EGU24-12608, updated on 30 Aug 2024
https://doi.org/10.5194/egusphere-egu24-12608
EGU General Assembly 2024

NeGIX and TEGIX: two new indices to characterize the topside ionosphere with Swarm

Juan Andrés Cahuasquí[1], Mohammed Mainul Hoque[1], Norbert Jakowski[1], Dmytro Vasylyev[1], Stephan Buchert[2], Grzegorz Nykiel[3], Martin Kriegel[1], Paul David[1], Youssef Tagargouste[1], and Jens Berdermann[1]

[1]German Aerospace Center (DLR), Institute for Solar-Terrestrial Physics, Neustrelitz, Germany (andres.cahuasqui@dlr.de)
[2]Swedish Institute of Space Physics (IRF), Uppsala, Sweden
[3]Gdansk University of Technology, Gdansk, Poland

Since its launch in 2013, ESA's Swarm satellite constellation has pushed the frontiers of space weather research and monitoring by means of its broad spectrum of high-quality experiments on-board. Particularly, Swarm observations are being used to globally characterize small- to mid-scale perturbations in the topside ionosphere that may cause severe amplitude and phase scintillations of trans-ionospheric radio signals. Ionospheric scintillation can cause radio signal outage, as well as disruption of modern technological systems used for telecommunication, navigation and remote sensing.

While performing the Swarm DISC project "Monitoring of Ionospheric Gradients at Swarm (MIGRAS)", the MIGRAS team has profited from the close orbits and synchronization of Swarm satellites Alpha (A) and Charlie (C) to develop two new products that focus on the monitoring of small- to mid-scale plasma density irregularities with horizontal spatial scales in the order of about 100 km - the electron density (Ne) Gradient Ionospheric indeX (NeGIX), and the Total Electron Content (TEC) Gradient Ionospheric indeX (TEGIX). NeGIX estimates spatial Ne gradients using Langmuir probe measurements, and TEGIX estimates spatial TEC gradients using GNSS Precise Orbit Determination (POD) data of Swarm.

In this work, we provide a comprehensive analysis of the capability of these two novel Swarm data products to characterize the perturbation state of the ionosphere at different geographic locations and conditions of geomagnetic activity. Our analysis covers the whole period of available Swarm observations to quantitively describe expected signatures of ionospheric variability, e.g. gradients at sunrise and sunset time, or equatorial crests. The analysis concentrates also on events of perturbed geomagnetic conditions to compare the performance of NeGIX and TEGIX with existing ground-based indices (e.g. GIX) and Swarm products (e.g. IPIR). Moreover, these indices have been developed technically compatible with Swarm's and DLR's operational data services. Therefore, our analysis validates and discusses their applicability for space weather science and purposes.

Acknowledgement: The work is funded by the MIGRAS (Monitoring of Ionospheric Gradients At Swarm) project under the Swarm DISC Subcontract Doc. no: SW□CO□DTU□GS□133, Rev: 1, 13

September 2022.