Electrical Discharges in the Overshooting Tops of Five Storms

Intended for the Lightning Occurrence Relative to Meteorology topic

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Individual electrical discharges detected by VHF Lightning Mapping Arrays in the overshooting tops of strong storms typically occur continually at rates of roughly 1 – 10 per second and do not appear to cluster systematically in time or space as flashes. This study analyzed discharges relative to S-band polarimetric radar data and to GOES infrared imagery in the overshooting tops of five storms ranging from moderately strong multicell storms to supercell storms. Although the density of VHF sources in overshooting tops is much less than the maximum densities below the level of neutral bouyancy, the overshooting top typically contained a secondary maximum of density. The onset of discharges in an overshooting top corresponded to an increase in the maximum magnitude and height of reflectivity as the top substantially penetrated the level of neutral bouyancy. Once the discharges began, most were within reflectivities of at least 18 dBZ and formed a dome having geometry similar to that of the dome in reflectivity. Discharges persisted for approximately as long as the reflectivity dome persisted and could last anywhere from a few minutes for short-lived overshooting tops to a few hours for cases with an overlapping series of overshooting tops produced by a succession of updraft pulses. The 99.99th percentile in the height of VHF sources was well correlated (correlation coefficient of at least 0.8) with the height of 18 and 30 dBZ, and the timing of variations in height of these parameters agreed well.

The onset of discharges in an overshooting top preceded the detection of overshooting tops in satellite imagery. The poorer performance probably was the result of the poorer spatiotemporal resolution of cloud-top imagery in the present GOES constellation. Severe weather was either imminent or occurring when discharges were detected in the overshooting top for these cases, especially when the discharges occurred well above the level of neutral bouyancy. Because LMA data have better spatial and temporal resolution than current satellite imagery and are subject neither to the poor vertical resolution nor to the cone of silence of operational radars in the upper portion of storms, detecting VHF sources in overshooting tops may provide a useful complement to enhance confidence in the warning decision process.