Formation of finger-like structure along the edge of polar patch: two-dimensional numerical simulations and ESR observations

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Polar patches, which are regions of dense electron density in the polar cap F region ionosphere, have been frequently observed during southward interplanetary magnetic field (IMF) conditions. One of the interesting subjects in the studies of polar patches is their fine-scale structure. Recently, finger-like structures along the trailing edges of polar patches have been detected by using all-sky airglow imagers. Previous studies proposed that the finger-like structures are generated through the gradient drift instability (GDI). In those papers, it was further suggested that the GDI should make the density gradient across the trailing edge less steep due to interchange stirring of plasma. As a result, there should exist an asymmetry in the gradient between the leading edge and trailing edge of patches. To confirm these hypotheses, we have performed a two-dimensional numerical simulation of polar cap patches.

In the simulation, electric field of 50 mV/m and geomagnetic field of 50000 nT were employed as background conditions. Under the conditions, finger-like structures having 10 km scale-size appeared along the trailing edge of patches, and then the gradient in the leading edge was much steeper than that in the trailing edge. We also found that the Pederson conductivity significantly contributed to the production of the finger-like structures. In order to verify these simulation results, it is necessary to confirm whether the simulation conditions (e.g., Pederson conductivity, primary electric field, and gradient in the plasma density) were reasonable.

In this presentation, we will show these simulation results and comparison of simulation condition with the Pederson conductivity, electric field, and gradient in the plasma density observed by EISCAT Svalbard radar (ESR) operative in Longyearbyen.