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Investigating Possible Future Changes in Hailfall Occurrence and Intensity Using a Pseudo-Global Warming Approach

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Over North America, climate-model projections indicate widespread increases in frequency and magnitude of convective available potential energy (CAPE) throughout the 21st Century. CAPE alone, however, is a poor proxy for predicting intense thunderstorm occurrence, as well as hail occurrence. Here we pursue a "pseudo-global-warming" (PGW) approach, which provides a flexible framework for experimentation and examination of cause and effect in the relevant dynamical and microphysical processes that can create large hail events. We apply this approach to the 19 May 2013 severe convective storm event over the Central U.S., which produced over 150 reports of severe hail over a 12-h period. Past hailstorms that have occurred in other regions, including Europe, could also be studied with this technique.

The event is first simulated using the WRF model both in its true environment (the "control" simulation), and then re-simulated in 3 different possible late 21st-century environments, by modifying the true environment by projected climate-change "deltas" based on 3 different climate model predictions (the PGW simulations). Each climate-change delta is computed from a set of simulations under historical and future (RCP8.5) conditions using a different global model. We conduct the WRF simulations at 1 km grid spacing to capture more detail in the simulated storms. Sensitivities to different microphysical schemes are also investigated.

The results suggest that hail swaths from this event, if occurring in a late 21st century environment, would be 50% greater in their areal coverage, and that the amount of 2.5 cm and 5 cm diameter hail at the ground would increase by 10 to 20%. The PGW simulations also produced rainfall over a 10-30% smaller area, but with slight increases in rain accumulation over 30 mm. Hypotheses related to possible microphysical reasons for these changes will be presented, including the roles of a possibly stronger warm rain process, and a deeper but sometimes drier melting layer.