磁気圏電離圏対流生成機構

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The mechanism driving the magnetosphere-ionosphere convection

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We present a new idea about the driver of the magnetosphere-ionosphere convection. Traditionally, the magnetospheric convection was regarded to be driven by the tension force derived from the dayside reconnection [Dungey, 1961; Hughes, 1995]. This idea has been widely accepted by many scientists. The epoch-making paper discussing the magnetosphere-ionosphere compound system [Tanaka, 2003] did not clearly manifest the driver of the convection. It has been passed a half-century since Dungey [1961] proposed the convection model based on a simplified two-dimensional configuration. It is the time when we should re-consider the old idea in the three-dimensional configuration with the realistic global MHD simulation.

First, we need to understand the three-dimensional topology of the magnetic field merging in the dayside magnetosheath under the obliquely southward IMF condition. The global simulation presents the null-separator structure [Watanabe et al, 2005] for the merging. When the IMF enters the magnetosheath in the northern to the separator line, the null in the northern hemisphere makes an open field line bending in the dayside magnetosheath. This field line drives the Lorentz force in the magnetosheath which confines the high-pressure plasmas in the cusp. The other null point in the southern hemisphere induces the field-aligned acceleration of the plasma flow in the low-altitude magnetosheath in the vicinity of the entry layer of the cusp. This null point works to yield the magnetic field erosion from the dayside magnetosphere to the nightside one.

Second, we can confirm that the magnetic tension force associated with the bending open field line does not affect the plasma dynamics in the magnetosphere from the simulation result. This fact indicates that the simulation does not support Dungey's idea. From further analysis of the simulation results, we notice that the field-aligned flow into the cusp from the magnetosheath can be converted to the field-perpendicular flow if there is a curvature of the magnetic field line. Indeed, the conversion is the most effective in the region of the larger magnetic field curvature. We also confirm the Alfven wave is emitted from the conversion region. Namely, the momentum of the magnetospheric convection enters into the magnetosphere along the eroded field line. As summary, the solar wind flow enters the magnetosheath and accelerated along the field line in the low-altitude magnetosheath in front of the cusp. Then, the plasmas flow guided to the cusp along the magnetic field is converted to the field-perpendicular flow (the convection flow) in the region with larger magnetic field curvature.

References

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