A Not-So-Elevated Supercell from the Quad Cities-to-Chicago Area on 4 April 2023

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Introduction

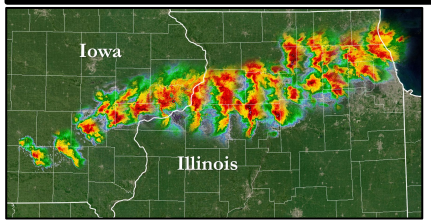

Figure 1: Evolution of the supercell as seen in 30-minute time steps over a 6-hour period as it tracked from eastern Iowa to the Chicago metro area. Note the right hand turn as the storm reached the Mississippi River.

- In the early morning hours of April 4th, a strong thunderstorm developed across southeast Iowa and became a supercell as it progressed eastward. This storm produced large hail of golf ball to tea cup size as it moved across Muscatine and Davenport, Iowa.
- As the supercell entered the Quad Cities metro, subtle hints of a downdraft surge were noted on radar velocity and were confirmed as a 90 MPH wind gust was measured at the Quad Cities International Airport in Moline, IL. This surge would also go on to spawn four separate tornadoes in and near the Illinois Quad Cities metro. The parent supercell, along with eventual other supercells, continued into the Chicago metro re-acquiring more of large hail threat.

Figure 2: Very brief (<1 mile) EF-2 Tornado Surveyed Through Colona, IL and confirmed via webcam.

Figure 3: Tornado Damage Surveyed in Colona, IL

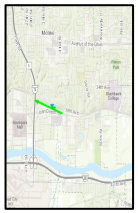

Figure 4: EF-1 Tornado Surveyed 1 S Moline, IL

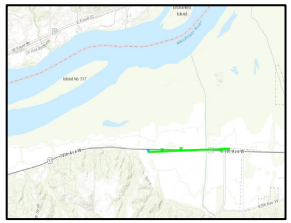

Figure 5: EF-1 Tornado Surveyed 3 E of Andalusia, IL

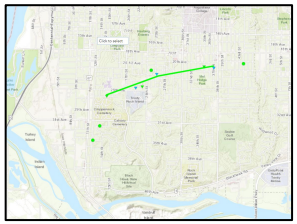

Figure 6: EF-1 Tornado Surveyed Through Rock Island, IL

- A stable layer was present at the surface and low-levels as noted in the KDVN 1200 UTC sounding. This would "typically" act as a cushion and keep higher winds from reaching the ground. However, ongoing research into elevated convection conducted in recent years has discovered potential scenarios of where strong downdraft winds could reach the surface in "elevated" storms, mainly through gravity waves.

Meteorological Analysis

- 1200 UTC sounding from KDVN showed a temperature inversion denoting a stable layer extending from the surface to about 4kft (1.2 km) above the ground.
- Radar velocity confirmed this abrupt inversion with a sharp turning in winds from easterly to west-southwesterly.

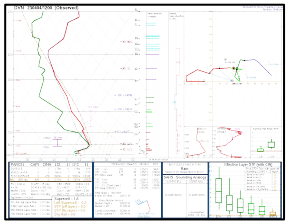

Figure 7: KDVN Sounding Taken 4 April 2023 12Z

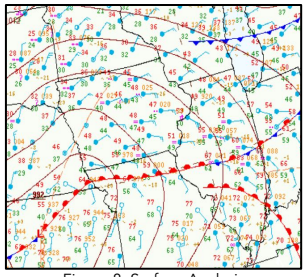

Figure 8: Surface Analysis 4 April 2023 15Z

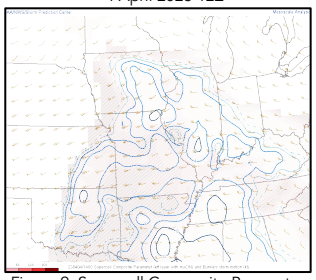

Figure 9: Supercell Composite Parameter & Bunkers Right Motion 4 April 2023 15Z

- At 1400 UTC, SPC mesoanalysis revealed the Quad Cities on the northern edge of a robust MUCAPE gradient and surface warm front over northern Missouri. Bunkers Right Storm Motion is favored more easterly around 20 kts, providing effective inflow layer winds along the tight thermal and instability gradient.
- As the storm progressed northeast towards Muscatine, IA, movement began to align more along the Bunkers Right vector, hinting at potential the storm was beginning to latch onto a layer closer to the surface. Radar reflectivity had shown the storm splitting just south of the Cedar Rapids metro before beginning the right turn.
- Around 1430 UTC, hints of a damaging wind signature were appearing on KDVN at 1200-1500 ft AGL near Buffalo IA and Andalusia IL. This would work its way to the ground in the next 10-15 minutes.
- Quad Cities International Airport recorded a **90 MPH wind gust** as the supercell passed overhead. Of equal interest, is the surface observation data in the below right figure taken before, during, and after the storm's passage. Note the altimeter and wind changes..

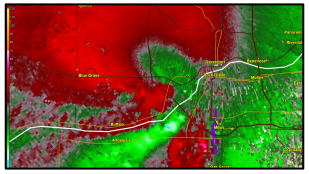

Figure 10: KDVN Velocity 4 April 2023 1437 UTC

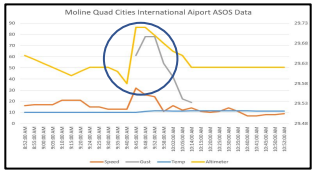

Figure 11: KMLI ASOS Data From 852 AM to 10:52 AM CST

Past Work & Ties To Current Research

- A great deal of literature exists on elevated convection, how it typically evolves, and potential hazards (Fujita 1981, Parker 2008, Reif and Bluestein 2017).
- Horgan et al. 2007 found that the most common severe weather reports from elevated convection were associated with damaging hail with a secondary report of damaging surface winds. However, there was not much literature on why surface winds were a hazard at all.
- Recent work from NWS and research from CSU (presentation made recently from Brett Borchardt, NWS Chicago) on damaging winds with elevated convection are hinting at potential storms being influenced by gravity waves.

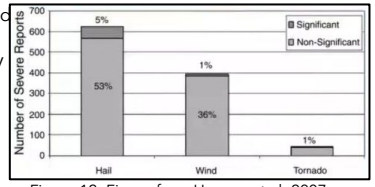

Figure 12: Figure from Horgen et al. 2007 on severe reports from elevated convection

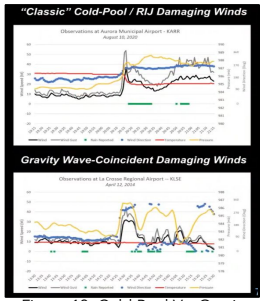

Figure 13: Cold Pool Vs. Gravity Wave Obs (Borchardt et al. 2023)

- Surface observations from cases in this recent work were rather unique. It was stated by the authors that damaging winds were concurrent with a jump in surface pressure and a change in wind direction, but little to no change in temperatures values. This situation is not typical of downbursts or cold pools, but consistent with *gravity waves*.
- Observations were similar at Moline, IL on April 4, and given the lack of widespread wind damage during much of the storm track, confidence is high gravity waves provided some influence.

Future Work

- A goal of this project is to foster collaboration and discussion within the meteorological community for more focus and awareness of this deceptive severe wind and tornado potential, especially to meteorologists in charge of issuing convective warnings.
- Collaboration between the NWS and research community on published research as data is collected on cases in the next few years.

References & Contacts

- Horgan, K. L., D. M. Schultz, J. E. Hales, S. F. Corfidi, and R. H. Johns, 2007: A five year climatology of elevated severe convective storms in the United States east of the Rocky Mountains. Wea. Forecasting, 22, 1031-1044.
- Borchardt, B., P. Schaltter, R. Schumacher, K. Sherburn, 2023: Elevated Convection: Radar Signature and Possible Mechanism for Damaging Surface Wind Production, *NWS Central Region Guest Speaker Series*

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