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A numerical study of the interaction of the convective boundary layer and orographic circulation with locally-triggered deep convection around the Santa Catalina Mountains in Arizona

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This presentation examines the daytime evolution of the thermally-forced boundary-layer (BL) circulation over a relatively isolated mountain, about 30 km in diameter and 2 km high, and its interaction with locally-initiated deep convection, by means of numerical simulations validated with data collected in the 2006 Cumulus Photogrammetric, In situ and Doppler Observations (CuPIDO) field campaign in southeastern Arizona. The impacts of both shallow non-precipitating orographic cumulus convection and of deep convection are examined. The results are based on output from the Weather, Research and Forecasting v.3 model run at a horizontal resolution of 1 km. The model output verifies well against CuPIDO observations.

In the absence of Cu convection, the thermally-forced (solenoidal) circulation is largely contained within the BL over the mountain. Thunderstorm development deepens this BL circulation, with inflow over the depth of the BL and outflow in the free troposphere aloft. Primary deep convection results from destabilization over elevated terrain, and tends to be triggered along a convergence line, which arises from the solenoidal circulation but may drift downwind of the terrain crest. While the solenoidal anabatic flow converges moisture over the mountain, it also cools the air. Thus a period of suppressed anabatic flow following a convective episode, at a time when surface heating is still intense, can trigger new and possibly deeper convection. The growth of deep convection may require enhanced convergent flow in the BL, but this is less apparent in the mountain-scale surface flow signal than the decay of orographic convection. A budget study over the mountain suggests that the precipitation efficiency of the afternoon convection is quite low, $\sim$10 % in this case.