Response of atmospheric electric fields to cloud parameters using a field mill and 95-GHz cloud radar FALCON-I

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It is known that lightning and precipitations of rain droplets generated from thunderclouds are the generator of global atmospheric electric circuit. In the fair weather, the atmospheric electric fields (AEF) are downward (positive), while they are upward (negative) during lightning and precipitations. However, the correlations between the AEF, and the cloud parameters such as cloud cover, weather phenomenon, have been not yet revealed quantitatively. In this study, we investigate the correlations between the AEF and the cloud parameters, weather phenomenon such like lightning and snow using a field mill, the 95 GHz-FALCON (FMCW Radar for Cloud Observations)-I and all-sky camera observations.
In this study, we installed a Boltek field mill on the roof of Engineering Research Building-2 in Chiba University, Japan, (Geographic coordinate: 35.63 degree N, 140.10 degree E, the sea level: 55 m) on the first June, 2016 to observe the AEF. The sampling time of the AEF is 0.5 s and the voltage range is ±20 kV/m. On the other hand, the FALCON-I has been originally developed by our group, and has observed the cloud parameters throughout 24 hours every day. The vertical cloud profiles and the Doppler velocity of cloud particles can be derived by the FALCON-I with high spatial resolutions (48.8 m). In addition, the images of the clouds and precipitations are recorded with 30-s sampling by an all-sky camera using a CCD camera on the same roof during 05:00-22:00 LT every day. The distance between the field mill and the all-sky camera is 3.75 m, while the distance between the field mill and the FALCON-I is 76 m.
We developed the automatic procedure to estimate the cloud cover from cloud optical images using the RGB color values. We estimated the correlation between the AEF and the cloud cover during 05:00 LT – 22:00 LT, June - November, 2016. The AEF decreased with increasing the cloud cover. The standard deviation of AEF was small when the cloud cover increased.
During 08:30 UT –10:30 UT, on 4 July, 2016, we found two kinds of variations in the AEF. One was slow variation due to the movement of thunderclouds, and the other was rapid variation associated with lightning discharges. As for the movement of thunderclouds, the AEF increased when the upper cloud was located over the field mill, which was opposite direction of the previous studies (Boltek Corporation, 2015). This change might be due to the positive charges in the upper cloud more than 14 km altitudes. As for the rapid variations of the AEF, 12 peaks of the AEF coincided with the occurrence of the lightning located within 37 km from the field mill.
On 23-24 November, 2016, we found the variation of the AEF due to snowfall. The AEF oscillated largely during snowfall. The period of the oscillation was about 72 minutes 49 seconds by FFT.
In this session, we will discuss the cause of the variations in the AEF during lightning and snowing.

Keywords: Atmospheric electric fields , Field mill

