Study of cloud effects on atmospheric electric field during lightning activities and snowfall using the 95-GHz cloud radar FALCON-I

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It is known that cloud-to-ground lightning and precipitations generated from thunderclouds are a generator of global electric circuit (e.g., Williams, 2009). In the fair weather, the atmospheric electric field at the ground is generally 100 V/m and downward (positive). The atmospheric electric field varies during not only lightning/thunderstorms, but also snowfall/blizzard (e.g., Minamoto and Kadokura, 2011). The atmospheric electric field had positive correlations with flush rate (R^2 = 0.67) and clouds of more than 30 dBZ with temperature range of -35˜-5˚C (R^2 = 0.62) observed by the TRMM satellite [Lavigne et al., 2017]. However, satellite observations cannot monitor cloud internal structures in detail. In this study, we investigate the variations of the atmospheric electric field during lightning activities of 4 July, 2016, and snowfall of 23-24 November, 2016, using a field mill, the 95 GHz cloud radar, FALCON (FMCW Radar for Cloud Observations)-I, and a X-band radar (9.4 GHz). We have observed the atmospheric electric field with a Boltek field mill, and cloud reflectivity and the Doppler velocity with the FALCON-I in Chiba University, Japan, (CHB, 35.63˚N, 140.10˚E). At 16.2 km southeast from the CHB, a phased array X-band radar operated by Japan Radio Corporation observed precipitations/cloud. During lightning activities of 4 July, 2016, there were two variations in the atmospheric electric field: short pulse signals and slow variations due to passage of thunderclouds. Small increase in the atmospheric electric field in the initial phase was caused by positive charges in anvil using the FALCON-I, although the cause of the initial phase has been regarded as negative charges in the bottom of the thunderclouds so far. The duration of the short pulse signals due to lightning itself had a positive correlation with the lightning peak current (r = 0.44). During the snowfall of 23-24 November, 2016, periodic oscillations in the atmospheric electric field with periods of 70-90 minutes were observed at four observation sites; CHB, Kakioka (KAK, 36.23˚N, 140.19˚E), Tokyo Gakugei University (KGN, Kokubunji, Tokyo, 35.71˚N, 139.49˚E), and Seikei High School (MSN, Musashino, Tokyo, 35.72˚N, 139.57˚E). The distances of CHB-KAK, CHB-TGU, and CHB-SHS are 64.8 km, 55.9 km, and 49.0 km, respectively. This is the first observations of similar oscillations in the atmospheric electric field at different observation sites separated by a long distance of 50-65 km. At the end of snowfall, the periods of the oscillations became shorter to be 20-50 minutes at all sites. Based on the FALCON-I and X-band radar observations, we found that the reflectivity of the snow cloud had the same period of 80 minutes at CHB at 0-2 km heights during the snowfall. In the presentation, we will discuss the cause of the variations in the atmospheric electric field.

