligned current sheets on multiple spatial scales in the Earth's plasma sheet: lessons from Cluster for Swarm

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Field-aligned currents (FACs), alongside with Alfvén waves, represent the coupling mechanisms and transmitters of energy between the magnetosphere and the ionosphere. At the magnetospheric end, equatorward (Region 2) auroral FACs close in the ring current region, while poleward (Region 1) auroral FACs close at the magnetopause and in the plasma sheet boundary layer. This presentation is concerned with observations of FACs in the plasma sheet by the four Cluster spacecraft. We apply and compare one-, two-, three- or four-satellite analysis methods to show how the spatial scales and orientations of current structures affect the estimation of current densities, and discuss implications for the interpretation of results from previous statistical studies of FACs in the plasma sheet. In view of the forthcoming Swarm mission with two satellites orbiting side-by-side, the information obtained from four-point plasma and field measurements is used as a benchmark to evaluate the performance of different two-satellite approaches to gradient and current estimation.