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Quasi real-time monitoring of the ionosphere plasma irregularities by the records of the Swarm mission

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The magnetic and plasma observations of Low-Earth orbit (LEO) space missions represent not only the dynamical state of the ionosphere but also the physical variations of its electromagnetically connected surroundings, i.e. of the plasmasphere and magnetosphere, as well as of their driver, the solar wind. The monitoring of the ionosphere plasma variables is therefore a big asset for the study of our space environment in broad spatial region. Within the framework of the EPHEMERIS project supported by ESA, we aim at investigating two ionosphere phenomena that exhibit close relationship to global physical processes and space weather activity. We use the magnetic and plasma records of the LEO Swarm mission. First, we investigate the temporal and spatial occurrences of the mid-latitude ionosphere trough (MIT), a typical feature of the topside sub-auroral ionosphere appearing as a few degree wide depleted zone, where electron density (Ne) drops by orders of magnitude. It is shown that the locations of MITs are excellent proxies for the detection of the plasmapause position as well as of the equatorward edge of the auroral oval. Secondly, we monitor the irregular fluctuations of the magnetic field along the Swarm orbits via their intermittent behaviour. A new index called intermittency index (IMI) is introduced for the quantitative exemplification of the spatial and temporal distribution of irregular variations at the Swarm spacecraft altitudes. The paper focuses on the introduction of the methodology of IMI time-series compilation. Since IMIs are deduced via a statistical approach, we use the 50 Hz sampling frequency magnetic field records of the mission. We show that most frequently, the ionosphere magnetic field irregularities occur at low-latitudes, about the dip equator and at high latitudes, around the auroral region. It is conjectured that the equatorial events are the results of equatorial spread F (ESF) or equatorial plasma bubble (EPB) phenomena, while the auroral irregularities are related to field-aligned currents (FAC). The ionosphere plasma irregularities may result in the distortion or loss of GPS signals. Therefore our analysis also concerns the investigation of the correlation between observed intermittent events in the ionosphere and contemporary GPS signal loss events and scintillations detected both by on-board Swarm GPS receivers and ground GNSS stations.