HOW THE ESA SWARM SATELLITES CAN IMPROVE OUR KNOWLEDGE ON ELECTRIC CURRENTS IN THE MAGNETOSPHERE-IONOSPHERE SYSTEM?

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Electric currents flowing along geomagnetic field lines couple Earth's ionosphere and magnetosphere at auroral latitudes. The pioneering statistical studies by T. Ijima and T.A. Potemra on intensities and global spatial distribution of these currents were published some forty years ago. These studies are based on magnetometer data collected by a single satellite at polar circular orbit and by 10-12 ground stations distributed at different longitudes along the auroral oval. Today magnetosphere-ionosphere currents are probed with extensive ground-based magnetometer networks including hundreds of stations and with multi-satellite constellations. With improving instrumentation the focus in our research has shifted towards smaller scales and rapid variations in the currents. An important recent advancement in this field has been the ESA Swarm satellite constellation of three satellites (launched in November 2013) which allows for the first time measurements of auroral current structures in spatial scales of ~10-200 km.

In the presentation we will compare auroral current estimates derived from Swarm magnetometer data with three different methods: i) the traditional method assuming longitudinally homogeneous field-aligned current sheet crossing, ii) the quad-method combining along- and across-track measurements [1], and iii) the method using Spherical Elementary Current Systems [2]. Ground-based magnetometer data by the MIRACLE network will be used as reference material. Spatio-temporal ambiguity in the satellite magnetic field measurements poses a challenge for all the three methods as the satellites probe structured and time-varying currents. With a set of different example cases we will discuss strengths and weaknesses of the methods and challenges in interpretation of their results.

[1] Ritter, P., H. Lühr and J. Rauberg, Determining field aligned currents with the Swarm constellatin mission, Earth Planets Space, 65, 1285-1294, 2013.

[2] Amm, O., H. Vanhamäki., K. Kauristie, C. Stolle, F. Christiansen, R. Haagmans, A. Masson, M.G.G.T. Taylor, R. Floberghagen, and C.P. Escoubet, A method to derive maps of ionospheric conductances, currents, and convection from the Swarm multisatellite mission, J. Geophys. Res., 120, doi:10.1002/2014JA020154.