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Modelling large-scale structures in the high-latitude ionosphere using 15 years of data from the EISCAT Svalbard Radar

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The ionosphere is a highly complex plasma containing electron density structures with a wide range of spatial scale sizes. Large-scale structures with horizontal extents of tens to hundreds of km exhibit variation with time of day, season, solar cycle, geomagnetic activity, solar wind conditions, and location. Whilst the processes driving these large-scale structures are well understood, the relative importance of these driving processes is a fundamental, unanswered question. The large-scale structures can also cause smaller-scale irregularities that arise due to instability processes such as the gradient drift instability (GDI) and turbulence. These smaller scale structures can disrupt trans-ionospheric radio signals, including those used by Global Navigation Satellite Systems (GNSS).

Statistical modelling techniques have been used to generate models of various measures of large-scale plasma structuring in the high-latitude ionosphere using 15 years of data gathered by the EISCAT Svalbard Radar. These models quantify the relative importance of the dominant driving processes in four time sectors (noon, dusk, midnight and dawn). In every sector the dominant process is the seasonal variation, and this difference is attributed to both the variation in the chemical composition of the atmosphere and the maintenance of the background ionosphere by photoionization in summer. Secondary processes vary with time sector, but include variations with the solar cycle, geomagnetic activity, and the strength, orientation and variation of the Interplanetary Magnetic Field. Geophysical variables are used as proxies for these physical processes. As data for the geophysical variables selected are available in real time, these models have the potential to make real time predictions of the amount of plasma structuring in the ionosphere for GNSS applications.