An Assessment of Cloud Microphysical Characteristics of Three Mei-yu Rainfall Systems in Taiwan as Simulated by A Cloud-Resolving Model

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This study selected three heavy-rainfall events of different types in the Mei-yu season in Taiwan for high-resolution simulations at a grid size of 1 km and assess the model's capability to reproduce the morphology and characteristics of them. The three cases include a pre-frontal squall line, a mesoscale convective system (MCS) embedded in southwesterly flow, and a local convection near the front in southern Taiwan during the South-West Monsoon Experiment (SoWMEX) in 2008, chosen mainly because of the availability of the S-band polarimetric (S-Pol) radar observations, especially the particle identification results. The model used is the Cloud-Resolving Storm Simulator (CReSS), a cloud model that treats all clouds explicitly without any cumulus parameterization.

The simulations using the CReSS model could reproduce all three corresponding rainfall systems at roughly the correct time and location, including their kinematic structures such as system-relative flows with minor differences, although the cells appeared to be coarser and wider than the S-Pol observations. The double-moment cold-rain microphysics scheme of the model could also capture the general distributions of hydrometeors, such as heavy rainfall below the updraft core with lighter rainfall farther away below the melting level, and graupel and mixed-phase particles in the upper part of the updraft with snow and ice crystals in stratiform areas between updrafts above the melting level. Near the melting level, the coexistence rain and snow corresponds to wet snow in the observations. Differences in cloud characteristics in the events are also reflected in model results to some extent. Overall, the model's performance in the simulation of hydrometeors exhibits good agreement with the observation and appears reasonable.