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Ionospheric plasma irregularities in relation to dynamic auroral forms

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Auroral particle precipitation potentially plays a main role in ionospheric plasma structuring. The impact of particle precipitation on plasma structuring are investigated using multi point measurements from scintillation receivers and all sky imagers on Svalbard. This provides us with the unique possibility of studying the auroral dynamics in a spatial and temporal evolution.

We consider three substorm events to investigate how auroral forms impact on transionospheric radio waves. It is observed that elevated phase scintillation indices correspond best to the spatial and temporal evolution of auroral forms when both projected to the estimated green emissions altitude (150 km). This suggests that plasma structuring in the ionospheric E-region is an important driver for phase scintillations.

We demonstrate that plasma structuring impacting the GNSS signals is largest at the edges of the auroral forms. Studying an arc in detail, only poleward edges are associated with elevated phase scintillation indices, whereas for auroral spiral and band the structuring is attributed to all boundaries. There is a time delay (1-2 min) shown for the temporal evolution of aurora (e.g., commencement and fading of auroral activity) and elevated phase scintillation index measurements. This can be due to the intense influx of particles, which increase the plasma density and cause the recombination to carry on longer, which may lead to a memory effect. The irregularities and instabilities causing the elevated phase scintillation indices especially in the E-region may be due to e.g., field-aligned currents, Kelvin-Helmholtz instability or Farley-Buneman instability. The auroral fine structure and forms may be controlled by kinetic instabilities, such as Alvén waves, acoustic waves. The nature of the effects is studied using the ionospheric-free linear combination to understand whether this is a refractive or diffractive effect. This study can contribute to the development of models of ionospheric plasma irregularities and related space weather effects in the polar regions.