EGU22-9366
https://doi.org/10.5194/egusphere-egu22-9366
EGU General Assembly 2022

Statistical Study of Decameter Scale Plasma Irregularities in the Polar Ionosphere

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The polar ionosphere is often highly irregular and turbulent with significant plasma structures. As a result, the satellite-based navigation and communication systems that rely on trans-ionospheric radio signals can be severely disrupted. In this study, we take advantage of the high-resolution (1 kHz) electron density observations of a polar orbiting satellite (NorSat-1) to address plasma structures at several 10s of meters that are responsible for scattering of High Frequency (HF) radar signals. The in-situ electron density data are taken from the winter season of 2017-2018. Though the solar activity is very low, NorSat-1 frequently observes significant plasma irregularities from several 10s km down to several decameter. These are often observed near the dayside cusp and dawnside auroral zone. The decameter-scale irregularities are positively correlated with intermediate-scale (10 km) density gradients, for both negative and positive gradients encountered by the satellite. The spatial distribution of electron density over two winter months in the Northern hemisphere along NorSat-1 orbits is constructed, which shows significant density increases in the cusp ionosphere (75°-80° MLAT) and in regions near the dawnside auroral oval. Intermediate scale density gradients and small-scale irregularities are clearly collocated with these density enhancements. These density enhancements and irregularities are likely induced by auroral particle precipitation/plasma dynamics. The power of decameter scale irregularities is also directly compared with the backscatter echo of HF radars.