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3D mapping of winter lightning discharges observed in the Shonai area

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The Shonai area railroad weather project has investigated fine-scale structure of wind gust using two X-band Doppler radars and the network of 26 surface weather stations since 2007, in order to develop an automatic strong gust detection system for railroad. In 2009, the project was expanded and started lightning observation to investigate the mechanism of winter lightning and the application to strong gust prediction. Lightning discharge is known to be related to microphysical and dynamical processes within storms. Many scientists have indicated that lightning activity is associated with severe weather. Therefore, integration of continuous three-dimensional (3D) lightning monitoring (intracloud and cloud-to-ground lightning) and comprehensive high-density meteorological observation can provide useful index for predicting strong gust.

We developed a lightning observation system. The azimuth and elevation of VHF radiation sources originated from lightning flashes are computed using arrival time difference of three VHF pulses. After operation test at Meteorological Research Institute (MRI), we installed this system in the north of Shonai area (Ohama, Sakata) in October 2009. Moreover, we constructed three lightning observation sites in the Shonai area in September 2010, in order to visualize lightning discharges in 3D.

Our sensors detected lightning discharges at 01:13:32 JST on 4 December 2010. Using the VHF waveform data, we conduct 3D lightning mapping. The duration of discharge is about 60 ms and divided into two stages. The locations of discharges are compared with the radar echo data observed with two X-band Doppler radars in the Shonai area. As a result, the distribution of lightning discharges is consistent with the strong echo region. The lightning flash was also recorded with the network cameras at each site. In this presentation, we will show the lightning discharge process in detail.

Keywords: Winter lightning, 3D mapping, VHF observation, X-band radar, Shonai area