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Variability of ionospheric plasma studied and modelled based on data from the Swarm satellites

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The state of the Earth's ionosphere is an important aspect of the Sun-Earth system. It reflects dynamical coupling of the solar wind with the Earth's magnetosphere. Its understanding has also an applied aspect in the context of the space weather effects. For example, ionospheric plasma irregularities impact the propagation of radio waves, and they can degrade radio communication or positioning with the Global Navigation Satellite Systems (GNSS). The European Space Agency's Swarm+ 4DIonosphere initiative aims at advancing our understanding and characterisation of the processes in the ionosphere to better model and eventually predict the state of the ionosphere. Within this framework, through the project "Swarm Variability of Ionospheric Plasma" (Swarm-VIP), we analyse spatiotemporal characteristics of ionospheric plasma at different geomagnetic latitudes and uncover coupling between various scales in the ionosphere. Taking advantage of the orbital characteristics of the Swarm satellites and using complementary analysis techniques, such as wavelets or Fast Iterative Filtering, we ascertain the dominant scales at given geomagnetic conditions. The result of the study is a semi-empiric model of the ionosphere based on the generalised linear modeling approach. The model determines the probability of occurrence of different scales in ionospheric plasma with respect to geomagnetic conditions. It also gives insight into ionospheric structuring and related space weather effects. The Swarm-VIP model is provided globally, along the whole orbits of the Swarm satellites, and a special emphasis is put on the polar regions, Arctic and Antarctica, and the European sector, where the validation study is carried out with a network of the ground-based instruments.