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Surprising sensitivity of lightning and related storm processes to environment on 4 June 2012 in West Texas

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On 4 June 2012, during the Deep Convective Clouds and Chemistry field campaign, relatively disorganized cellular convection developed near the New Mexico-West Texas border and was observed by the West Texas Lightning Mapping Array (WTLMA). This convection contained an extremely unusual variety of charge structures in contemporaneous storms only tens of kilometers apart. The observed distribution of charge correlated best with the Texas Tech University Weather Research and Forecasting model's representation of the depth and dryness of the elevated mixed layer, the base of which was near 700 mb (below cloud base). Because the surface relative humidity did not directly correlate to this, it suggests that the parcels must have been modified before entering the cloud or in the lower levels of the cloud, impacting the microphysics within the cloud and thus electrification within the storms. Resulting differences among storms were also observed in other lightning patterns and in overall storm evolution. For example, the storms with the driest environment at 700 mb and a pronounced elevated mixed layer were dominated by mid-level positive charge, which agrees with the theory of slower depletion rate of cloud liquid water promoting more positive charging to graupel. These storms had fewer cloud-to-ground flashes and were slower to intensify but were still relatively long lasting. Storms with more moisture at 700 mb or with a shallower mixed layer were dominated by mid-level negative charge and had more frequent cloud-to-ground flashes. As more organized storms developed along the outflows from the initial convection and in overturned air, the charge structures became more uniform across the region, overall flash rates increased and a few severe events occurred. This case allows for a detailed and unique examination of how relatively small changes in environmental conditions (a few °C in temperature and dew point) and forcing mechanisms can result in different storm-scale characteristics morphologically and electrically.