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Observation of thunderstorms producing lightning narrow bipolar events with phased array radar

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Phased array radar (PAR) with unprecedented high temporal and spatial resolution is used for the first time to analyze structures of thunderstorms producing narrow bipolar events (NBEs), which are located with low frequency (LF) lightning location system comprising nine stations in Osaka region of Japan. The PAR has a temporal resolution of 30 seconds and a spatial resolution of 100 m in radial direction, 1.2? in azimuthal direction and 0.9? in elevation direction. Such resolutions are much better than traditional parabolic weather radar. During the summer of 2012, 232 positive NBEs and 22 negative NBEs were detected and located by the LF lightning location system. Thunderstorms producing these NBEs were observed by the PAR, and locations of NBEs are compared with thunderstorm structures.

It is found that NBEs usually correspond well with the deepest convection. However, in some thunderstorms with intense updraft extending above 15 km, positive NBEs are produced at the periphery, instead of the center, of the deepest convection. This may be because of decrease of electric field due to elevation of the upper positive charge layer or formation of screening negative charge layer in the region of the deepest convection.

Negative NBEs are generally higher than positive NBEs and are almost exclusively located at the cloud top of thunderstorm. Positive NBEs, on the other hand, are always located well inside thundercloud. Another important feature of negative NBEs is that they can only be produced in thunderstorms with cloud top higher than about 14 km, which is quite rare in Osaka region, resulting in rare occurrences of negative NBE. Numerous thunderstorms with lower height did not produce any negative NBE, indicating a height threshold for NBE production.

Such special features of negative NBE make it a perfect target for monitoring severe thunderstorms. If we can detect negative NBE and determine its height, we can estimate the thunderstorm top height right from the negative NBE height. Even if we cannot determine NBE height, we can roughly decide the severity of thunderstorm by the presence of negative NBE. As long as negative NBE is produced, the thunderstorm has probably developed above at least 14 km, which is quite severe. In this way, severe thunderstorms can be conveniently monitored by detecting negative NBEs.

キーワード: narrow bipolar event, phased arrya radar, severe thunderstorm
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