Gradient drift instability in the trailing edge of polar patches

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Polar patches, which are regions of high electron density in the polar cap F region ionosphere, are frequently observed during southward interplanetary magnetic field (IMF) conditions. Recently, finger-like structures along the trailing edges of polar patches have been detected by using all-sky airglow imagers. The observed its growth rate and spatial scale is approximately 300 s (~3×10^{-3} s^{-1}) and 100 km, respectively. Previous studies indicated that the gradient drift instability (GDI) plays an important role for the generation of the finger-like structure. However there are few studies that evaluate this hypothesis quantitatively based on observational and theoretical approaches. In this study, we derived the linear growth rate of GDI for cases of polar patches observed by the EISCAT Svalbard radar (ESR). We also performed a two-dimensional numerical simulation of polar cap patches to obtain linear growth rate for a typical polar cap patch. The estimated linear growth rates are 10-3 s-1 for polar patches observed by ESR. The numerical simulation showed that the linear growth rate is approximately 10^{-3} s^{-1}. This good agreement indicates that GDI is regarded as the dominant mechanism of the generation of the finger-like structure.
The linear growth rate used in above calculations depends only on the electron density gradient and electric field but does not depend on wave number. As a result, it cannot explain the appearance of the finger-like structure which has a particular scale size, namely ~100km. We found the difference in predominant finger scales which were seen in the numerical simulation calculated with changing the Pedersen conductivity. This result implies that the ion-neutral collision frequency strongly contributes to generation of predominant finger scale. Therefore, we developed the linear growth rate involving the finger scale calculated with the ion collision frequency. The growth rate suggested that the growth of large scale structure (<1000 km) is suppressed in the lower F region.
In this presentation, we will show these simulation results and observation results.

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