Statistical analysis of regional rainfall distributions around isolated Island by low-level winds during the winter season

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In Korea, rainfall systems passing over an isolated mountain tend to develop by orographic effects. We statistically analyzed regional rainfall distributions according to wind characteristics at low levels (925–850 hPa) during winter seasons in 2009-2016 around Jeju Island which is elliptically shaped and oriented from the west-southeast to east-northeast direction with a height of 2 km, width of 35 km, and length of 78 km. For this study, rain gauge data at 26 sites, two operational S-band Doppler radar data, and mesoscale analysis model data were used.
The accumulated rainfall was recorded by the 26 rain gauges during December–February from 2009 to 2016. The accumulated rainfall maximum larger than 40000 mm appeared on the mountain crest (altitude > 1.25 km). In contrast, the region of the accumulated rainfall less than 15000 mm appeared on the western coast of Jeju Island. This means that the rainfall distributions were affected by the mountainous region in Jeju Island. For radar data analyses, 3-Dimensional CAPPI radar data during precipitation periods were used. To determine a representative environmental wind on Jeju Island, the MSM-GPV (Mesoscale Model-Grid Point Value) data between 850 hPa and 925 hPa levels were used. By wind direction and wind speed, CAPPI radar data were classified into 32 wind categories. The 2 km-CAPPI radar reflectivities were time-averaged in each category.
In this study, characteristics of regional rainfall distributions classified into the 32 wind categories by wind direction and speed were investigated. The most of high rainfall frequencies occurred when the northwesterlies (51.6%) and northerly winds (16.0%) prevailed at low-levels. Rainfall frequencies at westerlies (8.6%) and southwesterlies (7.5%) were relatively low. At relatively strong northwesterlies (SPD > 10 m s^{-1}), rainfall systems that moved from the offshore region have developed on mountain slope. When the relatively weak southwesterlies (5 m s^{-1} < 10 m s^{-1}) and strong southwesterlies (SPD 20 m s^{-1}) were dominant, there were high rainfall distributions on the top of the mountain and the southern upslope, respectively. Similarly, when the relatively weak southerly winds (5 m s^{-1} < SPD 10 m s^{-1}) and strong southerly winds (SPD 20 m s^{-1}) prevailed, high rainfall frequencies were concentrated on the top of the mountain and the southern upslope, respectively. Therefore, the development of rainfall systems that pass over the mountain around the Jeju Island seems to be closely related to the characteristics of wind direction and wind speed at low-levels.

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Keywords: regional rainfall distribution, isolated elliptical terrain, low-level wind

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Abstract

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