A method to derive maps of ionospheric conductances, currents, and convection from the Swarm multisatellite mission

The European Space Agency (ESA) Swarm spacecraft mission is the first multisatellite ionospheric mission with two low-orbiting spacecraft that are flying in parallel at a distance of ~100–140 km, thus allowing derivation of spatial gradients of ionospheric parameters not only along the orbits but also in the direction perpendicular to them. A third satellite with a higher orbit regularly crosses the paths of the lower spacecraft. Using the Swarm magnetic and electric field instruments, we present a novel technique that allows derivation of two-dimensional (2-D) maps of ionospheric conductances, currents, and electric field in the area between the trajectories of the two lower spacecraft, and even to some extent outside of it. This technique is based on Spherical Elementary Current Systems. We present test cases of modeled situations from which we calculate virtual Swarm data and show that the technique is able to reconstruct the model electric field, horizontal currents, and conductances with a very good accuracy. Larger errors arise for the reconstruction of the 2-D field-aligned currents (FAC), especially in the area outside of the spacecraft orbits. However, even in this case the general pattern of FAC is recovered, and the magnitudes are valid in an integrated sense. Finally, using an MHD model run, we show how our technique allows estimation of the ionosphere-magnetosphere coupling parameter K, if conjugate observations of the magnetospheric magnetic and electric field are available. In the case of a magnetospheric multisatellite mission (e.g., the ESA Cluster mission) several K estimates at nearby points can be generated.

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