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The Diurnal Variation of Precipitation during MC3E: A Numerical Modeling Study

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Previous observational studies have identified three different types of diurnal precipitation variation over the conterminous U.S.: localized afternoon rainfall maxima over Mississippi and Ohio valleys, propagating mesoscale convective systems (MCSs) over Rocky Mountain regions, and propagating MCSs over the Appalachian Mountains. This study focuses on the second type, which involves nocturnal rainfall maxima from eastward-propagating MCSs on the lee side of the Rocky Mountains. This study evaluates model simulations with regard to rainfall using observations and assesses the impact of microphysics, surface fluxes, radiation and terrain on the simulated diurnal rainfall variation.

A regional high-resolution model was used to conduct a series of real-time forecasts during the Midlatitude Continental Convective Cloud Experiment (MC3E) in 2011 over the Southern Great Plains. The model was able to capture most heavy precipitation events. When all cases composited together, the forecasts depict accurate, propagating precipitation features and thus the overall diurnal variation. However, the forecasts tend to overestimate the rainfall for light precipitation events, have location errors and misrepresent convection in some cases. A post mission case study is performed on one multi-cell, eastward-propagating MCS event, and the results suggest that cold-pool dynamics were an important physical process. Model results also indicate that terrain effects are important during the initial stages of MCS development. By increasing the terrain height by 10%, the simulated rainfall is increased and in better agreement with observations. On the other hand, surface fluxes and radiation processes only have a secondary effect for short-term simulations.