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Global Study of Ionospheric Plasma Irregularities with Swarm Satellites

Wojciech MILOCH[1#+], Yaqi JIN[1], Chao XIONG[2], Andres SPICHER[1], Guram KERVALISHVILI[2], Lasse CLAUSEN[1], Claudia STOLLE[2]

[1]University of Oslo, Norway, *[2]Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Germany*

The Earth's ionosphere is often subject to instabilities and turbulence creating irregularities in plasma density at various scales and at all latitudes. Plasma density irregularities are one of the space weather effects, as they depend on the geomagnetic activity and can influence propagation of trans-ionospheric radio waves. Their quality is crucial for positioning with the Global Navigation Satellite Systems (GNSS), such as GPS, Galileo, BeiDou or GLONASS. Examples of measurable effects are radio wave scintillations in the phase and amplitude, which are significant issues at low geomagnetic latitudes and in the polar regions. Thus, a comprehensive characterization of ionospheric irregularities over all geomagnetic latitudes is vital for both research and operations that rely on trans-ionospheric radio waves. To study and characterize plasma irregularities at all latitudes, one can employ in-situ measurements by satellites in polar orbits, such as the European Space Agency's Swarm mission. For the Swarm mission, we have developed the Ionospheric Plasma IRregularities (IPIR) product for a global characterisation of ionospheric irregularities along the whole satellite track. This new Level-2 data product combines complementary datasets from the Swarm satellites, i.e. the electron density from the electric field instrument, the GPS data from the onboard GPS receiver, and the magnetic data. The data product is a new tool for the global studies of ionospheric irregularities and turbulence. In this work, we present the first dataset of the IPIR-product. We analyse the results together with the measurements from the ground-based scintillation receivers. Satellite in-situ data combined with the ground-based observations can provide better understanding of the phenomena associated with the largest disturbances of the GNSS signals. The development has been carried out within the framework Swarm-DISC, Data, Innovation and Science Cluster consortium.