Microphysical and Kinematical Characteristics of Merged and Isolated Convective Cells over the Complex Terrain of Taipei Basin during TAHOPE

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Abstract

One of the primary scientific objectives of the Taiwan-Area Heavy rain Observation and Prediction Experiment (TAHOPE) was to study the characteristics of microphysical processes in extreme precipitation associated with convective systems over complex terrain. To accomplish this goal, NCAR/EOL S-Pol radar was deployed near the northwestern coast of Taiwan (Hsinchu), accompanied by intense sounding release and dense operational observing network. Using observations of the polarimetric variables, microphysical processes were identified during an extreme rainfall event associated with afternoon thunderstorms (ATS) over the Taipei basin on 31 May 2022. Moreover, complete 3-dimensional wind fields are retrieved, providing valuable information about the interaction between convective cells over complex terrain.

It was found that there were two episodes of severe ATS in this event. In episode 1 (1200-1400 LST), the physical mechanism of single cell merger (SCM) was likely rear-end collision due to different propagation speeds, while the multiple cell merger (MCM) was favored by terrain-induced circulation. The low-level convergence produced by upslope winds favored the development and organization of ATS over Snow Mountain Range. The updrafts merged in tandem with MCM and then intensified dramatically with a maximum *w* of greater than 20 m/s. Furthermore, the multi-merger convection had a large region of graupel/small hail mixture extending up to 12 km MSL, with the prominent occurrence of hail, rain/hail, and graupel/rain mixture. Cloud microphysics in the multiple-merger cell transitioned to more active riming and melting processes, leading to heavy rainfall over the mountainous region.

In contrast, convective cells in episode 2 (1500-1700 LST) were isolated and much weaker than in episode 1. In the absence of cell and updraft merger, the

relatively weak updrafts showed a disorganized and slantwise structure with a maximum *w* of ~ 10 m/s. Accordingly, instead of hail and graupel, there was a large amount of dry snow at mid-to-upper levels and wet snow near melting level in episode 2. Compared to episode 1, the area of heavy rainfall reduced noticeably in episode 2, accompanied by much lower values of ZDR and KDP, which might be due to the lack of large raindrops produced by melting of hail and graupel.

We compared metrics of ZDR column development, updraft speed and area between the two episodes. In episode 1, the maximum height of ZDR column was highest (7.0 km) at the timing of MCM and preceded the highest updraft speed by more than 10 min. Meanwhile, the maximum width of ZDR column increased twofold to 8 km. The updraft velocity and area followed very similar evolution, seemingly related to the width of ZDR column, highlighting that ZDR column width was a promising forecasting parameter on thunderstorm evolution.