

29 JUNE 2012 OHIO VALLEY/MID-ATLANTIC DERECHO

A weakly cyclonic west-northwest flow aloft was in place during the morning of 29 June 2012 across the Great Lakes region with a 500 hPa closed low analyzed over northern Ontario (Figure 1). At the surface, a frontal boundary was draped that morning from central Iowa, east through central Indiana and into southern Pennsylvania (Figure 2). Very rich low level moisture was present to the south of the front with the 12 UTC 850 hPa analysis depicting dew points of 15 to 20 Celsius pooling immediately south of the boundary (Figure 3). The 12 UTC RAOBs from both ILX (Figure 4) and ILN (not shown) were indicative of an extremely unstable atmosphere featuring high theta-e parcels just off the surface and nearly dry adiabatic lapse rates in the mid-levels of the atmosphere. Both RAOBs also indicated a sharp decrease in theta-e temperatures just above 800 hPa, resulting in theta-e differentials exceeding 40 Kelvin (K).

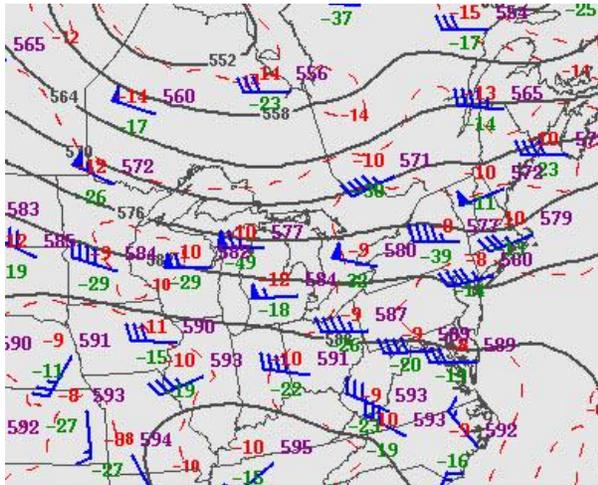


FIG. 1. 500 hPa plot valid on 29 June 2012 at 1200 UTC. Plot courtesy of the Storm Prediction Center (SPC).

Scattered to numerous thunderstorms initially developed that morning over northern Iowa as a low-level jet overrode the surface front. This convection initially shifted northeast with the mean atmospheric flow and was likely elevated in nature. As cold pools began to conglomerate, the convection took a notable turn to the east and began to accelerate across northern Illinois. Several reports of wind damage were received as this relatively compact quasi-linear convective system (QLCS) moved across northern Illinois, including the Chicago metropolitan area.

As this QLCS progressed into western Indiana, it encountered an increasingly unstable atmosphere. The 18 UTC RAP40 initialization indicated MUCAPE values in the 3500-5500 J/kg range from the southern two-thirds of Indiana, southeast through southern Ohio and West Virginia (Figure 5). Theta-e differentials also remained extreme, with an 18 UTC RAOB from Wilmington, OH indicating a low-level theta-e differential

of 42 K (Figure 6). The large values of CAPE and theta-e differentials indicated a high likelihood for a forward propagating system where the mean flow was perpendicular to the gust front. Interestingly, the axis of highest instability and theta-e differentials (not shown) corresponded with the orientation of forward propagating Corfidi vectors (Figure 7). 0-6 km bulk shear across the region was supportive of organized convection with values ranging from 18 to 23 m s⁻¹ (not shown).

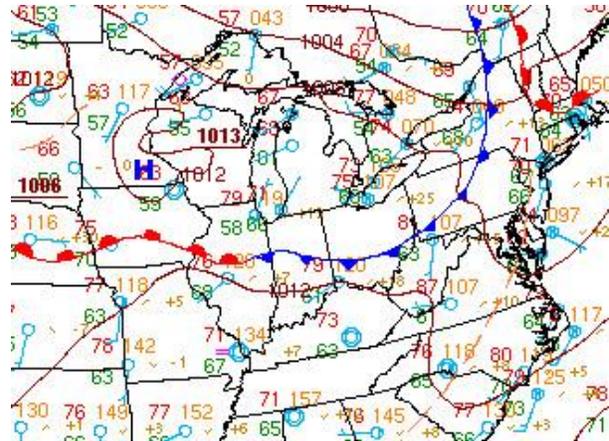


FIG. 2. Surface plot valid on 29 June 2012 at 1200 UTC. Plot courtesy of the Hydrometeorological Prediction Center.

As this line tracked across northern Indiana, the full magnitude of line-normal 0-3 km bulk shear was realized along the bow apex as the vectors were aligned normal to the updraft/downdraft convergence zone (Figures 8 and 9). Line-normal 0-3 km bulk shear magnitudes ranged from 10 to 14 m s⁻¹. Despite the normal orientation to the shear vectors along the bow apex, inspection of North Webster, Indiana (KIWX) radar data indicated that the QLCS appeared to be cold pool dominant in nature as the gust front consistently

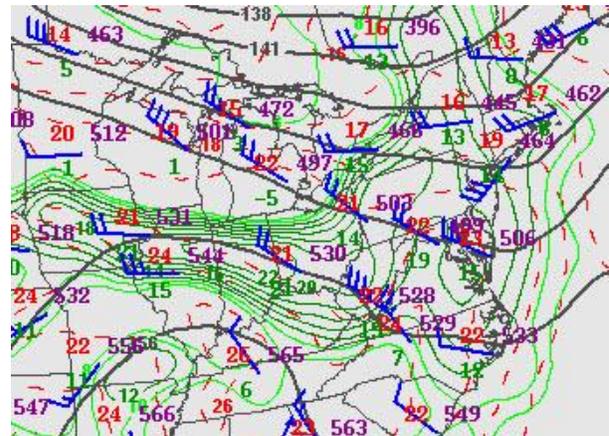


FIG. 3. 850 hPa plot valid on 29 June 2012 at 1200 UTC. Plot courtesy of SPC.

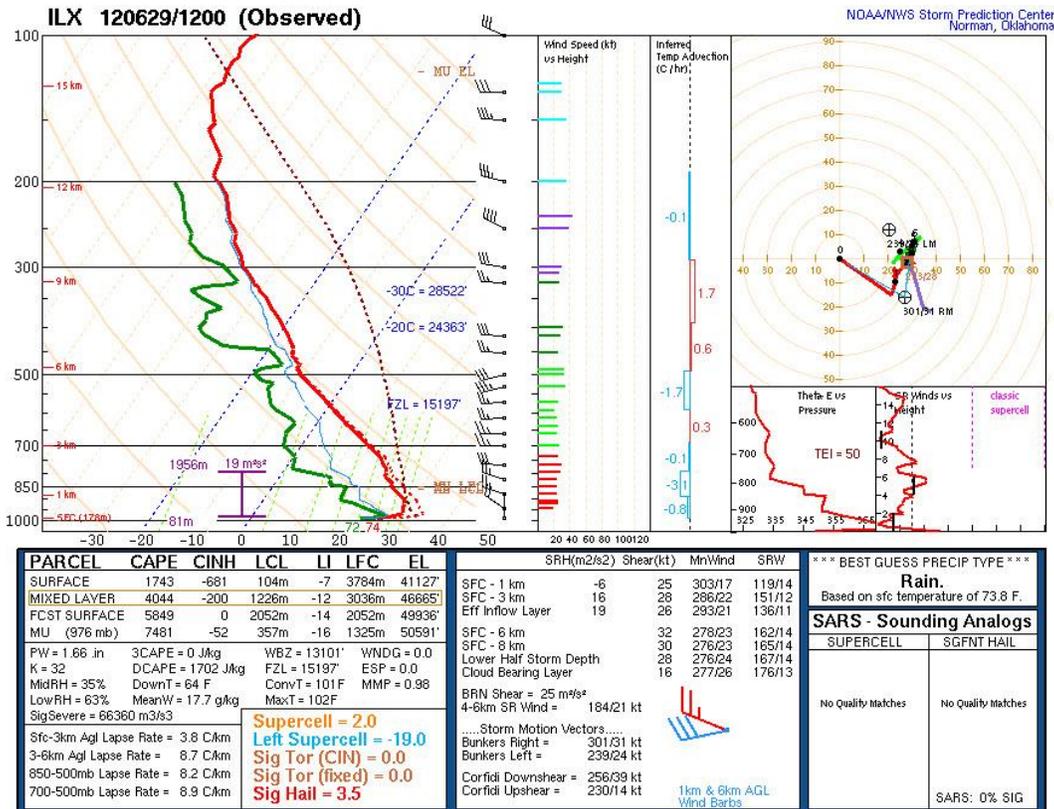


FIG. 4. KILX RAOB valid on 29 June 2012 at 1200 UTC. Image courtesy of SPC.

remained out ahead of vigorous updraft development (Figure 9). The cold pool dominant behavior was likely due in large part to the extreme low-level theta-e differentials in place across the region. As the line passed through Dayton, Ohio, a cold pool pressure rise of 7.1 mb was measured. Using Table 1 from the original manuscript as an approximation for cold pool strength, around 19 m s^{-1} of line normal 0-3 km bulk shear would be required to balance this strong of a cold pool.

This system therefore exhibited only one of the three characteristics required for mesovortex genesis and strong intensification during its lifespan.

- 1) The line was not in balance.
- 2) 0-3 km line-normal bulk shear magnitudes were less than 15 m s^{-1} .
- 3) A bowing structure was present as a rear-inflow jet impinged on the updraft/downdraft convergence zone (Figure 10).

Interestingly, brief mesovortex development was noted on the KIWX radar imagery along the advancing gust front (Figure 9). However, rapid mesovortex intensification was likely mitigated due to the system's outflow dominant nature and a resulting lack of mesovortex stretching. No tornadoes occurred with this event.

As the QLCS progressed to the east-southeast into the Mid-Atlantic States, it maintained cold pool dominant characteristics as low-level shear was too weak to balance the strong system cold pool. Despite the cold pool dominant nature, the orientation of the 0-3 km bulk shear vectors and resulting line-normal low-level shear magnitude likely played a key role in maintaining this system as it tracked over 1000 kilometers. Constructive interference between the system cold pool and ambient low-level shear lifted parcels above the level of free convection in what was a weakly capped environment. An incredible swath of wind damage occurred with this system as it tracked from eastern Iowa into the Ohio Valley and Mid-Atlantic regions (Figure 11). This included numerous wind gusts measured at or above 33 m s^{-1} .

ACKNOWLEDGEMENTS

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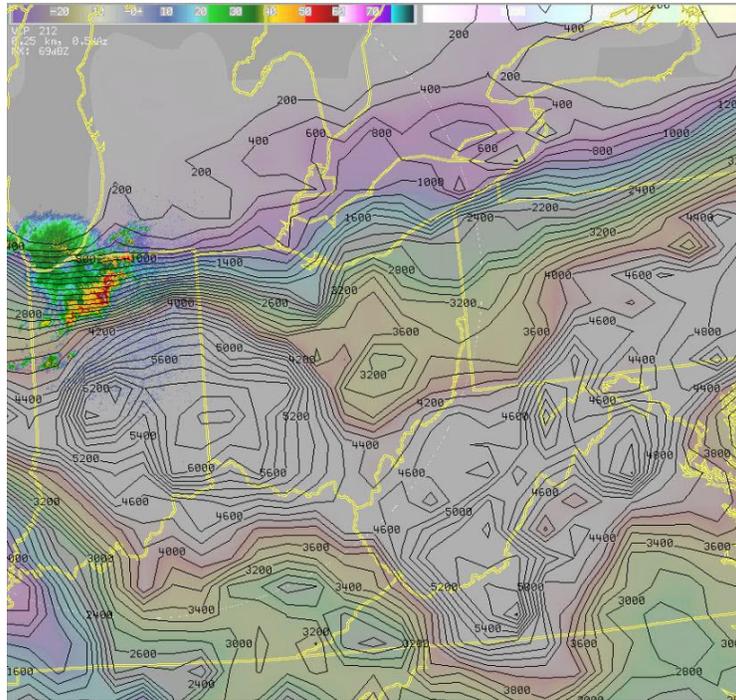


FIG. 5. KIWX 0.5° Z image valid on 29 June 2012 at 1759 UTC. RAP40 MUCAPE ($J\ kg^{-1}$) is depicted by black contours.

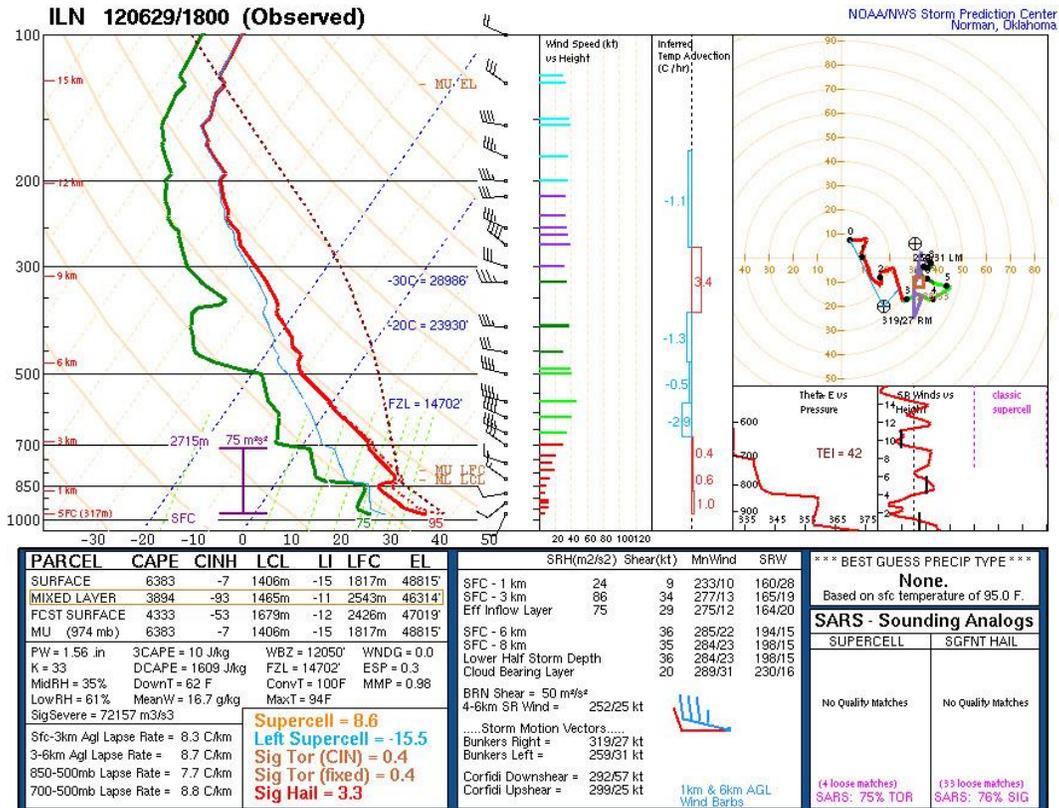


FIG. 6. KILN RAOB valid on 29 June 2012 at 1800 UTC. Image courtesy of SPC.

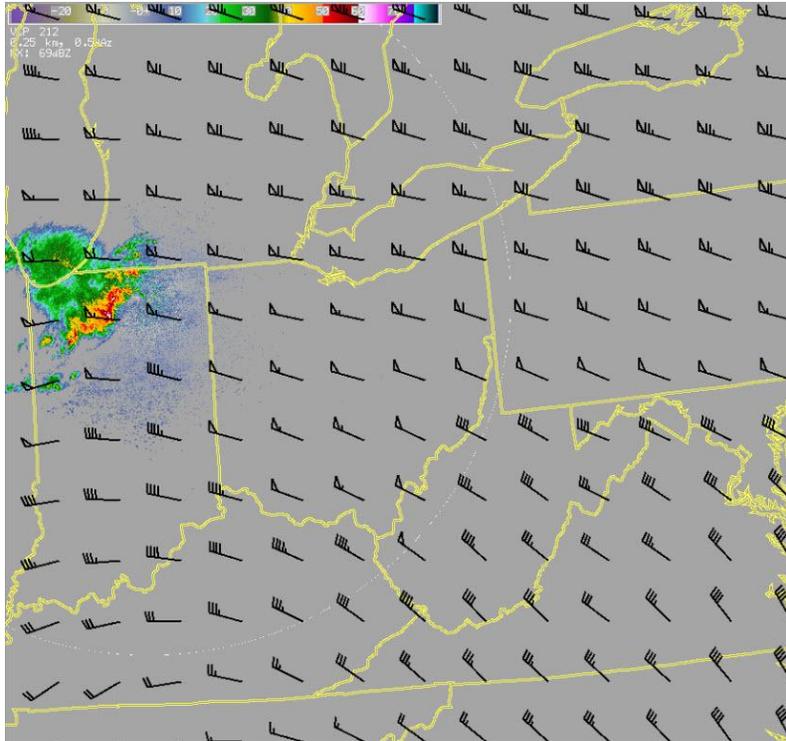


FIG. 7. KIWX 0.5° Z image valid on 29 June 2012 at 1759 UTC. RAP40 forward propagating Corfidi vectors (knots) overlaid in black.

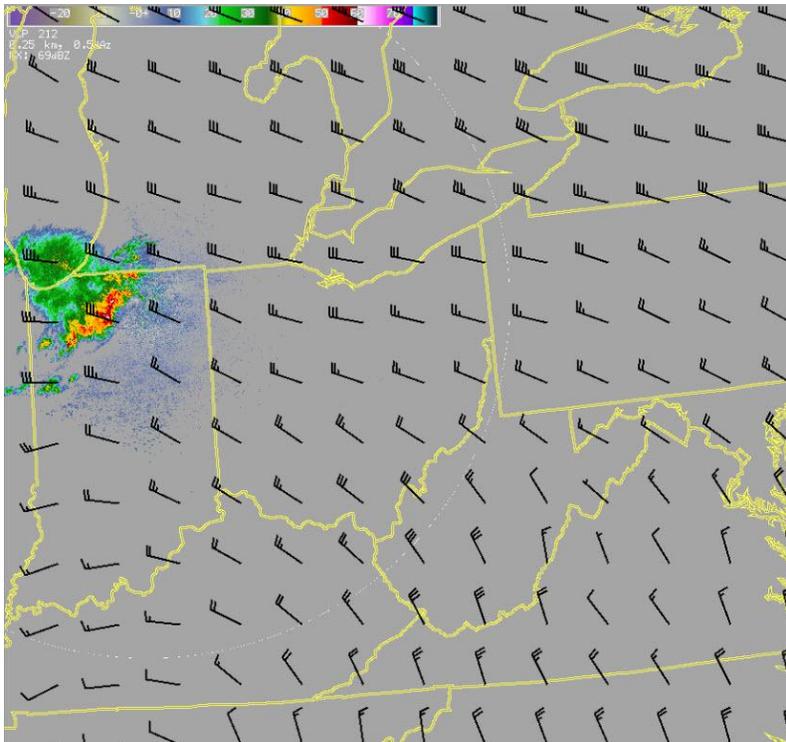


FIG. 8. KIWX 0.5° Z image valid on 29 June 2012 at 1759 UTC. RAP40 0-3 km bulk shear vectors (knots) overlaid in black.

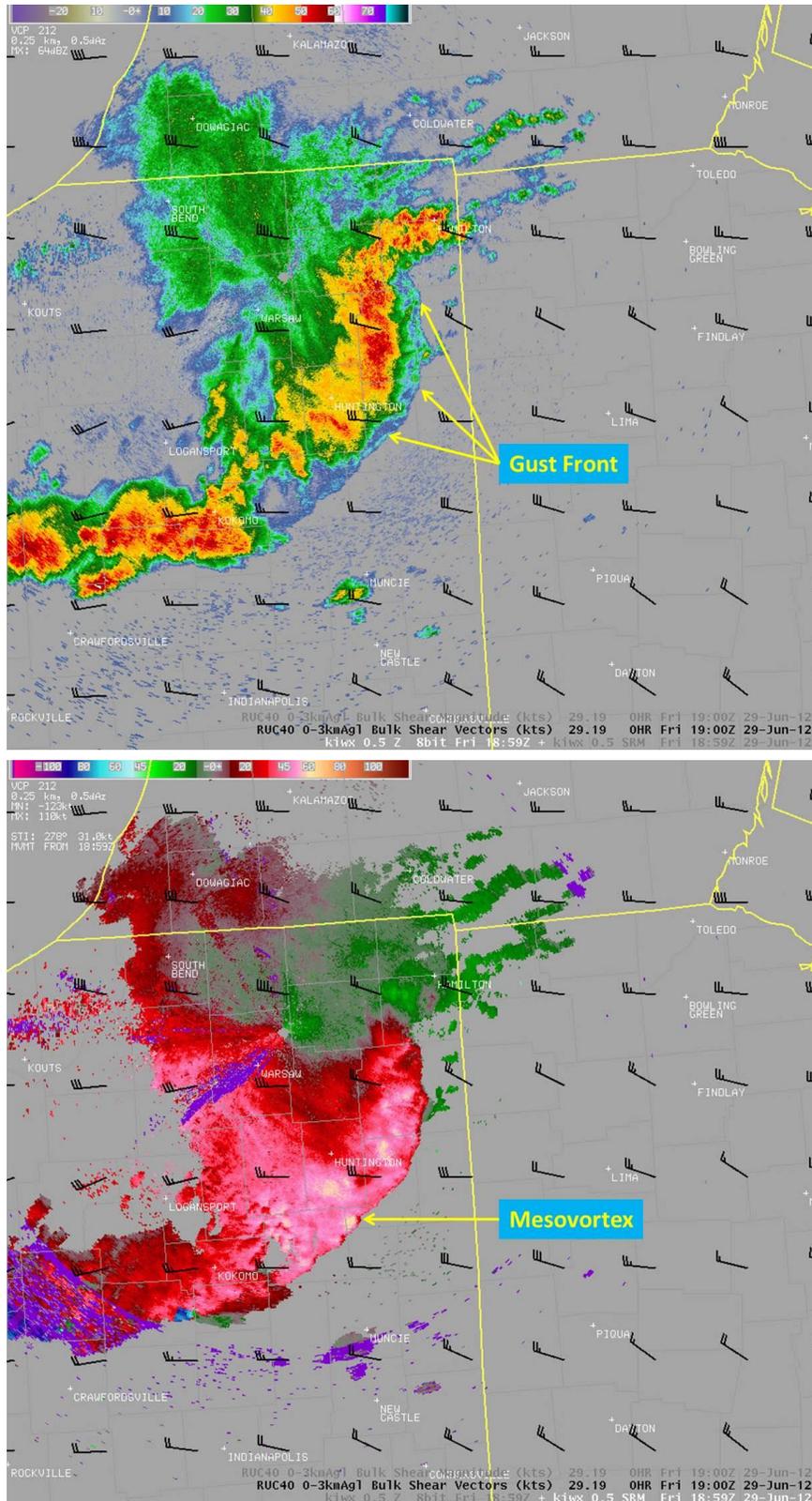


FIG. 9. KIWX 0.5° Z/SRM images valid on 29 June 2012 at 1859 UTC. RAP40 0-3 km bulk shear vectors (knots) overlaid in black.

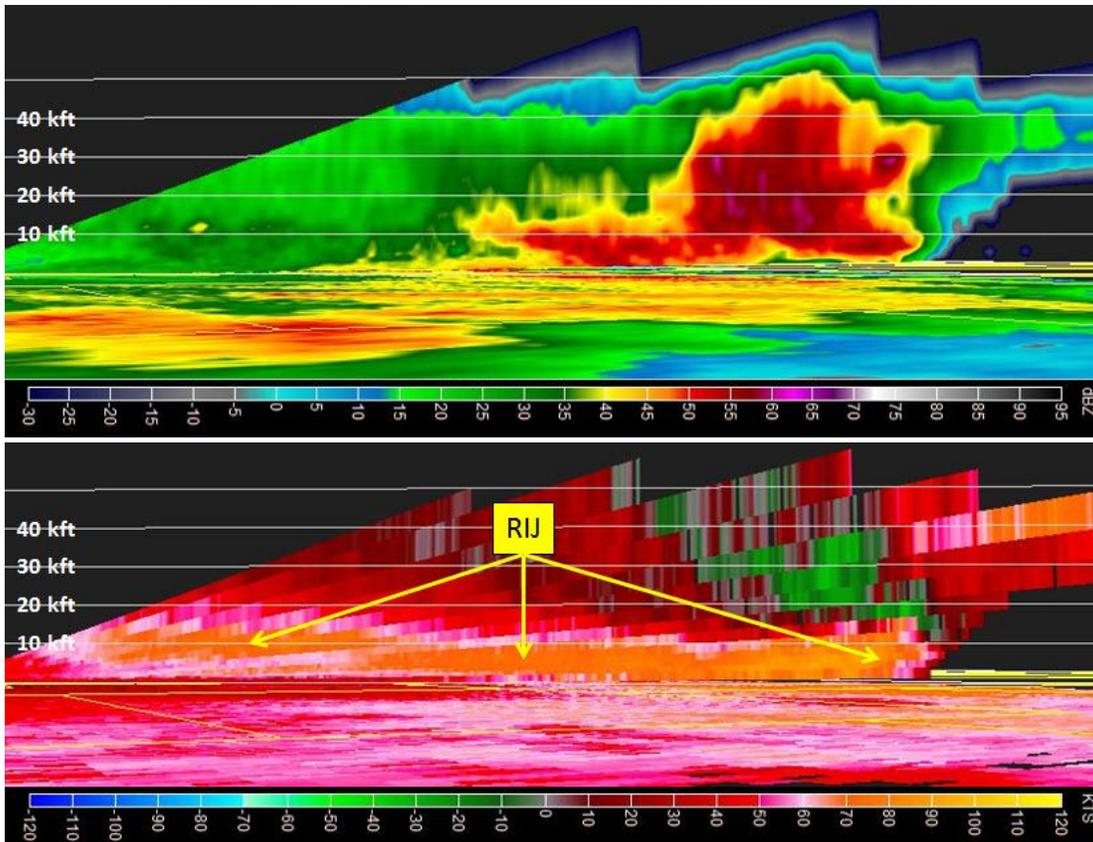
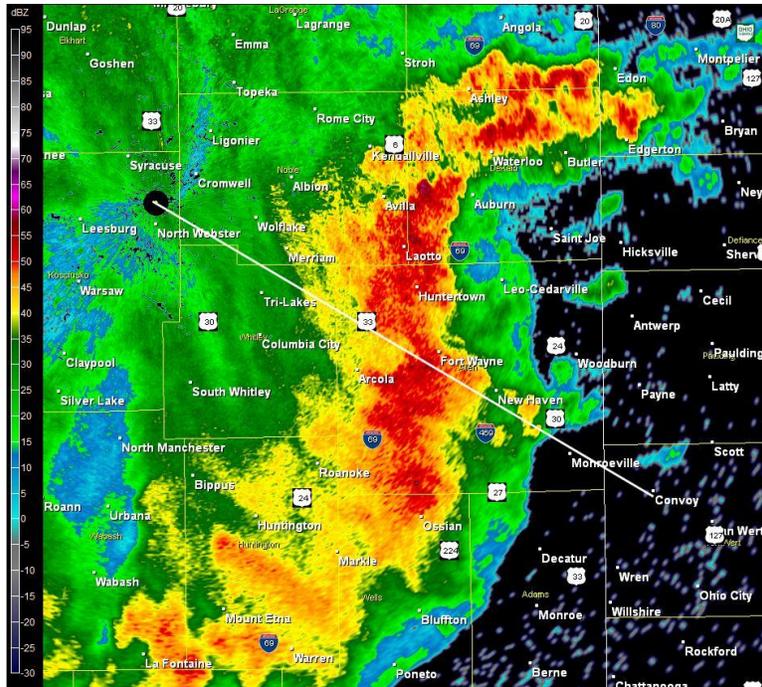


FIG. 10a. Radar cross-sections of the convective line to the southeast of the KIWX radar site. The cross-section slice is denoted in the top image. The middle image depicts a reflectivity cross-section while the bottom image depicts a radial velocity cross-section. In these images, the main convective towers are rooted well behind the updraft/downdraft convergence zone (UDCZ). The RIJ is readily apparent as it impinges on the UDCZ. Radar images created with Gibson Ridge Level 2 software.

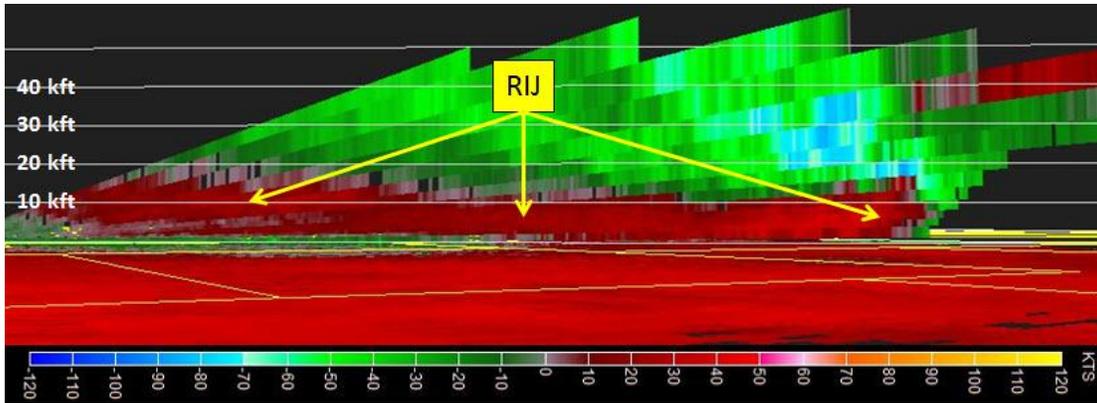


FIG. 10b. As in Figure 10a, but using storm relative motion. Radar image created with Gibson Ridge Level 2 software.

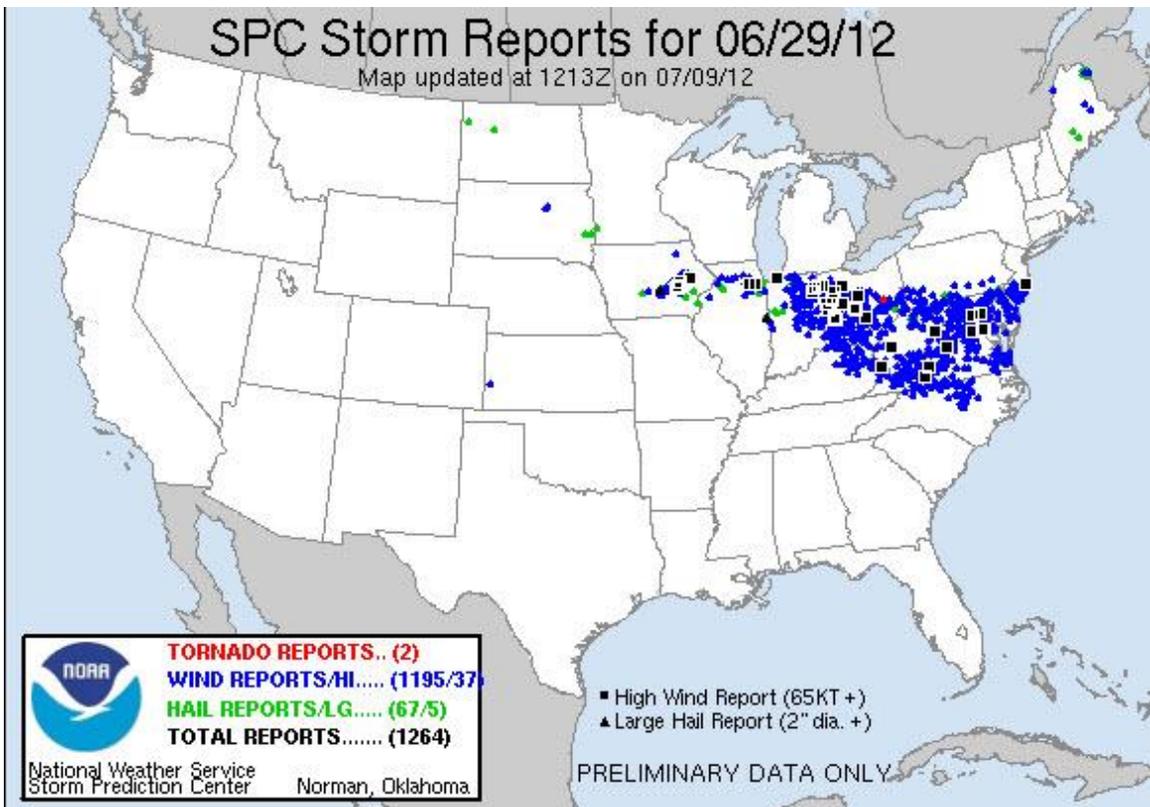


FIG. 11. Preliminary storm reports from SPC. Despite the two preliminary reports of tornadoes in eastern Ohio, storm surveys revealed that the damage was caused by straight-line winds.