Spontaneous formation and nonlinear evolution of auroral fine structures driven by the feedback instability in magnetosphere-ionosphere coupling

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Feedback instability is one of the possible mechanisms explaining spontaneous formation of auroral structures in the magnetosphere-ionosphere (M-I) coupling system. Previous studies on auroral growth through the feedback instability have primarily focused on global characteristics of arc-like structures that extend in the east-west direction. Local simulations using a slab geometry demonstrated spontaneous formation of curl-like fine structures - generated by the Kelvin-Helmholtz (K-H) instability triggered by enhanced **E ×B** flow shear - and a transition to a turbulence driven by Alfvén waves. However, global properties of auroral fine structure formation have not been sufficiently discussed.
In this study, we perform nonlinear simulations of auroral growth through the feedback instability in the dipole field under two conditions with different polarities of the latitudinal electric field. The simulation results have revealed that curl-like fine structures are formed through the K-H type instability in a nonlinear stage of the feedback instability growth. In both cases, auroral structures with ionospheric density enhancement undergo counterclockwise distortion due to vorticity fluctuations behind the density increase. In the nonlinear phase, non-uniform viscosity, of which magnitude depends on the background magnetic field strength, plays a significant role in the dissipation of fine structures, where stronger dissipation effect appears at higher latitude. As a result, energy spectrum of the Alfven waves in the magnetosphere becomes steeper at the higher latitude.
In the session, we will also discuss introduction of a non-uniform background electric field into the numerical simulations.

Keywords: Aurora, Alfvén wave

