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# Estimate of plasma structures inducing TEC fluctuations on GPS signals in the European auroral sector by using EISCAT/ESR radars

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The global demand for products and services using Global Navigation Satellite System (GNSS) is continuously increasing in the modern society. However, GNSS-based technologies experience disruption of service and outages during adverse ionospheric conditions. Plasma gradients forming in the ionosphere over large-to-small scales during adverse space weather conditions introduce signals and services disruptions in terms of scintillation and temporal fluctuations in the Total Electron Content (TEC). The presence of plasma gradients can limit the GNSS receiver tracking capability and therefore degrades the positioning and timing accuracy. In the particular case of magnetic auroral latitudes, ionospheric gradients originate from particle precipitation and are associated with disruption of GNSS services. These disruptions are a consequence of the coupling between link geometry and propagation through specific plasma structures. An experiment was designed in order to appreciate and model such a propagation problem by combining measurements from EISCAT/ESR radars and geodetic GNSS receivers. The objective of the experiment was to estimate the ionisation structures responsible for TEC fluctuations on GPS signals in the auroral ionosphere by means of EISCAT/ESR electron density profiles. To achieve this, a multi-instrument approach experiment was designed to estimate the electron density gradients across a given GNSS ray path between 20:00 and 24:00 UT on several days in March 2018. The electron density structures were analysed by means of radar electron density profiles measured from Tromsø/Longyearbyen in combination with GNSS ray paths measured from an International GNSS Service (IGS) station in Kiruna/Ny Ålesund respectively. The main point of the experiment was to relate plasma structures in phase screens across specific GPS ray paths to TEC temporal fluctuations observed along these GPS ray paths. For example, the ionisation structures forming after particle precipitation were associated with enhanced GPS TEC temporal fluctuations. In this experiment, the radar electron density profiles and the GPS TEC fluctuations are used to infer the origin of the observed signature on the GPS signals from large-scale ionisation structures in the E and F regions during the time of observation. This contribution will discuss methodology and results of such an experiment, together with appreciation of the impact on positioning. The results will assist in the design of robust GNSS receivers and positioning algorithm for enhanced performance and reliability.