

Constitution of sources and mechanisms for the region 2 field-aligned currents

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1. Introduction

Field-aligned currents (FACs) flow along magnetic field lines between the ionosphere and the magnetosphere. In the ionosphere large-scale FACs reside in an annulus that encircle the geomagnetic pole. FACs located on the poleward side are called 'region 1', while FACs located on the equatorward side are called 'region 2'. Region 1 FACs are thought to be closed on the dayside, while region 2 FACs are thought to be closed on the nightside. Region 2 FACs are considered to be driven by the pressure gradient of the ring current region or inner edge of the plasma sheet. In order to drive FACs constantly, there must be a region where $\mathbf{j} \cdot \mathbf{E}$ is negative. To investigate the sources of region 2 field-aligned currents, we perform global MHD simulation and examine the dynamo processes in the magnetosphere.

2. Simulation results

We calculated a quasi-stationary magnetosphere with the following solar wind parameters $B_x=0\text{nT}$, $B_y=4.9\text{nT}$, $B_z=-1.0\text{nT}$, $n=10/\text{cc}$, $V_x=370\text{km/s}$. We obtained a typical pattern of the region 1 / region 2 FACs. Tracing the stream lines of region 2 FACs, we found that region 2 FACs were closed not only on the nightside but also on the dayside. This is a new discovery. On the nightside, region 2 currents were closed in the ring current region. In the midnight region, these currents flow above or below the equator and wrap the surface of the high-pressure region in the plasma sheet. In this region, $\mathbf{j} \cdot \mathbf{E}$ is positive. In contrast, in the magnetic local time sectors away from the midnight (18:00-21:00, 02:00-06:00), $\mathbf{j} \cdot \mathbf{E}$ is negative. On the dayside, on the other hand, the closure path is located on the low-latitude side of the cusp with $\mathbf{j} \cdot \mathbf{E}$ is positive in the midday region, and, $\mathbf{j} \cdot \mathbf{E}$ is negative in the magnetic local time sectors away from noon (=10:00, 15:00-17:00). This structure is very similar to the region 2 FAC system on the nightside.

3. Conclusion

We found that the region 2 FACs were closed on the dayside in quasi-stationary magnetosphere. This is a new discovery. Dayside region 2 FACs are driven by the pressure gradient and their energy source is the thermal energy of the plasma. This mechanism is similar to the one on the nightside. The dayside cusp is essential for the generation of dayside region 2 FACs, just like the ring current for nightside region 2 FACs.