Observation of summer thunderclouds on 13 August 2018 over Kanto-Plain using Multi-Parameter Phased Array weather radar

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Recent years, severe weather disasters have (heavy rainfall, gust, hailfall and tornado) been gained prominent attention in Japan. These disasters are generated by thunderclouds, which develop and decay rapidly. Thunderclouds contain various types of hydrometeors (raindrop, snow aggregates, ice crystal, graupel and hail), whose distribution have spatially and temporally significant variation. Thus, it is important to obtain the distribution of hydrometeors with high spatial and temporal resolutions for understanding and predicting severe weathers.

In order to obtain the information of hydrometeor distribution in thunderclouds, polarimetric radar is very useful tool because it obtains various variables, which contain microphysical information (shape, canting angle, and liquid/solid homogeneity) by 3-dimensional remote sensing. Polarimetric radar commonly used have parabolic antenna, and they need typically several minutes for volume scan with multi-elevation angles changing elevation angle step by step for 3-dimensional observation of thunderclouds. Thus, the time resolution is rough and there is a problem that the distribution of hydrometeors in thunderclouds may change during the volume scan.

An X-band Multi-Parameter Phased Array Weather Radar (MP-PAWR) was developed and installed at Saitama University in 2017. And then, full time observation with MP-PAWR was started in March 2018 (Takahashi et al., 2019). MP-PAWR obtains three dimensional polarimetric variables (receive powers of horizontal and vertical polarization [H-pol and V-pol], Doppler speed in radial direction, Doppler spectral width, phase different between H-pol and V-pol, and correlation coefficient of H-pol and V-pol receive power) in 30 seconds with 60 km range or in 60 seconds with 80 km range. Thus, MP-PAWR enables 3-dimensional polarimetric radar observation of thunderclouds in much shorter time intervals, resulting in observation of more precise structures (hydrometeor distributions) of thunderclouds than pre-existing polarimetric radars.

In this study, a case of thunderclouds on 13 August 2018, whose silhouettes were shot by time-lapse web camera at Saitama University, is picked up and polarimetric radar data obtained by MP-PAWR will be analyzed to demonstrate the performance of MP-PAWR. In the case, two thunderclouds are target of the analysis; one (Thundercloud A) generated west of Tokyo Metropolitan Prefecture around 1200 Japan Standard Time (JST = UTC +9 hours) moving eastward, and the other (Thundercloud B) generated south edge of Saitama Prefecture around 1300 JST moving southward. According to LIghtning DEtection Network system (LIDEN) of Japan Meteorological Agency (JMA), Thunderclouds A and B generated cloud-to-ground (CG) lightning flashes from 1240 JST and 1335 JST, respectively. They produced violent CG activities and merged around center of Tokyo Metropolitan Prefecture. After the merge of Thunderclouds A and B, a violent CG activity continued and then, weakened rapidly. The merged thundercloud produced an electricity failure at National Institute of Information and Communications Technology, Koganei, Tokyo, around 1520 JST in its decaying stage.

For the case, a hydrometeor classification (HC) method (Kouketsu et al., 2015) will be applied for microphysical exploration of the thunderclouds, comparing LIDEN data. The results HC with MP-PAWR

will help more temporally profound microphysical analysis than that with pre-existing polarimetric radar, such as in Kouketsu et al. (2017), whose time interval of volume scan was 6 minutes.

References

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