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Modeling the large-scale environments of long-lived mesoscale convective systems conducive to heavy precipitation in the Central United States

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Mesoscale convective systems (MCSs) are important precipitation producers that account for 30-70% of warm season rainfall between the Rocky Mountains and Mississippi River and some 50-60% of tropical rainfall. Besides the tendency to produce floods, MCSs also carry with them a variety of attendant severe weather phenomena. Observed increases in springtime total and extreme rainfall in the central United States in the past 35 years are dominated by increased frequency and intensity of long-lasting MCSs. Understanding the environmental conditions producing long-lived MCSs is therefore a priority in determining how heavy precipitation events might change in character and location in a changing climate. Continental-scale convection-permitting simulations of the warm seasons using the WRF model reproduce realistic structure and frequency distribution of lifetime and event mean precipitation of MCSs over the central United States. The simulations show that MCSs systematically form over the central Great Plains ahead of a trough in the westerlies in combination with an enhanced low-level moist jet from the Gulf of Mexico. These environmental properties at the time of storm initiation are most prominent for the MCSs that persist for the longest times. MCSs reaching lifetimes of 9 h or more occur closer to the

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approaching trough than shorter-lived MCSs. These long-lived MCSs exhibit the strongest feedback to the environment through diabatic heating in the trailing regions of the MCSs that helps to maintain them over a long period of time. The identified large-scale and mesoscale ingredients provide a framework for understanding and modeling the potential changes in MCSs and associated hydrometeorological extremes in the future.