Study on electrical activity of small convective clouds by using a vertically scanning X-band marine radar

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The author is interested in electrical activity of small convective clouds, especially winter snow clouds. Multi-paprameter Doppler radars are quite useful tool to classify hydrometeors type. However, their relatively low temporal and spatical resolutionThe author is interested in electrical activity of small convective clouds, especially winter snow clouds. Multi-parameter Doppler radars are quite useful tool to classify hydrometeor type. However, their relatively low temporal and spatial resolution may limit the research topics to such larger scale of storms as a severe hailstorm and organized convective systems. The lifetimes of small convective clouds (less than several km both in height and width) are generally less than 30 minutes. Their radar echo structures change rapidly associated with formation, growth and distribution of hydrometeors within clouds. Therefore, we studied the relationship between the electrical activity and temporal change in radar echo structure of convective clouds by using a conventional X-band marine radar. Its temporal and spatial resolutions are 2 seconds and 12.5 m, respectively. We conducted simultaneous observation of a vertically scanning X-band marine radar and a field mill deployed on the roof of ILTS of Hokkaido University, Sapporo, from 2013 to 2017. The horizontal and vertical detection ranges of the marine radar are 4 km and 7 km, respectively. Since this radar scans very fast, lightning echoes were sometimes detected as reported by Ligda (1956).
It is well known that the lightning activity of winter snow storms in Hokuriku district, southeastern coastal area of the Japan Sea, is quite high. On the other hand, it is empirically known that the lightning activity of snow clouds in Hokkaido, northern Japan, is much weaker than that in Hokuriku district. The temperature at the radar echo top (20 dBZ) and the altitude of the -10 ℃ level are used as good indicators of lightning activity in winter convective clouds in Hokuriku district (Michimoto 1989). Michimoto (1993) also proposed several criteria to classify the lightning activity.
In this study, we applied the criteria proposed by Michimoto (1989, 1993) to winter snow clouds in Sapporo to study the reason of the low lightning activity in Hokkaido. We used the data observed by an X-band marine radar and a field mill deployed on the roof of ILTS of Hokkaido University during 2013-2017 winter seasons. It is found that almost all winter thunder clouds in Sapporo were found within the criteria (-10 ℃ level < 1.8 km and temperature at the radar echo top < -20 ℃), where snow clouds exhibited no lightning activity or only very weak lightning activity in Hokuriku district. Electric activity of snow clouds in Sapporo became high when radar echo top height exceeded -15 ℃ level. It is also found that multi-cell type of convective snow clouds with much radar echo amount above -15 ℃ level are electrically quite active.

Keywords: electrical activity, snow cloud, X-band marine radar

