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Quantifying the interaction of the neutral atmosphere and the ionosphere at high-latitudes during polar darkness

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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 dependence of these plasma structures on the neutral atmosphere has never been fully established, despite the well-understood ionosphere-neutral coupling mechanism. The neutral atmosphere influences the vertical dynamics of the atmosphere which, in turn, alters the density profile of the thermosphere and hence the lifetime of the plasma density structures.

The EISCAT (European Incoherent Scatter) Svalbard Radar is approximately collocated with UCL's Fabry-Perot Interferometer (FPI). Ionospheric observations from EISCAT are compared to neutral temperature and wind data from the FPI, as well as proxies for the geophysical conditions. The technique of Generalised Linear Modeling (GLM) is employed to account for the many different system variables involved in this complex relationship. GLMs as functions of ionospheric and geophysical terms produce statistically significant correlations with observations of the neutral atmosphere, particularly the temperature. Mechanisms to explain these results are discussed.

A number of small, but statistically significant, correlations between geophysical parameters and neutral atmosphere temperatures are also found, and the implication of these is discussed.