

Maps of ionospheric conductances, currents, and convection from the Swarm multi-satellite mission

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The recently launched ESA Swarm spacecraft mission is the first dedicated multi-satellite ionospheric mission with two low-orbiting spacecraft that are flying in parallel in a distance of ~ 100 km, thus allowing to derive spatial gradients of ionospheric parameters not only along the orbits, but also in the direction perpendicular to them. In addition, a third satellite with a slightly higher orbit regularly crosses the paths of the lower spacecraft pair. Using the Swarm magnetic and electric field instruments, we present a novel technique that allows to derive 2-dimensional (2D) maps of ionospheric conductances, currents, and convection in the area between the trajectories of the two parallel flying spacecraft, and even to some extent outside of it. This technique is based on Spherical Elementary Current Systems (SECS). We present several test cases of modelled ionospheric situations from which we calculate virtual Swarm data, and show that the technique is able to reconstruct the model electric field (or convection), horizontal currents, and conductances with very good to excellent accuracy. Larger errors arise for the reconstruction of the 2D field-aligned currents (FAC) map, especially in the area outside of the spacecraft orbits. However, even in this case the general pattern of the model FAC is recovered, and the magnitudes are valid in an integrated sense. Finally, using an MHD model run, we show how our technique allows to estimate the ionosphere-magnetosphere coupling parameter K , if conjugate multi-point observations of the magnetospheric magnetic and electric field are available, as they can be obtained, e.g., from the ESA Cluster mission.

Keywords: ionosphere, ionospheric electrodynamics, ionospheric currents, ionospheric convection, magnetosphere-ionosphere coupling, Swarm mission