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Transient luminous events above two mesoscale convective systems

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Two warm-season mesoscale convective systems (MCSs) were analyzed with respect to production of transient luminous events (TLEs), mainly sprites. Sprites were documented over the lightning mapping array (LMA) network in Oklahoma, USA, using highly sensitive optical cameras operated at Yucca Ridge in Ft. Collins, Colorado, as part of our Sprites 2007 field campaign. Information about charge moment changes in lightning flashes was obtained by the National Charge Moment Change Network (CMCN). Cloud-to-ground lightning data were obtained from the National Lightning Detection Network (NLDN).

The 20 June 2007 symmetric MCS produced 282 observed TLEs over a 4-h period, during which time the storm's intense convection weakened and its stratiform region strengthened. In contrast to previous sprite studies, the stratiform charge layer involved in producing the TLE-parent positive cloud-to-ground (+CG) lightning flash was situated at upper levels as opposed to near the melting level. This layer was physically connected to an even higher upper-level convective positive charge region via a downward-sloping pathway. The average altitude discharged by TLE-parent flashes during TLE activity was 8.2 km above mean sea level (MSL; -25 °C). The 9 May 2007 asymmetric MCS produced 25 observed TLEs over a 2-h period, during which the storm's convection rapidly weakened before recovering later. The 9 May storm best fit the conventional model of low-altitude positive charge playing the dominant role in sprite production; however, the average altitude discharged during the TLE phase of flashes still was higher than the melting level: 6.1 km MSL (-15 °C).

The average TLE-parent +CG flash in the symmetric 20 June case initiated at higher altitude, discharged a substantially larger area, had a larger peak current, and tapped positive charge at higher altitude compared to the asymmetric 9 May case. Analysis of full charge moment change (CMC) data from TLE-parent +CGs in these two cases revealed that TLE-parent flashes in the 20 June storm featured larger impulse CMC (iCMC) and impulse charge, which concerns only the first two ms after the CG stroke, while 9 May featured larger continuing current duration and charge, but also weaker current amplitude. In the sum, 9 May TLE parents had smaller total CMC but greater total charge. The implications of these results for the relationships between sprite production, stratiform positive charge layer density and altitude, and stratiform lightning flash rate are currently being examined. Research on these two cases is additionally focused on the key differences (e.g., flash size, flash altitude, etc.) between energetic stratiform +CGs that lead to sprites and related TLEs, and those that do not. The ultimate goal is to better understand why some MCSs produce TLEs more efficiently than other MCSs.