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Understanding Climate Controls of Severe Local Storm Environments over North America

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Severe Local Storms (SLS), such as severe thunderstorms and tornadoes, pose significant risk to life and property in the United States every year. While these SLS events are small scale, they develop principally within favorable larger-scale environments (i.e. SLS environments). Why these large-scale environments are confined to specific regions of Earth, particularly the Eastern United States, is not well understood. This can, in part, be related to a limited fundamental knowledge of how the climate system creates SLS environment, which provides uncertainty in how SLS environments may be altered in a changing climate.

Previous research has identified the Gulf of Mexico to the south and elevated terrain upstream as important land surface features for the generation of SLS environments over the Eastern United States. This work investigates the relative role of these geographic features through “component denial” experiments in the Community Atmosphere Model version 5 (CAM5). CAM5 simulation experiments are performed with topography is removed (globally and regionally) as well as where the Gulf of Mexico is converted to land, and the results are compared to a CAM5 control simulation of current climate following the Atmospheric Model Intercomparison Project (AMIP) protocols. In addition to exploring differences in general characteristics of the large-scale environments amongst the experiments, SLS changes will be explored through a combination of high shear and high Convective Available Potential Energy (CAPE) environments. This work suggests that the removal of elevated terrain reduces the inland extent of SLS environments in the United States, but not the existence of these events altogether. This indicates that topography is crucial for inland SLS environments but perhaps not for their existence in general (e.g., near the Gulf of Mexico). This work is a crucial first step to building a reduced-complexity framework within CAM5 to quantify how land-ocean contrast and elevated terrain control SLS environments.