

3D-Cowling Channel Model in the Sq Current System

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Cowling channel formation mechanism in the 3D-Sq current system using two-current layer model of Hall and Pedersen current is proposed.

In the earth's ionosphere, formation of Cowling channel is quite universal phenomena in which a continuity of Hall current generated by the magnetospheric or atmospheric dynamo is broken. In the high-latitude regions, horizontal gradient of Hall conductance becomes a necessary condition for Cowling channel formation and vertical gradient of Hall conductance also becomes important in the low and mid-latitude regions. Although generation mechanism of Cowling channel is different between the high latitude region and the low-mid latitude regions, their primary structure and energy circulation role has following universality:

(1) The Cowling channel is essentially formed by the upper Pedersen current layer and lower Hall current layer, which are connected through a field-aligned current. The channel is composed of a pair of two current systems; one is 3D-Cowling current directly coupled to the dynamo region and the other is 3D-meridional current, which encircles Cowling current system.

(2) For preserving the Cowling channel, the Cowling current system absorbs electromagnetic energy from generator and supplies holding energy of meridional current system. In each current system, Pedersen current layer becomes an energy sink, while Hall current layer acts as an energy sink in the Cowling current system and as an energy source in the meridional current system.

(3) Connection between Pedersen current layer and Hall current layer through the field-aligned current is indispensable condition for describing Poynting vector between energy sources and energy sinks.

In this paper, we will show that in addition to the well-known substorm-auroral electrojet and equatorial electrojet, Sq-current system in the low and mid latitude ionosphere is also a result of formation of Cowling system.