The evolution and structure of a long-lived triple-hailfall storm using polarimetric radar in southeast China

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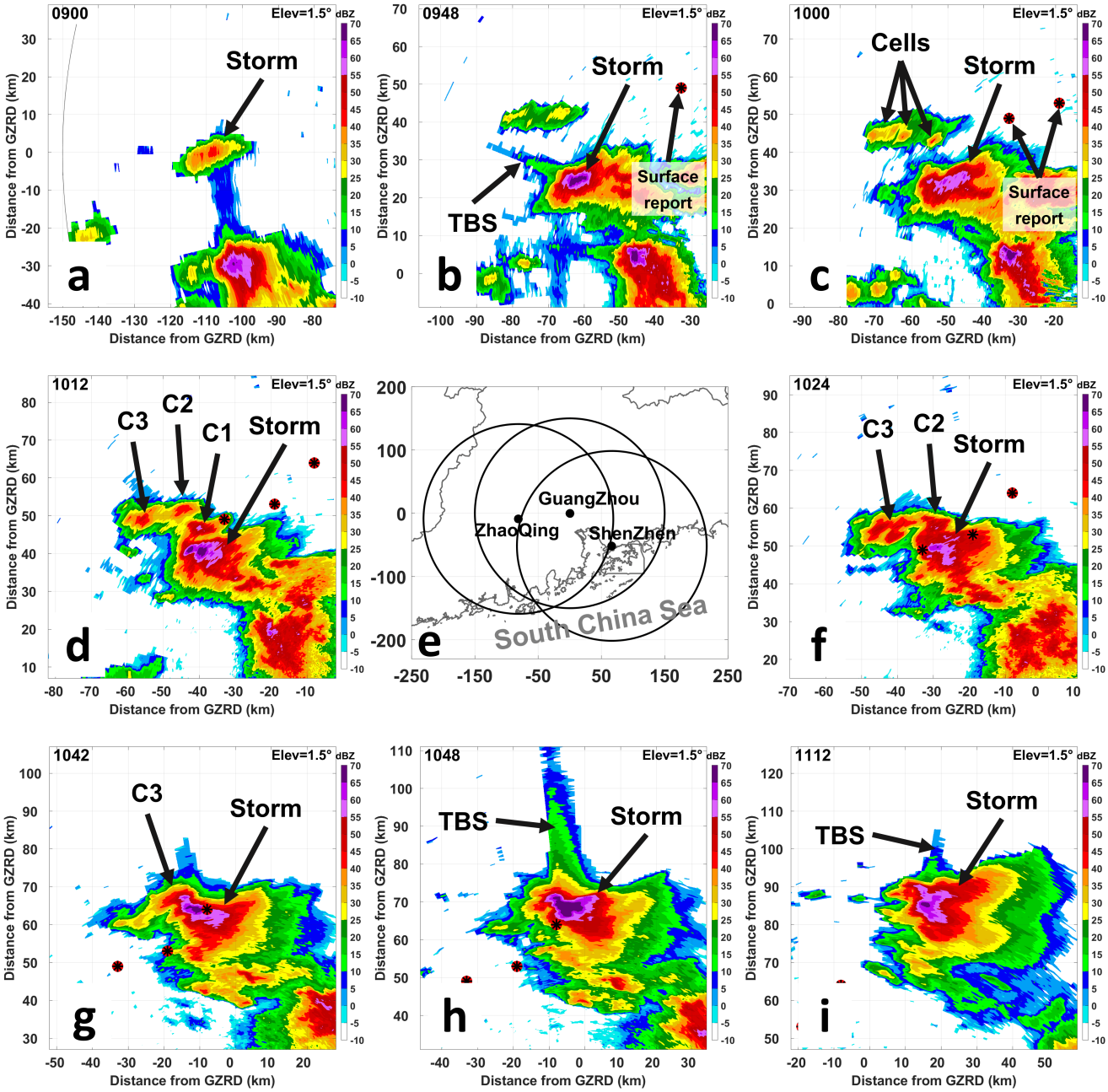
A long-lived hailstorm which presented three hailfall processes was documented using multi-Doppler and polarimetric radar observations in southeast China on 19 March 2016. Such multi-hailfall processes were associated with convective merger of successive cells, when the explosive growth of hailstones occurred after the merger. Prior to the interaction between the hailstorm in study and the convective cells, only one gentle hailfall process was identified, and the system tended to weaken after that. However, two cells were initiated in front of the storm and merged with the storm successively, leading to a slight enhancement of updraft and the second hailfall process. In the meanwhile, a third convective cell developed and merged with the storm, resulting in the third explosive hailfall. The updraft was intensified dramatically exceeding 20 m/s at 8 km AGL, accompanying with the 70 dBZ echo top reached up to 10 km AGL, and the surface hail reports notified the existence of large hailstones (> 2.0 cm). This hail growth process lasted for more than 40 minutes.

The modes of maximum updraft and identified hail area within convective regions (> 35 dBZ) demonstrated high similarity during the third hailfall process, implying the significant role of vertical velocity in generating hailstones kinematically. In addition, supercooled liquid water suggested by Z_{DR} columns provided a favorable microphysical condition for the burst of hail particles. Notably, three types of hail trajectories were identified during the third hailfall process using a simple hail growth model via observational wind fields, where both single up-down path and loop path existed simultaneously. Hail embryos came from at least two places (front-to-rear low level inflow and left-to-right upper level inflow), and about a half effective trajectories started from the left-side of hailstorm in respect to the moving direction where successive cell merger occurred. This implying the relationship between the merger and hail burst that upwind cell might provide extra hail embryos to be transported into the hailstorm for the following hail growth during/after merger. The time lag between merger and hail landed was 20~30 minutes, consisting with the typical temporal scale of hailstones growth.

Such observational case verified the significant impact of merger to the structure and evolution of hailstorm, revealing the interaction between different convective entities kinematically and microphysically. As our modeling results were far from satisfying with respect of hailstorm related to merger phenomena, more polarimetric observational cases were needed for further understanding of physical processes of hail growth.

Keywords: hailstorm, convective merge, microphysical processes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a
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b
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1012
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C2
C1
Storm
d
GuangZhou
ZhaoQing
ShenZhen
South China Sea
e
1024
C3
C2
Storm
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1042
C3
Storm
g
1048
TBS
Storm
h
1112
TBS
Storm
i
dBZ
Distance from GZRD (km)