Cell-Scale Analysis of Convective Cloud Merging in a Squall Line and the Associated Lightning Behaviour

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The merging process of convective cells in a severe squall line and its impact on lightning behaviour is analysed in detail, by using the observations from the Beijing Lightning Network (BLNET), Doppler weather radar, and other meteorological data. The vertical profiles of the radar reflectivity indicate that the convective cells connected each other through cloud bridges at heights of 3~7 km during the merging process. The lightning data with high spatiotemporal resolution show that the total flash rate dropped immediately at the beginning of the cloud merger, then increased sharply and eventually peaked when the merger finished. A Similar feature was also involved in the cloud-to-ground (CG) lightning activity. At the later stage of the merger, the lightning activity of the cells in the front seemed to be more consistent. It is found that the cell-merging process had significantly different effects on different cells. The cells at the rear of the storm tended to be weakened by the merging and they dissipated thereafter, while the front cells were enhanced substantially with rapid growth in scale and intensity, termed as a rear-cell feeding merger. The dynamic field inferred from the VDRAS (Variational Doppler Radar Analysis System) shows that the updraft was dominant at the front cells of the storm, while downdraft was dominant in the middle and in the lower layers at the rear cells during the merger, as combined with strong low-level wind shear. The inflow contains both the humid air in the lower layer ahead of the cell and the outflow of the rear cells, providing abundant water vapour which favoured the development of the front cells.

Keywords: squall line, convective cloud merger, cloud bridge, lightning activity, radar reflectivity