Cowling conductance estimated from the equatorial electrojet and midlatitude ionospheric drift velocity during the Halloween storm PC5 events

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During the stormtime PC5 magnetic pulsations on 31 October 2003, we detected large amplitude oscillations in the ionospheric drift velocity with the HF Doppler sounder at midlatitude for 10 hours from 11 to 21 MLT. We estimated the electric field (E) from the HF Doppler frequency (HFD) under an assumption that the vertical motion of the reflection height is caused by the ExB drift of the ionospheric plasma. Similar oscillations were recorded on the magnetometer data at high-to-equatorial latitudes with significant amplitude enhancement at the dayside equator. We estimated the equatorial electrojet (EEJ) as a deflection of the equatorial PC5 from the low latitude PC5 and found that the midlatitude E is well correlated with the EEJ with correlation coefficients (0.80-0.95) calculated in each 60-min time interval over the 10 hour period, suggesting that the midlatitude E is associated with the ionospheric currents transmitted from high latitude to the equator. Taking the geometrical attenuation of the transmitted electric field into the estimation of the electric field at the equator, we estimated the ionospheric conductance enhanced by the Cowling effect at the equator as ranging from 140 mho at 11 MLT, 50 mho at 16 MLT, and 3 mho in the night after 18 MLT. The conductance depends on the solar zenith angle in a function of $\cos^{0.6}$(zenith angle), roughly matching the Chapman layer formation due to the solar radiation. It is remarkable that the nighttime Cowling conductance is large enough to drive the EEJ with the transmitted electric field, although the magnetic effects of the nighttime EEJ are overcome by the PC5 propagated directly from the magnetosphere. We point out that the usage of the PC5 enables us to obtain the LT/solar zenith angle dependence of the ionospheric conductivity and to improve the capability of the HFD which would be less sensitive to longer period disturbances such as the DP2, substorms and so on.

Keywords: Cowling conductance, PC5 magnetic pulsation, equatorial electrojet, ionospheric electric field, Halloween storm event

