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Dynamical and microphysical structures associated with enhancement of convective cells over Mt. Halla, Jeju Island, Korea on 6 July 2007

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Enhancement of convective cells within a precipitation system was observed over the northern and lee sides of an isolated elliptical-shaped area (Mt. Halla: height 1950 m, width 35 km, length 78 km) of Jeju Island on 6 July 2007. The dynamical and microphysical structures of the convective cell (radar reflectivity greater than 45 dBZ) were investigated by dual-Doppler radar observation and cloud-resolving storm simulator (CReSS) with 1 km resolution. Regarding the enhancement of convective cell off the northwestern shore of the island, variational wind analysis identifies a localized updraft region between the convective cell of the system and the island. As the distance between the system and the island narrowed, the southwesterly wind blowing between them strengthened; the resultant local updraft appears to be crucial in enhancement of the convective cell on the northwestern shore of the island. The significant enhancement of the convective cell occurred from the sea surface to an elevation of 5.5 km. Having a coincidence with the observational result, the control experiment (CNTL) showed the increase in updraft from the sea surface to an altitude of 1.5 km (maximum at 4.5 km), where the moisture content was high (17 g kg–1). Due to the increased updraft and plentiful moisture supply at low altitudes, cloud water increased from the sea surface to reach a maximum at an altitude of 2.7 km. Consequently, the microphysical processes that convert cloud water into raindrops (collection and conversion) were significant below 4.3 km, and an increase in rainfall was seen between heights of 1.0 and 4.2 km; i.e. mainly below the freezing layer (4.9 km). Regarding the enhancement of the convective cell on the lee side of the island, a stationary convergence region by terrain-modified weak westerly from the northern island and relatively strong southwesterly over the southeastern slope (elevation 500 m) of the mountain was observed on the lee-side. By the southwesterly upslope wind at low altitudes, the plentiful moisture on the southeastern side of the island was supplied to the convective cell. As the result, the significant enhancement of the convective cell occurred up to a height of 8 km. The CNTL result indicates the increase in updraft above 1 km (maximum at 5.5 km). The related cloud water increased above 1.5 km, and the microphysical processes that produce raindrops were significantly activated in the region between 1.5 and 5.3 km in altitude, which extended above the freezing layer. Consequently, above the freezing layer, the melting rate of graupel decreased while cloud water increased during the enhancement of the convective cell on the lee side. The precipitation system of 6 July 2007 enhanced significantly off the northwestern shore and to the lee side of the elliptical and steep topography of Jeju Island. The enhancement of the convective cells occurred in the vicinity of terrain with relatively small horizontal scale; however, the dynamical and microphysical structures associated with enhancement of the convective cells differed on its location relative to the terrain.