



A Not-So-Elevated Supercell from Eastern Iowa to the Chicago Area on 04 April 2023

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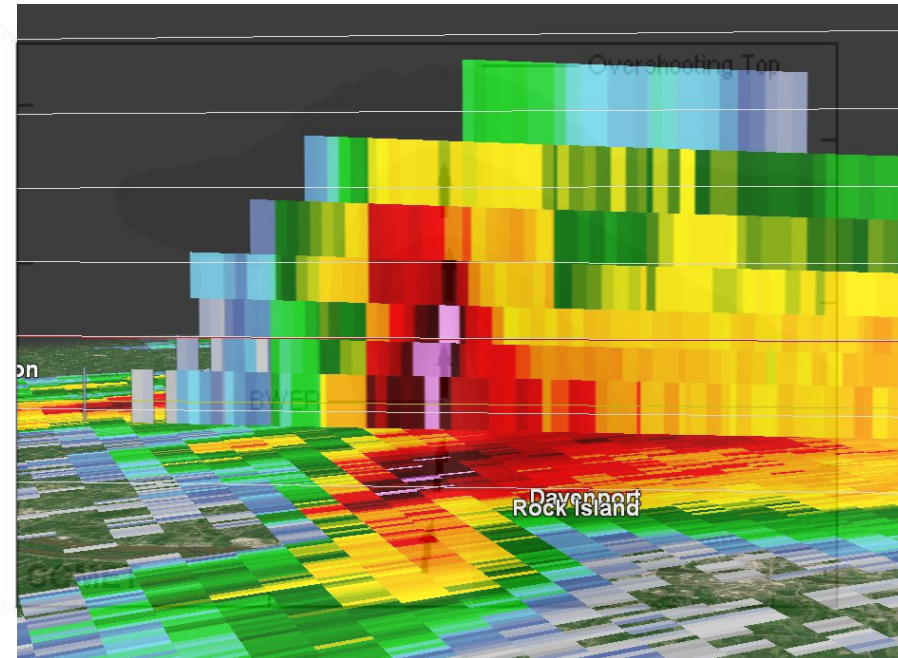




Goals of this Presentation

Outline

1. The significance of this prolonged supercell
2. Think about the challenging in recognizing a low confidence yet high impact signal
3. Expecting the traditionally unexpected: “elevated” supercells can at times produce severe winds, at times significant
4. Messaging and warning takeaways that others can use from this event

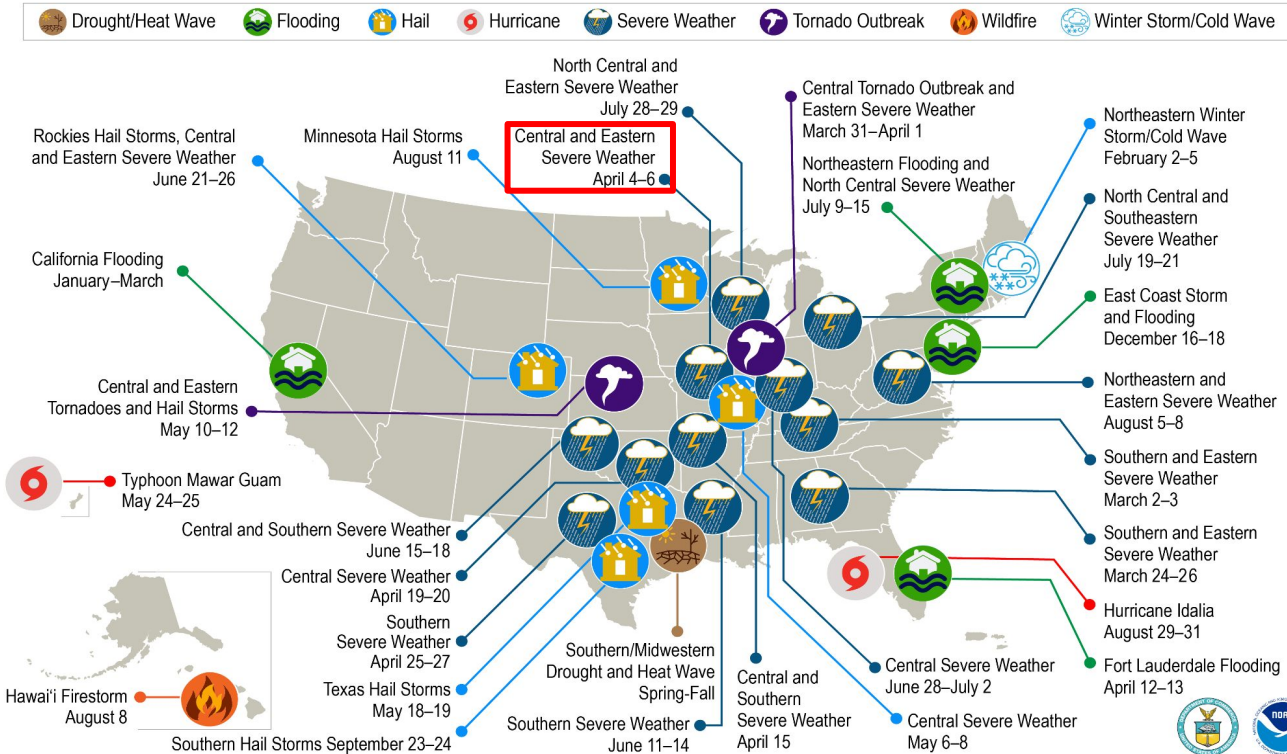




April 4, 2023: Part of a Billion \$ Weather Disaster

2023 Billion \$ Weather Disasters (NCEI)

U.S. 2023 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 28 separate billion-dollar weather and climate disasters that impacted the United States in 2023.

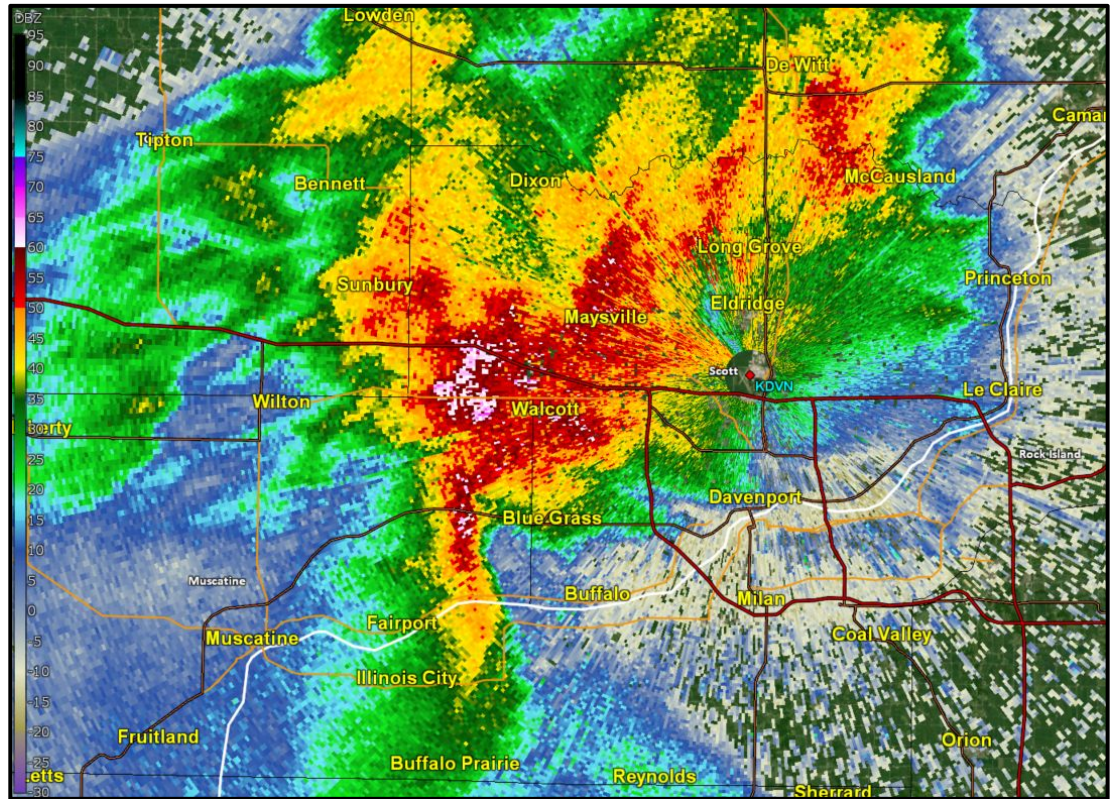




So What Happened on the Morning of April 4?

Overview

- Lone supercell at first in southeast IA transitioned into an eventual family of supercells in north central into northeast IL
- Event duration from 7:00 A.M. - 1:30 P.M. CDT across the NWS Quad Cities and Chicago CWAs
- Approximately 250 miles eclipsed from west to east
- Will show next a storm-centric reflectivity loop from both KDVN and KLOT of the primary supercell during that time window at ~5 min intervals

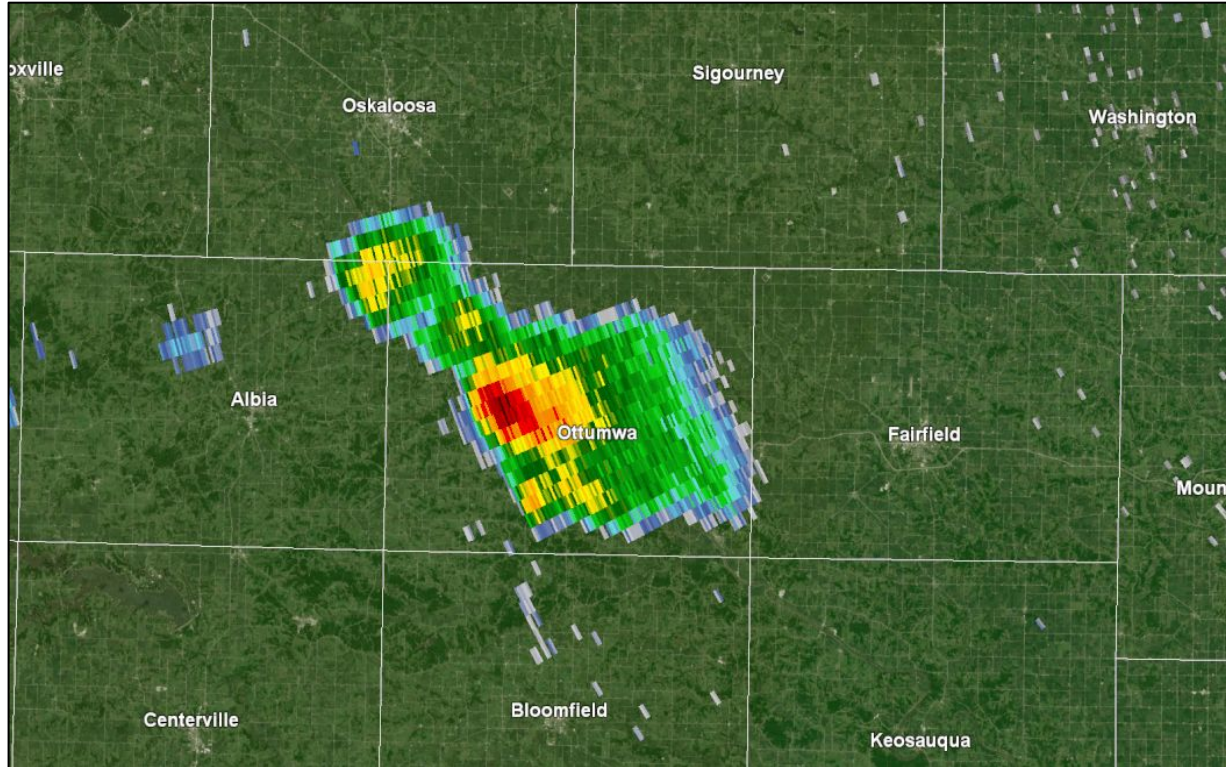




Storm-Centric Radar Loop

7:00 A.M. - 1:30 P.M. Reflectivity Loop

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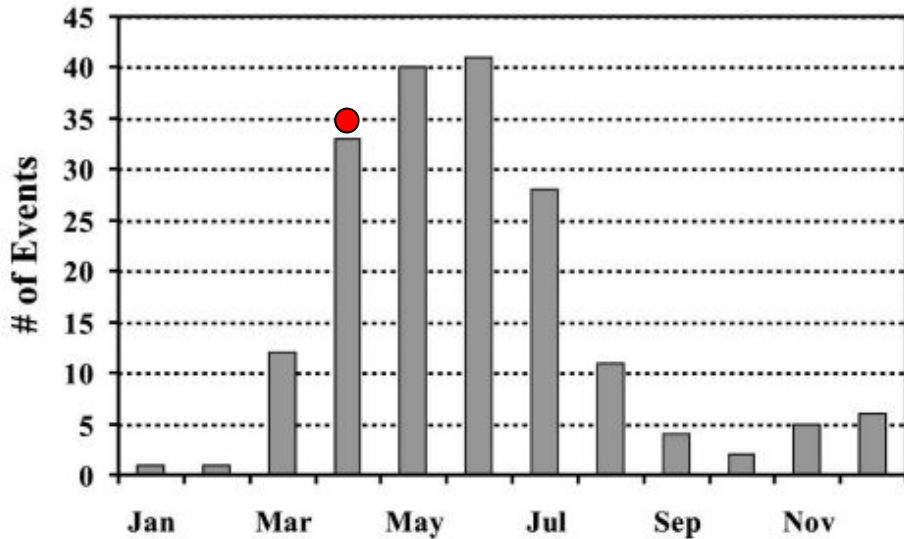


Long-Lived Supercell Climatology

Bunkers et al. (2006)

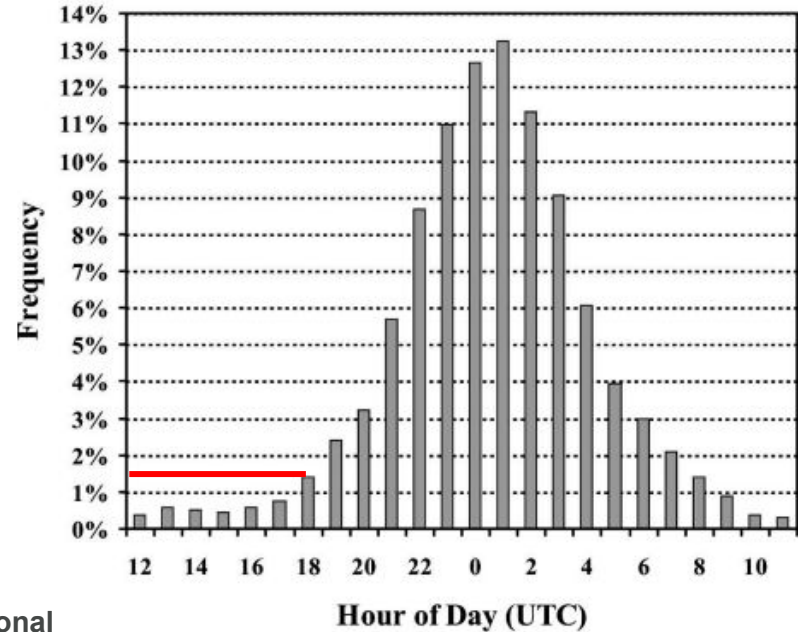
Time of Year

Long-Lived Supercell Events



Time of Day

Long-Lived Supercell Events



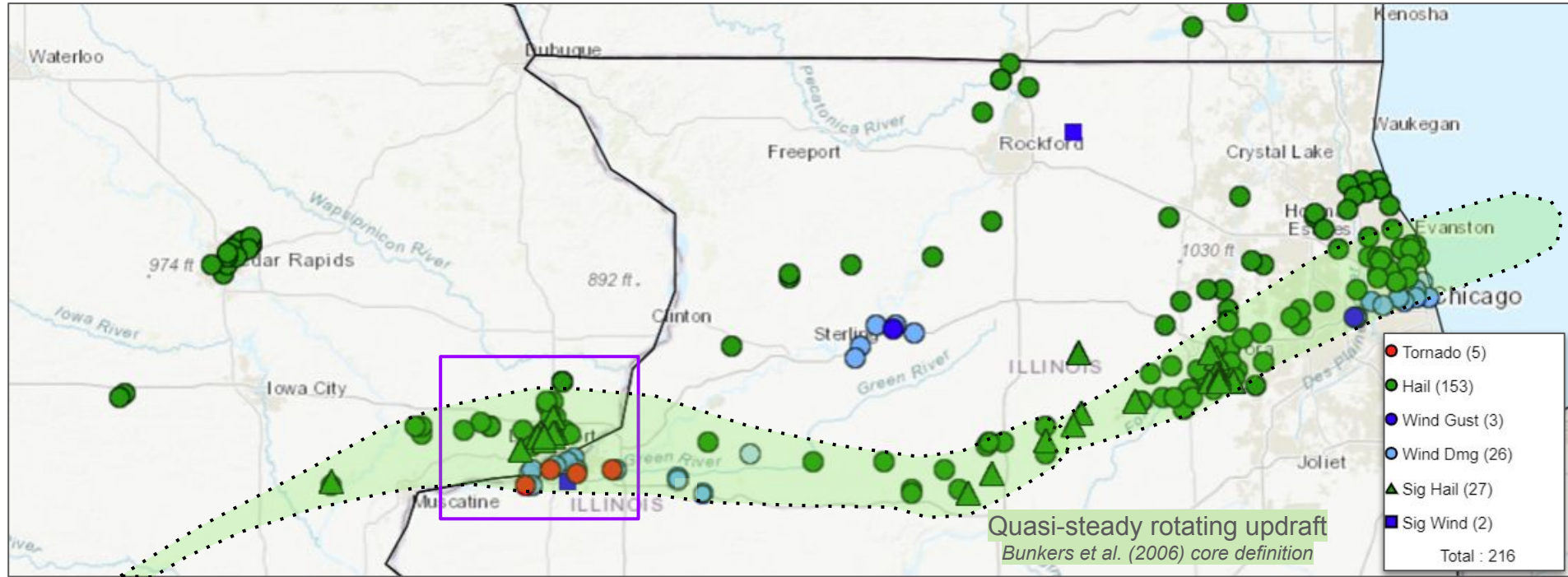
From: Bunkers M. J., M. R. Hjelmfelt, and P. L. Smith, 2006: **An Observational Examination of Long-Lived Supercells. Part I: Characteristics, Evolution, and Demise.** *Wea. Forecasting*, 21, 673–688. [Link](#)





April 4, 2023 Observed Swath of Severe Weather

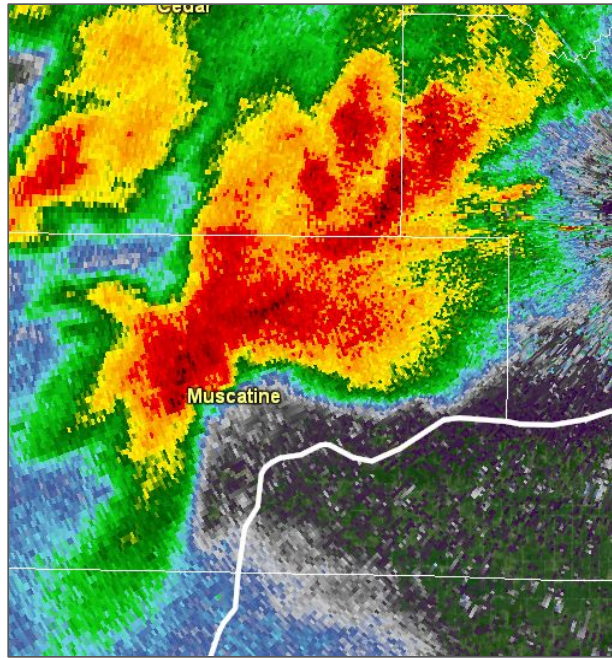
Storm Reports



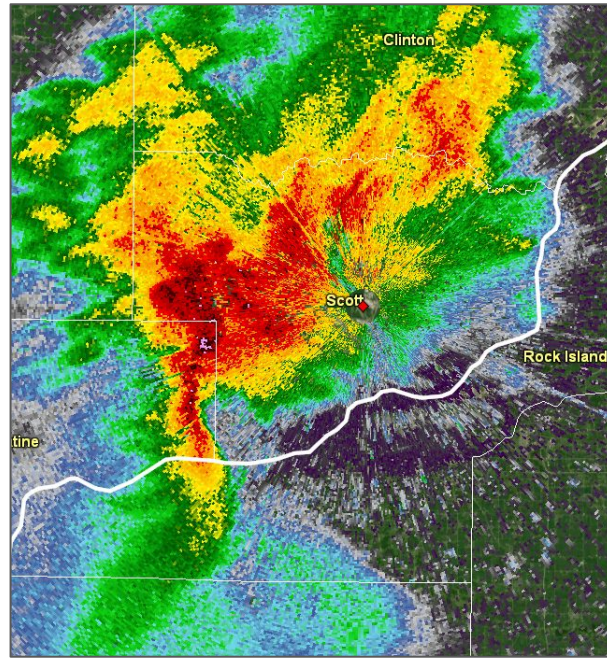


April 4, 2023: Radar vs Storm Reports

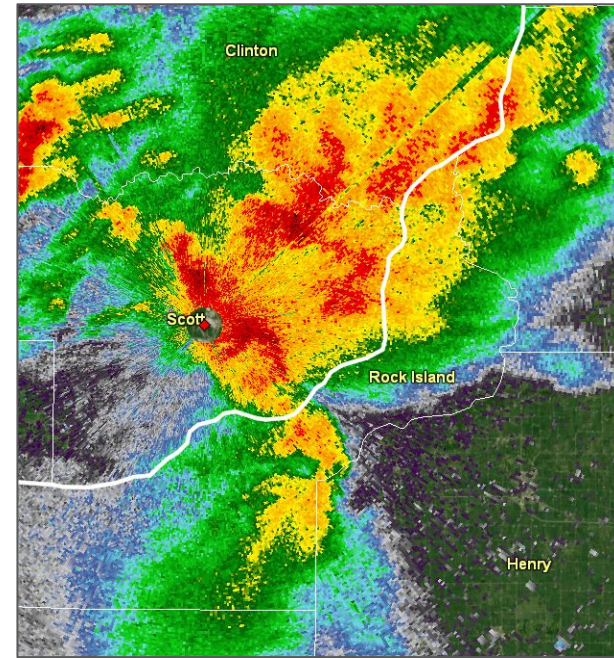
Images 30 Minutes Apart



Storm Motion: ➡
Severe Weather: Hail



Storm Motion: ➡
Severe Weather: Sig Hail



Storm Motion: ➡
Severe Weather: Sig Hail & Sig Wind





April 4, 2023: Observed Large Hail

Storm Photos



Courtesy: Rebecca Kopelman, KGAN,
Marian, IA



Courtesy: Andy Ervin, Davenport, IA



Courtesy: Maureen Murray,
Davenport, IA

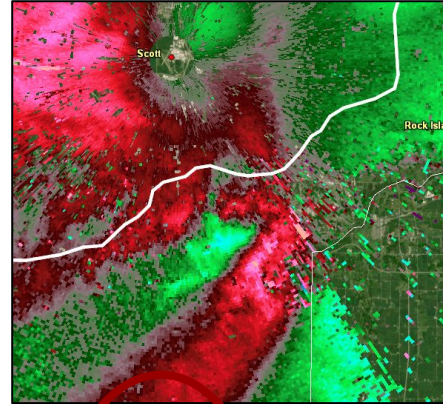




April 4, 2023: Transition of Severe Threats

Hail → Wind

- As the supercell entered the Quad Cities metro, signs of a downdraft surge as well as an increase mesocyclone were noted on velocity
- 90 MPH wind gust measured at KMLI 1448Z
- Four separate tornadoes formed in the Illinois side of the Quad Cities metro



← Distance north of the warm front at this time: ~65 mi.

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SPECI KMLI 041502Z 07016G42KT 1 1/2SM R09/3000VP6000FT TSRA BR SCT006 BKN0
SPECI KMLI 041458Z 04011G54KT 3/4SM R09/2400VP6000FT +TSRA BR SCT006 BKN0
METAR KMLI 041452Z 13024G78KT 110V180 3/4SM R09/2000VP6000FT +TSRA BR SQ
SPECI KMLI 041448Z 07026G78KT 310V120 1 1/4SM R09/2000VP6000FT -TSRA BR SQ
SPECI KMLI 041445Z 31032G61KT 290V350 7SM TS SQ OVC006 10/08 A2972 RMK AO2
  
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April 4, 2023: Observed Severe Winds

Storm Photos



Courtesy of Mike Thompson via B100 QC Radio Station



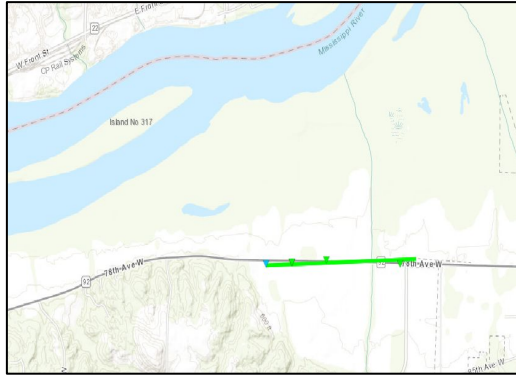
↑ NWS Storm Survey, Colona, IL ↓



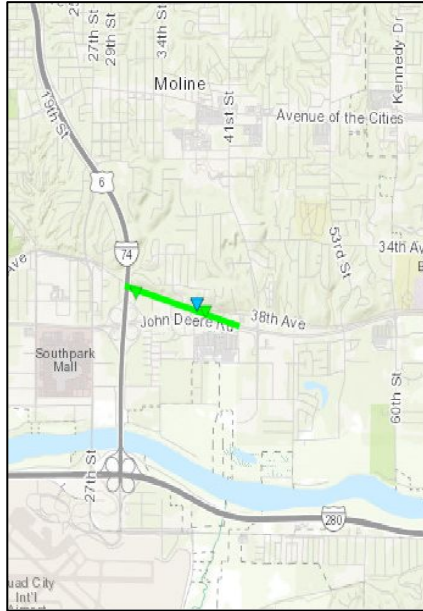


April 4, 2023: Short-Lived Tornadoes

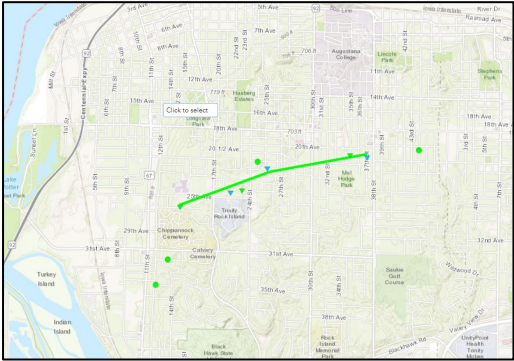
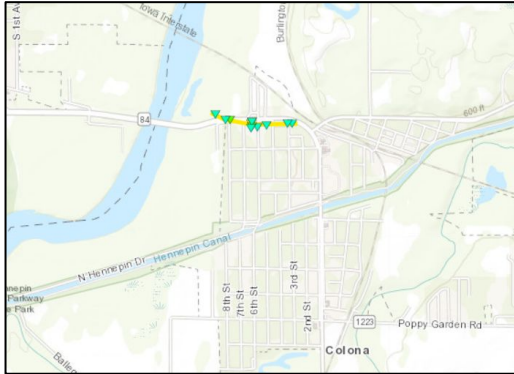
Illinois Portion of the Quad Cities



Tornado #2 -
Rock Island, IL



Tornado #4 -
Colona, IL



Tornado #3 -
1 S Moline, IL

Tornado #1 - 3
E Andalusia, IL

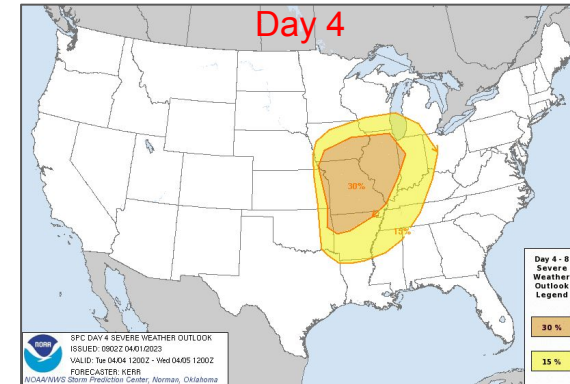
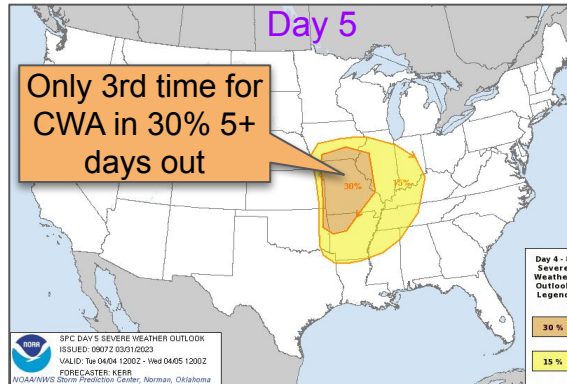
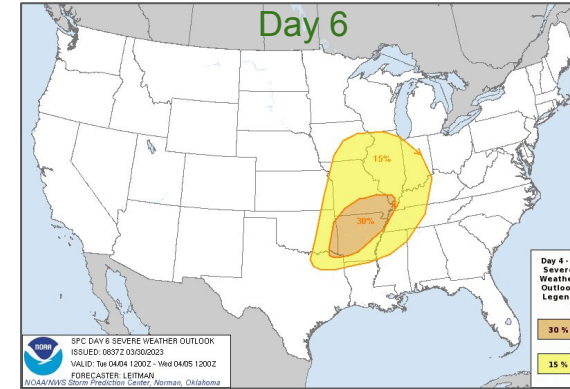
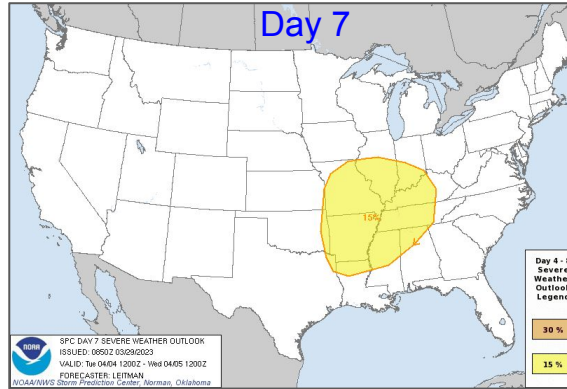




Forecasts Leading Up to April 4

SPC Outlooks

- Signal for severe weather SEVERAL days before the event
 - SPC Day 7 Outlook showed hints with build up in subsequent outlooks
 - Our minds on March 31st event with similar build up
 - Also still doing post-event from this at the time





Forecasts Leading Up to April 4

NWS Quad Cities Messaging

- Our messaging of the event began on April 1
- However, emphasis was on the late day and evening
- Timing of rounds of storms and what to expect

April 1, 2023 4:23 AM
Tuesday Severe Weather Threat
What: Potential for another high-end severe weather Tuesday. Long track supercells turning into a line of storms looks possible. All hazards are expected from these storms during the evening. Could see some isolated storms during the day with a better chance in the evening.
Hazards Expected: Damaging Winds, Tornadoes, Large Hail
Severe Weather Outlook Tuesday, April 04, 2023

April 2, 2023 4:38 AM
Severe Storms Possible Monday night into Wednesday
Key Messages
 • Severe storms are possible Monday night and again Tuesday afternoon into early Wednesday morning.
 • Severe thunderstorms Monday night could produce large hail.
 • More significant severe weather threat for Tuesday into Wednesday AM as long track supercells in the afternoon and early evening are possible (lower confidence) followed by a line of thunderstorms in the evening to overnight (higher confidence).
 • Large hail, tornadoes and damaging winds are possible from storms Tuesday. Some of these storms could cause significant severe weather.
 • A warm front will be in place on Tuesday. The exact placement of this front is still uncertain.
Severe Weather Outlook Tuesday, April 04, 2023

April 3, 2023 3:41 AM
Significant Severe Weather Outbreak Possible Tuesday
 Strong tornadoes possible again, especially near warm front and in the evening
Key Messages
 • Low possibility for thunderstorms overnight into Tuesday AM to produce 1" hail
 • Warm front moves north through the area on Tuesday as thunderstorms form.
 • Multiple rounds of severe weather possible
 • Strong tornadoes, damaging wind and large hail is possible
 • Thunderstorm development may occur later in day than Friday.
What Has Changed
 • Moderate risk issued for the area again
Next Scheduled Update
 • Monday afternoon
Severe Weather Outlook Tuesday, April 04, 2023

April 4, 2023 4:30 PM
Two More Rounds of Severe Possible!
 Tornadoes, damaging winds and large hail are possible from each round!
Round 2
Timing
 Now - 11 PM
 Scattered Supercells
Details
 1. Supercells will increase in coverage.
 2. Better chance for stronger tornadoes as they move through our area.
 3. Expect tornadoes, large hail and damaging winds
 4. Storms will be moving at 50-60 MPH!
Round 3
Timing
 Midnight - 6AM
 Line of Storms or supercells?
Details
 1. Uncertainty in timing and location
 2. Strong cold front is expected to catch up to the supercells with a line of storms similar to last Friday.
 3. Tornadoes, hail and damaging winds are possible
Severe Weather Outlook Tuesday, April 04, 2023

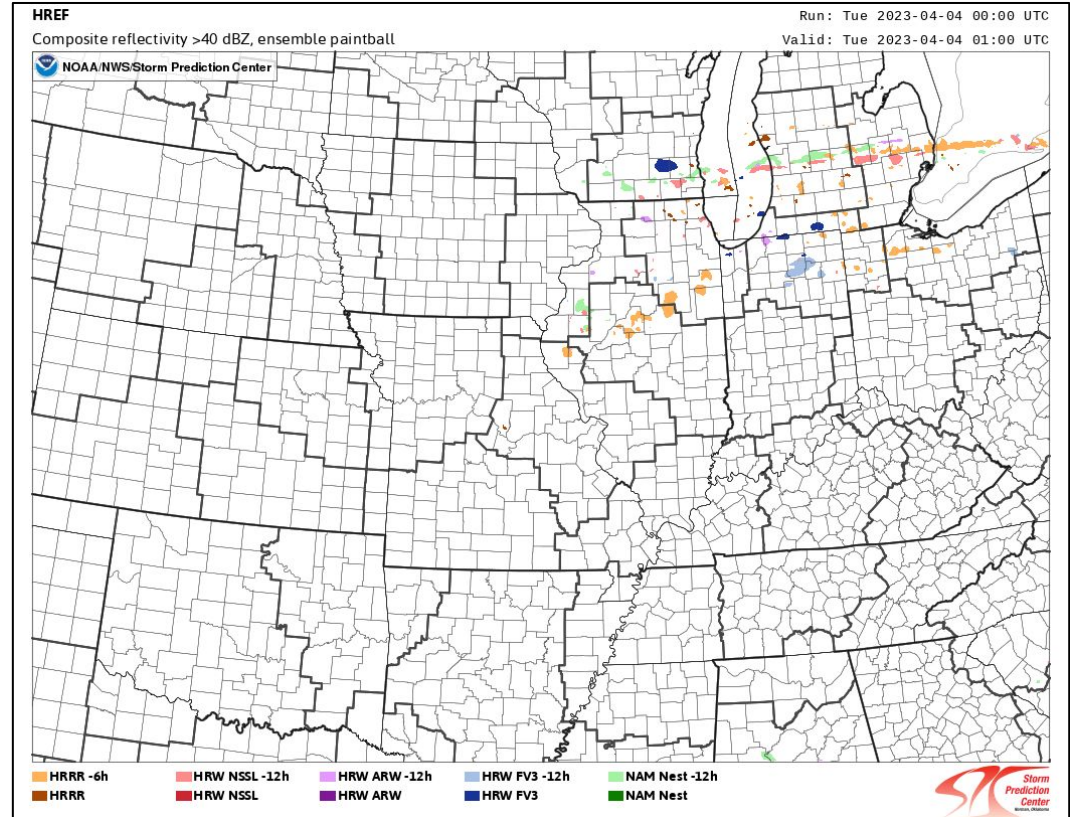




What Were We Seeing Beforehand?

00Z HREF from evening prior

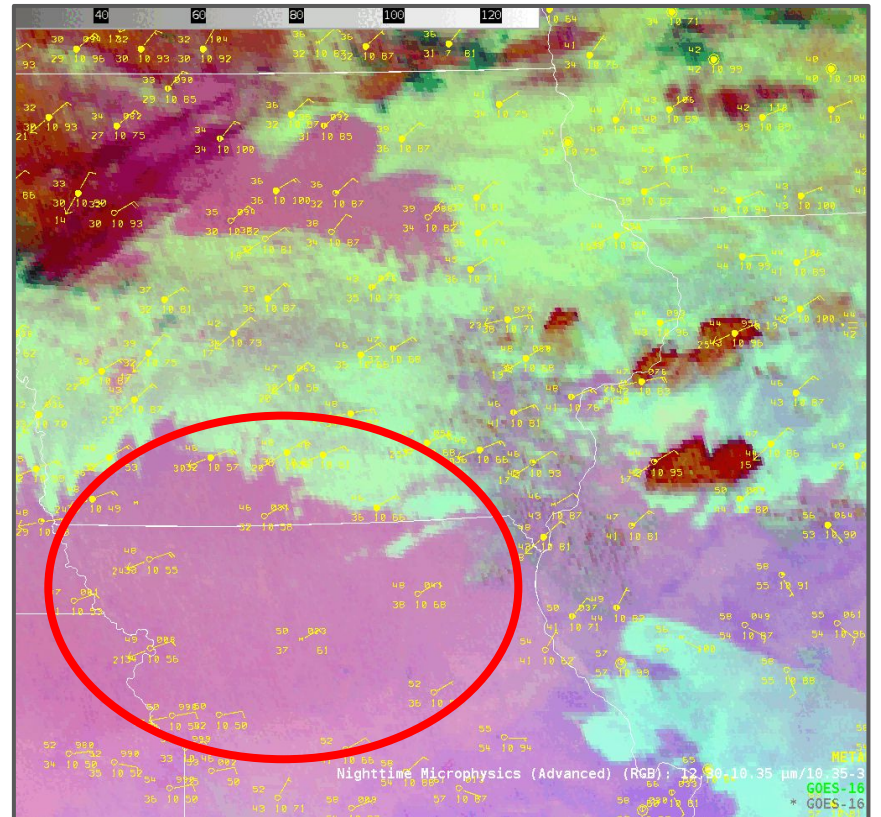
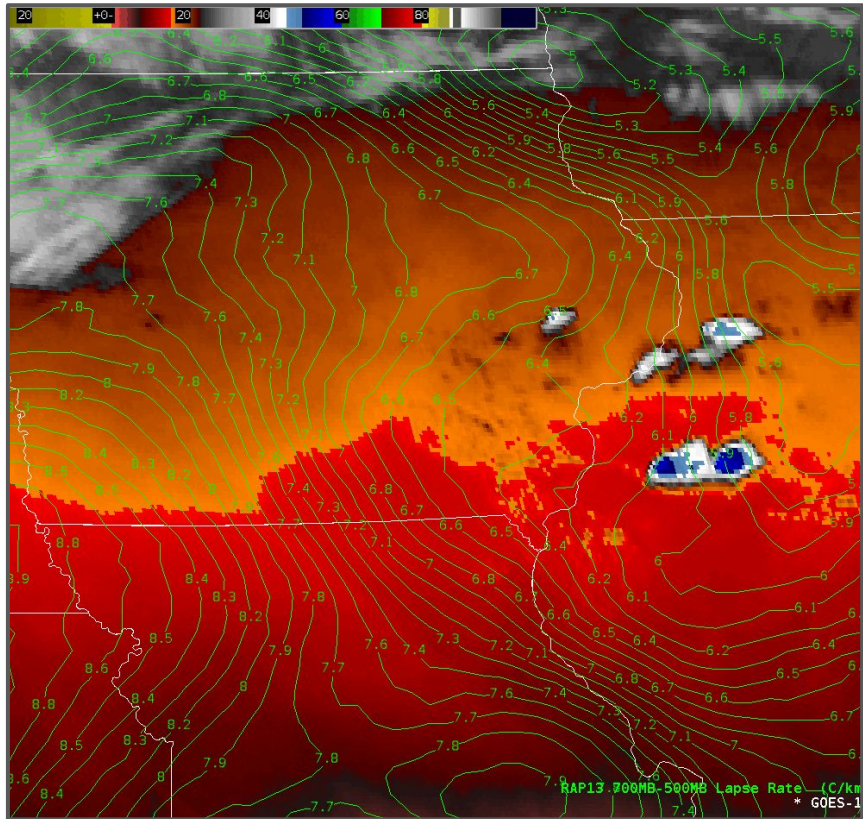
- Multiple members of the HREF showed convective initiation during the morning of April 4th
 - Namely NSSL WRF & NAM Nest





What Were We Seeing Beforehand?

Early Morning Satellite Low-Level Water Vapor Band & Nighttime Microphysics RGB

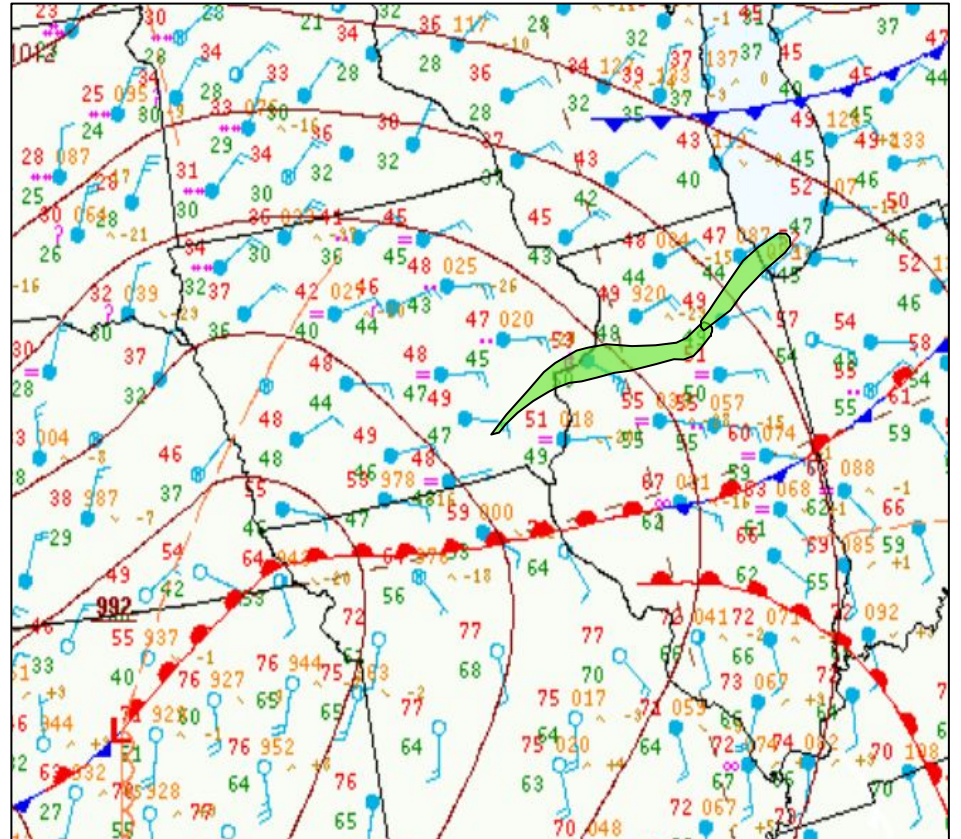




April 4 15Z Surface Analysis

Supercell Path Overlaid

- Morning surface analysis showed warm front draped across northern Missouri and central Illinois
 - Surface temps in the 40s/50s
 - Winds out of the east-southeast
 - Overcast with mist in eastern Iowa

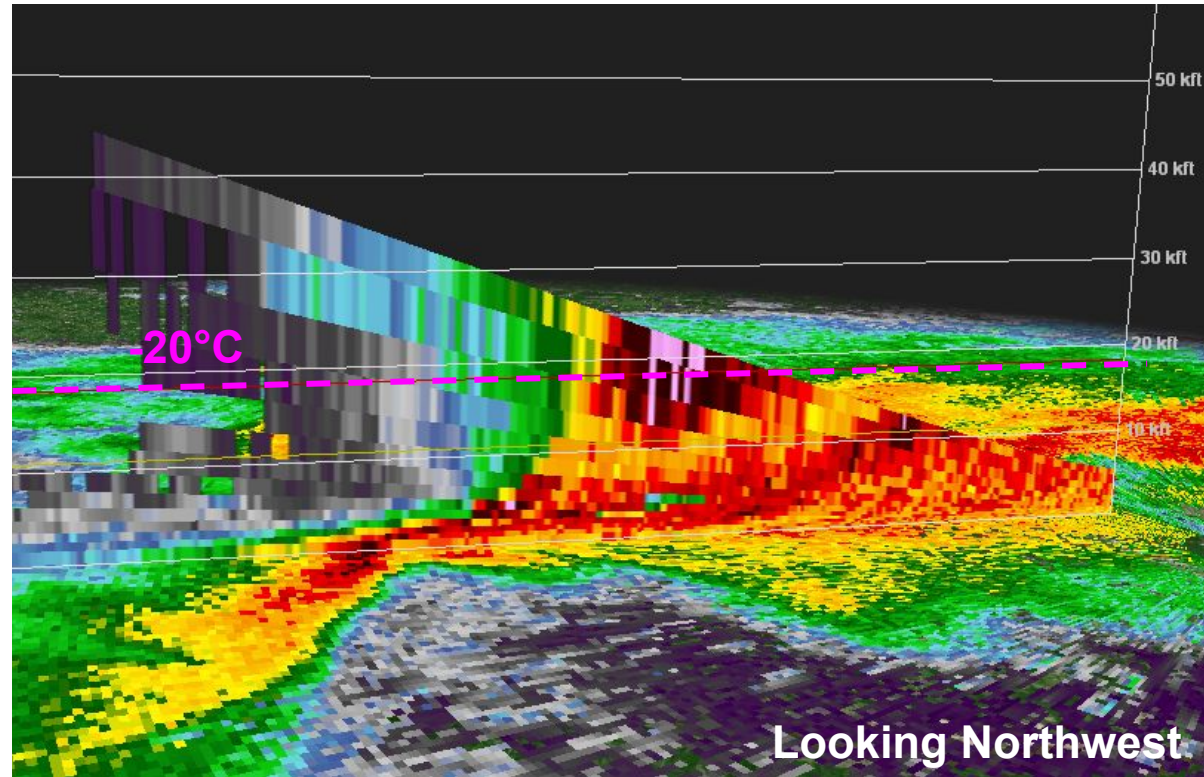




Significant Severe Hail Signals

Supercell Over the Quad Cities

- Supercell updraft gradually grew in height and width as it approached the Quad Cities
- Important to NWS forecasters for impact-based warning decisions and messaging
- Combination of environment and radar

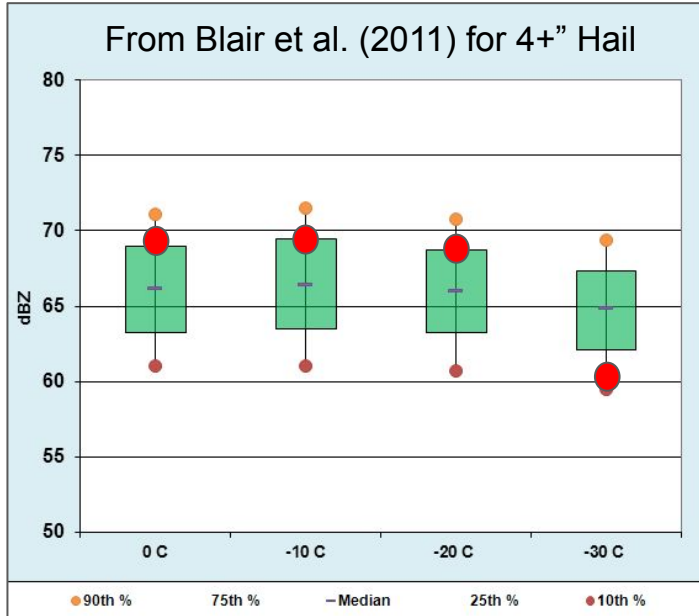




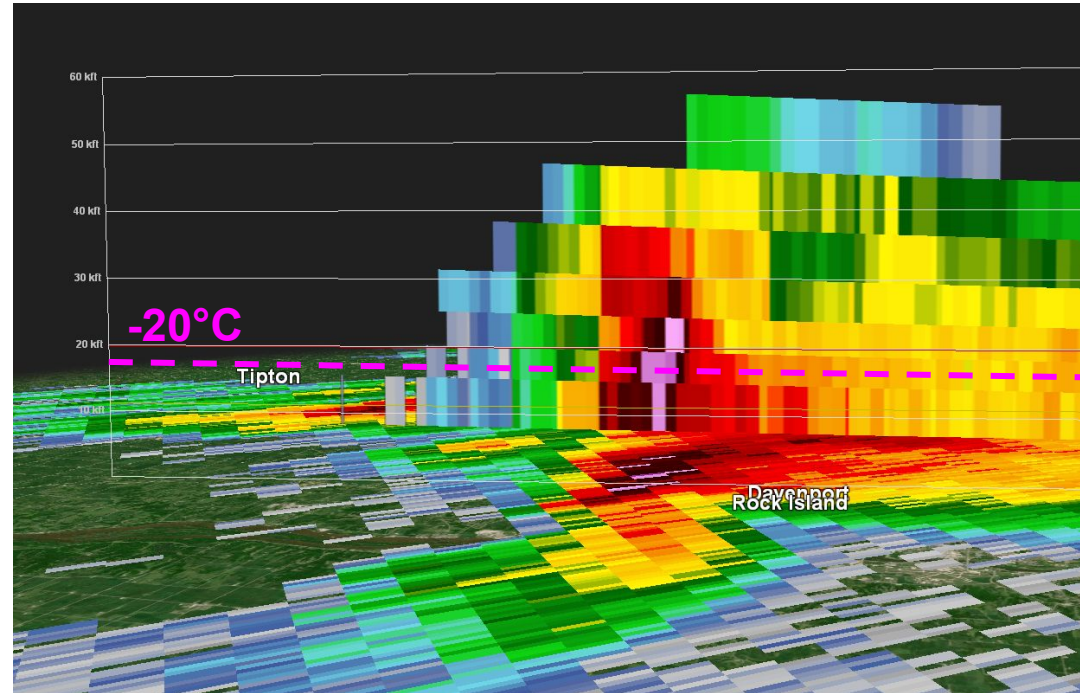
Significant Severe Hail Signals

Supercell Over the Quad Cities

- Deep storm mesocyclone
- Deep core in relatively cold env.
- Considerable Impact-Based Warnings



From KILX Radar Looking West-Northwest

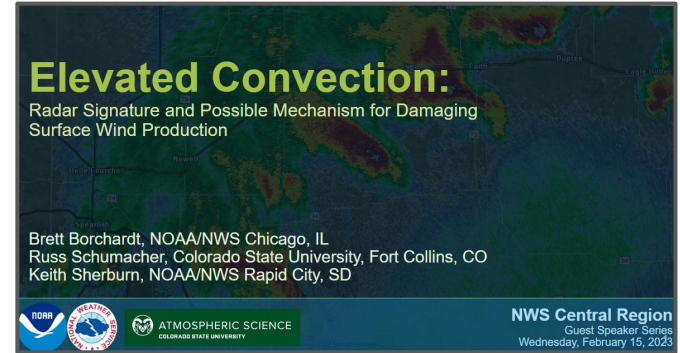




A Big Question: Why the Wind?

A Not-So-Elevated Supercell

- Morning sounding and surface analysis would favor storms remaining elevated, not surface base
- Little has been understood as to the mechanisms of severe winds accompanying “elevated” storms
- 80% of nocturnal damaging wind events occur with thunderstorms along or on the cool side of surface boundaries (Reif and Bluestein 2017)



Radar Signatures and Surface Observations of Elevated Convection Associated with Damaging Surface Winds

Brett S. Borchardt, Keith D. Sherburn, and Russ S. Schumacher

Online Publication: 09 Feb 2024

DOI: <https://doi.org/10.1175/WAF-D-23-0171.1>

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Abstract

Identifying radar signatures indicative of damaging surface winds produced by convection remains a challenge for operational meteorologists, especially within environments characterized by strong low-level static stability and convection for which inflow is presumably entirely above the planetary boundary layer. Numerical model simulations suggest the most prevalent method through which elevated convection generates damaging surface winds is via “up-down” trajectories, where a near-surface stable layer is dynamically lifted and then dropped with little to no connection to momentum associated with the elevated convection

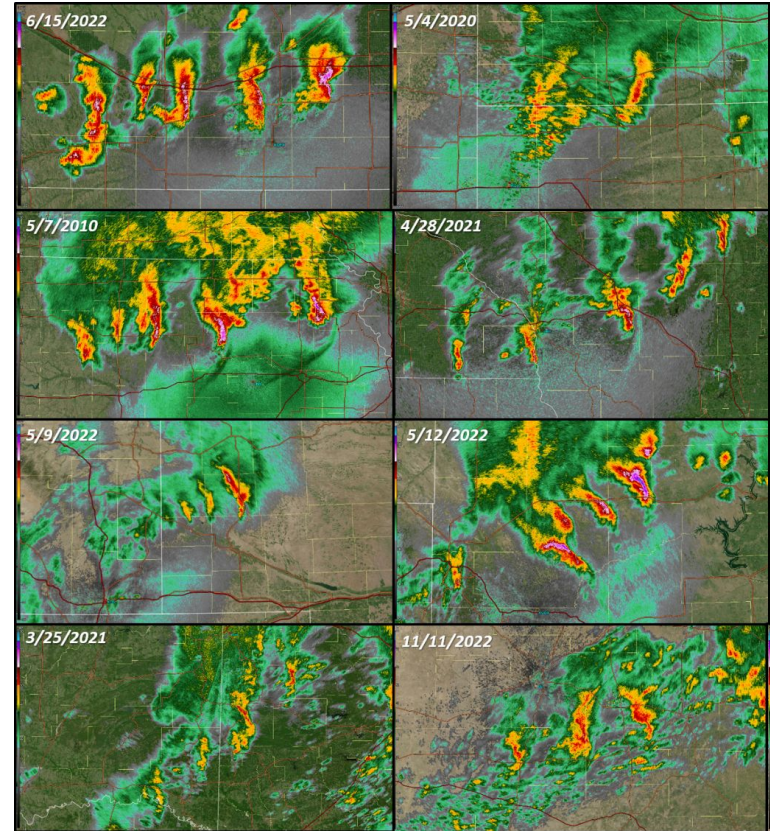




Gravity Wave?

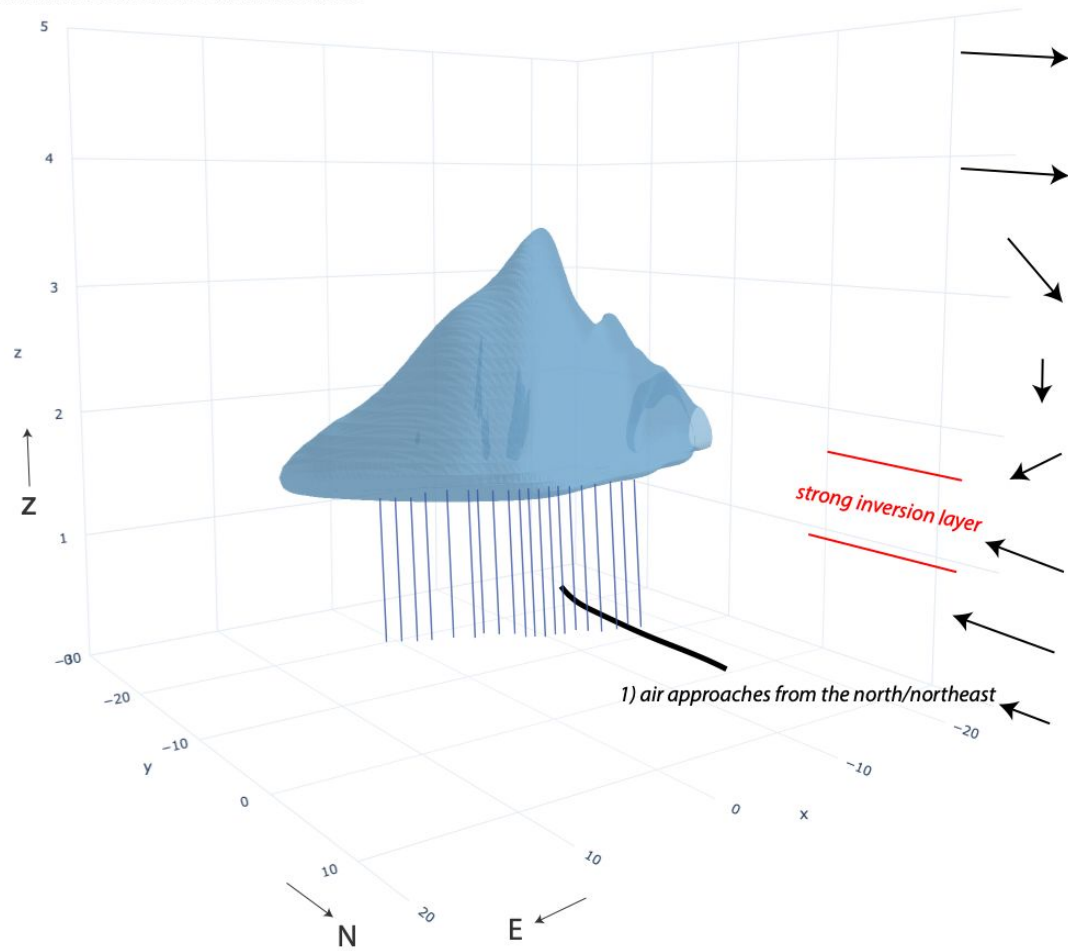
A Not-So-Elevated Supercell from Eastern Iowa to the Chicago Area on 04 April 2023

- New research by Borchardt et al. (2024) dives into gravity wave induced damaging winds with elevated storms
- Wave packets often present via either radar or satellite, and convection itself may be at evenly-spaced intervals
- Radar often demonstrates a unique divergent couplet on the leading edge of reflectivity



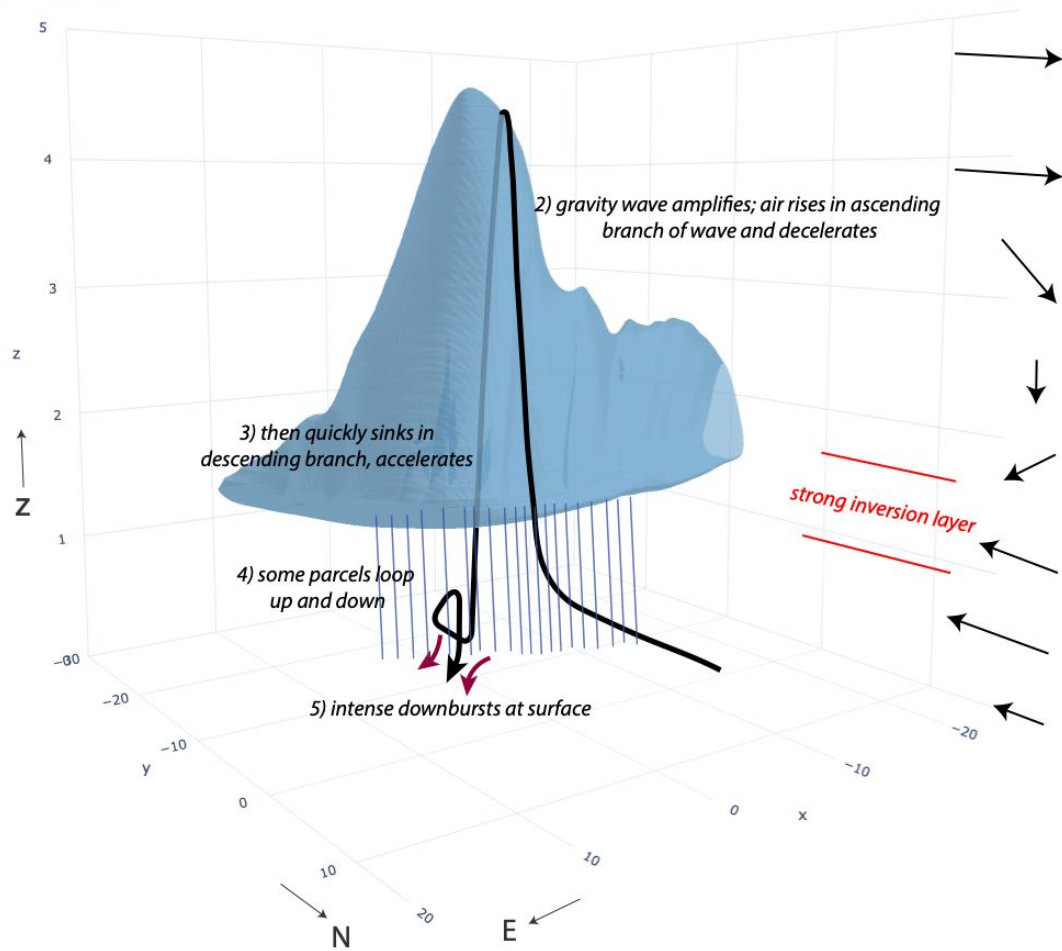
a) 10 minutes before downbursts

From Borchardt et al. (2024)



b) downbursts

From Borchardt et al. (2024)

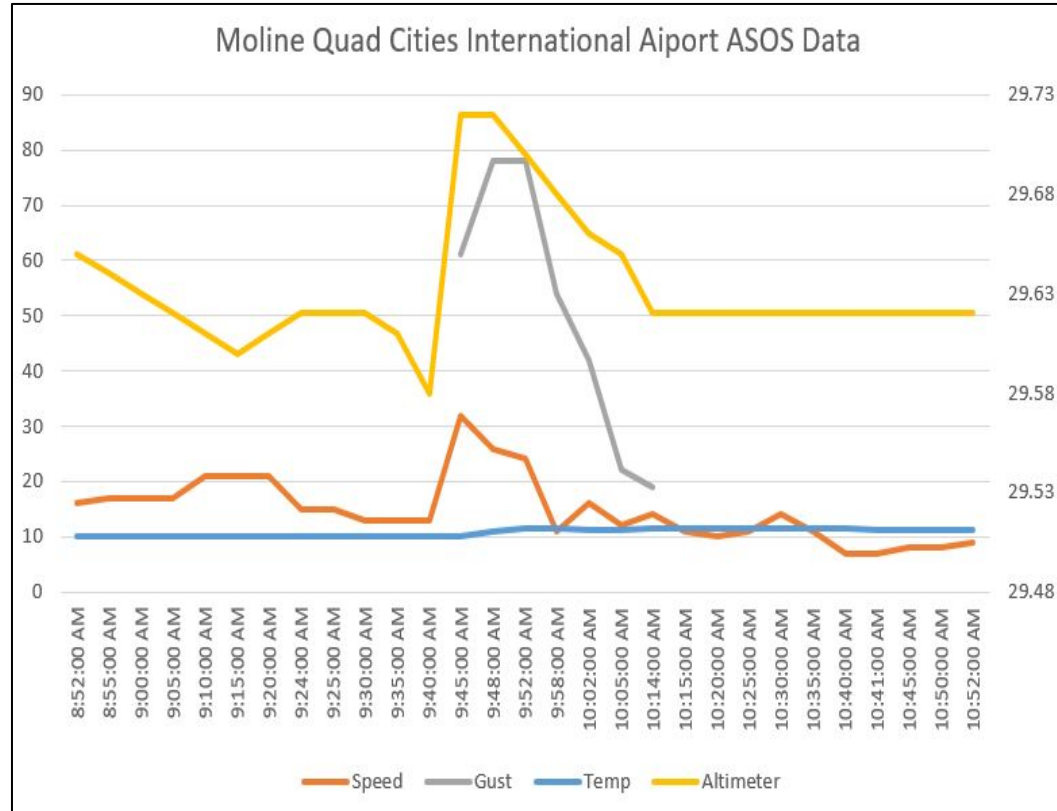
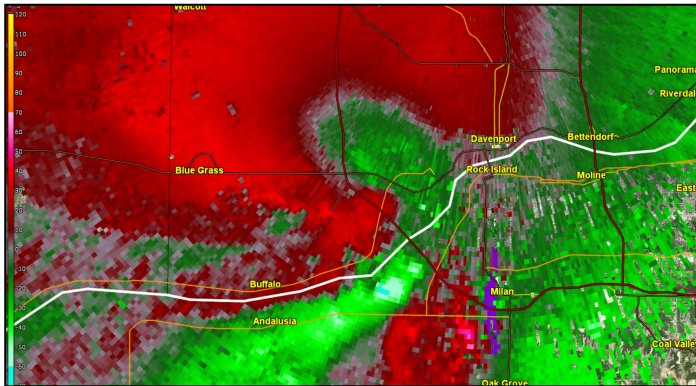




The Wind Side Of The Storm

A Not-So-Elevated Supercell from Eastern Iowa to the Chicago Area on 04 April 2023

- Pronounced wind signature was noted in low-levels around 1200-1500 ft AGL
- Note the altimeter, wind and temp changes as the storm passes KMLI



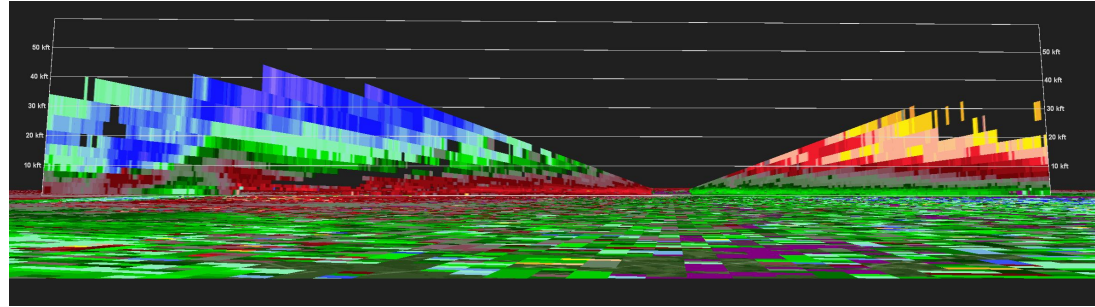
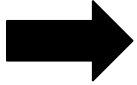


Goals Of This Presentation

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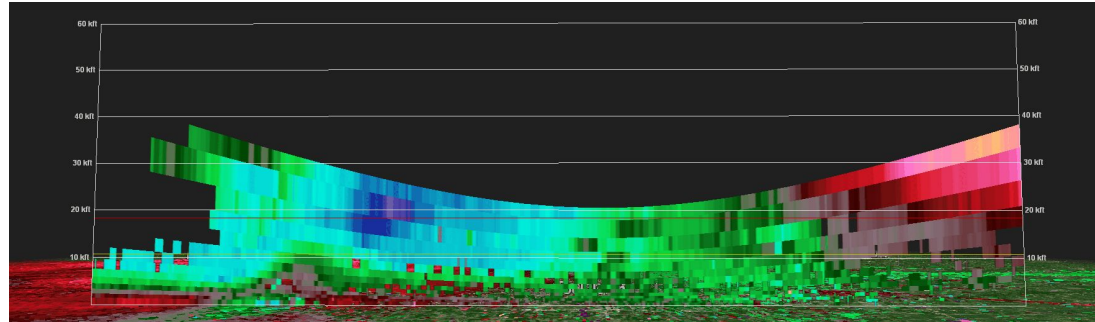
Borchardt et al, 2024:
La Crosse, WI
April 12, 2022

Storm Motion:



April 4, 2023:
radar viewing
to the south

Storm Motion:





Takeaways

A Not-So-Elevated Supercell from Eastern Iowa to the Chicago Area on 04 April 2023

- Evaluate the environment in full; expect the unexpected
- What possible changes to the environment would lead to threat changes
- Look for the presence of gravity waves using satellite and radar
- Note changes in convective evolution on radar for possible hints in changes to the background environment and hazards
- Check velocity data for the unique divergent couplet seen in elevated storms
- Ways to message the evening before or prior to daybreak? “Main threat remains late day tomorrow, but a heads up that if any storms do develop tomorrow morning (~20%), our confidence is high they will have a severe threat.”





References

Links included

- B. S. Borchardt, K. D. Sherburn, and R. S. Schumacher, 2024: **Radar Signatures and Surface Observations of Elevated Convection Associated with Damaging Surface Winds**. Wea. Forecasting, Early Online Release [Link](#)
[Training Video](#)
- Blair, S. F., D. R. Deroche, J. M. Boustead, J. W. Leighton, B. L. Barjenbruch, and W. P. Gargan, 2011: **A Radar-Based Assessment of the Detectability of Giant Hail**. Electronic J. Severe Storms Meteor., 6 (7), 1–30. [Link](#)
- Bunkers M. J., M. R. Hjelmfelt, and P. L. Smith, 2006: **An Observational Examination of Long-Lived Supercells. Part I: Characteristics, Evolution, and Demise**. Wea. Forecasting, 21, 673–688. [Link](#)

Also thank you to Dan Bikos at CIRA for the satellite imagery.





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