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Precipitation core behavior and surface rainfall variation in cumulonimbus clouds in the Kanto region, on 18 August 2011

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Descending precipitation cores in cumulonimbus clouds which caused localized heavy rainfall have been reported in several previous studies. The surveillance of precipitation cores aloft is expected to improve nowcast or short-time forecast methods of localized heavy rainfall. In addition, the investigation of correspondence between detailed behavior of precipitation cores and surface rainfall is important to understand developing and maintenance processes of vigorous cumulonimbus clouds. The National Research Institute for Earth Science and Disaster Prevention conducted a three-dimensional observation of cumulonimbus clouds which occurred on 18 August 2011 in Kanto region, Japan, at two-minute intervals using an X-band polarimetric radar at Ebina City. In this study, the detailed behavior of precipitation cores in these cumulonimbus clouds and its correspondence to the time variation of surface rainfall are presented.

In this study, precipitation core is defined as the closed area of radar reflectivity (Zh) right before merging with other closed area when the Zh threshold level is lower from 60 dBZ to 10 dBZ by 1 dB. Precipitation core is automatically detected in three-dimensional data sets (dx = 1 km, dy = 1 km, dz = 0.25 km) every two minutes and manually tracked. Core height is defined by the level of the maximum Zh within the detected precipitation cores at each time. This precipitation-core detection method was applied to the three precipitation cells (Cell A1, B1 and C1) observed on 18 August.

Cells A1 and C1 consisted of a single precipitation core each. Precipitation cores aloft in Cells A1 and C1 were detected 12 and 16 minutes before the time of maximum rainfall intensity at the surface, respectively. Descent of precipitation cores was observed once in Cells A1 and C1 each. Cell B1 composed of 5 precipitation cores. Five surface rainfall peaks were observed for Cell B1. First rainfall peak was observed after 18 minutes of the first detection of precipitation core aloft. At that time, the core height was 5-km altitude, which did not descend to the surface. Other 4 peaks in surface rainfall were observed in association with precipitation core descent. Thus, 6 of 7 rainfall peaks in three precipitation cells were observed in association with descents of precipitation cores.

Keywords: Localized heavy rainfall, precipitation core, Polarimetric radar