Transmission Line Model of the Magnetosphere-Ionosphere Coupling

Takashi Kikuchi[1]

[1] Communications Res. Lab.

When the dayside reconnection is enhanced by the southward interplanetary magnetic field (IMF), the Region-1 field-aligned currents (R1 FACs) are generated around the cusp, driving the plasma convection in the magnetosphere and ionosphere [1]. Magnetometer and SuperDARN observations provided evidence of the instantaneous reaction of ionospheric convection on the dayside and nightside [2][3]. The companion paper (Hashimoto and Kikuchi, this meeting) demonstrates that the magnetic signatures of the plasmasheet thinning at the geosynchronous orbit developed concurrently with the growth of the ionospheric convection. They further reveal that the partial ring currents developed several minutes after the growth of the ionospheric convection [4]. All these observational facts suggest that the convection electric field generated in the cusp propagated to the nightside inner magnetosphere through the ionosphere.

The purpose of this paper is to examine the propagation of the convection electric field from the generator to the nightside ionosphere and magnetosphere by applying a transmission line model. The transmission line model consists of the generator around the cusp, R1 FACs, earth-ionosphere waveguide [5][6] and the closed field lines in the inner magnetosphere. We first examine the electric potential at the ionosphere by assuming a unit strength electric potential in the generator, 2000 km/s for the Alfvén speed and variable ionospheric conductance. The electric potential at the ionosphere grows to the unit strength with a time lag of about 10 min depending on the ratio between the Alfvén conductance and the ionospheric conductance. The electric potential can be transmitted to the nightside ionosphere through the earth-ionosphere waveguide as proposed by Kikuchi et al. [5][6]. We next apply the transmission line model to the propagation of the ionospheric potential to the inner magnetosphere. As a result, the magnetospheric convection follows the ionospheric convection with no significant time lag, when the ionospheric conductance is greater than the Alfvén conductance. We also discuss the propagation of the ionospheric electric field produced by the inhomogeneity of the ionospheric conductivity.

Reference

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