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

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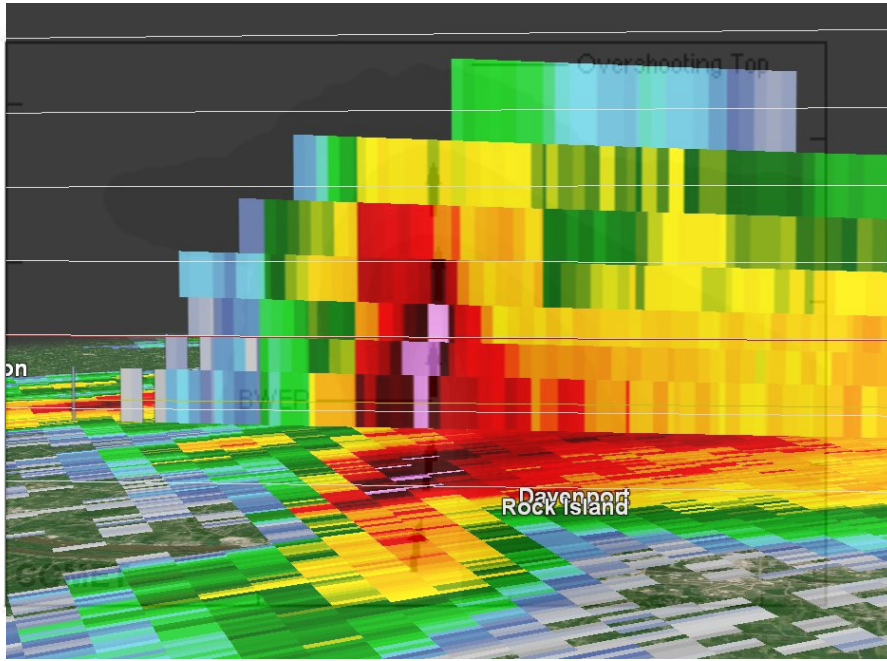
2024 Severe Storms & Doppler Radar Conference

March 28, 2024

Goals of this Presentation

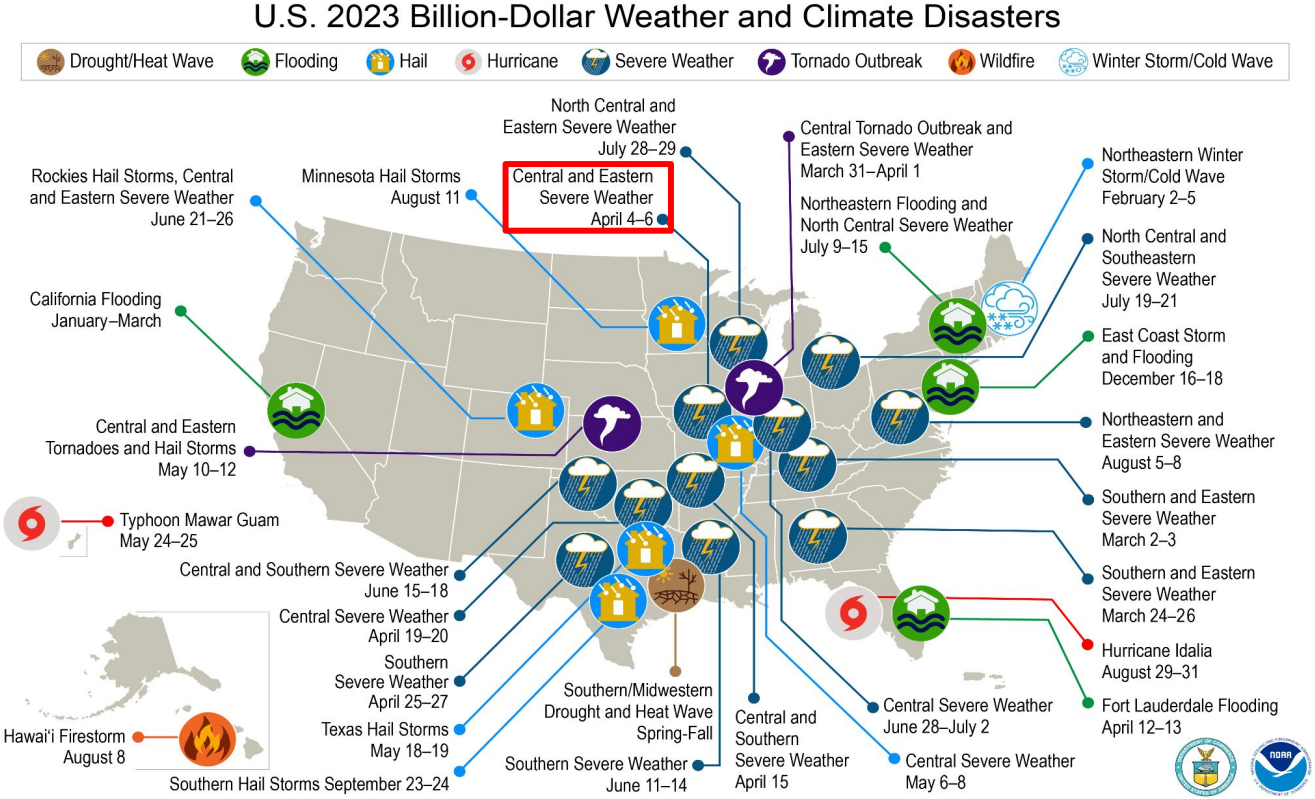
Outline

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)

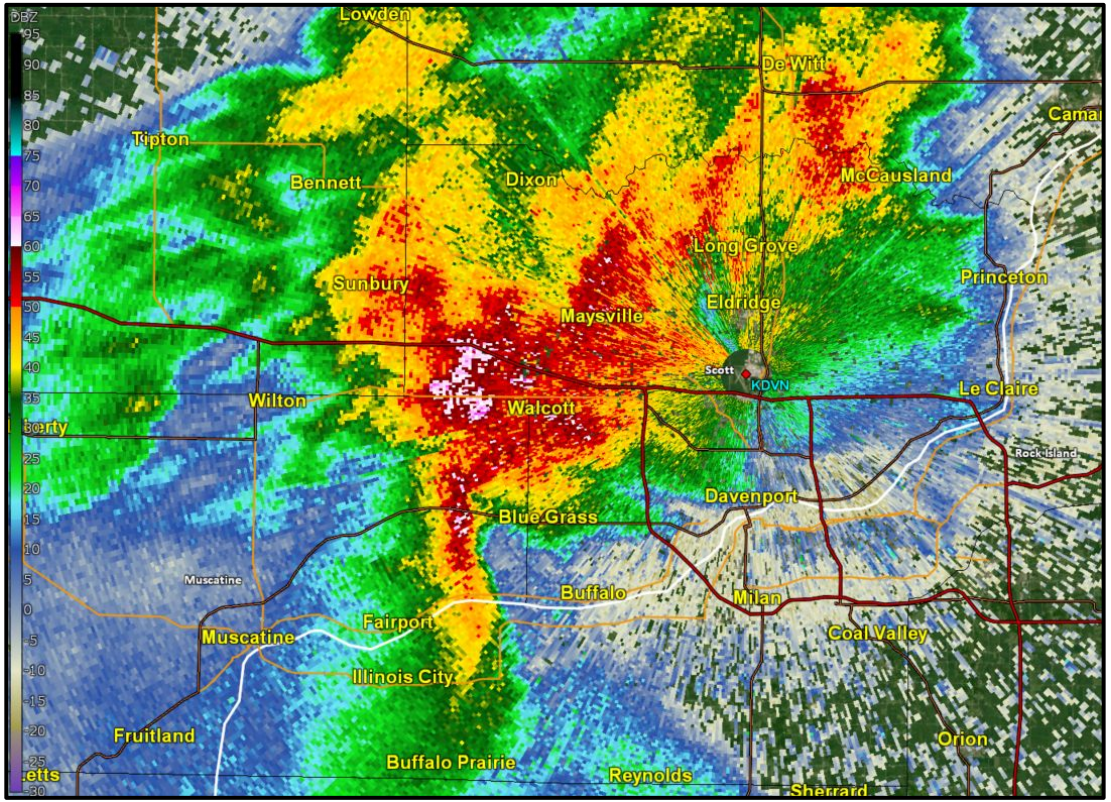


*This map denotes the approximate location for each of the **28 separate billion-dollar weather and climate disasters that impacted the United States in 2023.***

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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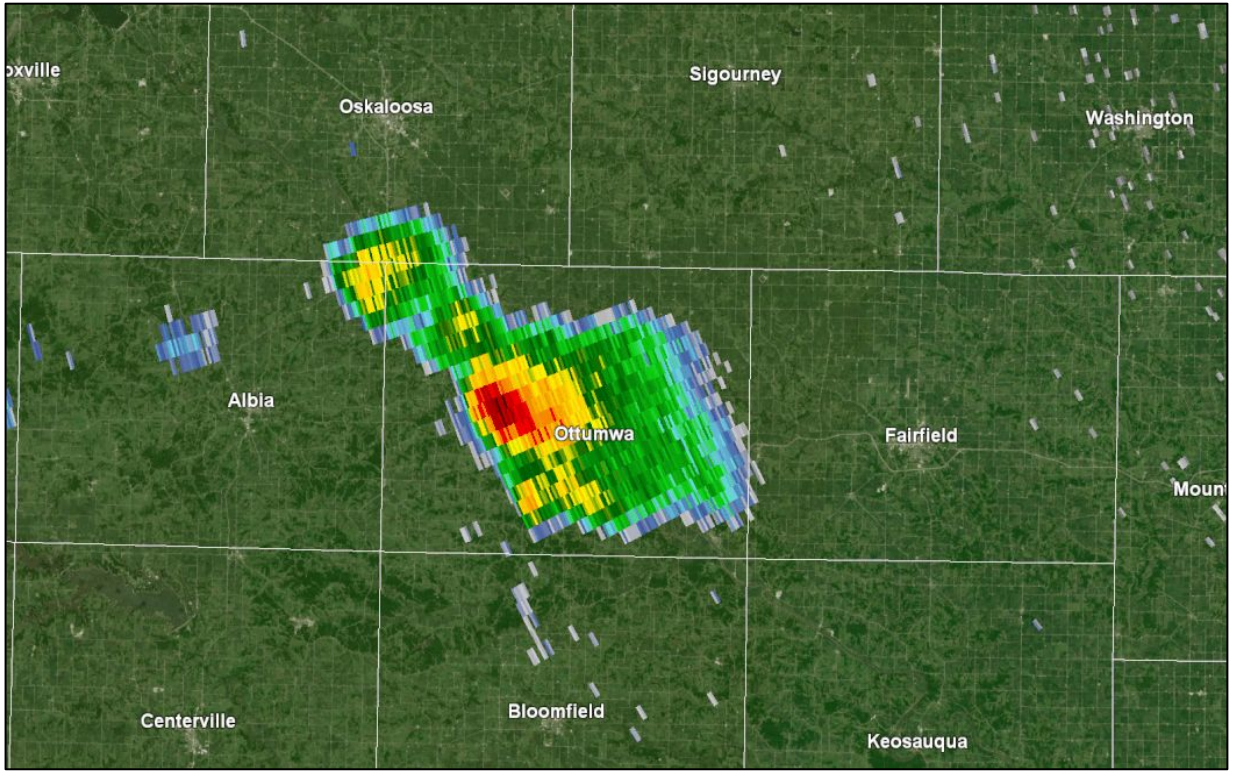
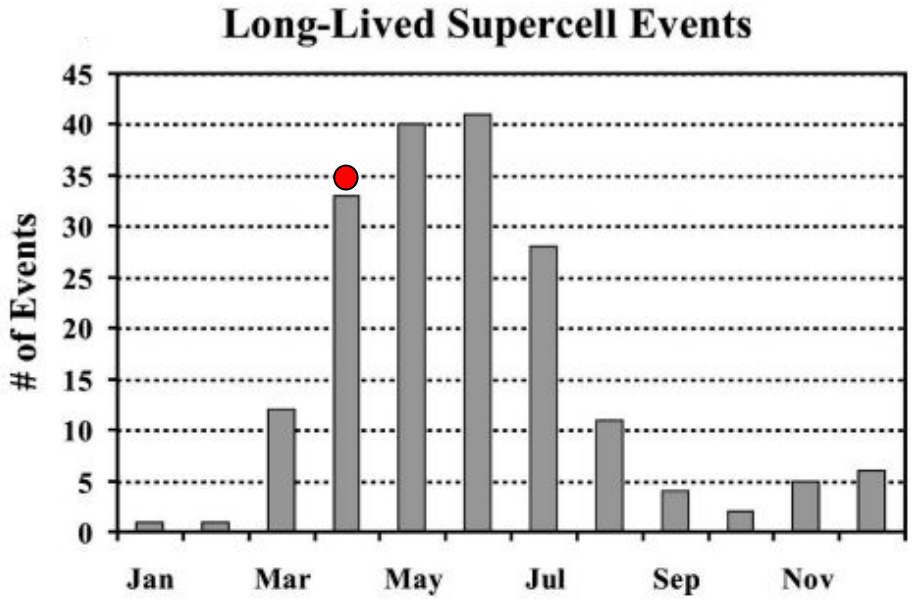


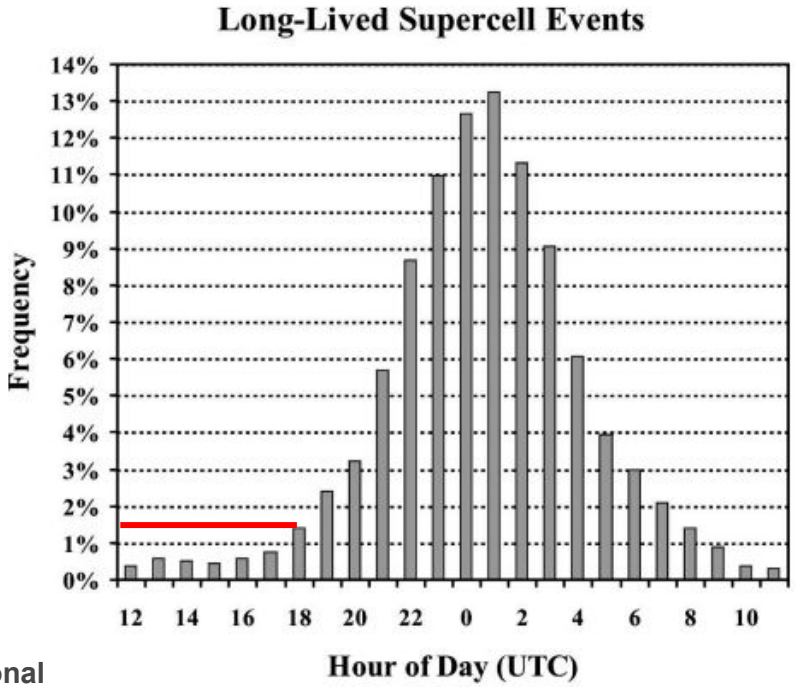
Long-Lived Supercell Climatology

Bunkers et al. (2006)

Time of Year



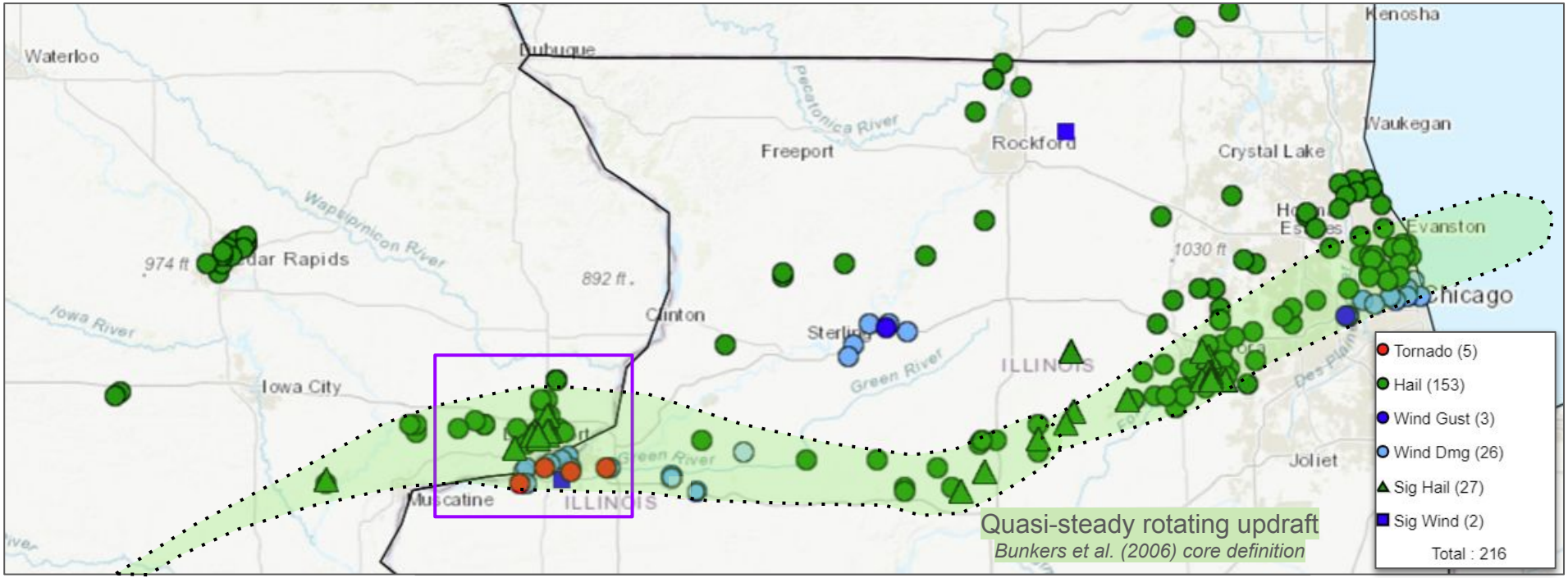
Time of Day



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

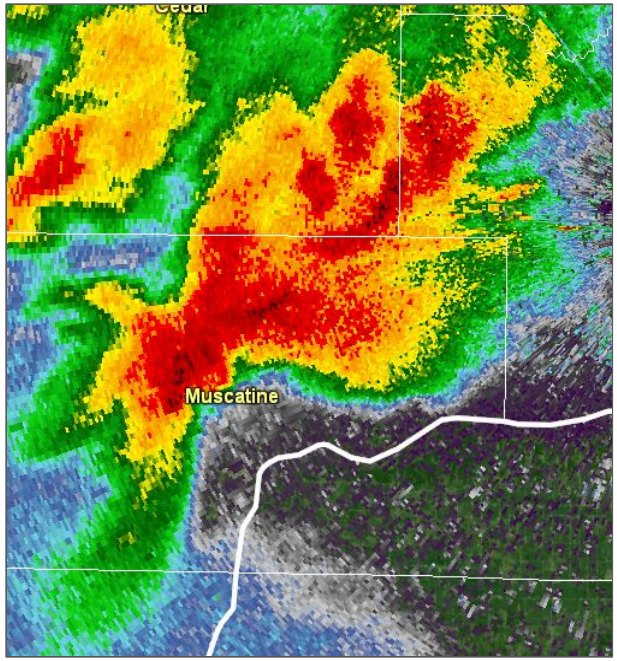
April 4, 2023 Observed Swath of Severe Weather

Storm Reports



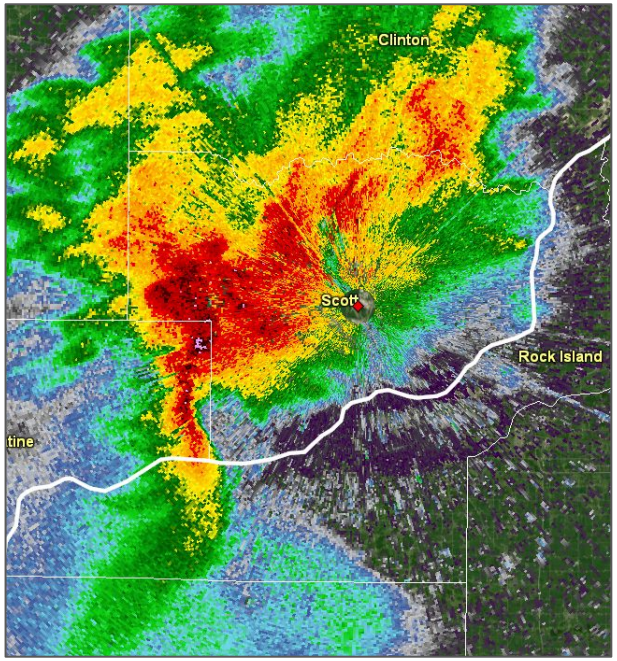
April 4, 2023: Radar vs Storm Reports

Images 30 Minutes Apart



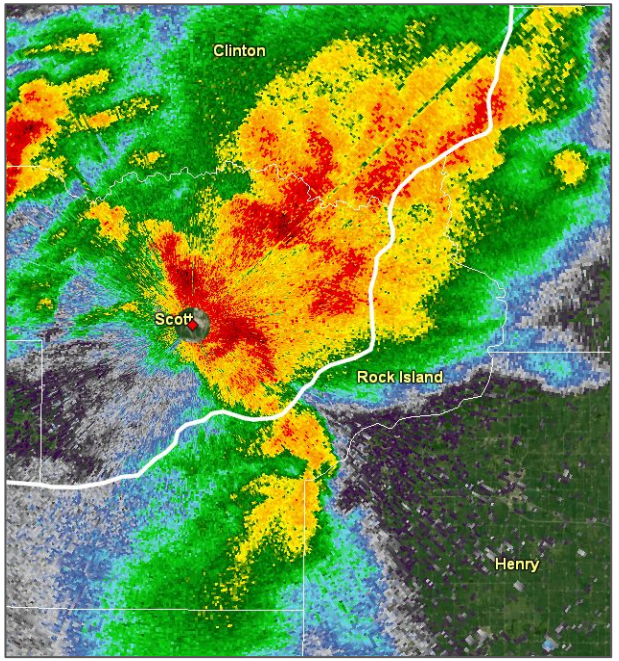
Storm Motion:

Severe Weather: Hail



Storm Motion:

Severe Weather: Sig Hail



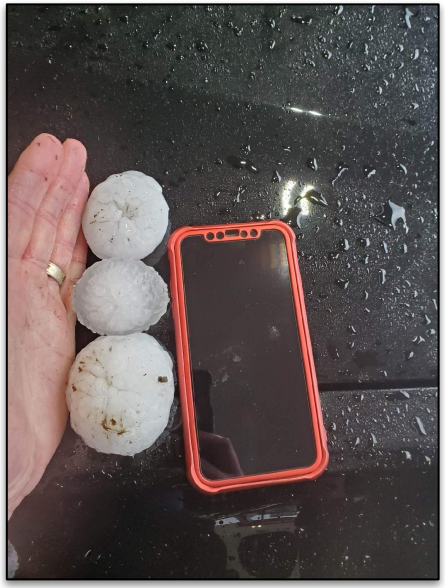
Storm Motion:

Severe Weather: Sig Hail & Sig Wind

April 4, 2023: Observed Large Hail

Storm Photos

Courtesy: Rebecca Kopelman, KGAN, Marian, IA



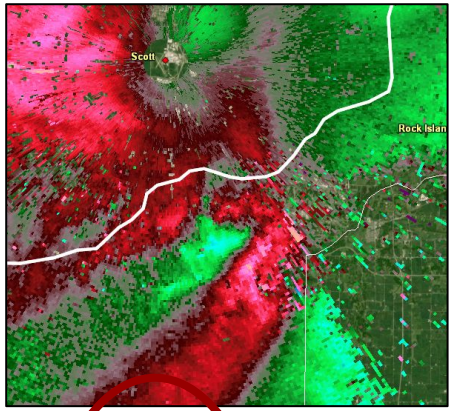
Courtesy: Andy Ervin, Davenport, IA

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.

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

April 4, 2023: Observed Severe Winds

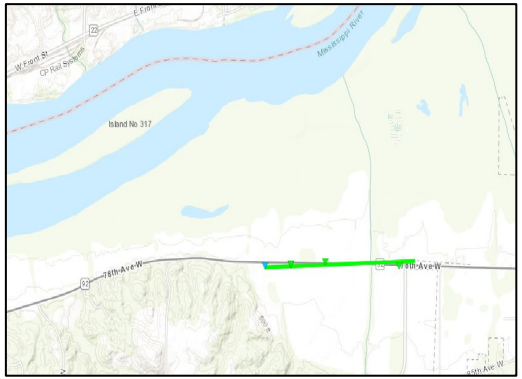
Storm Photos

Courtesy of Mike Thompson via B100 QC Radio Station

NWS Storm Survey, Colona, IL

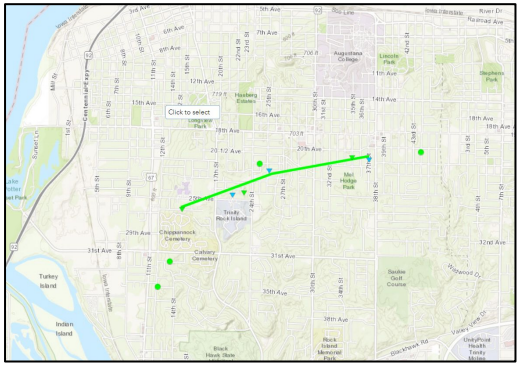
April 4, 2023: Short-Lived Tornadoes

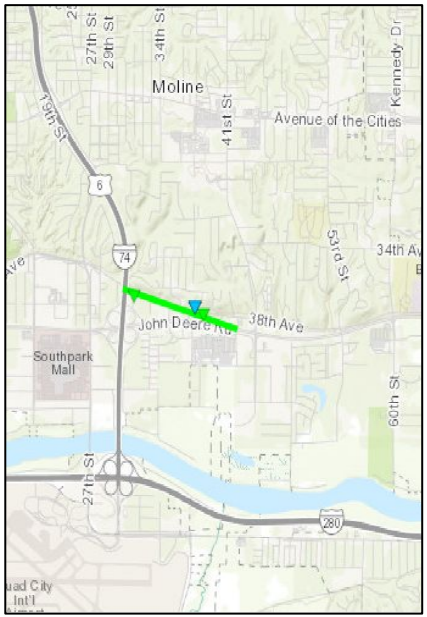
Illinois Portion of the Quad Cities



Tornado #1 - 3 E Andalusia, IL

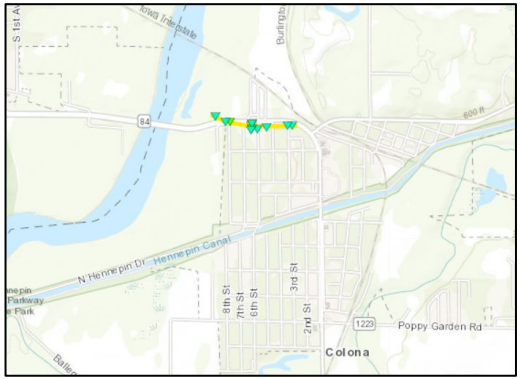
Tornado #2 - Rock Island, IL





Tornado #3 - 1 S Moline, IL

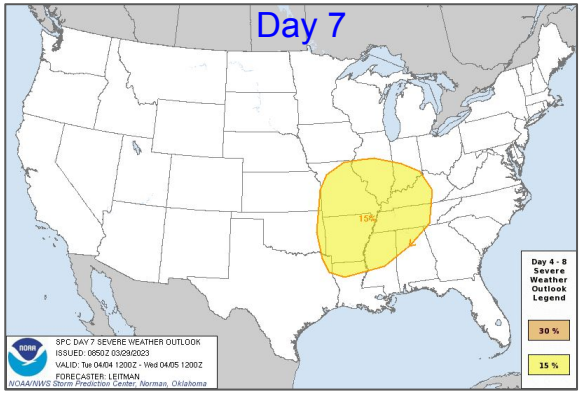
Tornado #4 - Colona, IL

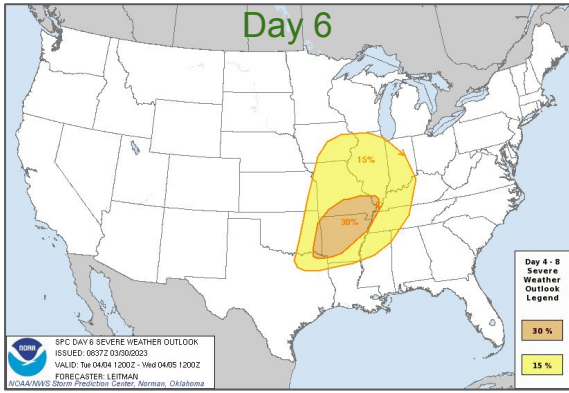


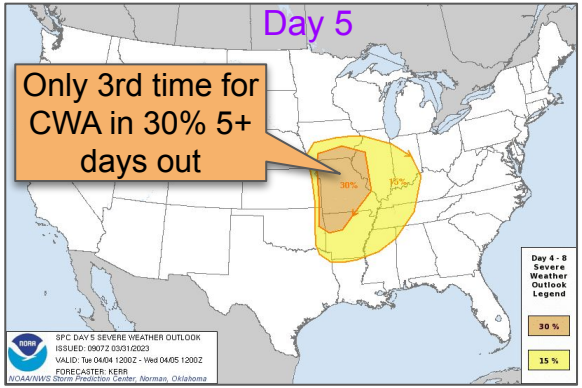
Forecasts Leading Up to April 4

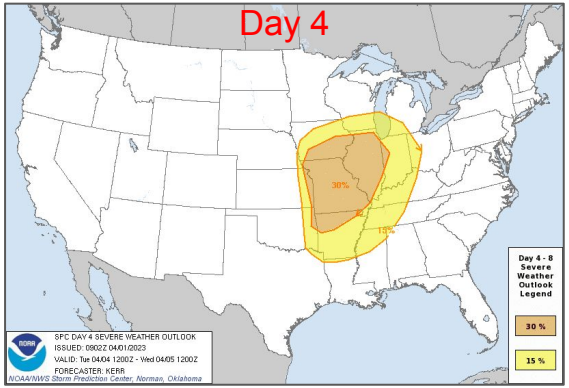
SPC Outlooks

- 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





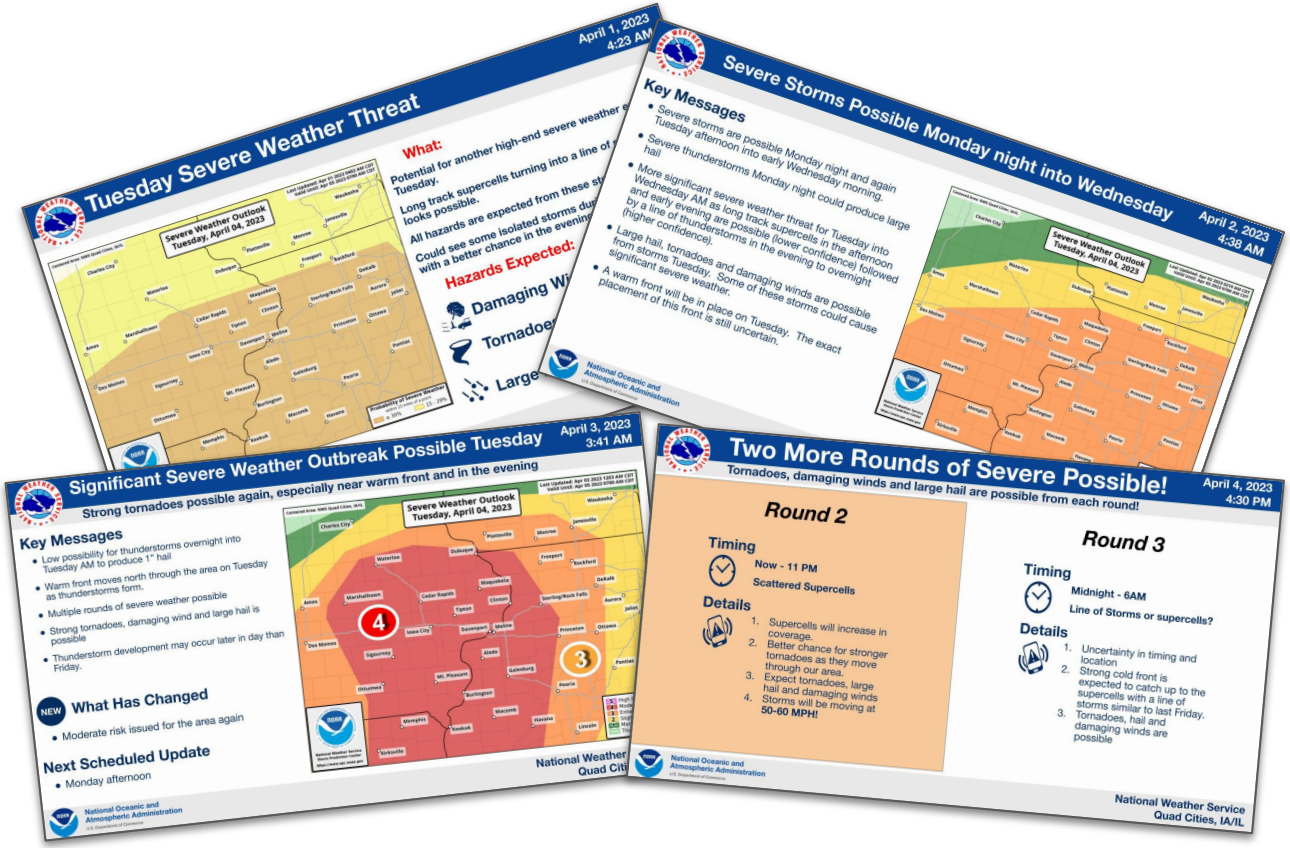




Forecasts Leading Up to April 4

NWS Quad Cities Messaging

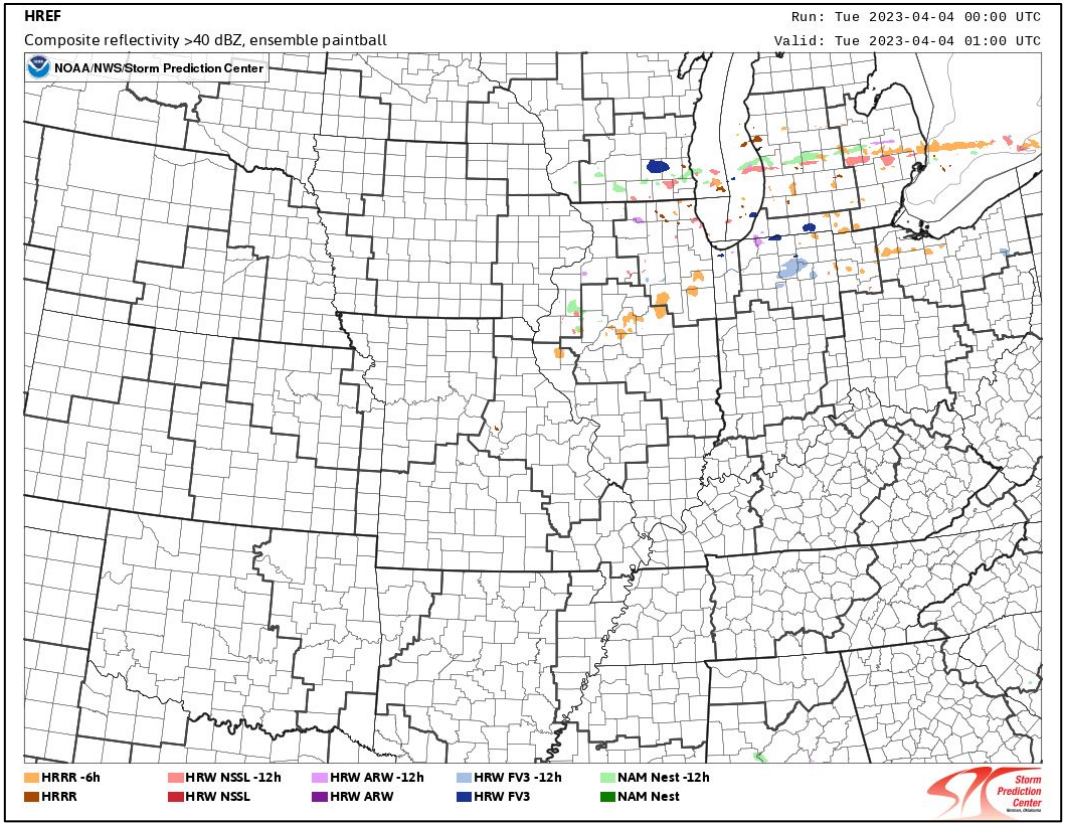
- Our messaging of the event began on April 1
- However, emphasis was on the late day and evening
- Timing of rounds of storms and what to expect



What Were We Seeing Beforehand?

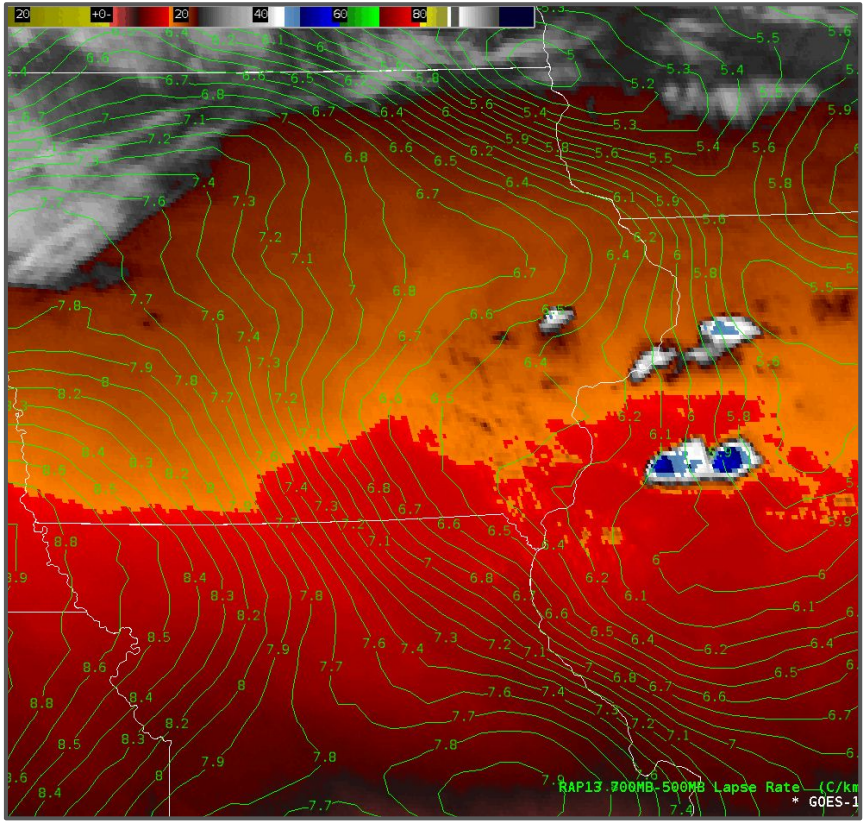
00Z HREF from evening prior

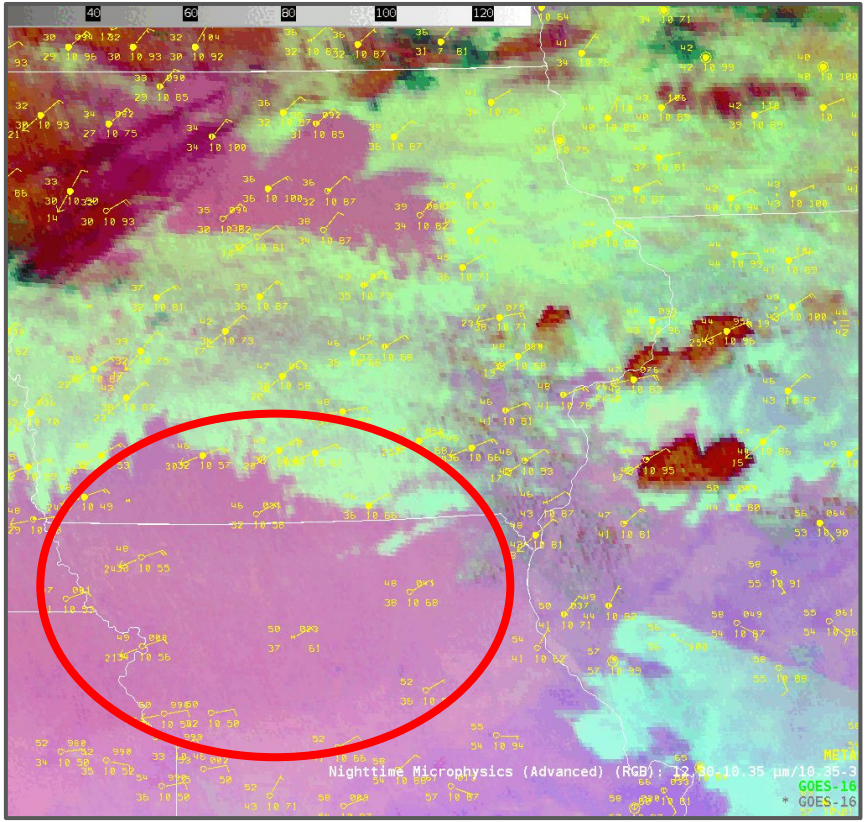
- Multiple members of the HREF showed convective initiation during the morning of April 4th
  - Namely NSSL WRF & NAM Nest



What Were We Seeing Beforehand?

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

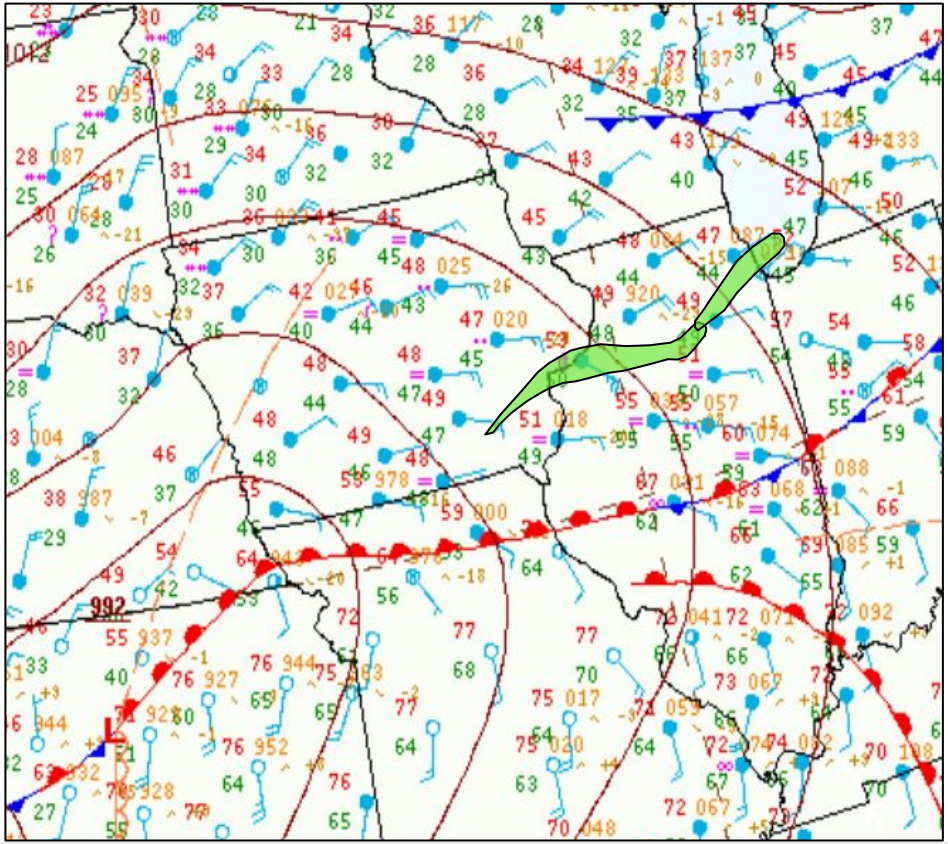




April 4 15Z Surface Analysis

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



Initiation and Progression Of Supercell

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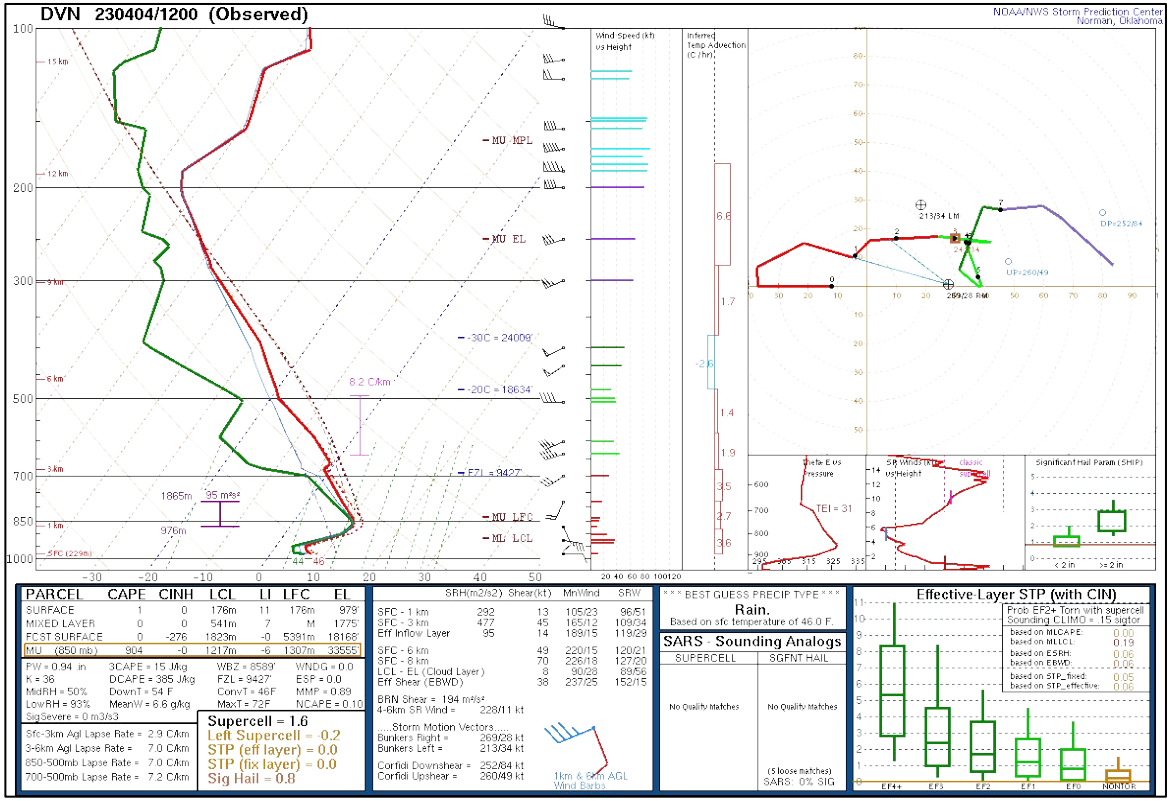
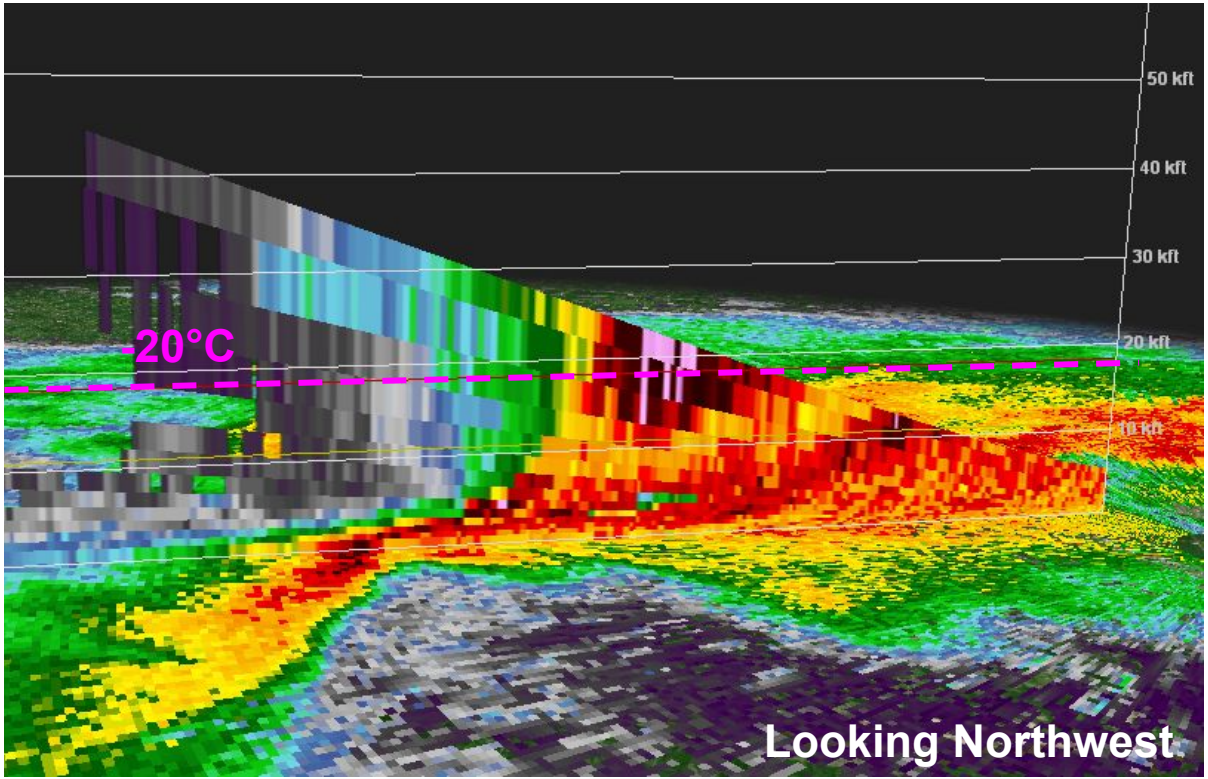
- Elevated storms began developing in southern Iowa ~ 11-1130 UTC
  - On par with CAMs
- Environmental favored elevated storms
  - Steep lapse rates aloft
  - Effective shear of 40 kts
- Sharply veering low-levels
- Still mixed within the boundary layer



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

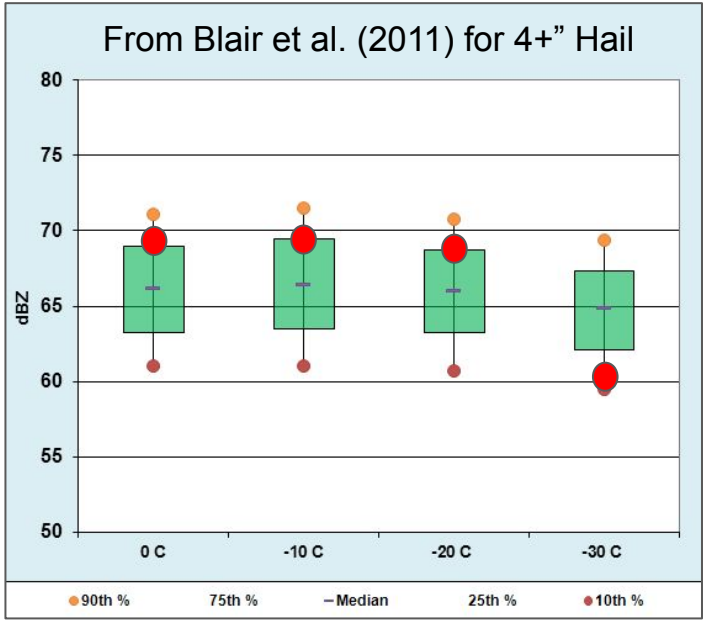


Significant Severe Hail Signals

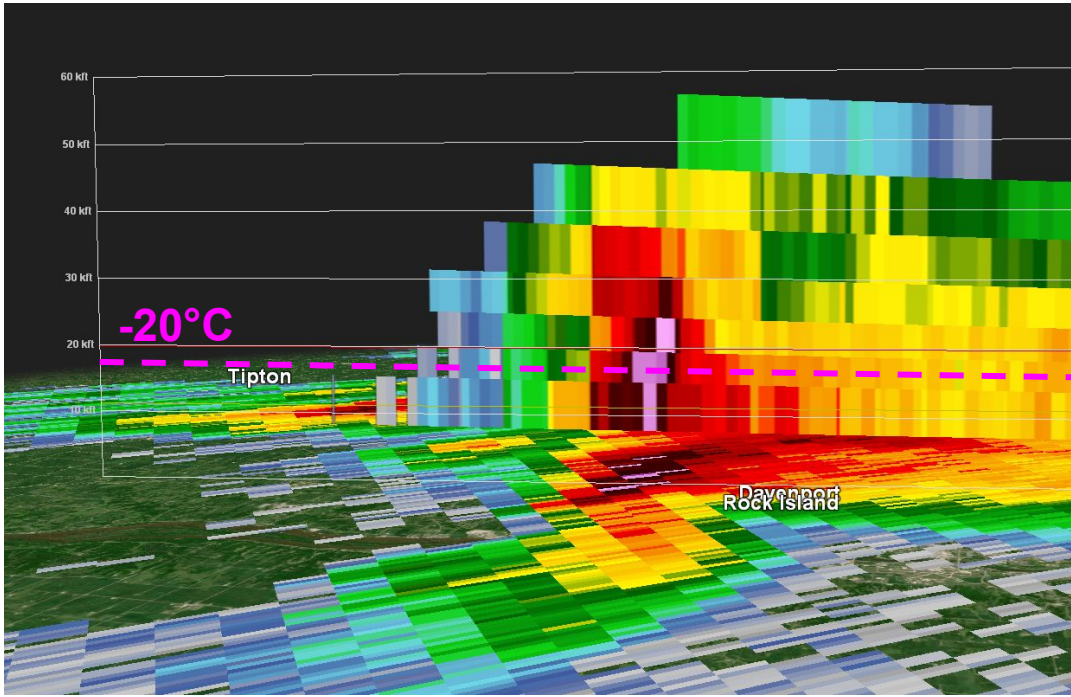
Supercell Over the Quad Cities

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

From Blair et al. (2011) for 4+" Hail



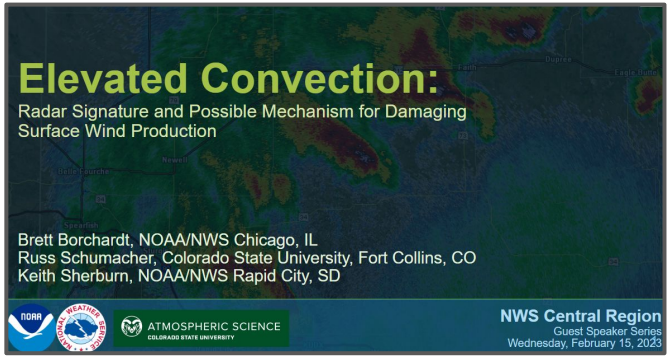
From KILX Radar Looking West-Northwest



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/Excerpt | Full Text

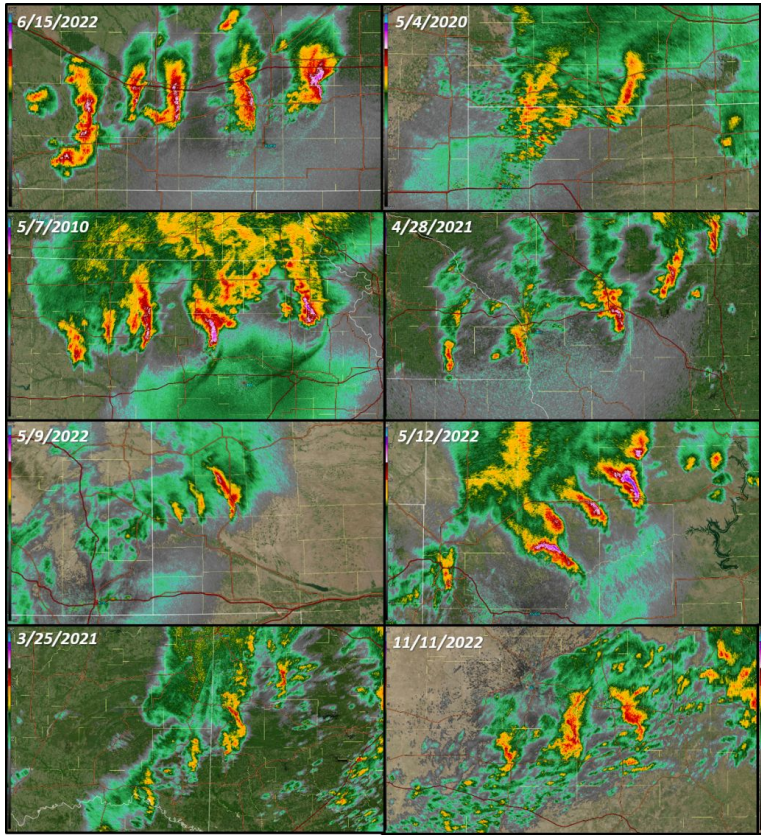
Abstract

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

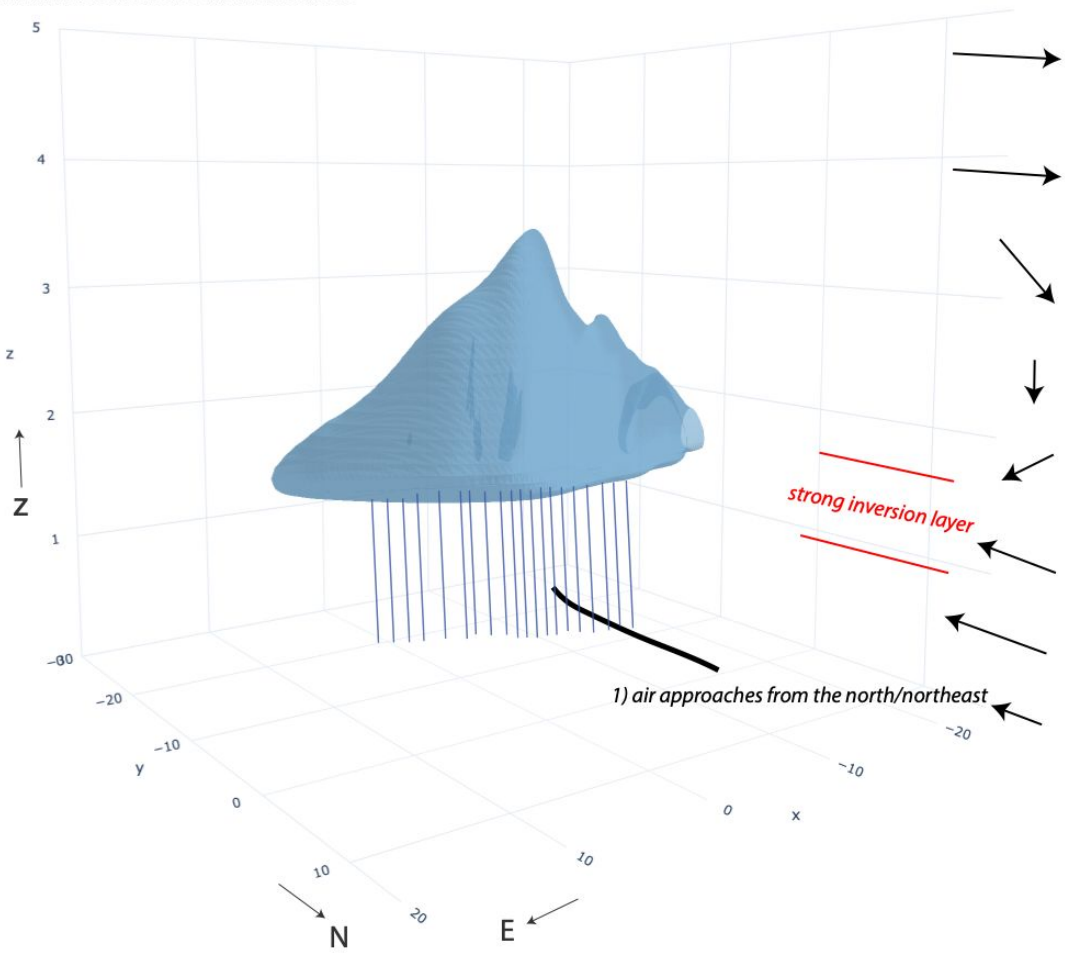
Gravity Wave?

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



From Borchardt et al. (2024)



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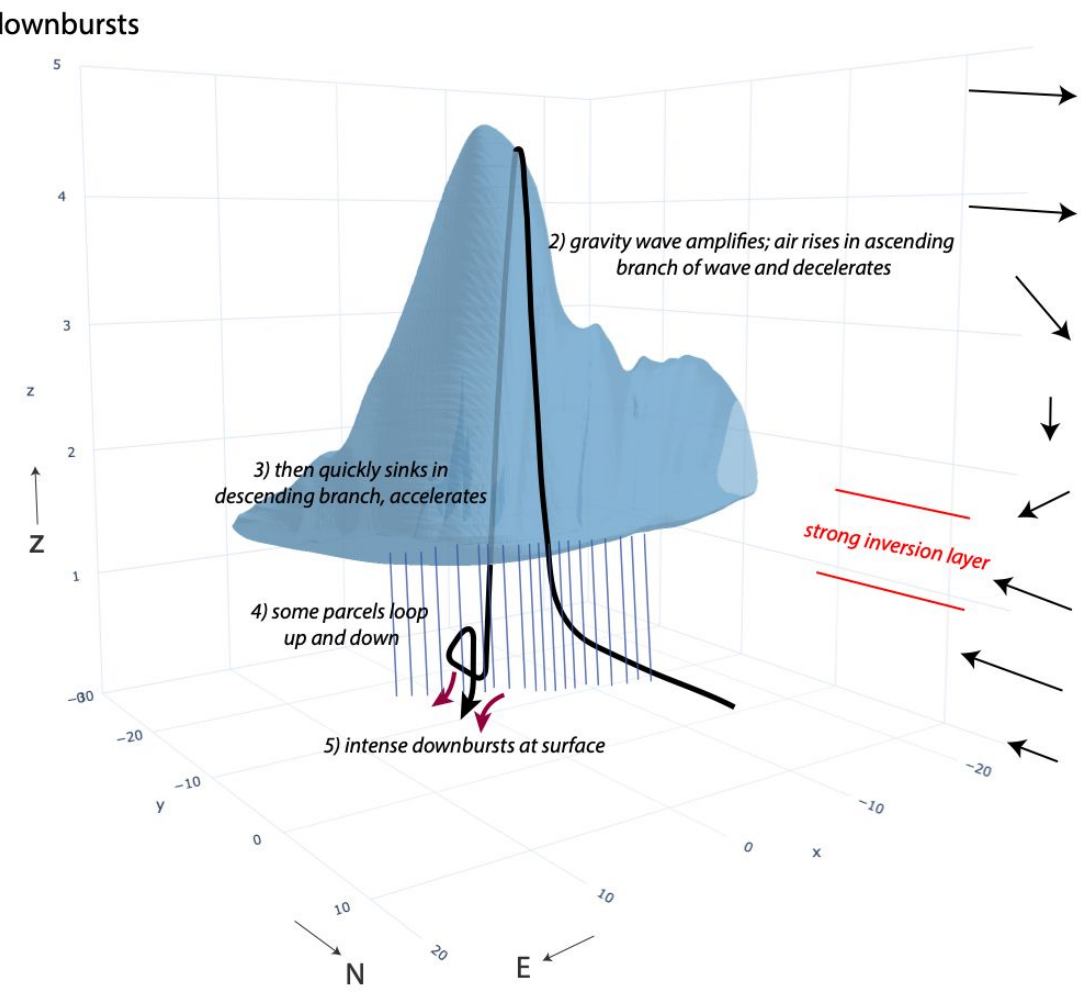

The Wind Side Of The Storm

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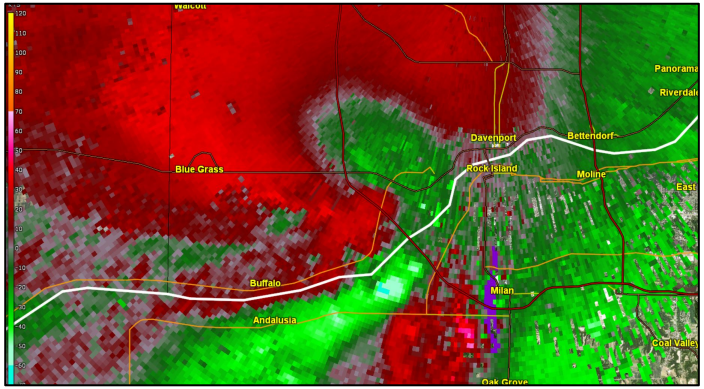
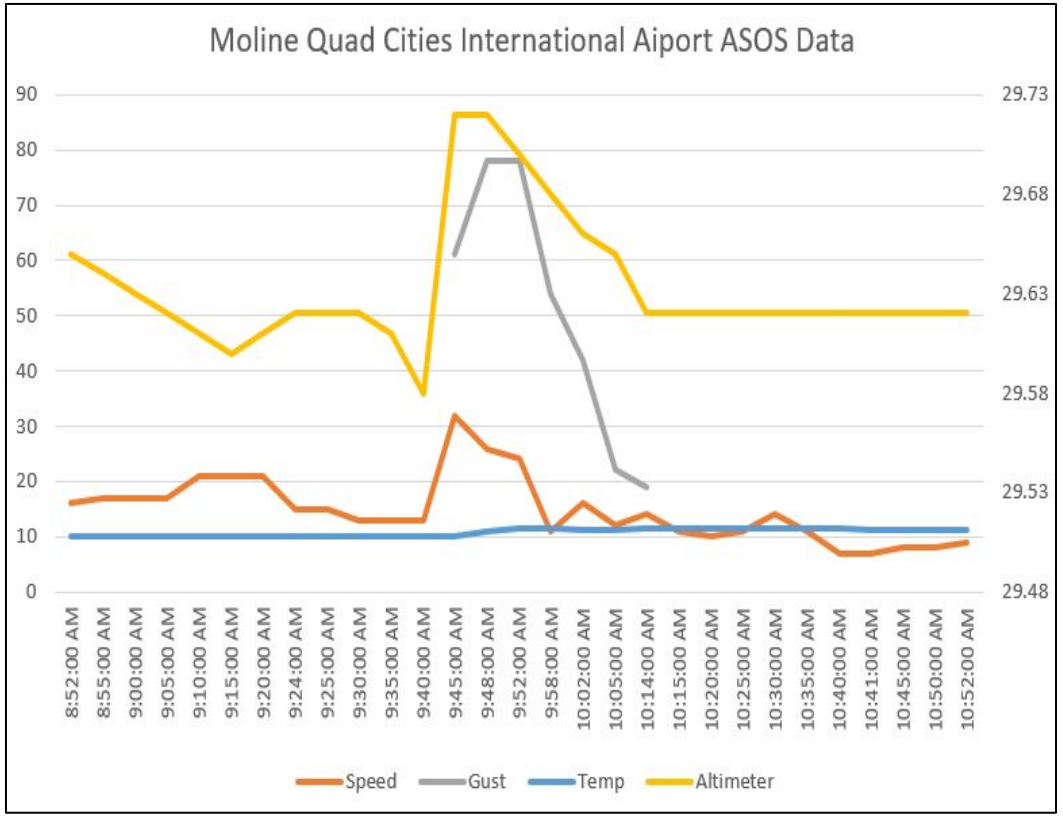
- Pronounced wind signature was noted in low-levels around 1200-1500 ft AGL
- Note the altimeter, wind and temp changes as the storm passes KMLI



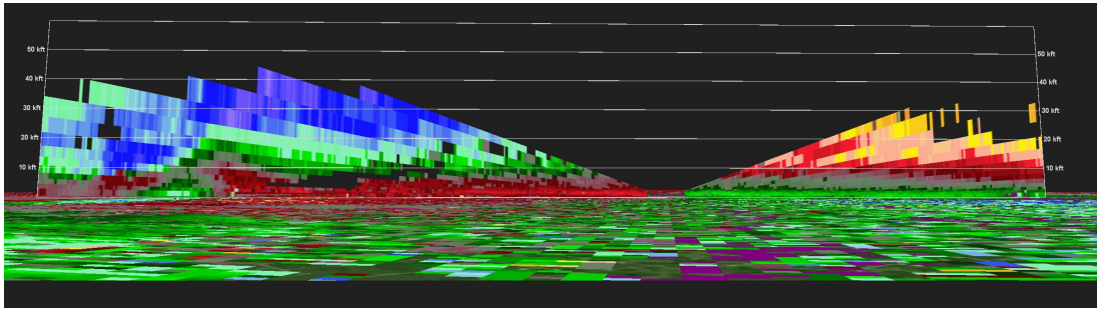


Goals Of This Presentation

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

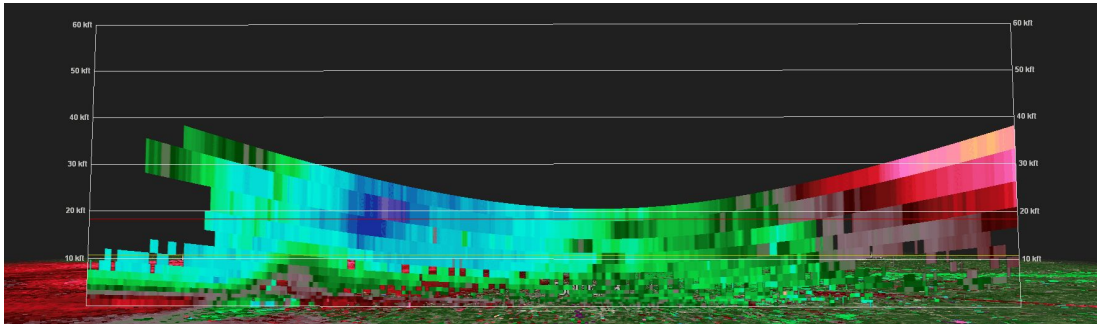
Borchardt et al, 2024:
La Crosse, WI
April 12, 2022

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

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