

Supplementary information

Altitude and polarity transitions of corona activity in thundercloud tops reaching the lower stratosphere

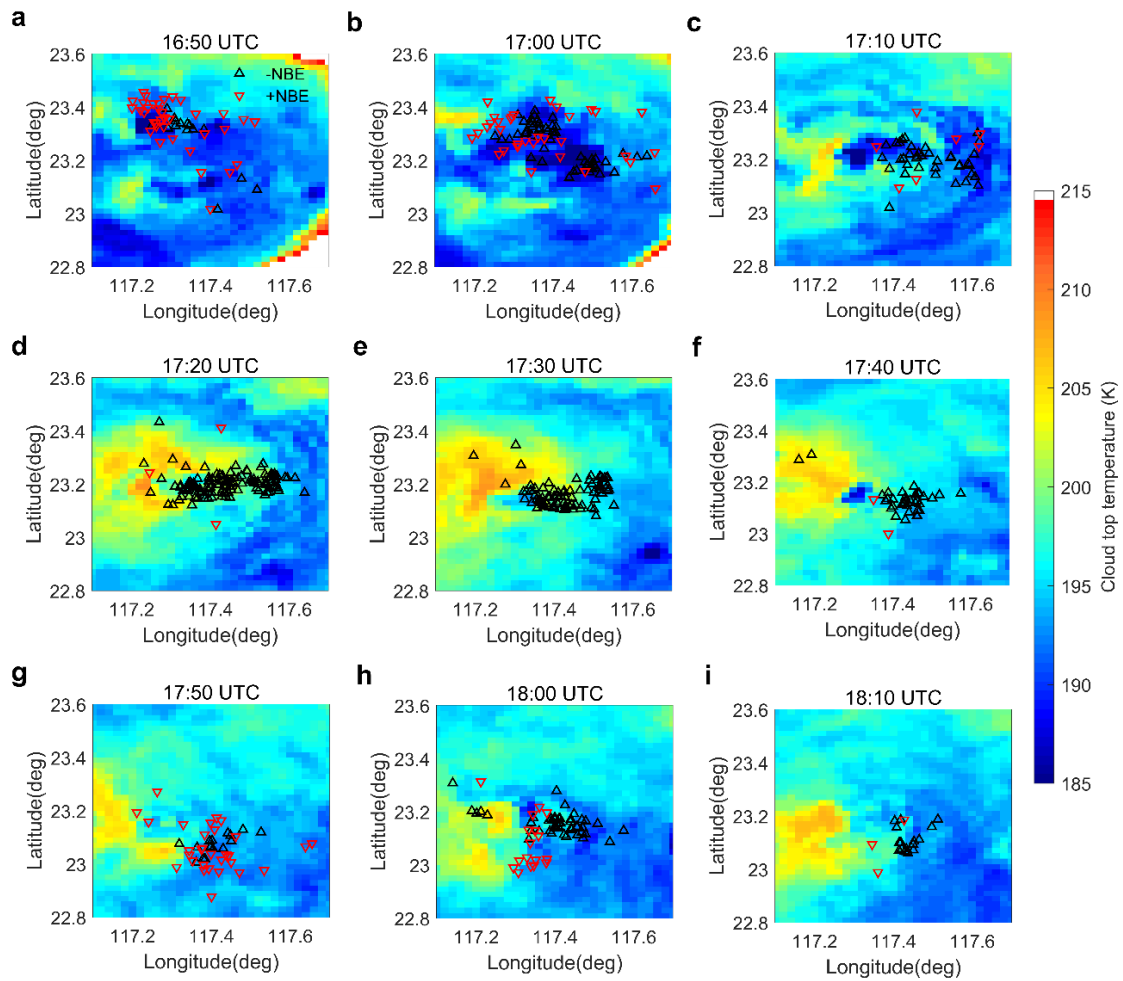
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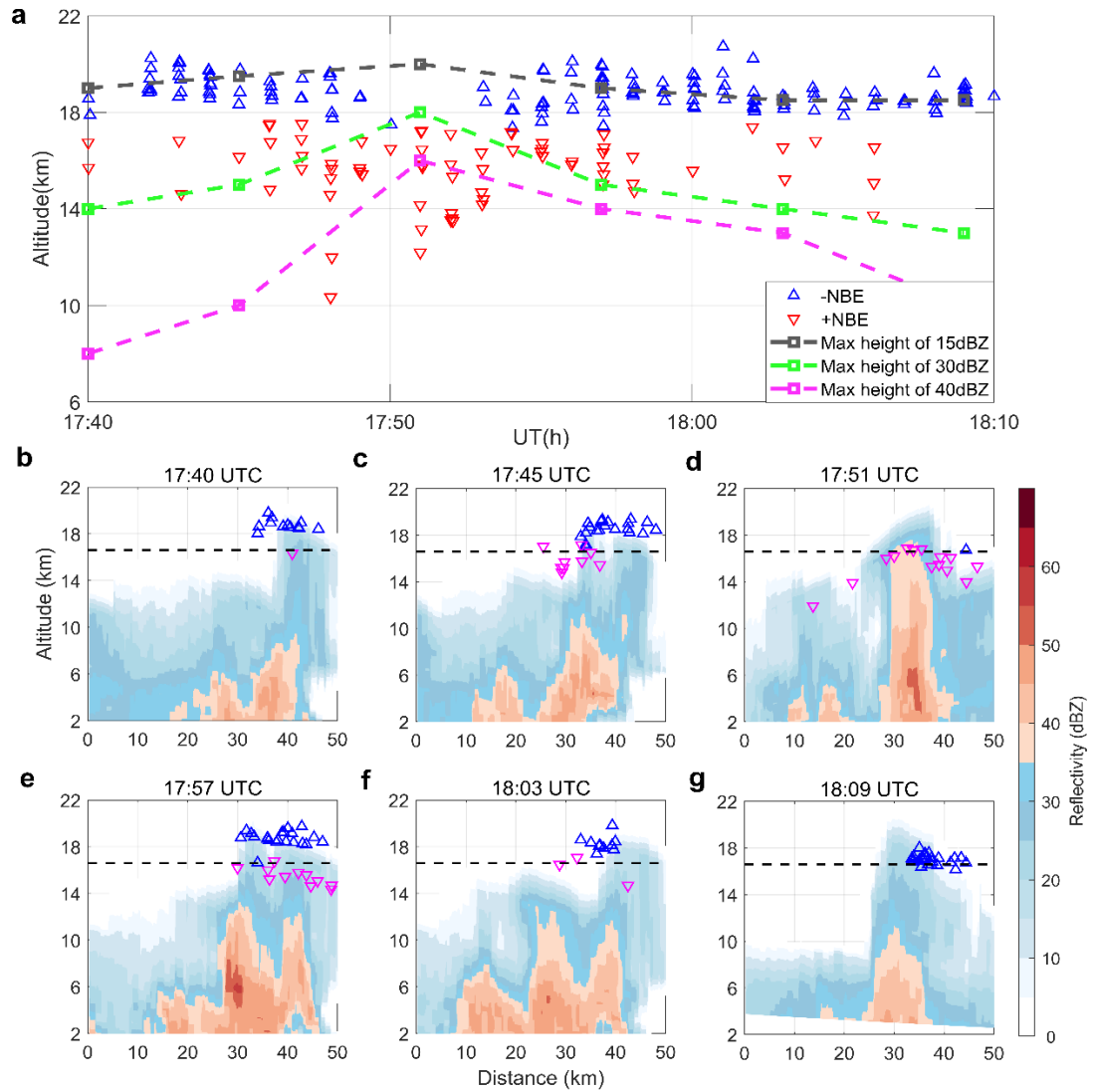
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26 **Supplementary Material:**

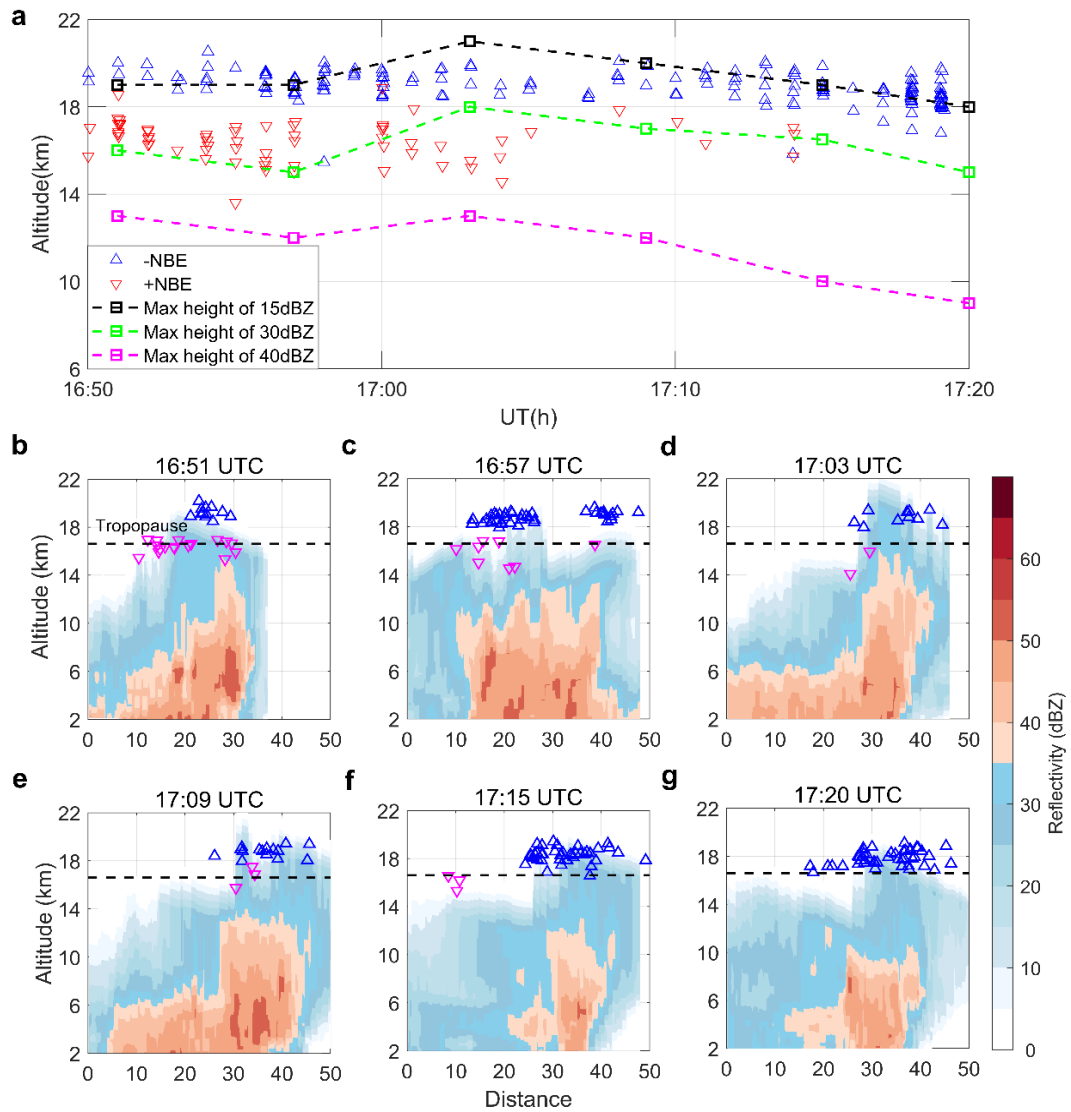
27 • Extended data figures 1-6



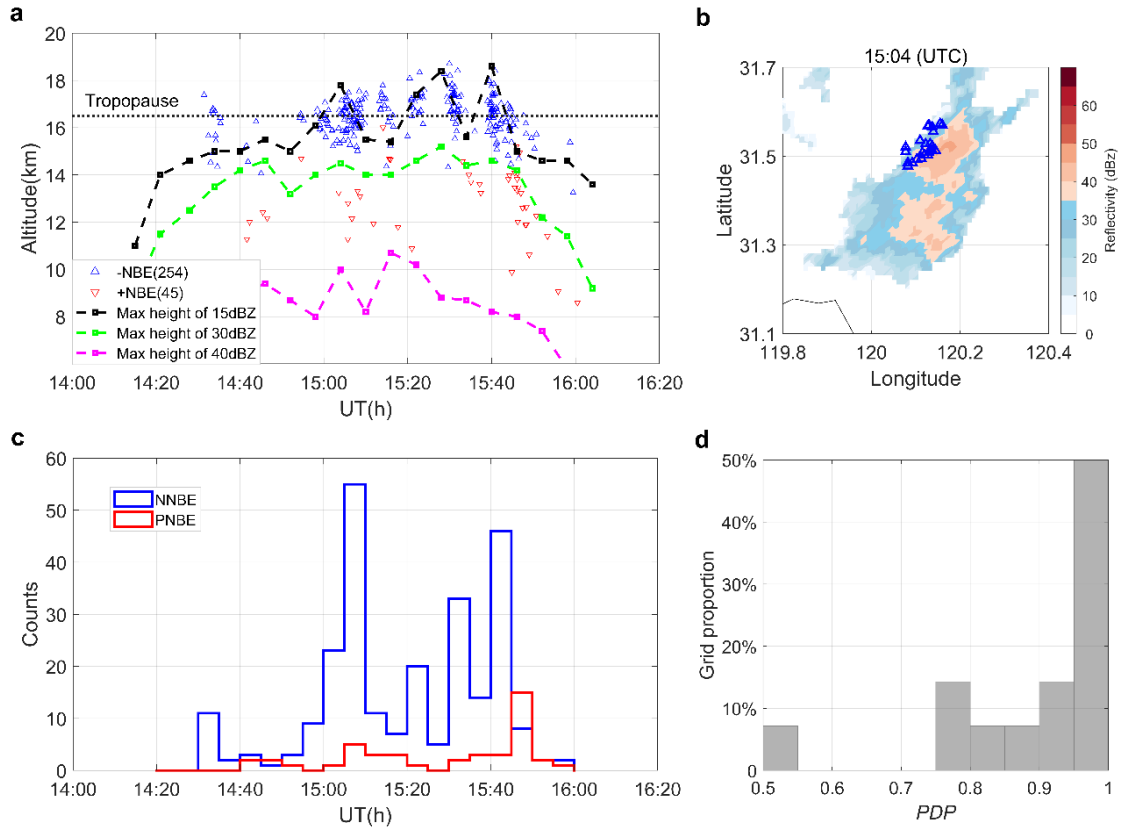
Extended Data Figure 1 | Positions of NBEs overlaid on the cloud top temperature. Black
 ‘ $\triangle$ ’ represents negative NBEs and red ‘ ∇ ’ presents positive NBEs. All NBEs within five
 minutes of the displayed time are shown.



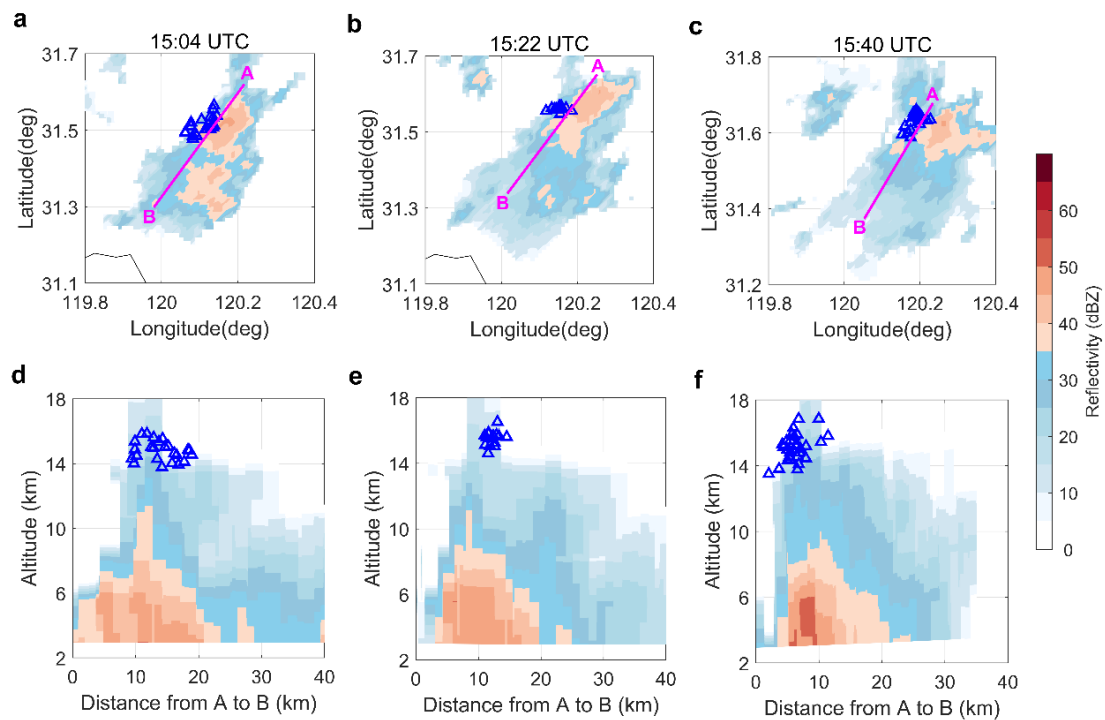
Extended Data Figure 2 | Vertical cross-section of radar along the NBEs outburst during 17:40-18:10 UTC. **a** Evolution of NBEs. The blue ' $\triangle$ ' presents negative NBEs while the red ' ∇ ' represents positive NBEs. The colored dashed line represents the height variations of the reflectivity. The dashed black, green and pink lines present the maximum height of 15 dBZ, 30 dBZ and 40 dBZ derived from the vertical cross-section radar, respectively. **b-d** Vertical cross-section radar profile of NBEs during the upwelling stage. **e-g** Vertical cross-section radar profile of NBEs during the decaying stage. The deep red contour shows a large reflectivity echo (>35 dBZ); the dim blue contour indicated a small reflectivity echo (<35 dBZ). NBEs within 10 km off the cross-section line on the plane position indicator (PPI) are overlaid on the vertical cross-section. The dashed black line shows the tropopause height obtained from sounding data.



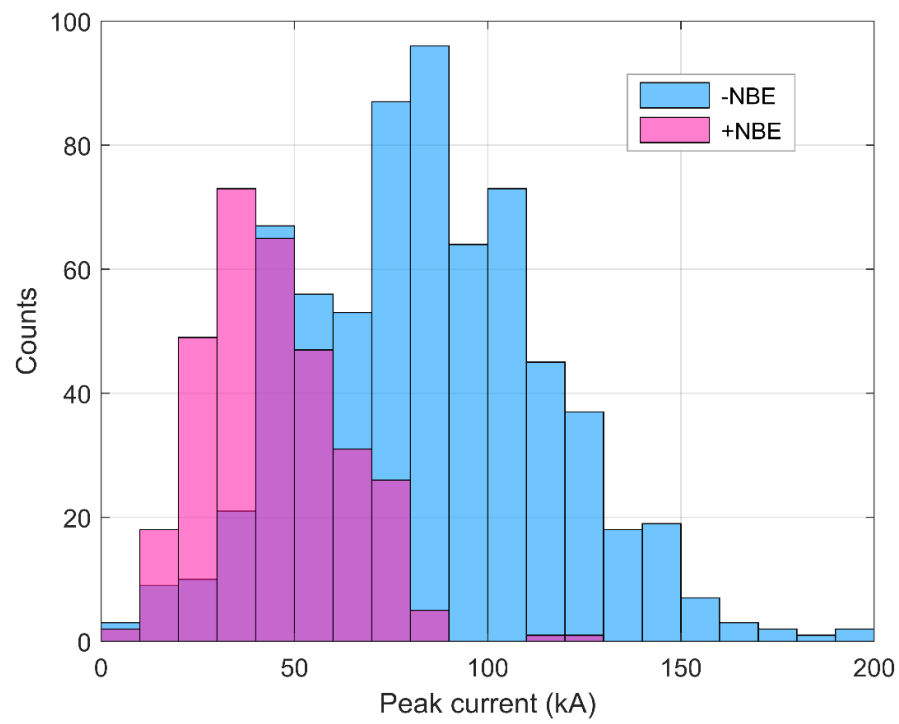
Extended Data Figure 3 | Vertical cross-section of radar along the NBEs outburst during 16:50-17:20 UTC. **a** Evolution of NBEs. The color dashed line represents the height variations of reflectivity. **b-g** Vertical radar profile of NBEs. The deep red contour shows a large reflectivity echo (>35 dBZ); the dim blue contour indicated a small reflectivity echo (<35 dBZ). NBEs within 10 km off the cross-section line on the plane position indicator (PPI) are overlaid on the vertical cross-section. The dashed black line shows the tropopause height obtained from sounding data.



Extended Data Figure 4 | Detailed information of a supercell thunderstorm with the outburst of negative NBEs on August 19, 2012. **a** Evolution of the NBEs and variations of the max height of radar reflectivity. **b** Negative NBEs overlapped on the radar reflectivity. **c** Time series of positive NBEs and negative NBEs, respectively; the time bin size is 5 minutes. **d** Histogram of the proportion of *PDP*. The grid with the sum of NBEs larger than 5 and at least one negative NBE is counted. A total of 35 grids meets the criteria and are used to count the histogram of the proportion of *PDP*.



Extended Data Figure 5 | Vertical cross-section profile for the outbreak of negative NBEs on August 19, 2012. a-c Negative NBEs overlapped on the radar reflectivity. **d-f** Vertical cross-section profile for the outbreak of negative NBEs.



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65 **Extended Data Figure 6 | Peak current distributions of NBEs in tropical storm Haitang.**