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An investigation of the role of daytime land-atmosphere interactions on nocturnal convective activity using a coupled land-cloud resolving model

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This study examines the effect of daytime land-atmosphere interactions on warm-season nocturnal convection in the Southern Great Plains. The focus of this study is a Mesoscale Convective System that occurred in the evening and overnight hours on 19-20 June 2007, during the Cloud and Land Surface Interaction Campaign. High-resolution numerical simulations of the 24-hour period containing the event were conducted using a coupled land-cloud resolving model. June 2007 was one of the wettest months in Oklahoma history, and the simulated event occurred during a one-week period of rainfall, with the exception of June 18. This hiatus in rainfall allowed for an enhancement of the signatures of soil and land-use heterogeneities in the study area. On the morning of June 19, simulations show that the differential sensible heating leads to the formation of convective rolls that gradually propagate through the domain. Additionally, the simulated dynamic and thermodynamic profiles at this time are conducive to the formation of gravity waves at the interface of the atmospheric boundary layer and the free atmosphere. During the day, non-precipitating convection forms in regions where boundary layer eddies and gravity waves are in-phase. This study also explores how low- and mid-level convective instability, whose release was prevented during the day due to a capping layer, can be utilized in the presence of the low-level jet (LLJ) and moisture convergence. Deep moist convection occurs at the forward edge of the mid-level capping layer in an area of mechanical lifting by the LLJ, which coincides with the location of maximum daytime sensible heat flux. The study suggests that, with strong synoptic forcing, land-atmosphere interactions have an indirect effect on nocturnal deep moist convection by increasing local stocks of convective instability below the capping layer.