

Monitoring of Ionospheric Gradients At SWARM (MIGRAS)

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Abstract:

Swarm satellite observations are able to address a broad spectrum of space weather science. In the MIGRAS project we address a few of the space weather challenges by an innovative approach that fits to existing measurements and observation tools in a complementary way. The suggested new data products focus on monitoring small to mid-scale plasma density irregularities with horizontal spatial scales in the order of about 100 km. The measurements take benefit from the coordinated flight of satellites A and C at an orbit height of about 460 km. The distance between both satellites is in the order of about 100 km and therefore well suited to monitor mid-scale density changes of the electron density between them utilizing Langmuir-probe data. Two new Swarm products developed under MIGRAS project are the total electron content (TEC) Gradient Ionosphere index (TEGIX) and the electron density (NE) Gradient Ionosphere index (NEGIX) derived from TEC and electron density measurements onboard Swarm satellites A and C.

The TEGIX measures spatial TEC gradients in the topside ionosphere (Swarm up to GNSS orbit) using GNSS Precise Orbit Determination (POD) measurements whereas the NEGIX measures the spatial electron density gradients using Langmuir probe measurements. Besides their potential to support applications utilizing trans-ionospheric radio signals, electron density gradients will be used to further explore the mechanism of ionospheric storms. From mathematical point of view, horizontal gradients pronounce spatial structures very clearly, thus being well suited to study dynamic processes in the ionosphere, e.g. during geomagnetic-ionospheric storms. This ground-based picture may be completed by the Swarm products NEGIX and TEGIX that represent different altitude ranges. The comparison helps to learn how strong the different approaches correlate and whether they can be substituted by each other, e.g. to use Swarm products for estimating the perturbation degree of the ionosphere for GNSS operators and customers over oceans. We will present both products and will explore their potential impact, utility, and use through case studies.

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