Simulation of auroral turbulence driven in feedback M-I coupling system

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Formation and dynamics of auroras in the polar ionosphere are considered as a visible footprint the magnetosphere-ionosphere (M-I) coupling. However, it is not a simple projection of the magnetospheric dynamics onto the ionosphere, but is a result of interactions between the two different plasma media, that is, the magnetospheric and ionospheric plasmas.

The feedback instability has been discussed as a possible mechanism explaining spontaneous growth of an auroral arc structure in a quiescent phase of geomagnetic activities [1]. By means of a reduced magnetohydrodynamic (MHD) simulation, a nonlinear evolution of the feedback instability has been investigated in a slab model of the M-I coupling system, where strong deformation of the auroral structure leads to roll-up of auroral vorticities [2]. A fully nonlinear evolution of the feedback instability has also been studied by means of the reduced MHD simulations with the spectral method, showing destabilization of the secondary instability of the Kelvin-Helmholtz (K-H) type mode along the auroral arc structure [3]. The secondary K-H instability leads to transition to the MHD (or Alfvenic) turbulence [3].

In the present simulation study, we discuss a recent extension of the auroral turbulence driven by the feedback instability. The M-I coupling simulations with higher resolution both in the parallel and perpendicular directions to the background magnetic field have shown a clear power law scaling of the energy spectrum close to $k_\perp^{-5/3}$. It is noteworthy that the upward and downward propagating shear Alfven waves collide to each other in the M-I coupling system, leading to the turbulence transition. This dynamical transition process is self-consistently included in the feedback M-I coupling model. In our more recent work, we elaborate to extend the model geometry and to introduce the gyro-viscosity as well as more detailed analysis of the turbulence in the magnetosphere and in the ionosphere.

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References

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