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High resolution climatology
- towards climate change services

Convective intitiation over a heated mountain: mechanisms and predictability

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In conditionally unstable flows over orography, the strong horizontal convergence generated by elevated heating locally weakens convective inhibition and increases the likelihood of convective initiation. This generally serves to enhance the predictability of deep convection, except when the associated uplift lies just at the margin of the forcing needed for convective initiation. In such marginal cases, airflows with very small initial differences may experience substantially different evolutions. To investigate the processes that govern cloud development in such cases, this study analyzes ensembles of idealized, high-resolution 2d simulations of the diurnal cycle in conditionally unstable flow over a mountain ridge. The case considered is based on a well-observed event from the Convective and Orographic Precipitation Study (COPS) that has proven highly difficult to predict in NWP models. This event was characterized by strong conditional instability but also large convective inhibition and a very dry mid-troposphere that presented a hostile environment for ascending clouds. Within each ensemble, the members differ only in their random seeds of low-amplitude, white-noise thermal perturbations added to the initial flow (0600 local time). The members of each ensemble experience similar mesoscale evolution, with convective inhibition (CIN) eroding completely and large CAPE developing over the high terrain by noon. Shallow orographic cumuli form predictably in response, but only in some cases do these transition to deep cumulonimbi. The dynamical and microphysical mechanisms that determine the cloud evolution in these simulations are examined through parcel trajectory analysis and an entraining thermal model.