Quantitative relationship between Mid-latitude ionospheric ExB drift and equatorial electrojet as a function of solar zenith angle

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In order to estimate the penetration electric fields in the mid-latitude ionosphere from the equatorial electrojet (EEJ), we analyzed stormtime global Pc5 magnetic pulsations. During the recovery phase of the geomagnetic storm on 31 October 2003, the HF Doppler sounder detected large amplitude oscillations in the ionospheric electric field at mid-latitude (Oarai and Sugadaira, Japan) over 10 hours from 11 to 21 LT. Prolonged excitation of Pc5 pulsations were recorded on the magnetometer data at high-to-equatorial latitudes with significant amplitude enhancement at the dayside equator. We deduced the EEJ by subtracting the low latitude Pc5 (Okinawa) from the equatorial Pc5 (Yap) and found that the ExB drift velocity (Vvert) in the mid-latitude is well correlated with the EEJ with correlation coefficients of 0.80-0.95 and that the EEJ to Vvert ratio reached maximum at 11 LT and dramatically decreased until 18 LT as a function of cos(solar zenith angle) for the zenith angle less than 92 degrees. The quantitative relationship is evaluated by estimating the root mean square error of 2.5 m/s for afternoon sector and 1.8 m/s for dusk sector, which is small enough compared to the observed Vvert of 15-40 m/s. On the other hand, the electric field at mid-latitude is well correlated with the EEJ even during the night after 19 LT (zenith angle > 100 degrees), showing that the EEJ to mid-latitude Vvert ratio is almost constant, on average 1.65. This result indicates that the Pc5 electric field is so strong as to drive equatorial electrojet in the nighttime ionosphere. By applying the quantitative relationship to other longitudes, such as Sao Luis in Brazil, Addis Ababa in Ethiopia, we estimated a local time distribution of the electric field at the mid-latitude and obtained the day-night asymmetry of the electric field.

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