Impact of a New Cloud Microphysics Parameterization on the Simulations of Mesoscale Convective Systems Using E3SM Regionally Refined Model (RRM) Framework

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Mesoscale convective system (MCS) is one of the most climatically significant forms of convection and is difficult to simulate in climate models because the relevant dynamics and physics are absent or poorly represented with coarse model resolutions (~100 km). In this study, a regional refined model (RRM) with 0.25° grid spacing embedded in the Energy Exascale Earth System Model (E3SM) is employed for simulating MCS properties over the contiguous United States. To overcome the limitations in Gettelman and Morrison (2015) (MG2) cloud microphysics scheme, i.e., (1) the important rimed precipitating ice particles are not considered, and (2) the artificial partitioning of frozen particles into cloud ice and snow, a newly developed Predicted Particle Properties (P3) scheme has been implemented. With an objective MCS tracking algorithm, we show that the simulation with P3 predicts higher hourly rain rates and a larger area of convective systems, resulting in more MCSs and a higher total MCS precipitation compared to MG2 during spring 2011, agreeing better with the observations. Also, the diurnal cycle of precipitation from P3 is in a better phase with the observation than MG2. Those improvements mainly result from the explicit simulation of rimed particles, which not only produce higher rain rate, but also help support the stronger large-scale ascending motion by releasing more latent heating. The improvements are not strong enough to close the gap between model and observations, suggesting other model parameterizations (e.g., convective parametrization) might play a more important role in simulating MCSs at the 25-km grid spacing.