Geophysical Research Abstracts
Vol. 19, EGU2017-2262-1, 2017
EGU General Assembly 2017

Orographic precipitation and vertical velocity characteristics from drop size and fall velocity spectra observed by disdrometers

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During a summer monsoon season each year, severe weather phenomena caused by front, mesoscale convective systems, or typhoons often occur in the southern Korean Peninsula where is mostly comprised of complex high mountains. These areas play an important role in controlling formation, amount, and distribution of rainfall. As precipitation systems move over the mountains, they can develop rapidly and produce localized heavy rainfall. Thus observational analysis in the mountainous areas is required for studying terrain effects on the rapid rainfall development and its microphysics.
We performed intensive field observations using two s-band operational weather radars around Mt. Jiri (1950 m ASL) during summertime on June and July in 2015-2016. Observation data of DSD (Drop Size Distribution) from Parsivel disdrometer and (w component) vertical velocity data from ultrasonic anemometers were analyzed for Typhoon Chanhom on 12 July 2015 and the heavy rain event on 1 July 2016. During the heavy rain event, a dual-Doppler radar analysis using Jindo radar and Gunsan radar was also conducted to examine 3-D wind fields and vertical structure of reflectivity in these areas.
For examining up-/downdrafts in the windward or leeward side of Mt. Jiri, we developed a new scheme technique to estimate vertical velocities (w) from drop size and fall velocity spectra of Parsivel disdrometers at different stations. Their comparison with the w values observed by the 3D anemometer showed quite good agreement each other. The Z histogram with regard to the estimated w was similar to that with regard to R, indicating that Parsivel-estimated w is quite reasonable for classifying strong and weak rain, corresponding to updraft and downdraft, respectively. Mostly, positive w values (upward) were estimated in heavy rainfall at the windward side (D1 and D2). Negative w values (downward) were dominant even during large rainfall at the leeward side (D4). For D1 and D2, the upward w percentages were larger than the downward w percentages. At the leeward side, the downward w percentages were larger than the upward at D4. Importantly, this suggests that rainfall with R >10 mm hr-1 at the leeward side was more associated by negative w-components of winds.
Therefore, we confirmed the possibility of w (up/down draft) estimation by DSD observation using disdrometers and quantitative contribution of w in orographic precipitation, roughly. In addition, the rainrates (R) of precipitation, radar reflectivities (Z) and vertical velocities (w) characteristics are related to the size and fall velocity spectra distributions by disdrometer. The vertical velocities contributed to the orographic precipitation development and dissipation and they clearly showed different values between windward side and leeward side with R variation.

Acknowledgement
This work was funded by the Korea Meteorological Industry Promotion Agency under Grants KMIPA 2015-5060 and KMIPA 2015-1050.