Geophysical Research Abstracts
Vol. 20, EGU2018-8424, 2018
EGU General Assembly 2018

Multiscale analysis of the field-aligned current density

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Field aligned currents (FACs) represent the main coupling agents that mediate the transfer of energy and momentum within the magnetosphere-ionosphere dynamically coupled circuit. Their signatures are commonly revealed as geomagnetic field perturbations, derived from spacecraft in-situ measurements. The observed FACs show typically complex signatures with contributions from a wide range of spatial and temporal scales. At medium and large scales the FACs are related to quasi-stationary coupling (FACs close in the ionosphere) whereas at smaller scales to time dependent coupling (FACs associated to dispersive Alfven waves).

To study these current structures the multiscale FAC analyzer (Bunescu et. al. 2015) has been developed, allowing to investigate how the current sheet planarity and orientation depend on scale. Here we introduce an extension of the multiscale FAC analyzer by computing the FAC density as a function of scale. We compute the current densities in two ways, namely, using (1) sliding windows for linearly spaced scale ranges, and (2) a fixed window scheme for logarithmically spaced scale ranges, similar to the wavelet analysis.

We show preliminary results based on both synthetic and measured data. For the synthetic data, produced by superposing Gaussian FACs of different scales, a comparison between the input FAC density and the reconstructed FAC density, obtained through the multiscale analysis, will be shown. The measured data were acquired by the Swarm satellites in both stable and more disturbed geomagnetic conditions that favor auroral structures of larger and, respectively, smaller scale. This extension of the multiscale FAC analyzer provides a suitable visualization tool for the study of complex FACs, that complement the other available tools. The results are compared with the other well established single- and dual-spacecraft methods available from the Swarm community.