3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Comparison Of Electron Density Fluctuations From Swarm Satellites With The Ground-based Scintillation Data: A Statistical Perspective

Daria S. Kotova* (1), Yaqi Jin (1), Luca Spogli (2), Alan G. Wood (3), Lucilla Alfonsi (2), Jaroslav Urbar (2), Lasse B. N. Clausen (1), Per Høeg (1), and Wojciech J. Miloch(1)
(1) Department of Physics, University of Oslo, Oslo, Norway, e-mail: daria.kotova@fys.uio.no; yaqi.jin@fys.uio.no; lasse.clausen@fys.uio.no; per.hoeg@fys.uio.no; w.j.miloch@fys.uio.no
(2) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy; e-mail: luca.spogli@ingv.it; lucilla.alfonsi@ingv.it; jaroslav.urbar@ingv.it
(3) University of Birmingham, Birmingham, United Kingdom; e-mail: a.wood.1@bham.ac.uk

The Swarm satellite mission is actively used to conduct various studies of the ionosphere, focusing on such aspects as the electric and magnetic fields or plasma temperature, structuring and irregularities. The mission is a constellation of three satellites that were launched in November 2013 and have been collecting data continuously since then. We use a global product based on the Swarm satellite measurements that characterizes ionospheric irregularities and fluctuations. The IPIR (Ionospheric Plasma IRregularities product) provides in-situ characteristics of plasma density structures in the ionosphere, of plasma irregularities in terms of their amplitudes, gradients and spatial scales and assigns them to geomagnetic regions. Ionospheric irregularities and fluctuations are often the cause increases the error in position, velocity, time determination based on Global Navigation Satellite Systems (GNSS), which signals pass through the ionosphere. The IPIR provides an indication, in the form of a numerical value index, on severity of irregularities for the integrity of trans-ionospheric radio signals and hence the accuracy of GNSS precise positioning.

This work demonstrates that data from the Swarm satellite's flyby height can be used as a proxy for ground-based scintillation data. We compare two datasets from Swarm satellites (with 1-second resolution) and from ground-based scintillation receivers (with 1-minute resolution). To consider the measured parameters for the same area, we find time intervals when the Swarm satellites pass over the field of view of the ground-based Global Positioning System (GPS) receiver. A geometry with an elevation angle of 30° above the receiver was used to calculate these passes. We also performed an azimuthal selection of the GNSS data according to Swarm satellite fly. We used only those GPS satellites that flew near the position of the Swarm satellite in azimuth sector ±10°. We provide validations of the IPIR product against the ground-based measurements, focusing on GPS TEC and scintillation data in low and high-latitudes regions in different longitudinal sectors. We calculate median, mean, maximum and standard deviation values for parameters for both dataset for each conjunction point (for each GPS satellite and Swarm). We observe a weak trend of stronger scintillations with an increasing IPIR index, where the IPIR index presents a product of amplitudes and temporal variations in plasma densities.

This work was supported by the Research Council of Norway grant number 267408, 275655 and it is a part of the 4DSpace Strategic Research Initiative at the University of Oslo. WJM also acknowledges funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (ERC Consolidator Grant agreement No. 866357, POLAR-4DSpace). The Swarm IPIR data set can be accessed through http://tid.uio.no/plasma/swarm/IPIR_cdf/ and also from ESA Swarm website.