Similarity between the atmospheric electric field variation and Sq variation

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The vertical atmospheric electric field variations depend on the state of the global circuit. Atmospheric electric field variations are mainly affected by the worldwide thunderstorm activity. Geomagnetic phenomena can also influence the downward atmospheric electric field (Ez) through ionospheric disturbances [e.g., Kleimenova, 2008]. The daily geomagnetic field variations (Sq variations) are mainly caused by electric field currents flowing in the E region of the ionosphere. Therefore, it is likely that Sq variations are relevant to Ez variations.

We analyzed Ez, and ground magnetic field data X (northward component) and Y (eastward component) at KAK station (G.G. Lat.: 36.2 N, G.G. Lon.: 140.2 E) during 2006 - 2014. The data was provided by the Kakioka Magnetic Observatory of the Japan Meteorological Agency. In here, we adopt the same definition for Sq amplitudes as defined by Yamazaki et al. [2010]. The daily amplitude of the Sq variation is derived by subtracting nighttime X values (22-24 LT and 00-02 LT) from daytime X values (peak time in LT) . Similarly, we calculated the Y values and daily Ez variation. The daytime Ez values were selected at the time when X values peak in daytime.

The Sq variations in X and Y, and Ez variations show annual variations with minimum (maximum) peaks in winter (summer). The seasonal variation of Ez is more similar with X than Y. Variations of X and Ez show a maximum peak during summer and minimum peak in winter almost at the same time. A clear semi-annual variation of X is seen in April and October, but such variation is not clear in Ez.

Based on the results, we conclude that Ez is affected by the ionospheric conductivity as same as the case of X. The semi-annual variations are not seen in Ez but seen in H. Thus, the ionospheric winds responsible for the semi-annual variations do not affect Ez.