Three-dimensional structure of Typhoon Mindulle (2016) observed by phased array radar

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Since 2015, Meteorological Research Institute has been operating a phased array radar (PAR, hereafter) which is a modern technology that performs high-speed volumetric scan in 10–30 seconds. On 22 August 2016, Typhoon Mindulle made landfall near Tateyama, Chiba and moved north across the Kanto Plain. We therefore succeeded in observing a fine-scale three-dimensional structure of Mindulle as it passed close to the PAR observation site in Tsukuba, Ibaraki. The obtained data show that the inner region of Mindulle consisted of several spiral rainbands located around the center of circulating winds, in which many convection cells with 20-dBZ echo top altitudes of 5–8 km were embedded. We derived wind fields by carrying out a synthesis analysis of the Doppler velocity data obtained by PAR and a nearby operational radar. The low-level synthesis data show a strongly circulating wind region with a velocity of >25 ms^{-1} which originally existed at several tens of kilometers from the center. The radius of the strong winds then monotonically decreased to <10 km in 20–30 minutes, implying a contraction of circulating winds presumably caused by a surface frictional force. Meanwhile, the PAR reflectivity data exhibited rapidly developing convection cells in the innermost rainband, with 20-dBZ echo top altitude increasing from ~8 km to 14–16 km. This convection intensification was also detected by a meteorological satellite (Himawari-8) as a signature of brightness temperature lowering from 205 K to 199 K around the region in question. These results suggest a frictionally forced updraft occurring in the inner region of Mindulle during its decaying stage. It is apparent that PAR finely resolves three-dimensional structure of typhoon and detects signatures of underlying physical processes.

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