

drivers of the magnetospheric convection

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We present here the role of the plasma bulk flow in generation of the magnetosphere-ionosphere convection. Traditionally, the magnetospheric convection is studied with the perpendicular flow because this flow is equivalent with the speed of migration of the magnetic field. For example, the perpendicular force balance equations are utilized in discussion of the dynamo generation ($E \cdot J < 0$) in the cusp-mantle region [Tanaka, 1995]. However, since the plasma kinetic energy flux and the internal energy flux are transported along the plasma bulk flow, it is evident that the plasma bulk flow should be considered in generation of the magnetospheric convection. In

addition, the global MHD simulation reveals that the plasmas are accelerated into the cusp from the magnetosheath along the magnetic field. Thus, the plasma bulk flow transports energy into the magnetosphere.

At first, we discuss the dynamo in the cusp-mantle region based on the full set of physical principles (mass conservation, momentum conservation, and energy conservation). As a result, the load in the lower-latitude side of the cusp is invoked by plasma compression due to sudden deceleration of the field-aligned flow from the magnetosheath. The adiabatic assumption invokes pressure enhancement associated with plasma compression. Thus, energy should be supplied to compensate increase in the plasma pressure. As the kinetic energy is much smaller than the electromagnetic energy in the magnetosphere, the electromagnetic energy is converted to the thermal energy. Therefore, the load appears in the lower-latitude side of the cusp. On the other hand, in the cusp-mantle region, plasmas are squeezed with the field-aligned flow toward the lobe region. This yields plasma rarefaction, which eventually invokes energy conversion from the thermal energy to the electromagnetic energy. Thus, the dynamo appears. This process is also explained in terms of the slow mode expansion fan in the cusp-mantle region.

Next, we define an unique magnetospheric energy convection in the dayside magnetosphere. It is noted that the Poynting flux activated in the cusp-mantle region is transported across the dayside magnetosphere to the dayside magnetopause. The electromagnetic energy is totally deposited here. The deposited electromagnetic energy is converted into the thermal energy in the magnetopause. Then we need a mechanism of transporting this thermal energy elsewhere. The MHD simulation shows the thermal energy and the high-speed solar-wind kinetic energy are transported into the cusp from the magnetosheath. This flow goes to the mantle region. Then, the thermal energy transported from the magnetosheath via the cusp is partially converted into the electromagnetic energy in the cusp-mantle region. Finally, the loop of energy convection is completed.

The magnetospheric energy convection is unique because the energy convection and the mass convection show quite different behavior. On the other hand, in the normal fluid like the atmosphere, the energy convection is related to the mass convection in the atmospheric global circulation (convection).

Keywords: magnetospheric convection, MHD simulation, bulk flow, energy conversion, magnetospheric energy convection, cusp dynamo