Tornadoes, rotating thunderstorms, and a look back at the 2024 severe weather season in New York

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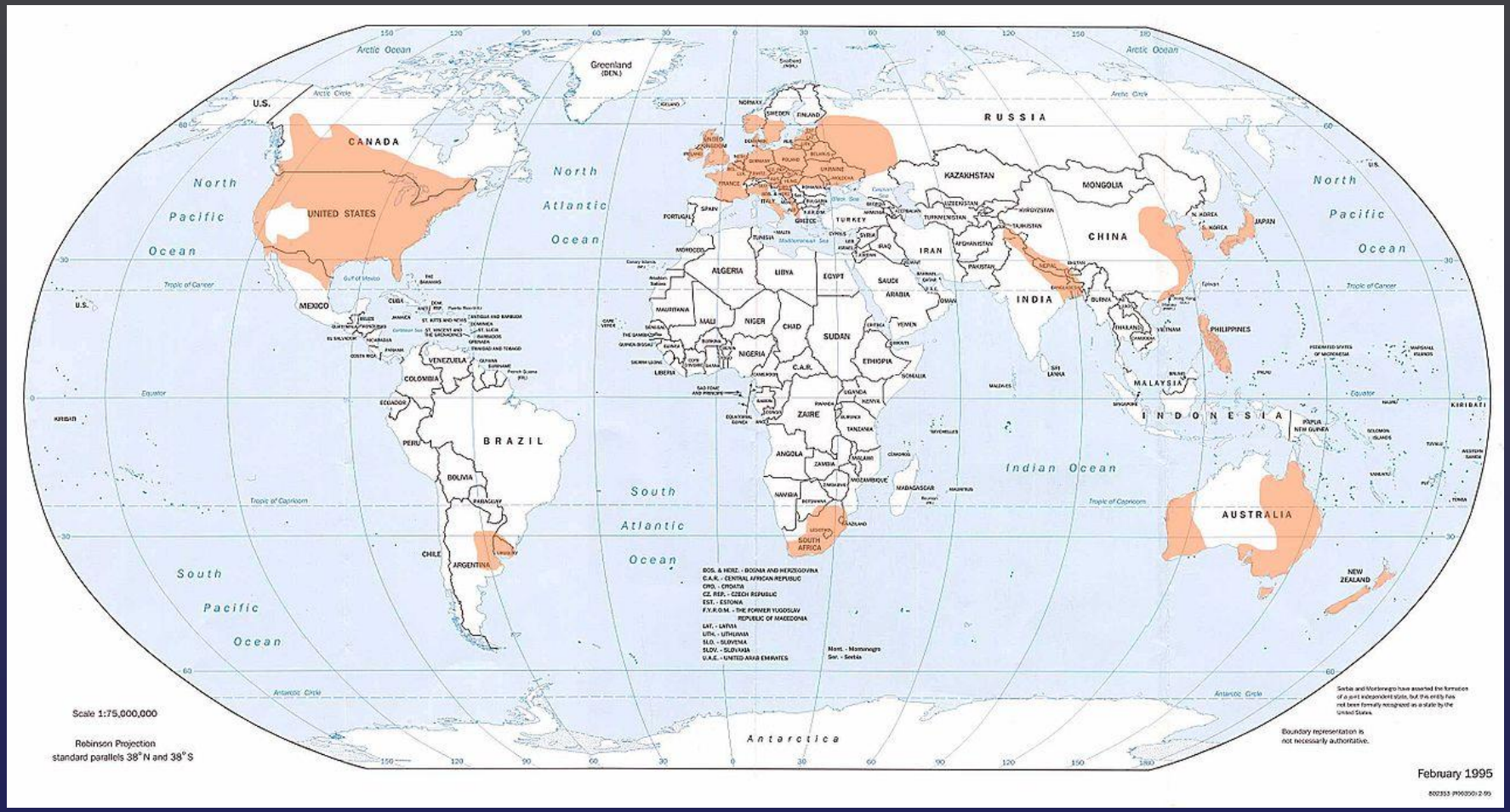
Outline

- Tornado climatology
- Rotating thunderstorm ingredients
- Rotating thunderstorms using radar data
- Duanesburg, NY tornado - 22 May 2014
- 2024: New York State's record-breaking year of tornadoes

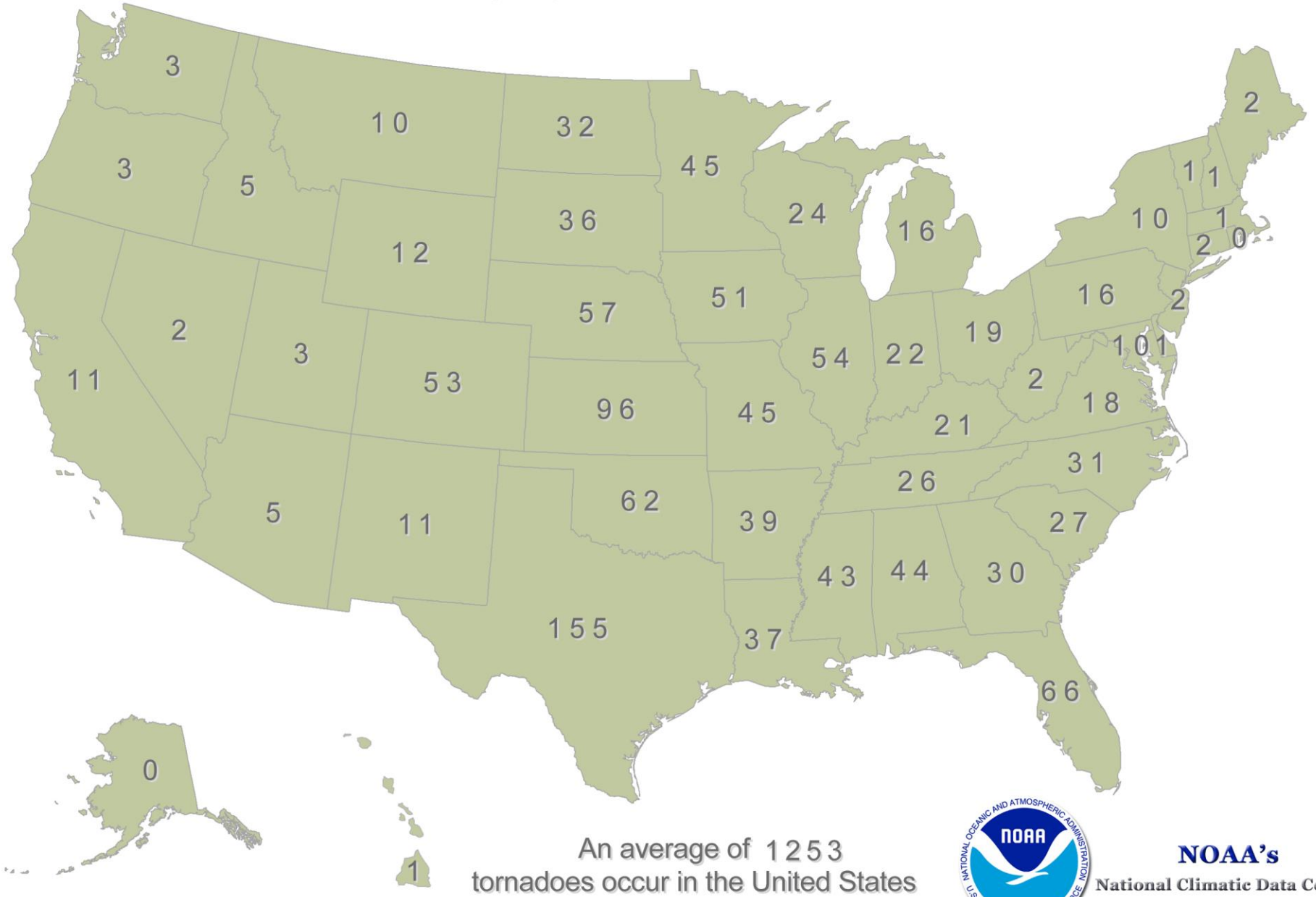
Global Tornado Occurrence



National Climatic Data Center (NCDC)

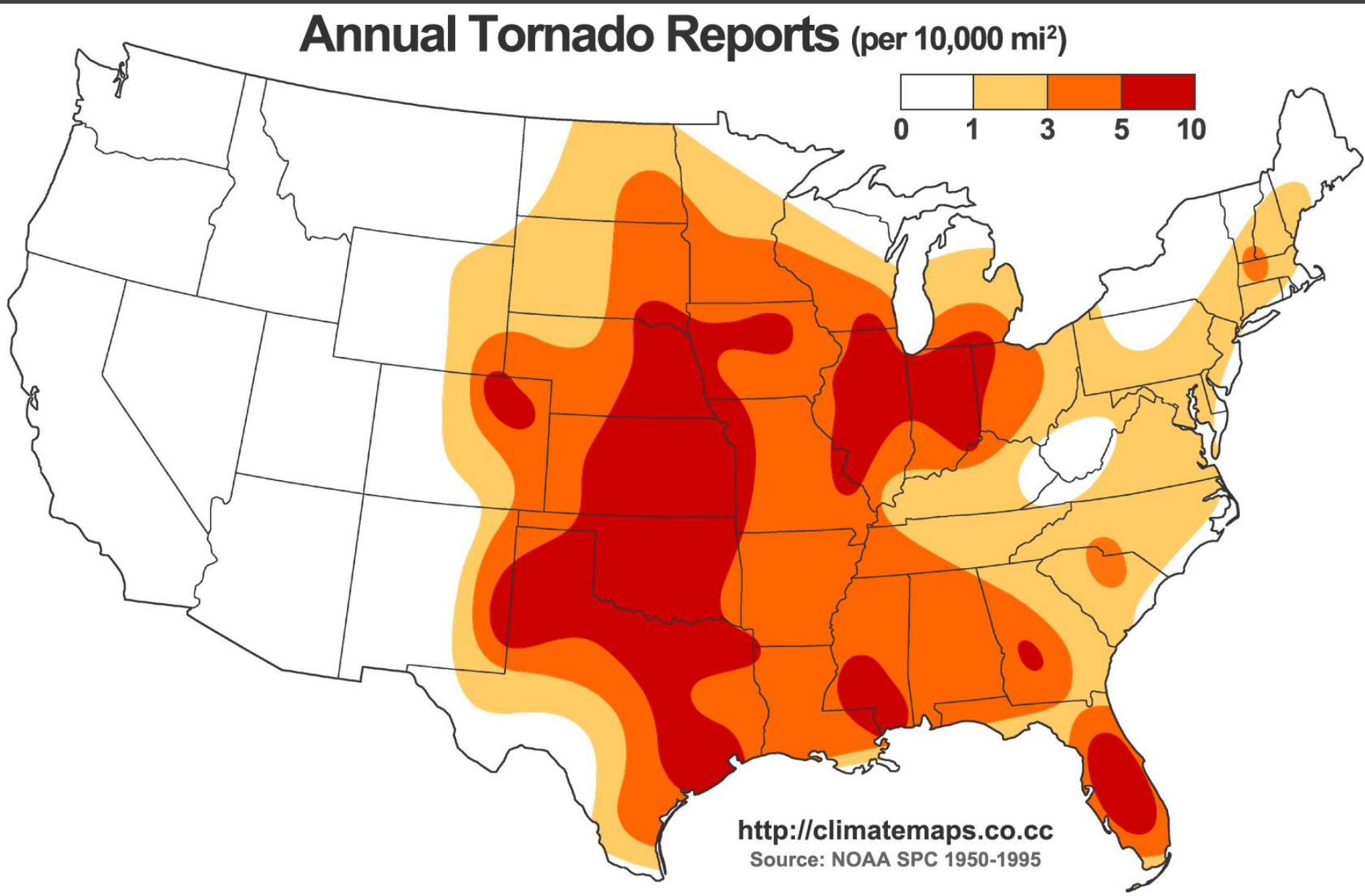
Average Annual Number of Tornadoes

Averaging Period: 1991 - 2010



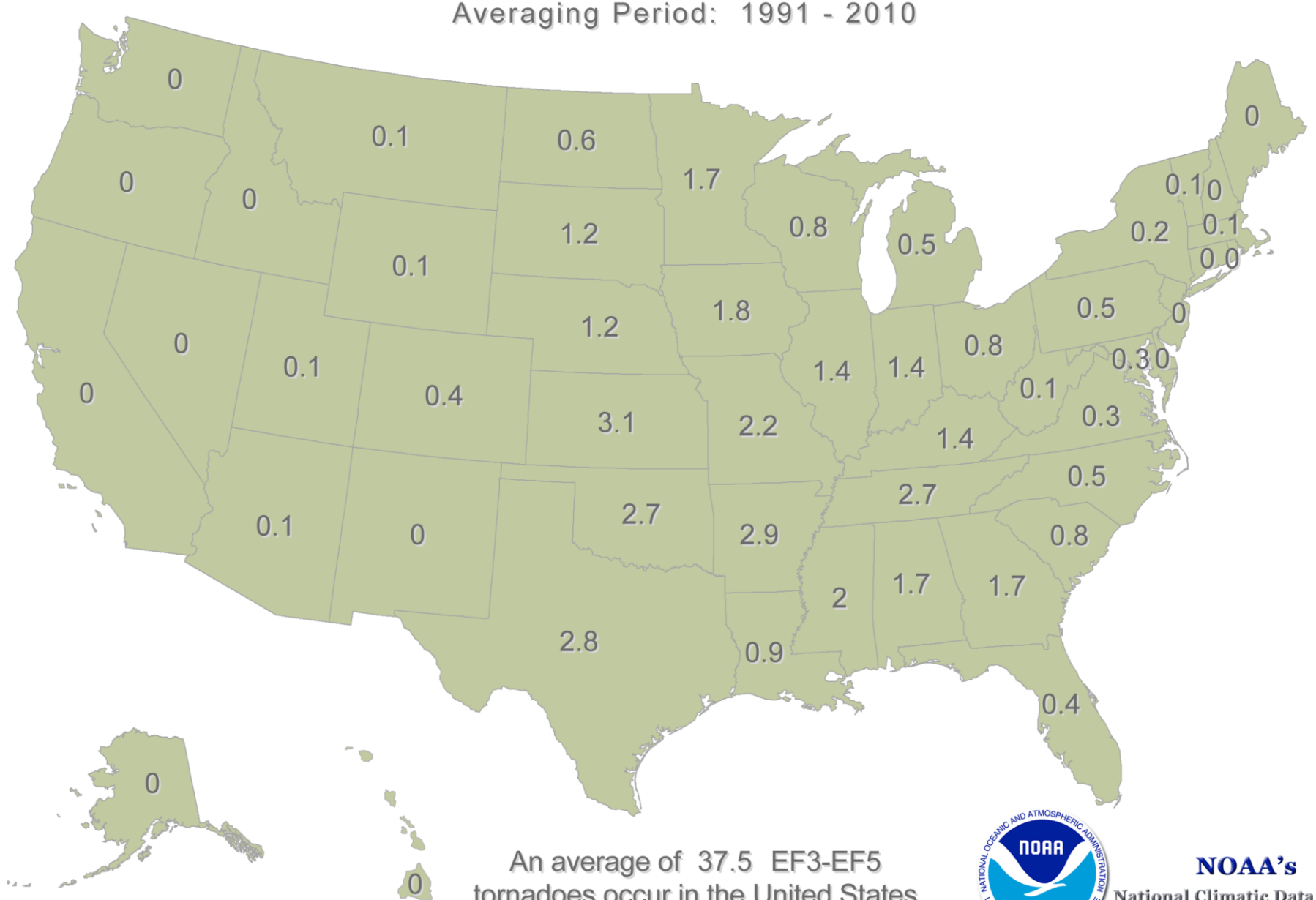
An average of 1253 tornadoes occur in the United States each year

NOAA's National Climatic Data Center


Annual Tornado Reports (per 10,000 mi²)
0
1
3
5
10
http://climatemaps.co.cc
Source: NOAA SPC 1950-1995

Average Annual Number of EF3-EF5 Tornadoes

Averaging Period: 1991 - 2010



An average of 37.5 EF3-EF5 tornadoes occur in the United States each year

NOAA's National Climatic Data Center

Why "Tornado Alley"?

Perfect combination of . . .

- Warm, moist air at surface
- Cool, dry air aloft (> ~2 km above surface)

  -Instability

- Coupled with this is often a change in wind speed and direction with height

  -Wind shear

Why are these tornado ingredients, and why are they such a common occurrence in Tornado Alley?

Why "Tornado Alley"?

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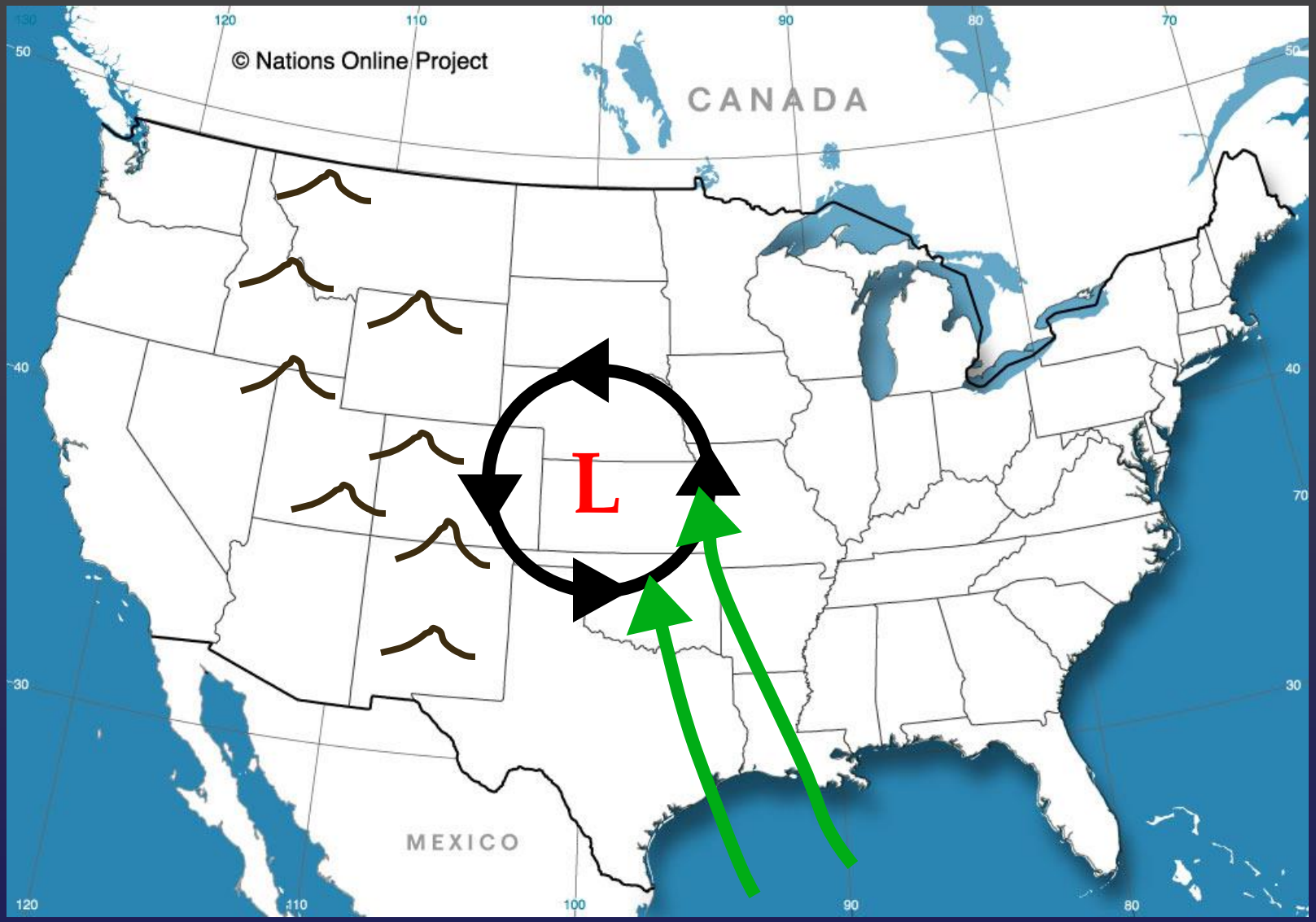

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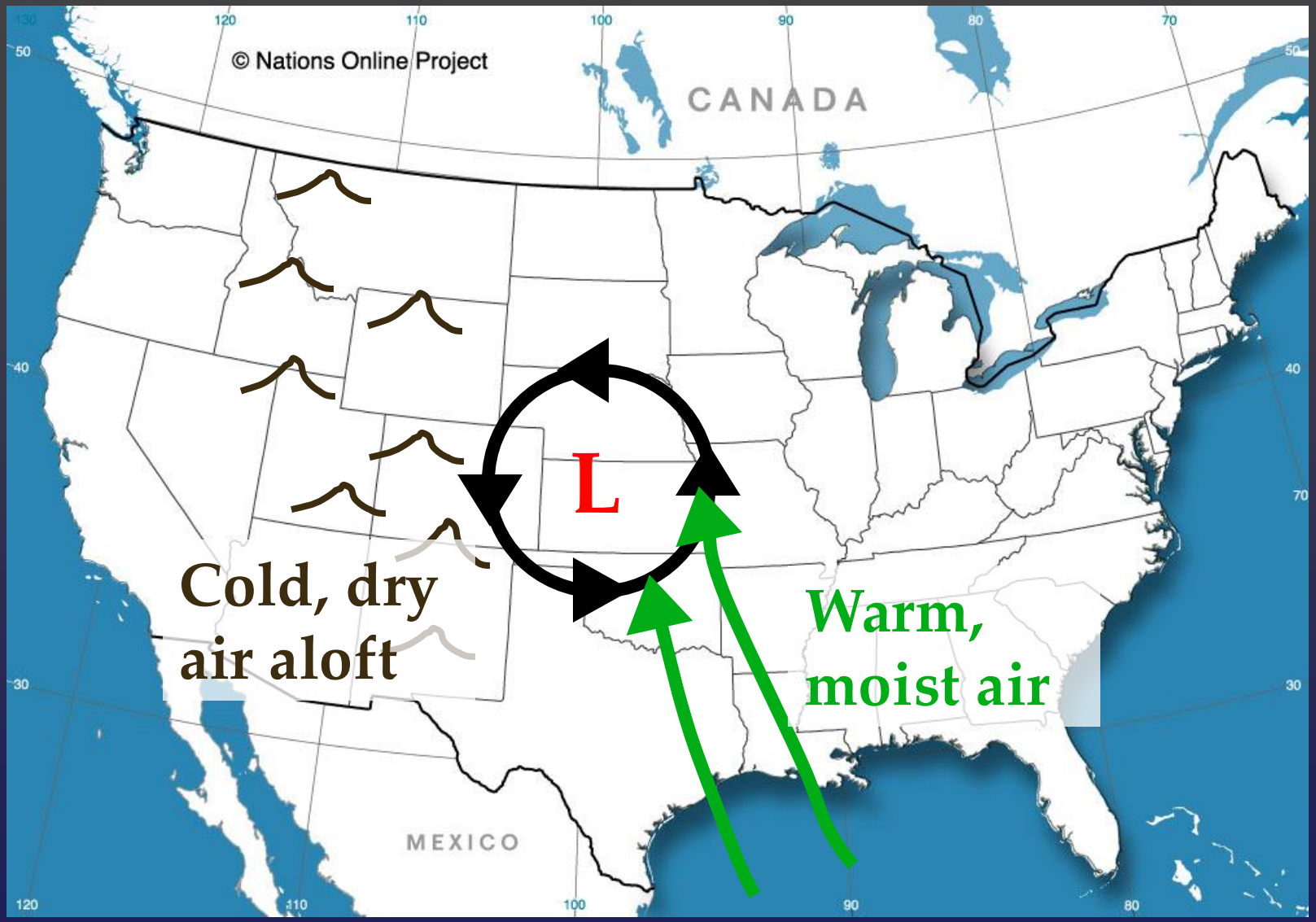


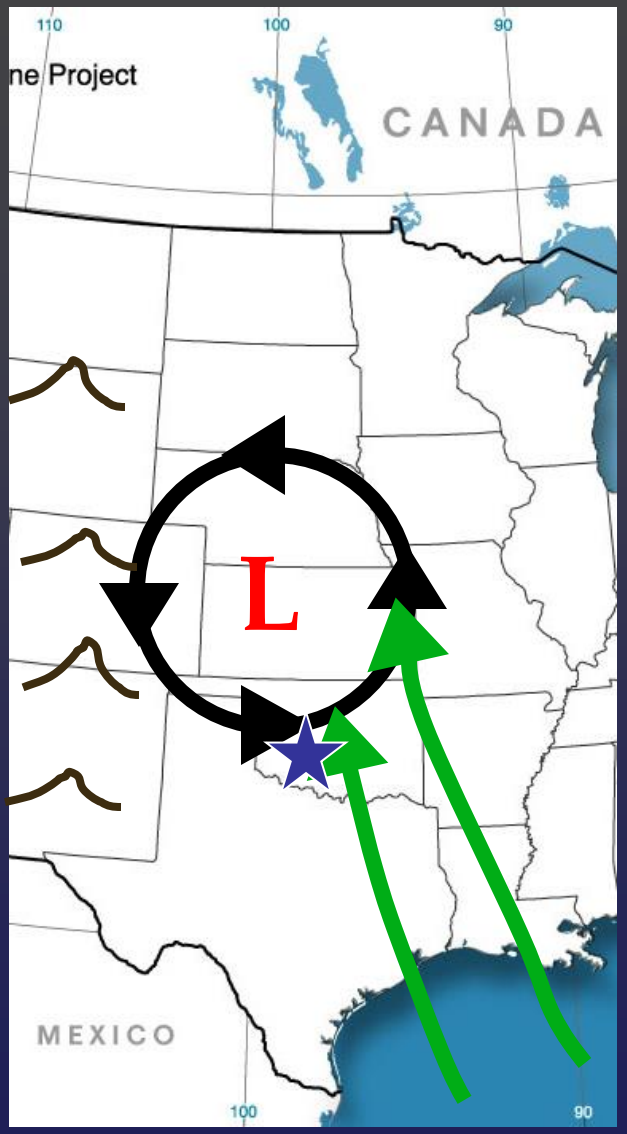
Why "Tornado Alley"?

-- ~10 km: Top of troposphere

Cold, dry air aloft

--1 km

Warm, moist air



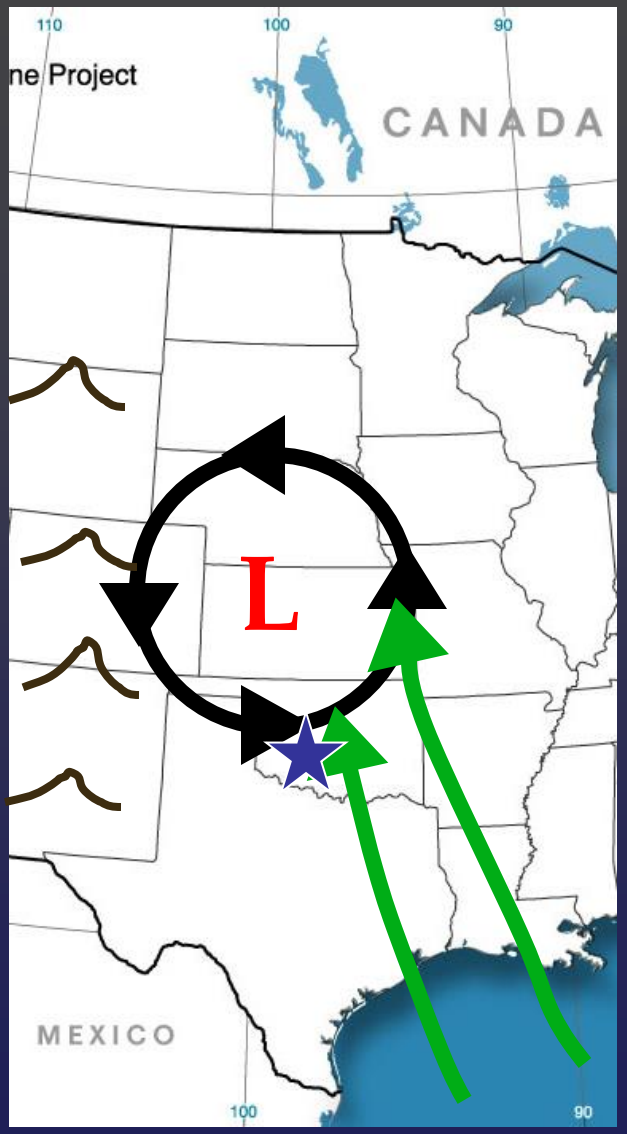
Why "Tornado Alley"?

-- ~10 km: Top of troposphere

Cold, dry air aloft — **More dense**

--1 km

Warm, moist air — Less dense



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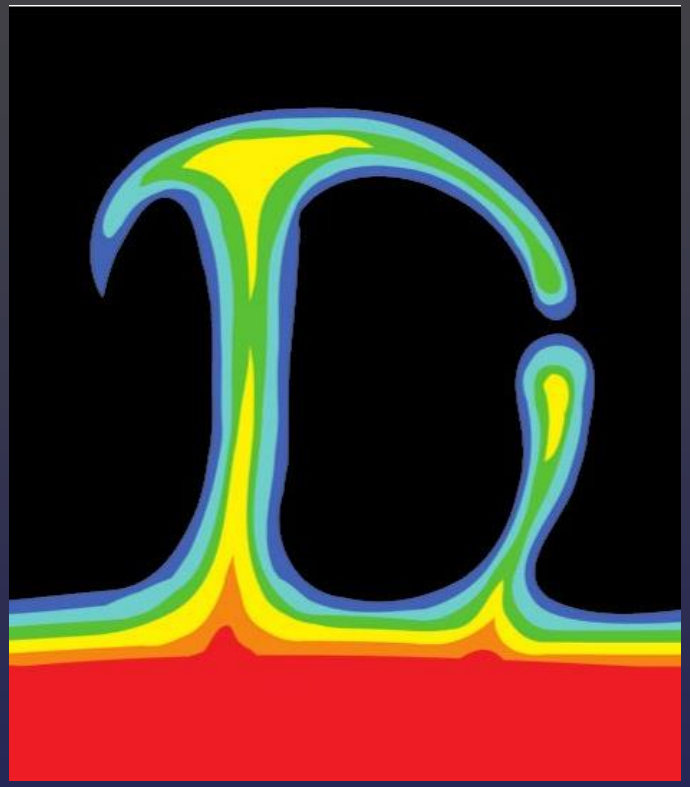


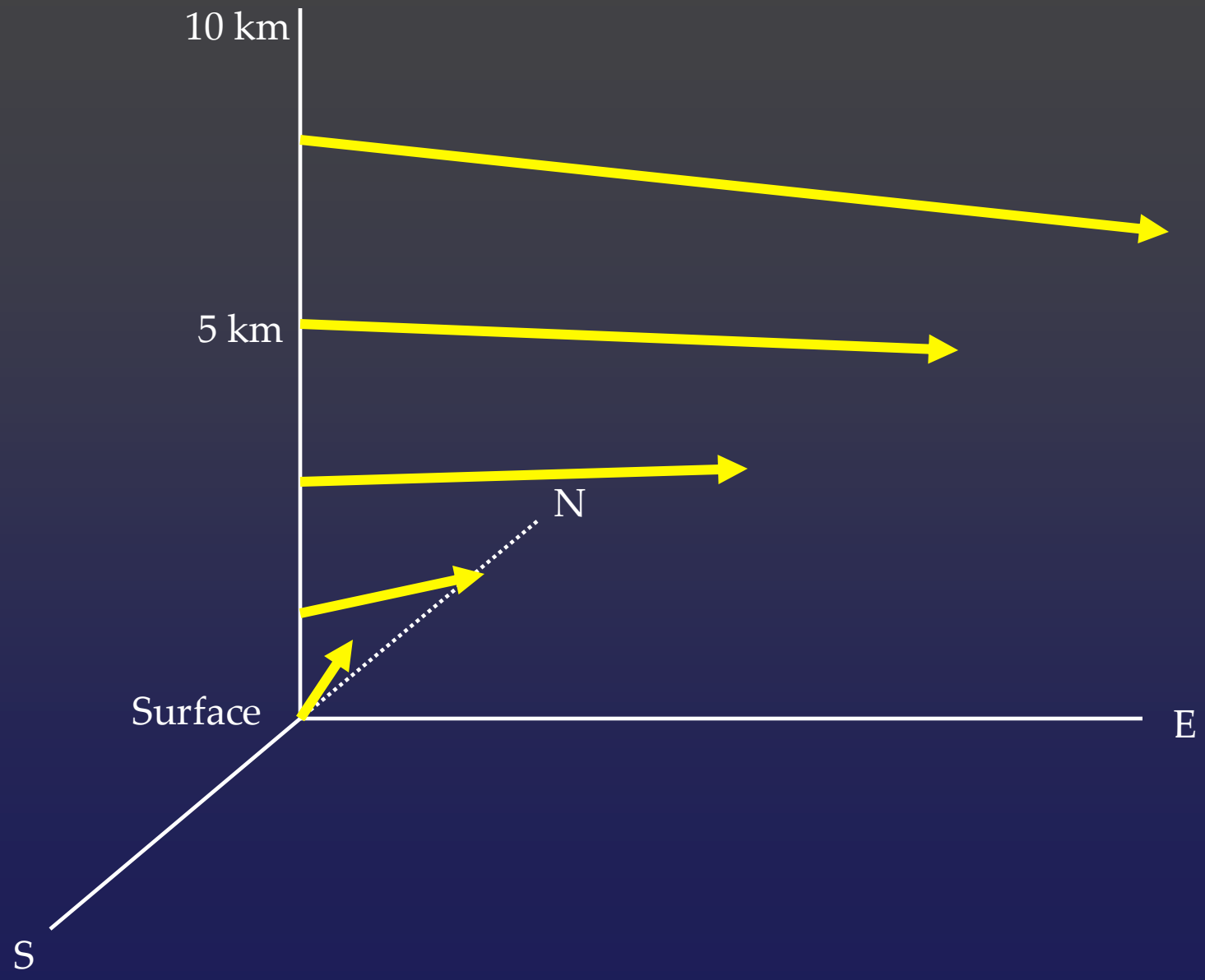
As in the convection tank:

Warm, less dense air rises

Now we have convection (cumulonimbus).
How do we get **ROTATION**?

Vertical wind shear

Change in wind speed and direction with height



Vertical wind shear

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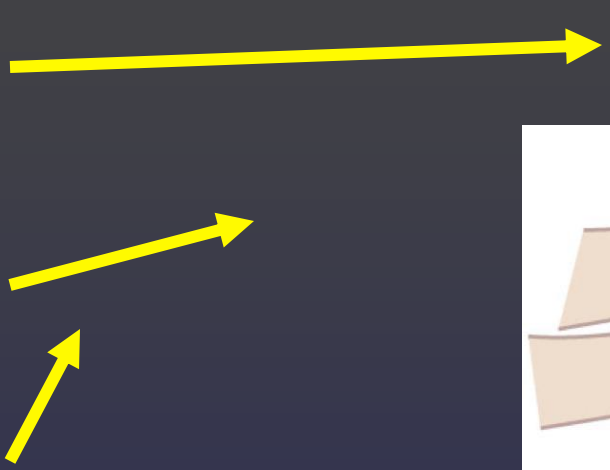
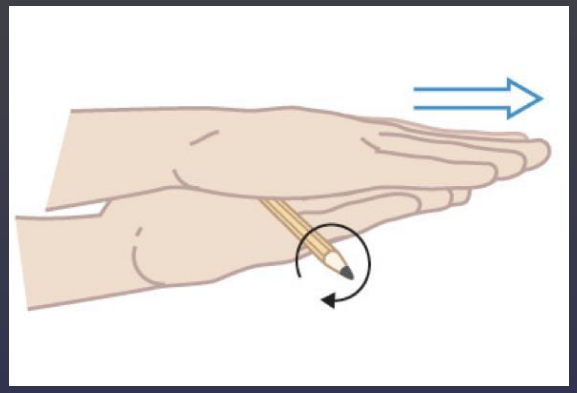
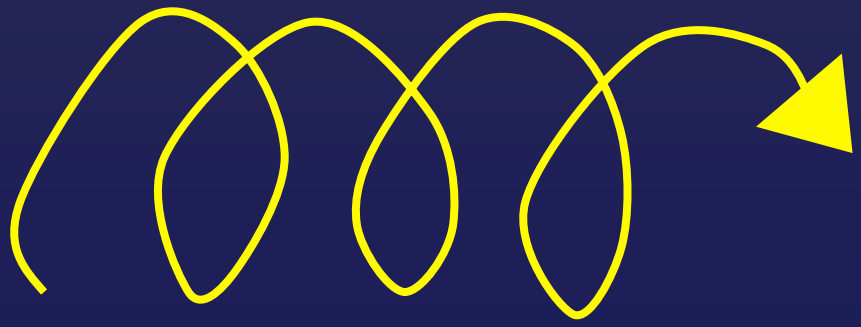
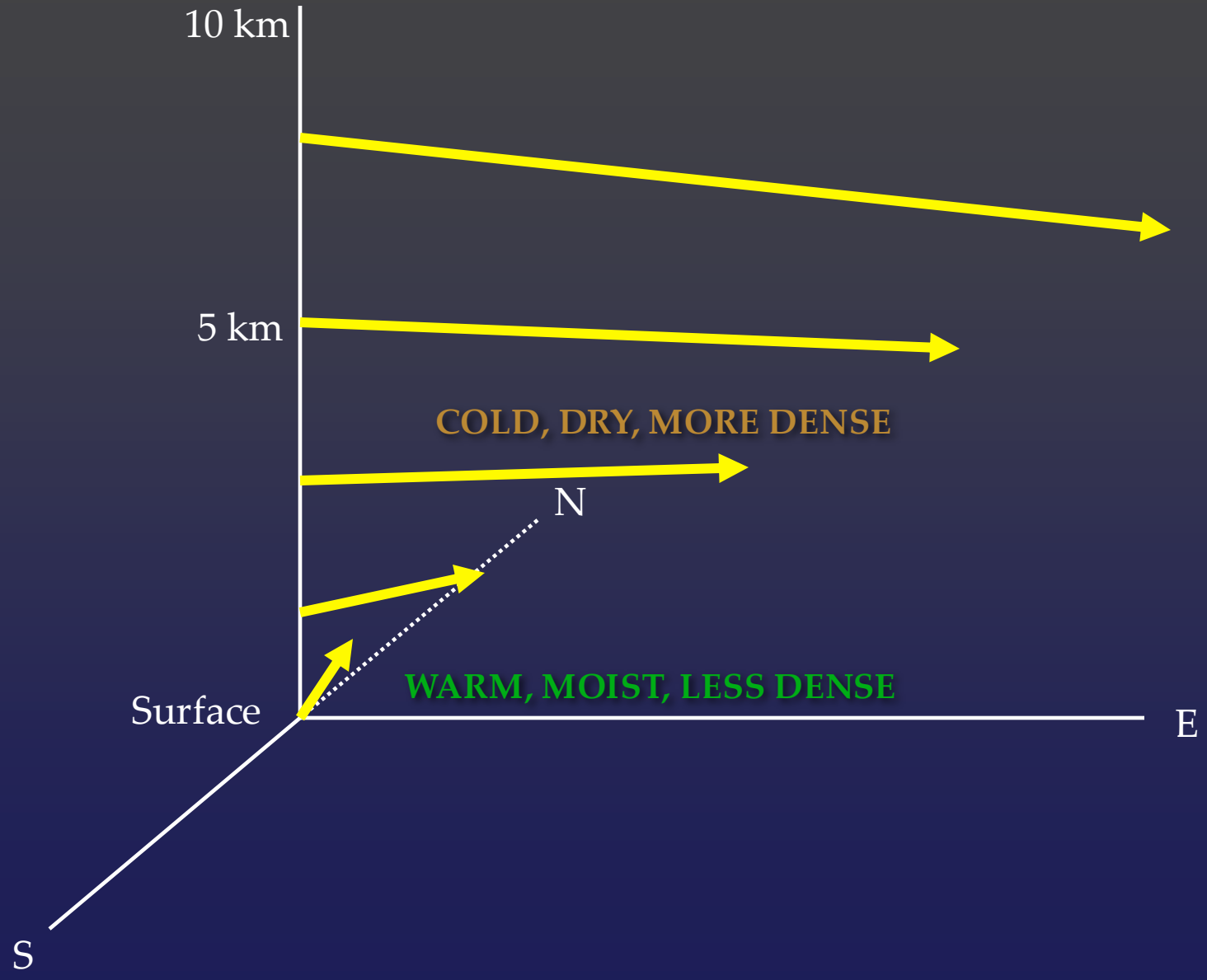




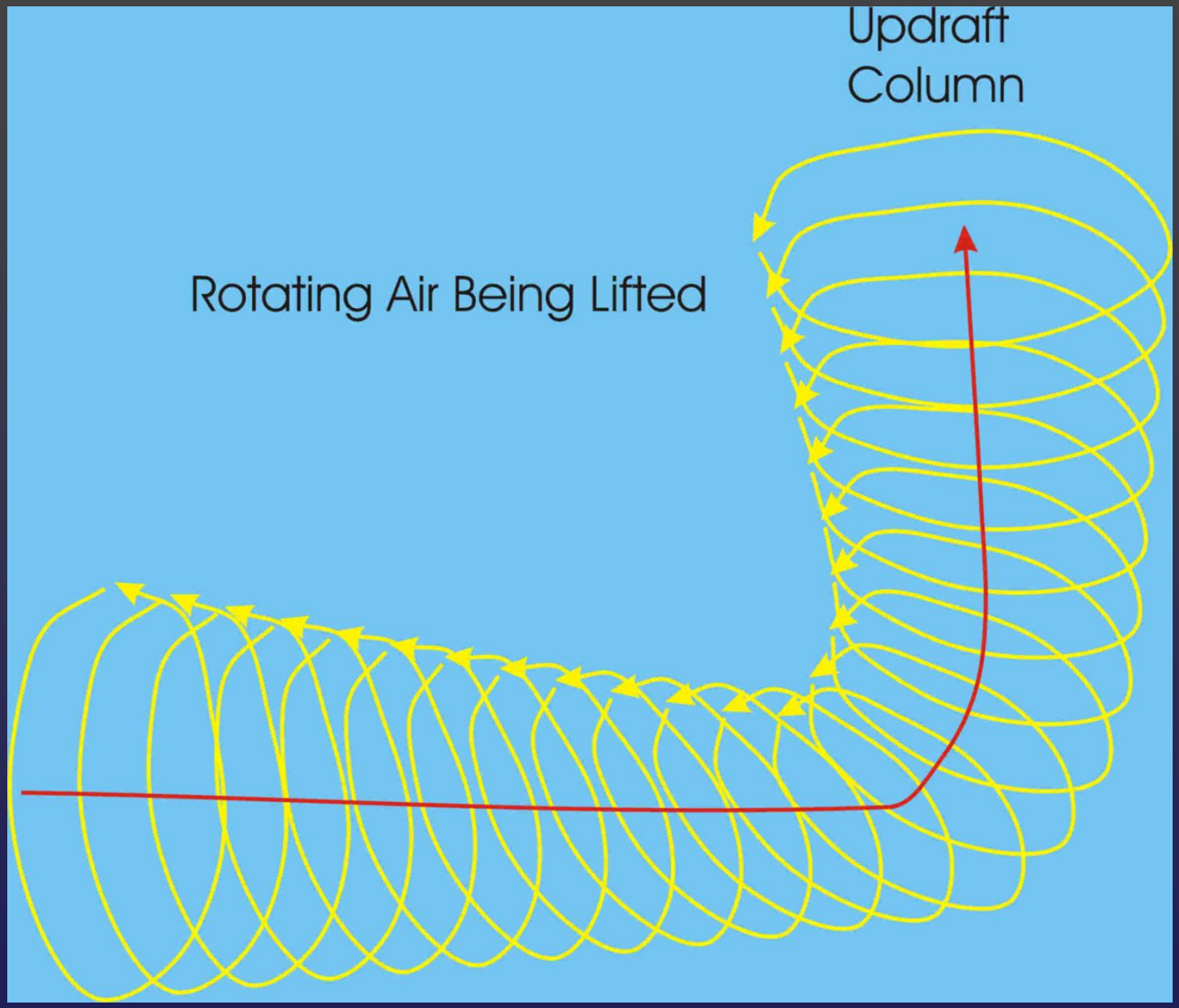
Wind shear creates a horizontal vortex



Add instability . . .



Convective "updraft" plus Vertical wind shear



From MadSciTech.org

2324 UTC
27 May
2014

Castroville
Texas

2334 UTC 27 May 2014 – Castroville, Texas

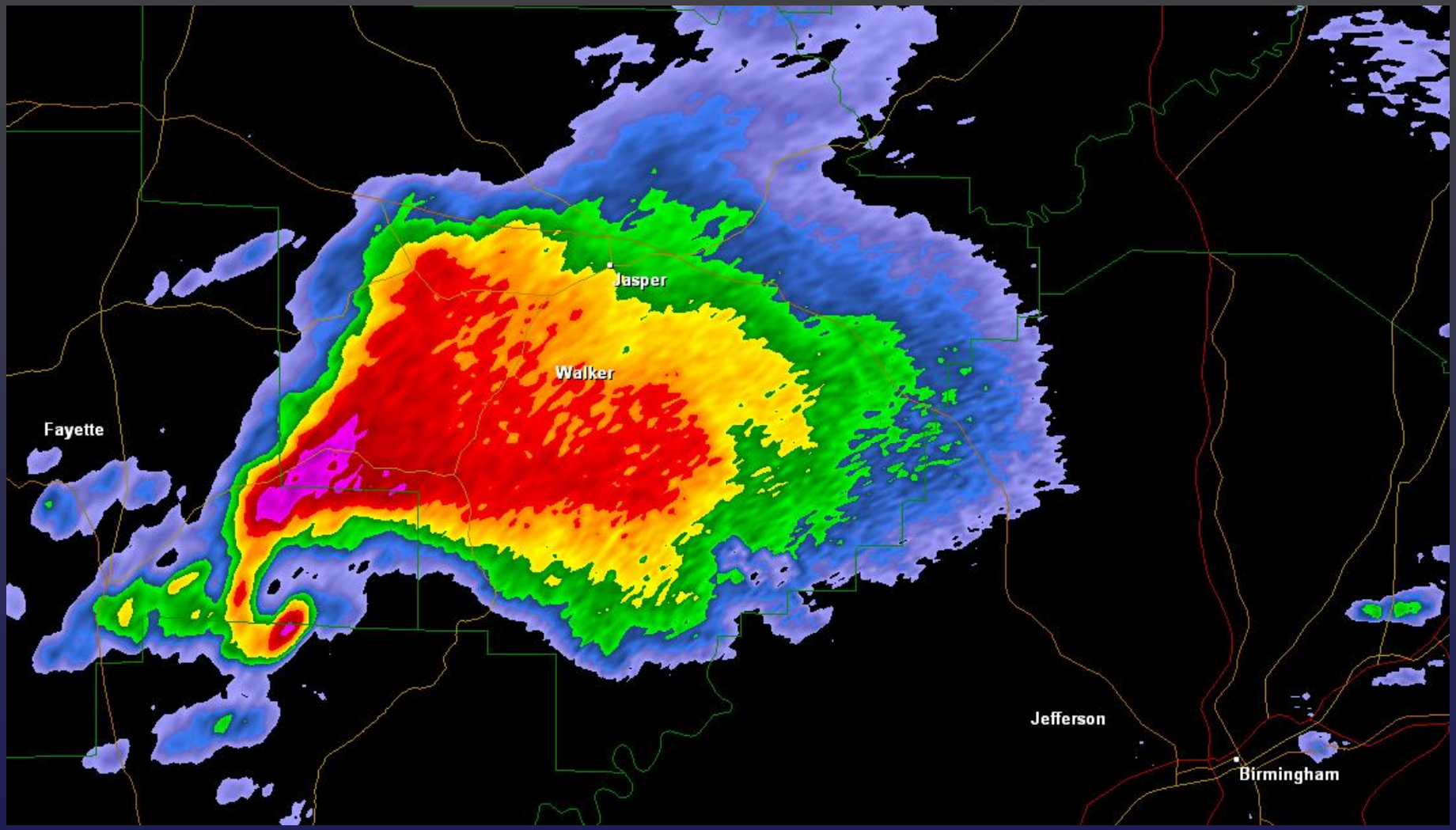
2337 UTC 27 May 2014 – Castroville, Texas

2247 UTC 10 July 2024 – Bridgewater, New York

Photo by Mike Hollingshead
June 13, 2004 – Alvo, Nebraska

Supercell Thunderstorm

A thunderstorm with a rotating updraft (mesocyclone)



Supercell near Birmingham, AL on April 27, 2011

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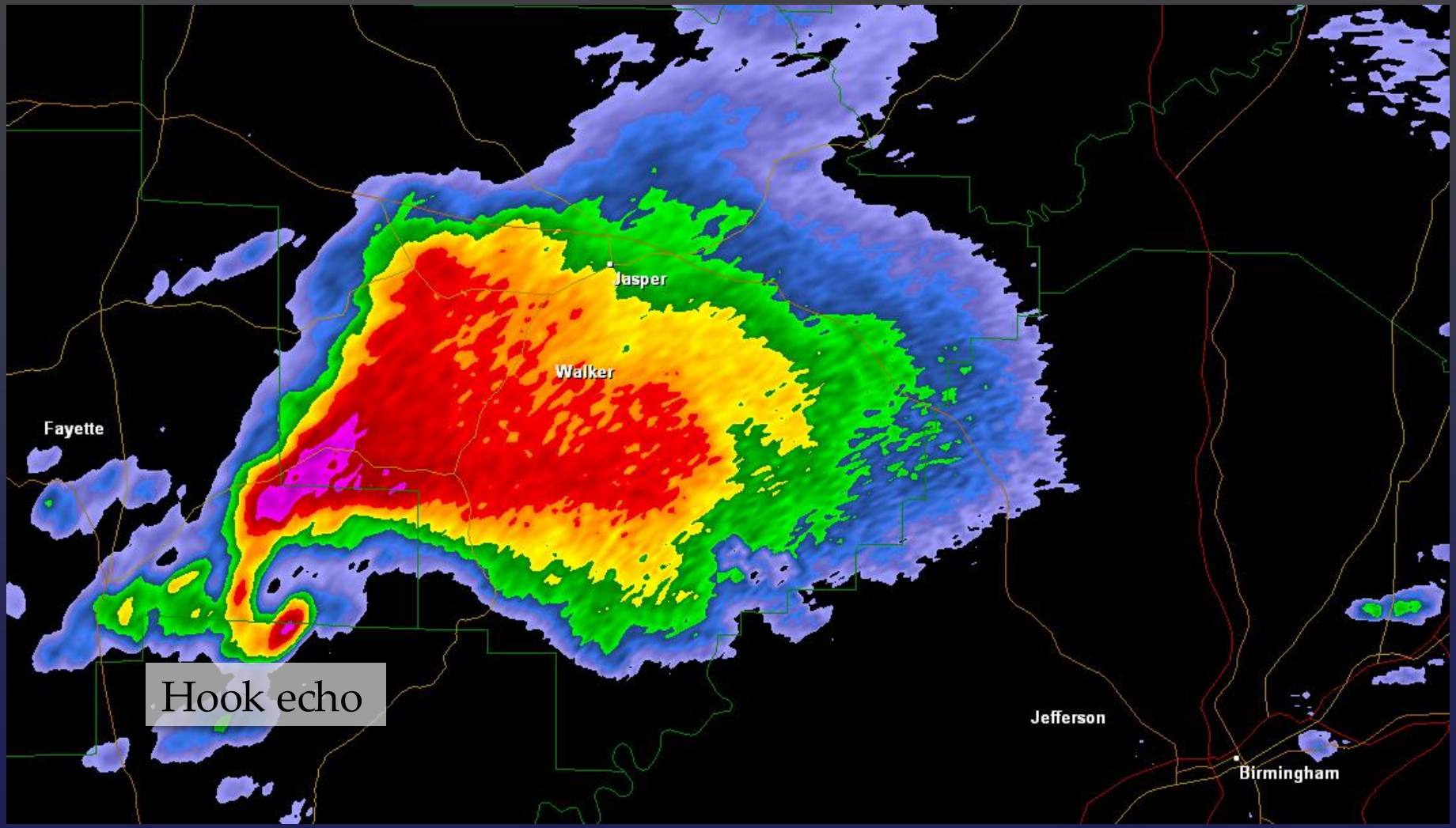

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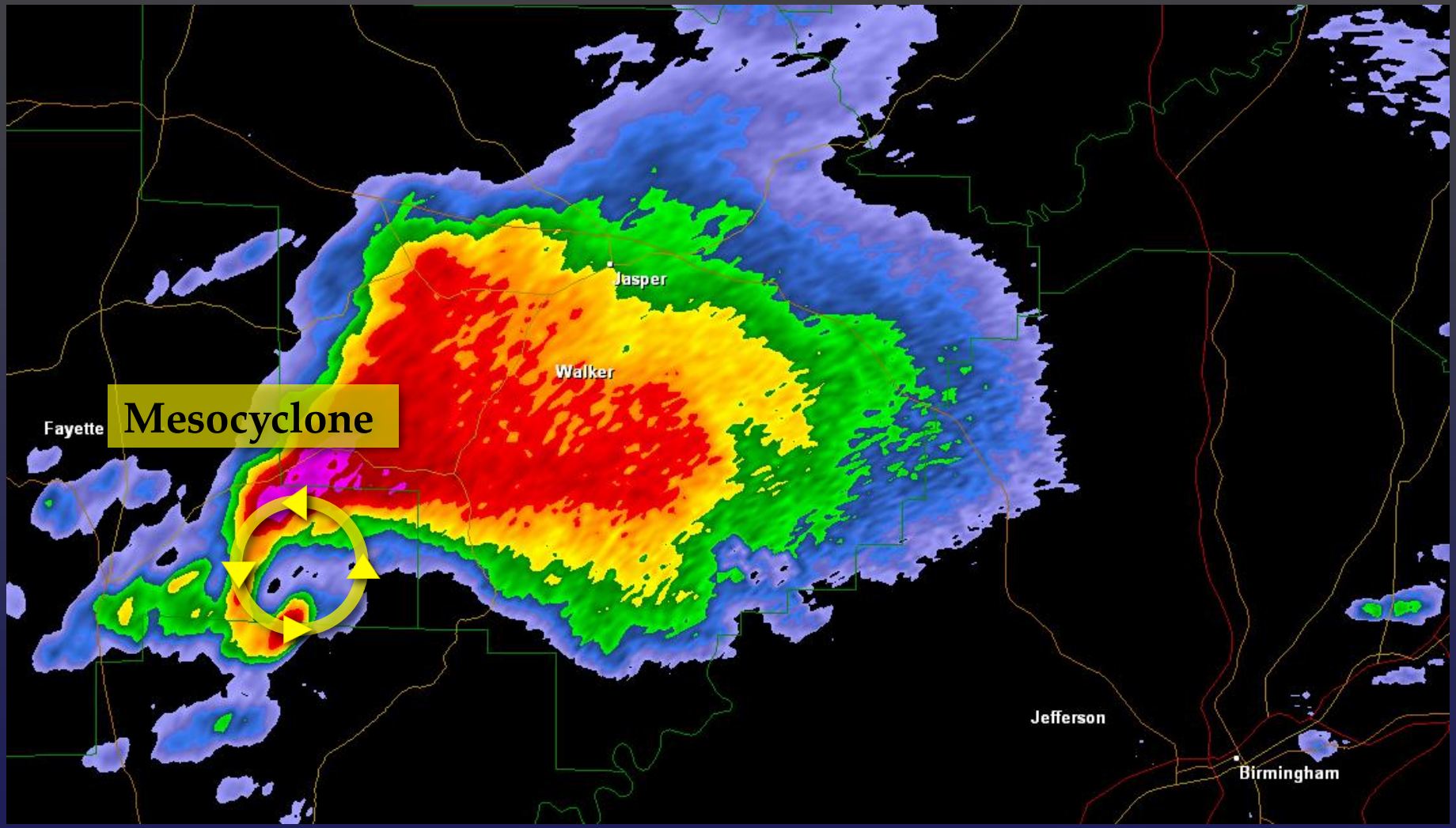

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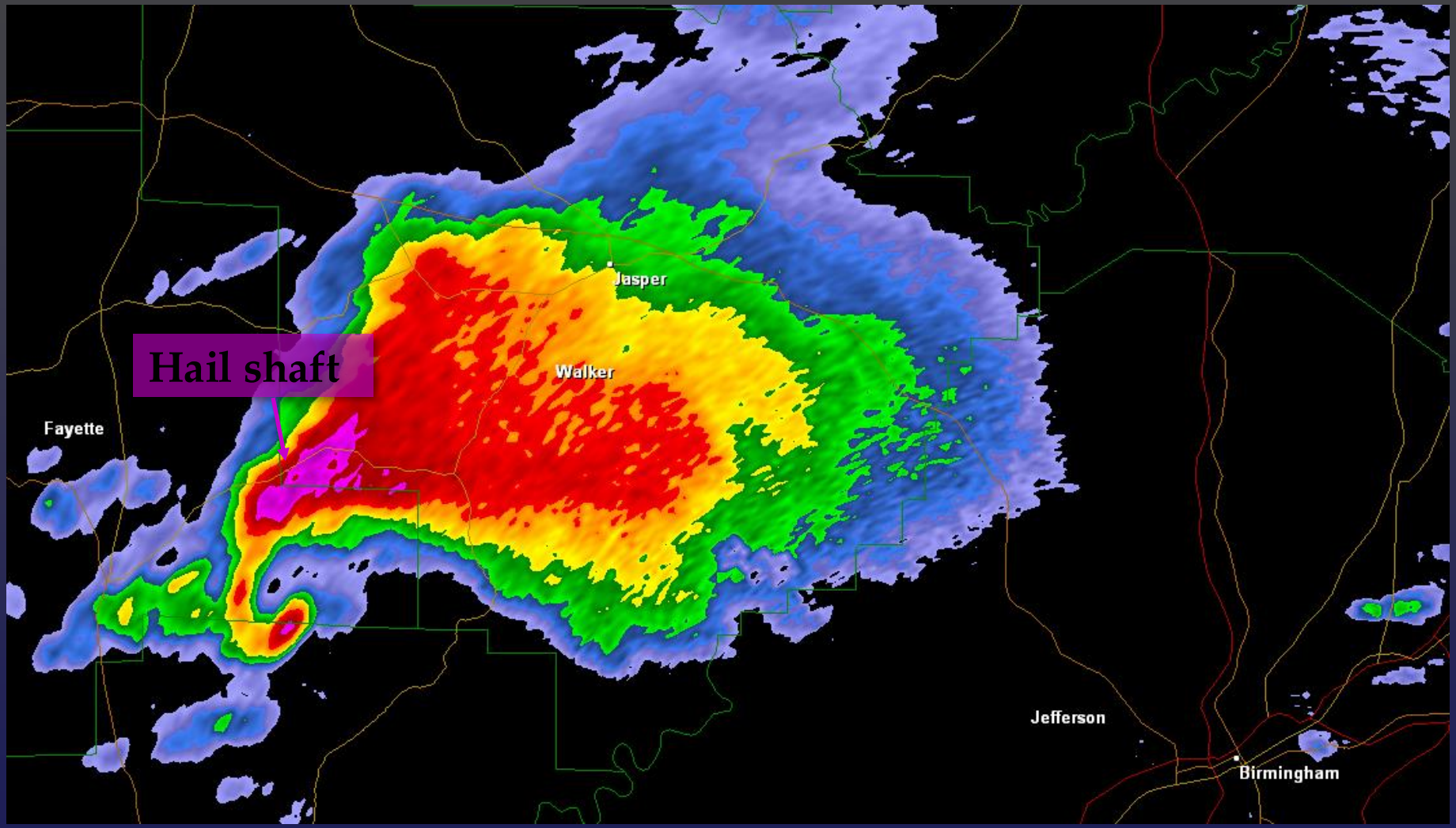

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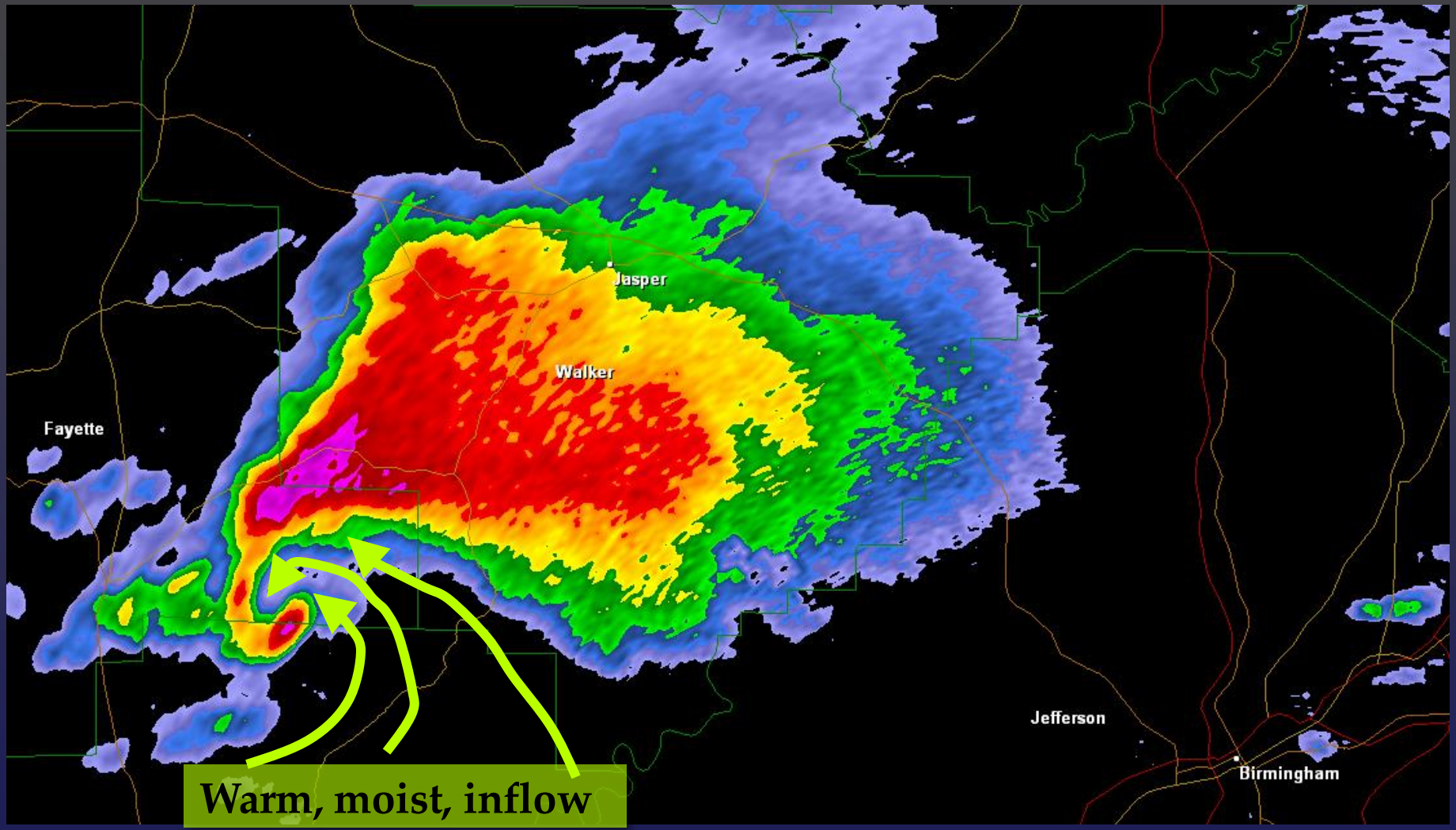

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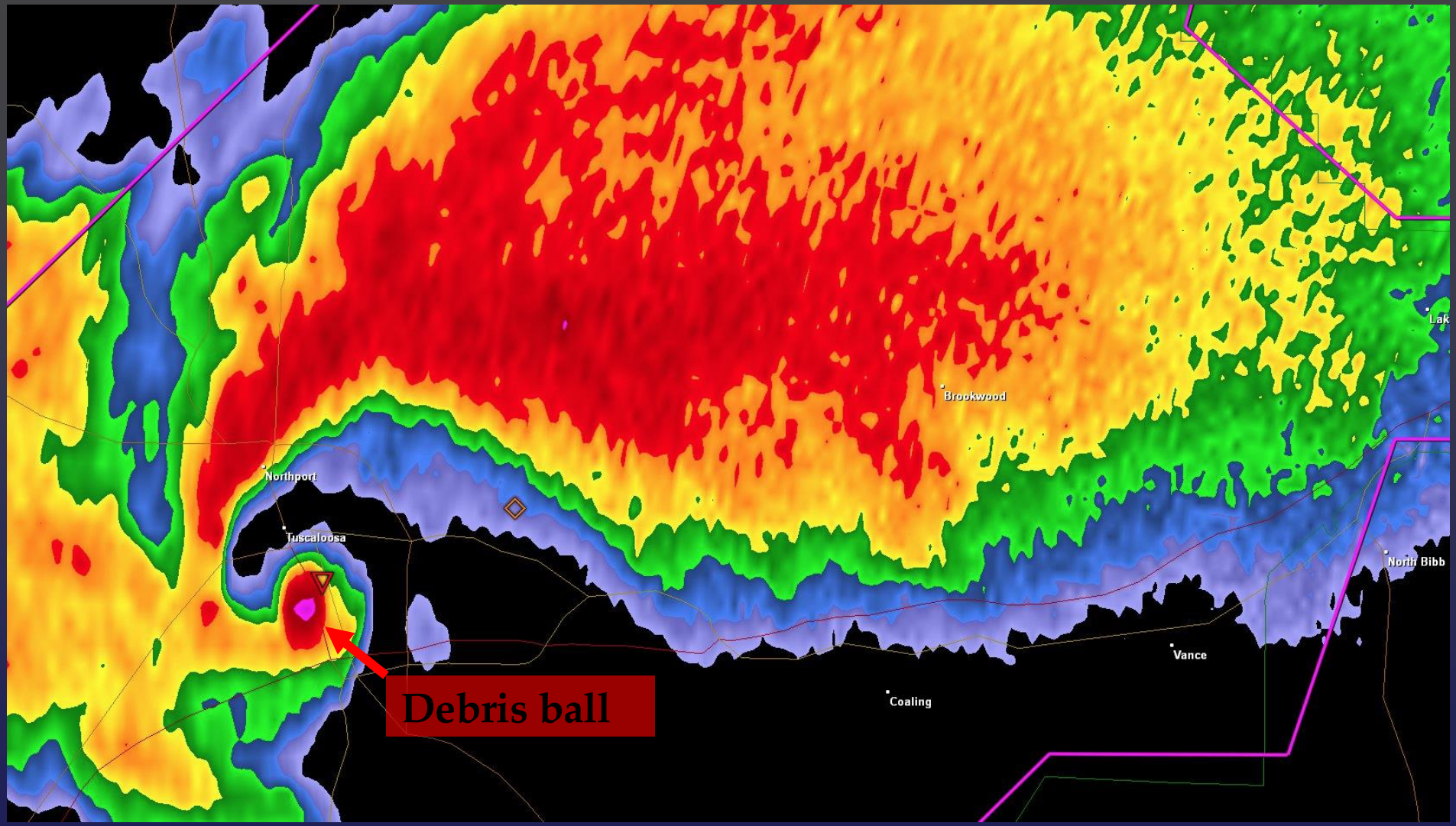
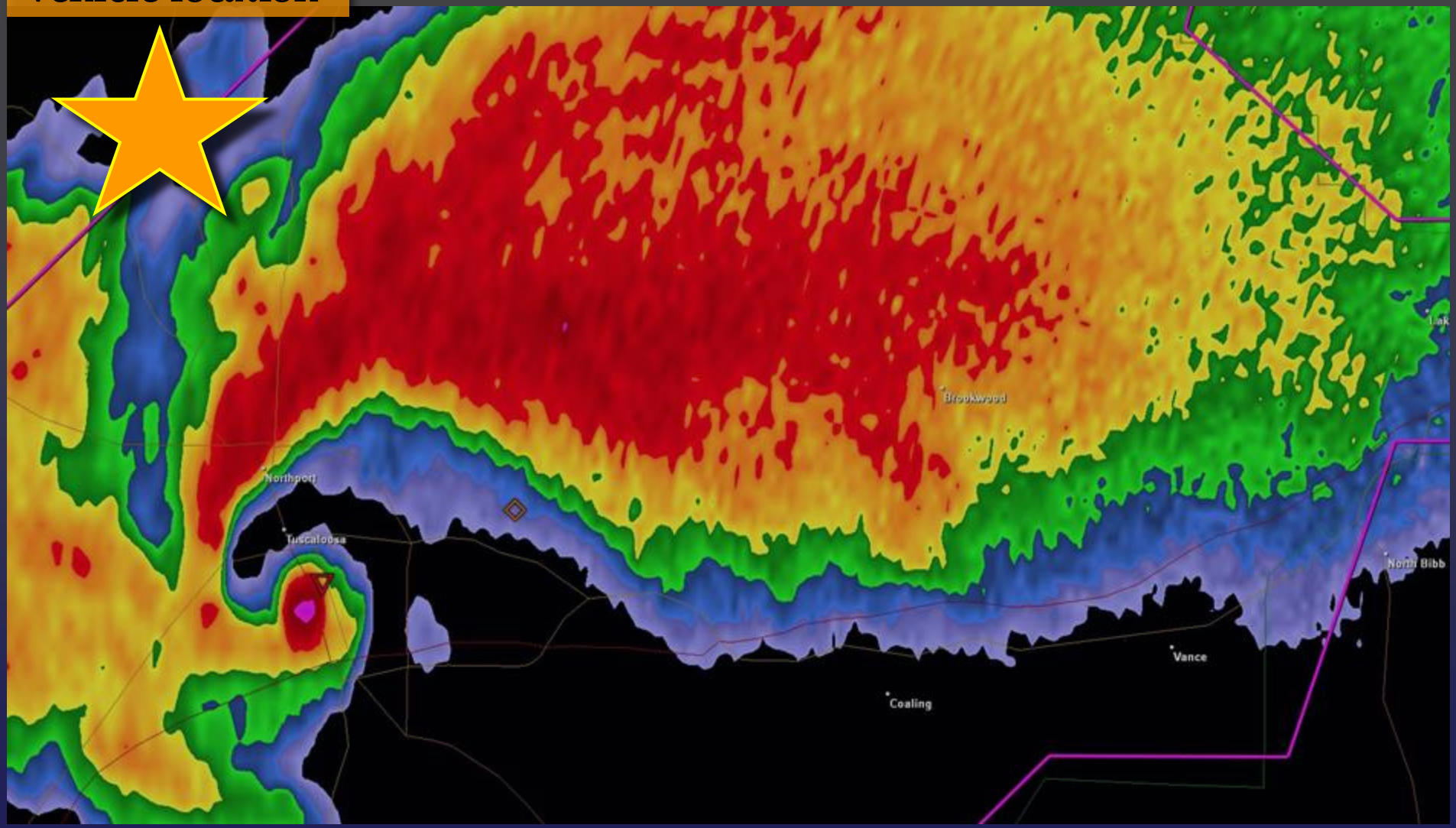


Supercell near Tuscaloosa, AL on April 27, 2011

Supercell Thunderstorm

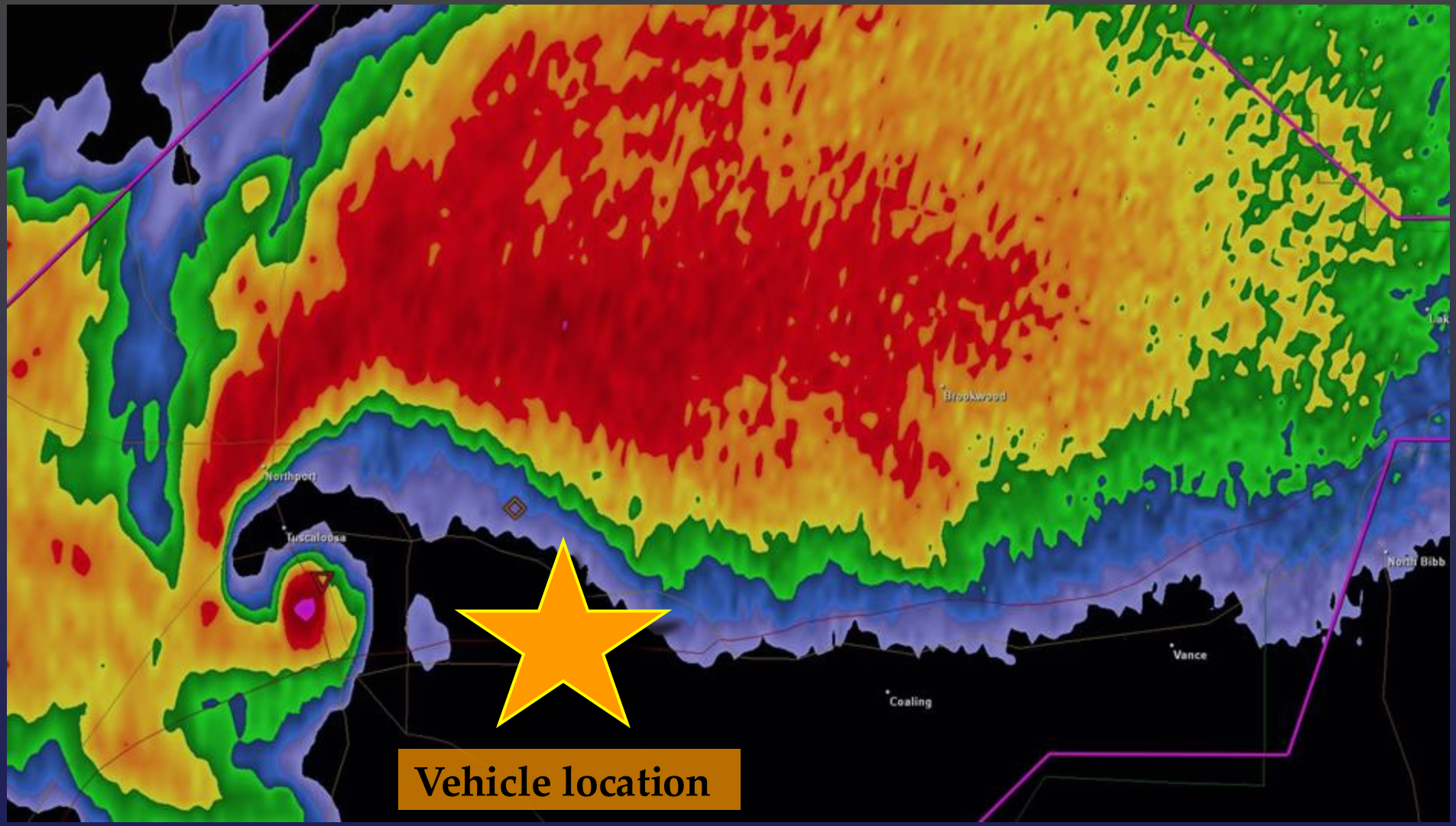


Supercell near Tuscaloosa, AL on April 27, 2011

Supercell Thunderstorm

Photo from storm chase on June 5, 2010 near Magnolia, IL

Supercell Thunderstorm



Supercell near Tuscaloosa, AL on April 27, 2011

Supercell Thunderstorm

Photo by Dusty Compton/Tuscaloosa News, 4/27/11

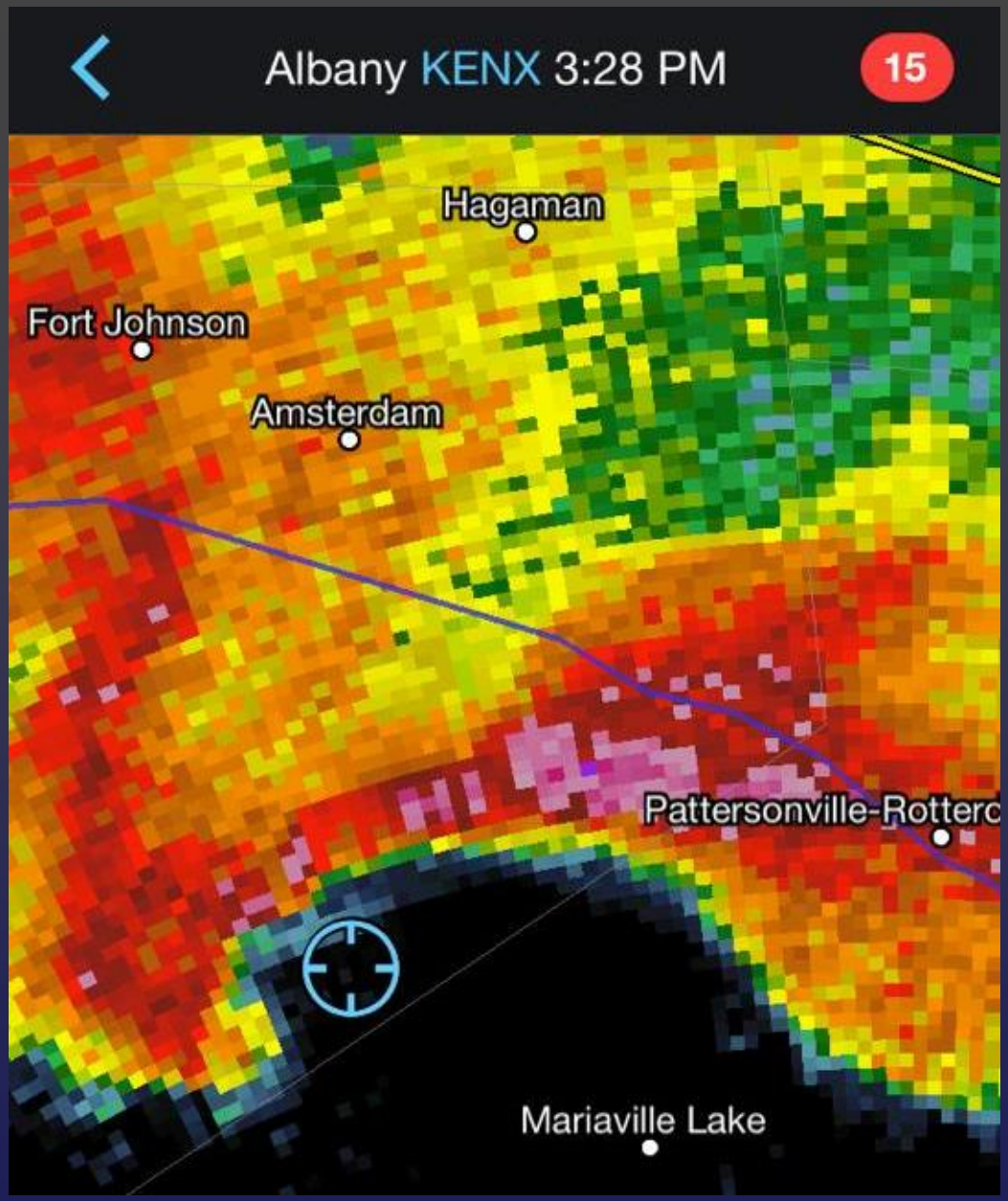
Severe weather outbreak

May 22, 2014

Montgomery and Schenectady County, New York

1920 UTC: 4” (10 cm) hailstone in Amsterdam, NY, tying New York state record

Source: CBS

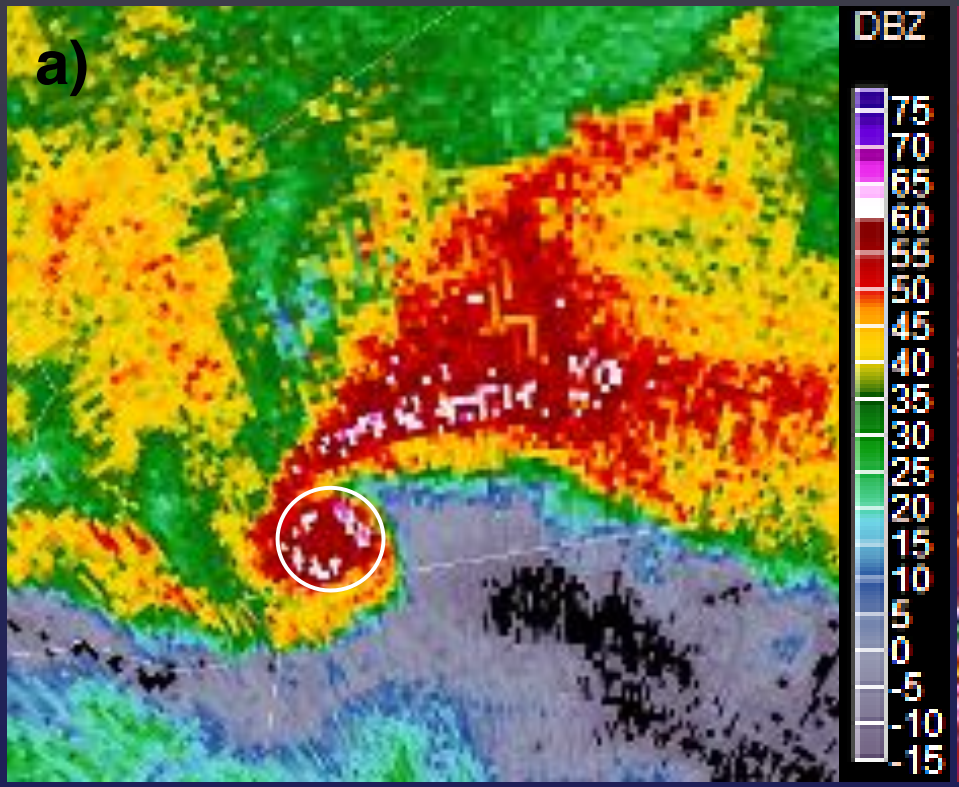


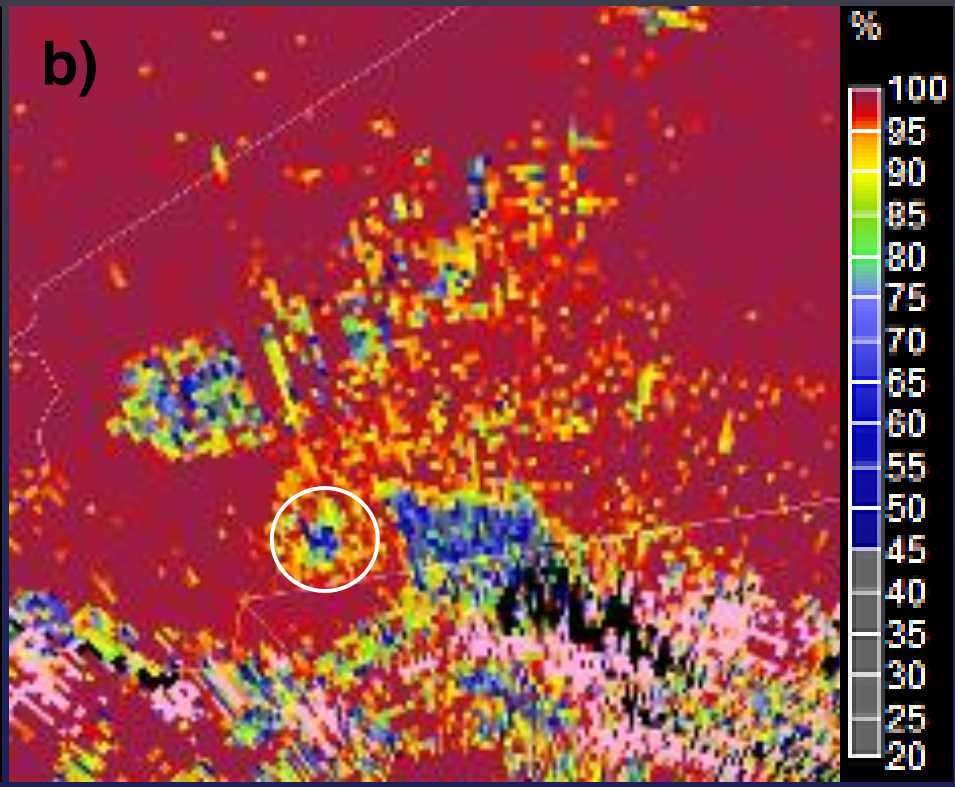
Five minutes prior to tornado touchdown west of Mariaville Lake

AT 351 PM EDT...NATIONAL WEATHER SERVICE DOPPLER RADAR CONTINUED TO INDICATE A TORNADO ON THE GROUND WITH A TORNADIC DEBRIS SIGNATURE JUST SOUTH OF DUANESBURG IN SCHENECTADY COUNTY

Reflectivity

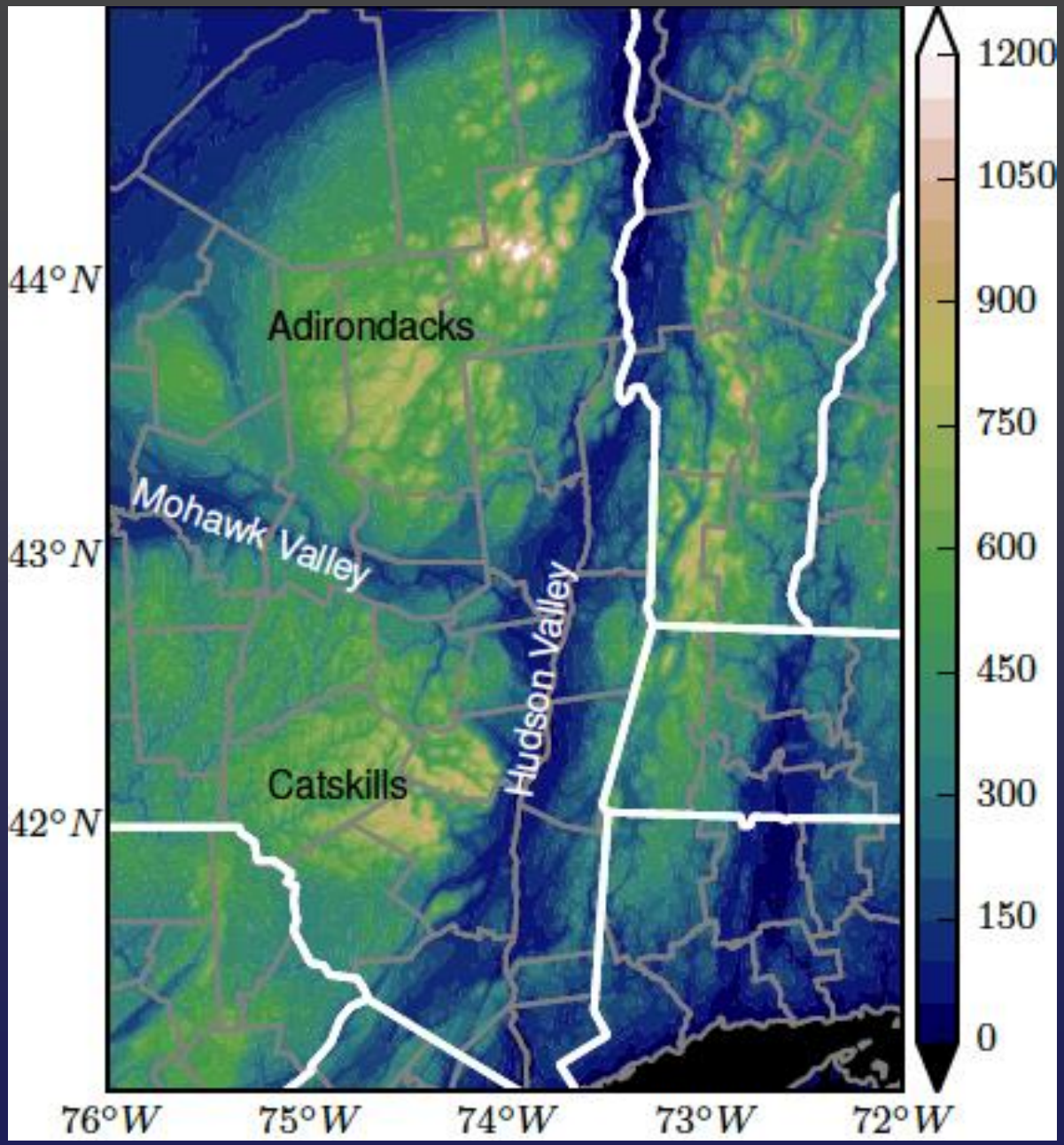
Correlation Coefficient





1951 UTC

How does local terrain increase the risk for severe weather in valley locations in New York State?



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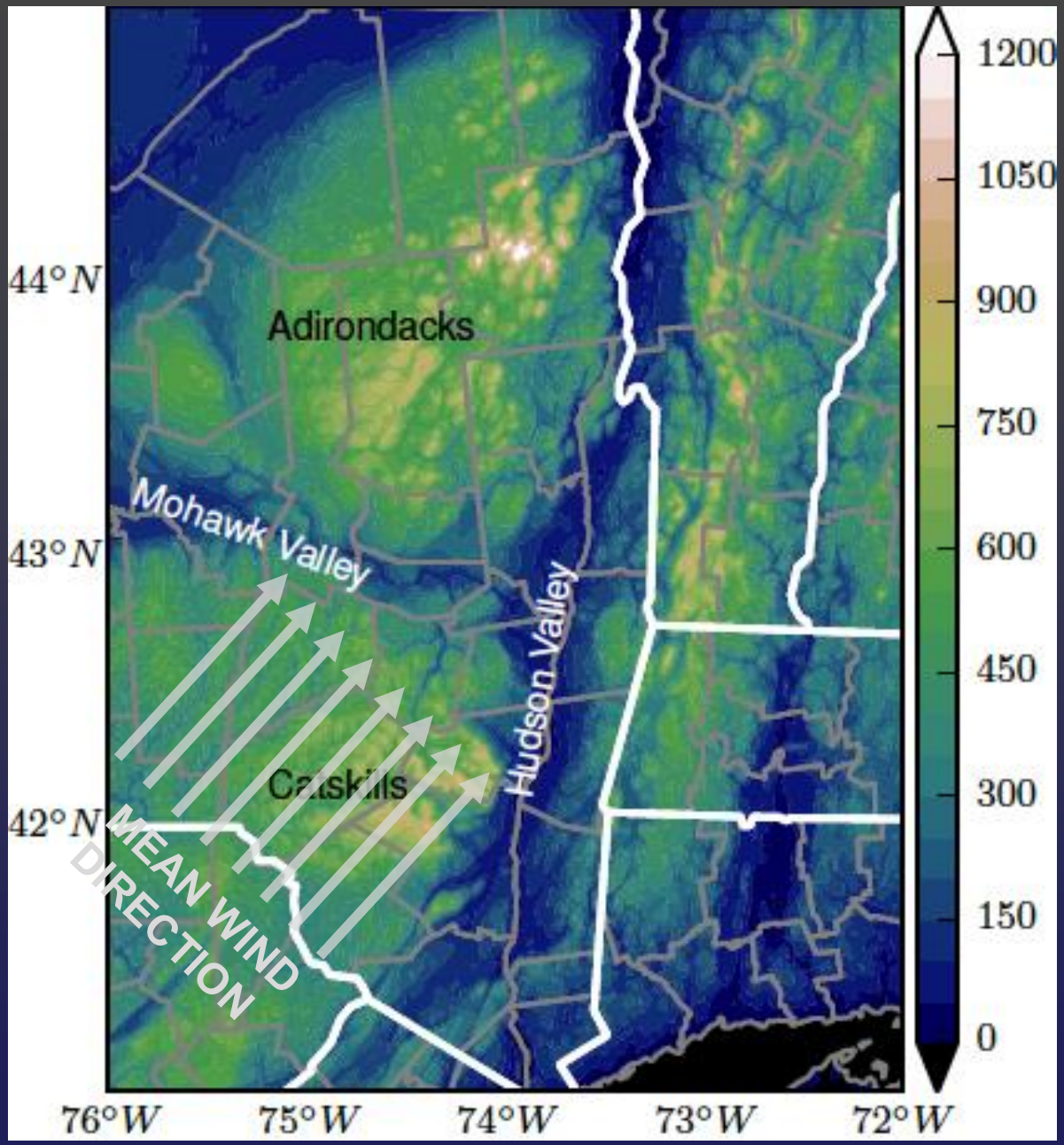

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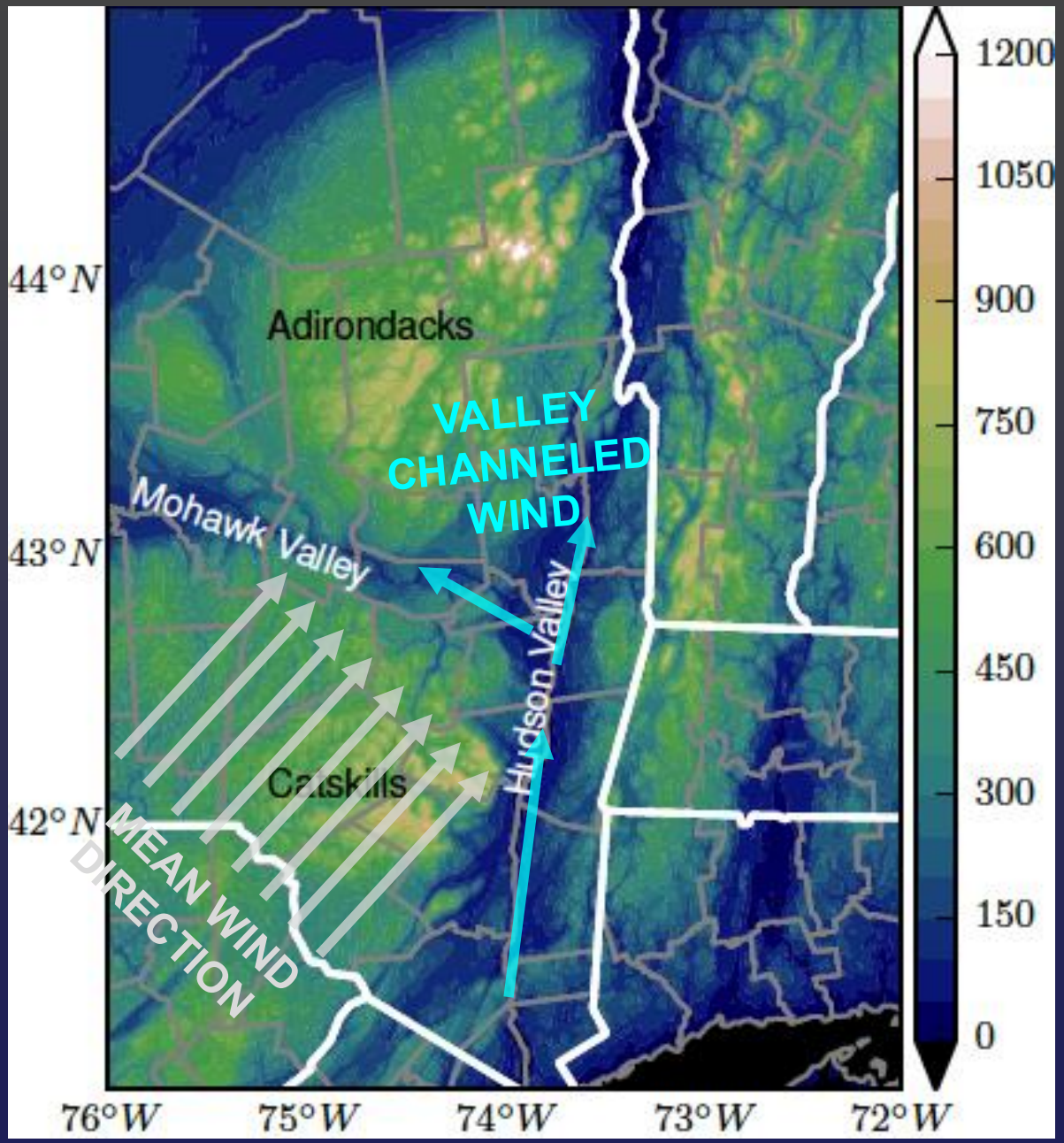
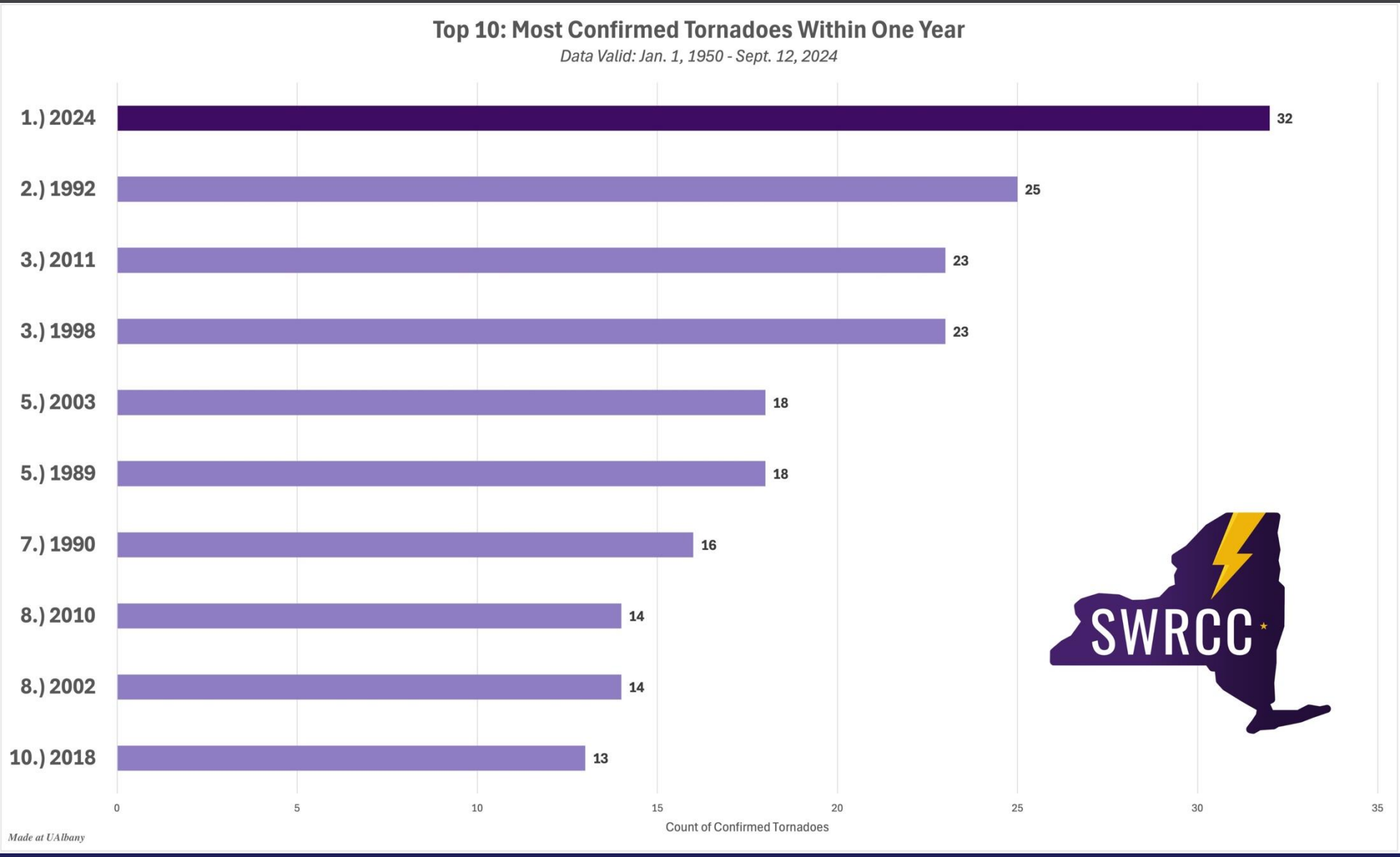


ICECREAM Field Campaign – Summer 2023


DUNDER
MIFFLIN
NO
PARKING

Tornadoes in New York in 2024

2024 New York State tornadoes



2024 New York State tornadoes

February 28 – Castle Creek
June 22 – West Winfield
July 10 – Arkwright
July 10 – Aurora
July 10 – Darien/Alexander
July 10 – Eden
July 10 – Forestport
July 10 – Redfield
July 10 – Wolcott
July 15 – Canandaigua
July 15 – Lincklaen
July 15 – Pavilion
July 15 – Virgil
July 16 - Canastota
July 16 – Chestertown
July 16 – Great Sacandaga Lake
July 16 – Lee Center
July 16 – Limekiln
July 16 – Ohio
July 16 – Oxbow Lake
July 16 – Rome
July 16 – Wells
July 16 – Wilcox Lake
July 24 – Broadalbin
July 24 – Orwell
August 5 – Buffalo
August 9 – New Paltz
August 11 – Pike Corner
September 9 – Grand Island
September 9 – Pembroke
September 9 – Wirt/Friendship
September 9 – Worth

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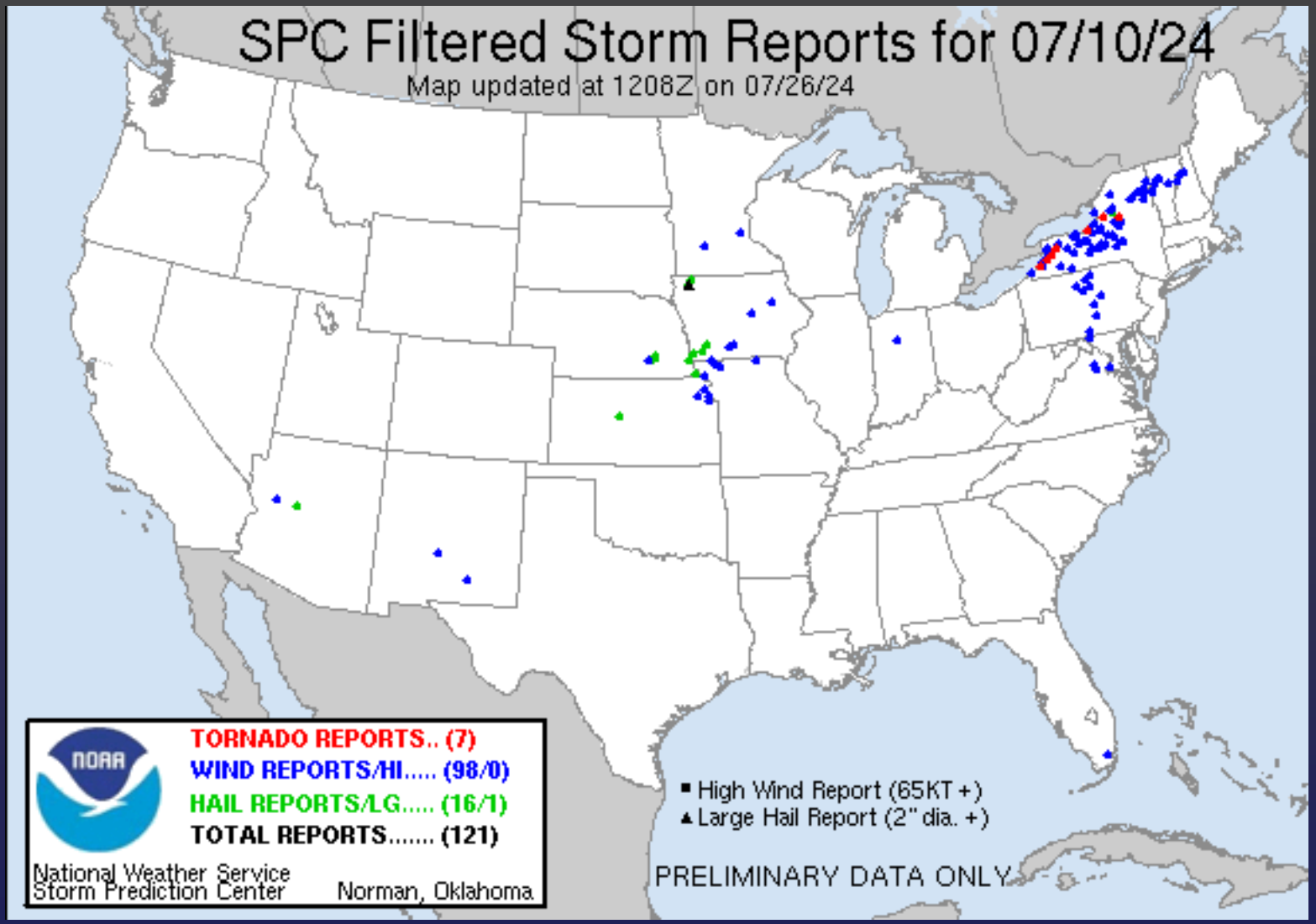
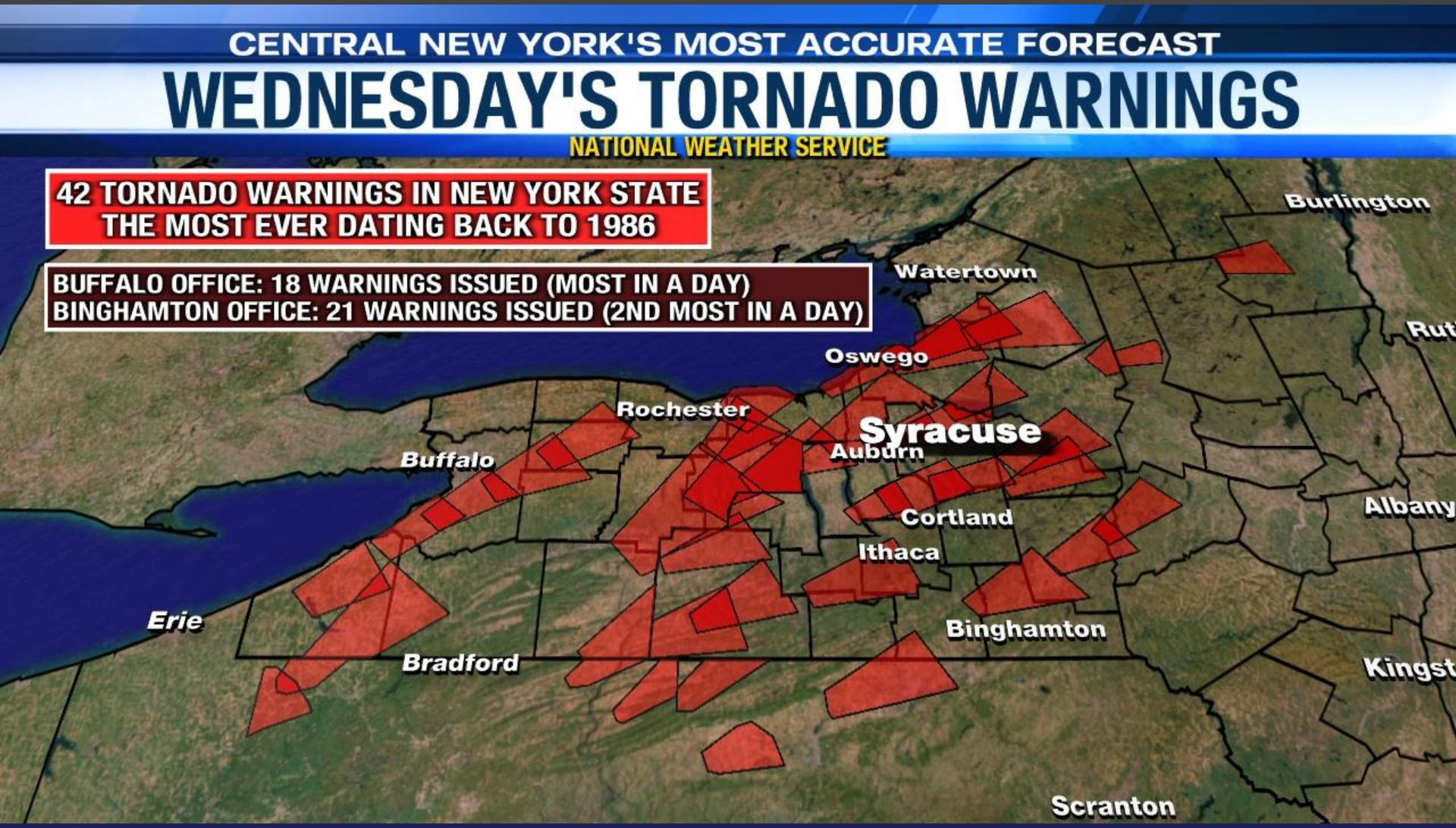
July 10

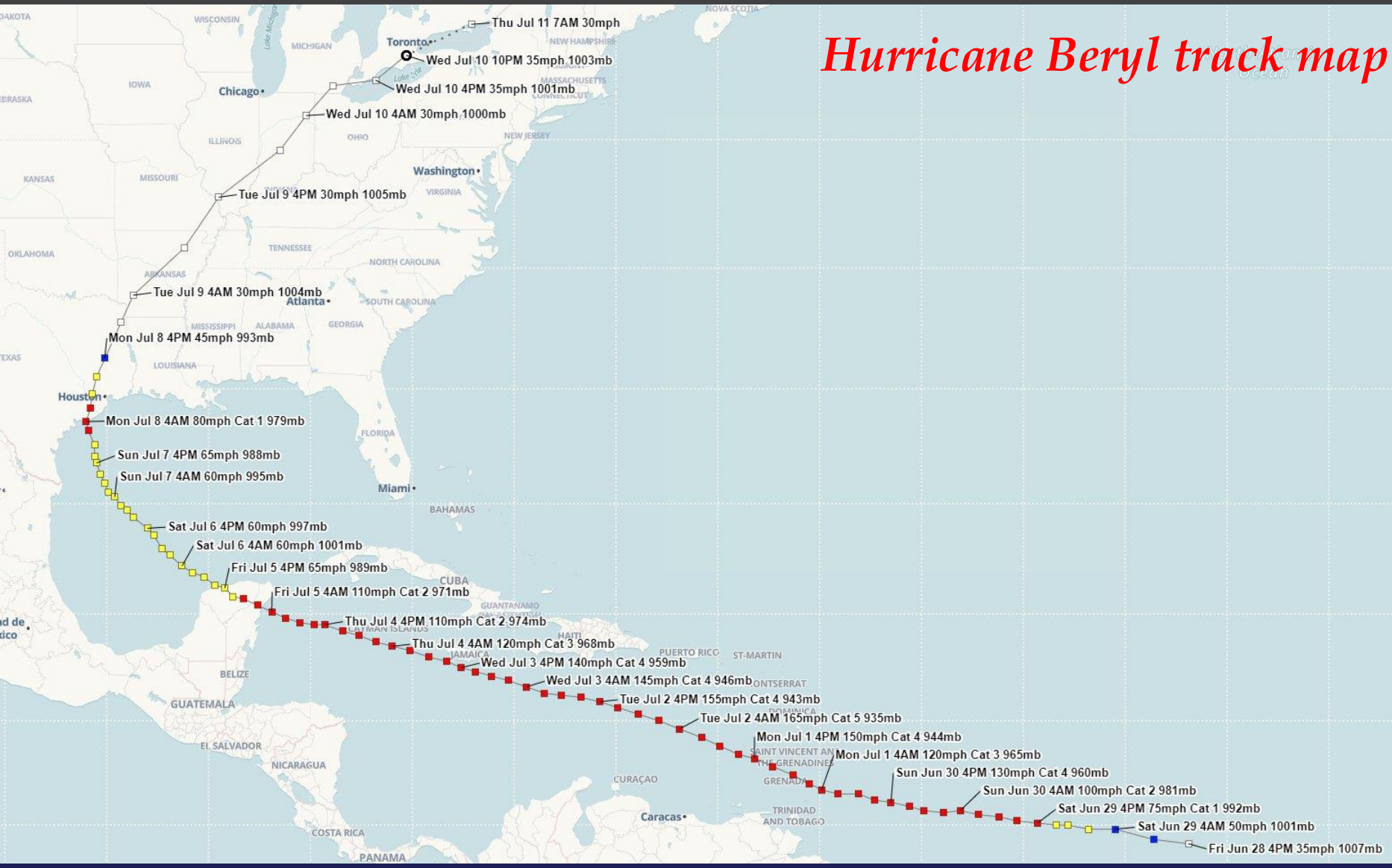

SPC Filtered Storm Reports for 07/10/24
Map updated at 1208Z on 07/26/24
TORNADO REPORTS.. (7)
WIND REPORTS/HI..... (98/0)
HAIL REPORTS/LG..... (16/1)
TOTAL REPORTS..... (121)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT +)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

July 10



From localsyr.com

July 10



From NWS Lake Charles, LA

July 10

Storm Prediction Center – 1300 UTC outlook

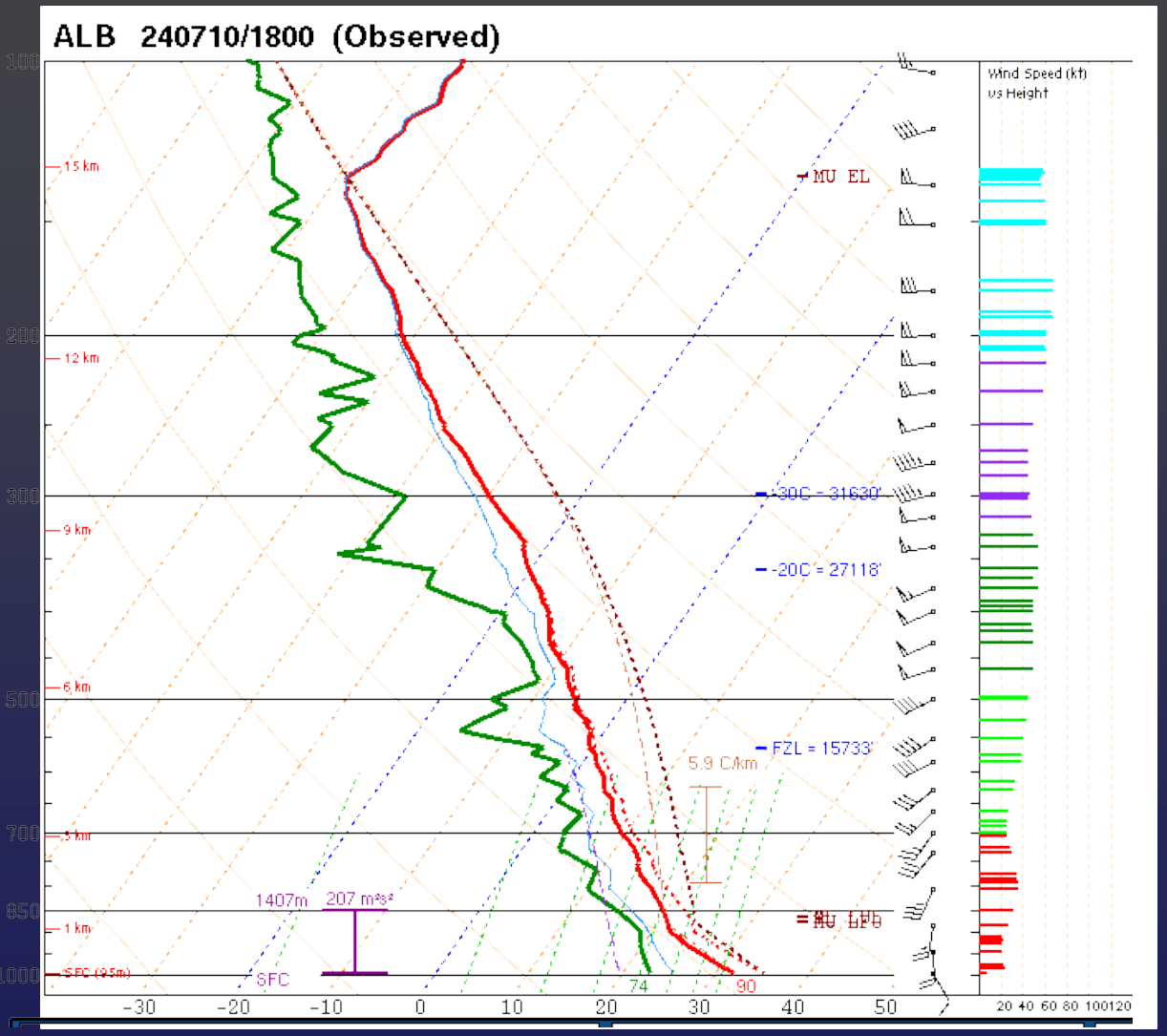
...Northeastern CONUS... Scattered thunderstorms are expected to develop along/ahead of the cold front , especially near the prefrontal trough (with that activity ultimately evolving upscale into a line. All severe hazards will be possible from relatively discrete convection (including potential for several supercells) from the early-stage, pre-linear regime, and perhaps even in the warm sector to its east. **Tornado potential should be relatively maximized near the warm front, where backed near-surface winds** will contribute to enlarged low-level hodographs and enhanced storm-relative flow in the boundary layer. The corridor of greatest tornado probabilities is narrow, and may need to be shifted around today as mesoscale trends suggest (especially with regard to warm-frontal position). However, at least marginally favorable low-level shear for embedded supercellular or QLCS mesovortex tornado potential is possible as far south as the western/upper Chesapeake Bay region.

Ample low-level moisture is in place, and will continue over the area, with surface dewpoints commonly in the upper 60s to low 70s along and south of the warm front. This will contribute to low LCL and, in concert with diurnal heating that satellite imagery suggests should be common, will yield peak/preconvective MLCAPE in the 1500-2000 J/kg range ahead of the main convective band. Activity should weaken in and near eastern parts of the "slight" to "marginal" probabilities this evening as it encounters a more-stable boundary layer.

July 10

Albany, NY
Weather balloon
launch

1800 UTC
(early afternoon)



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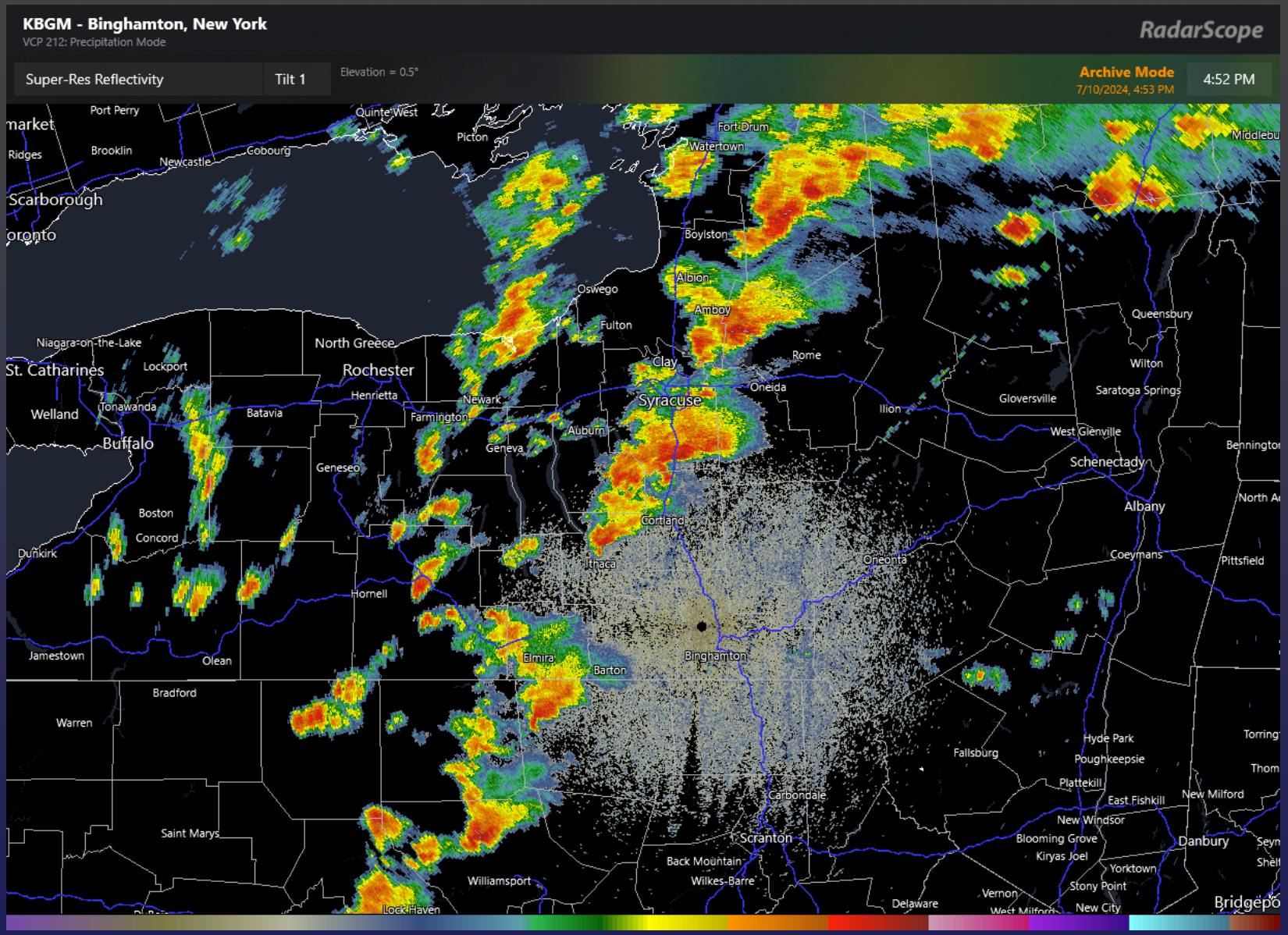
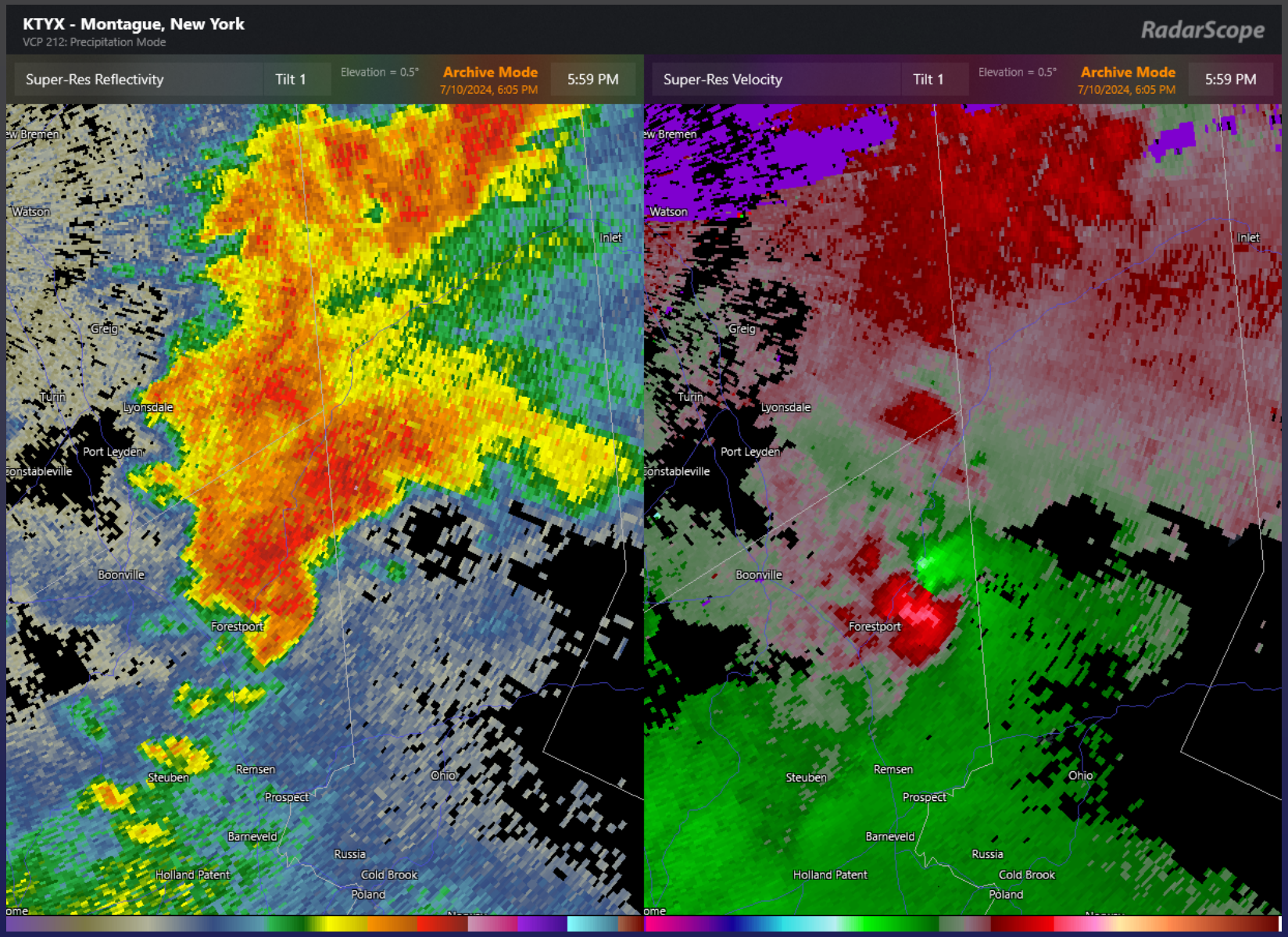


BGM radar – 1304 UTC

From RadarScope, courtesy of Erik Creighton

July 10



TYX radar – 1317 UTC

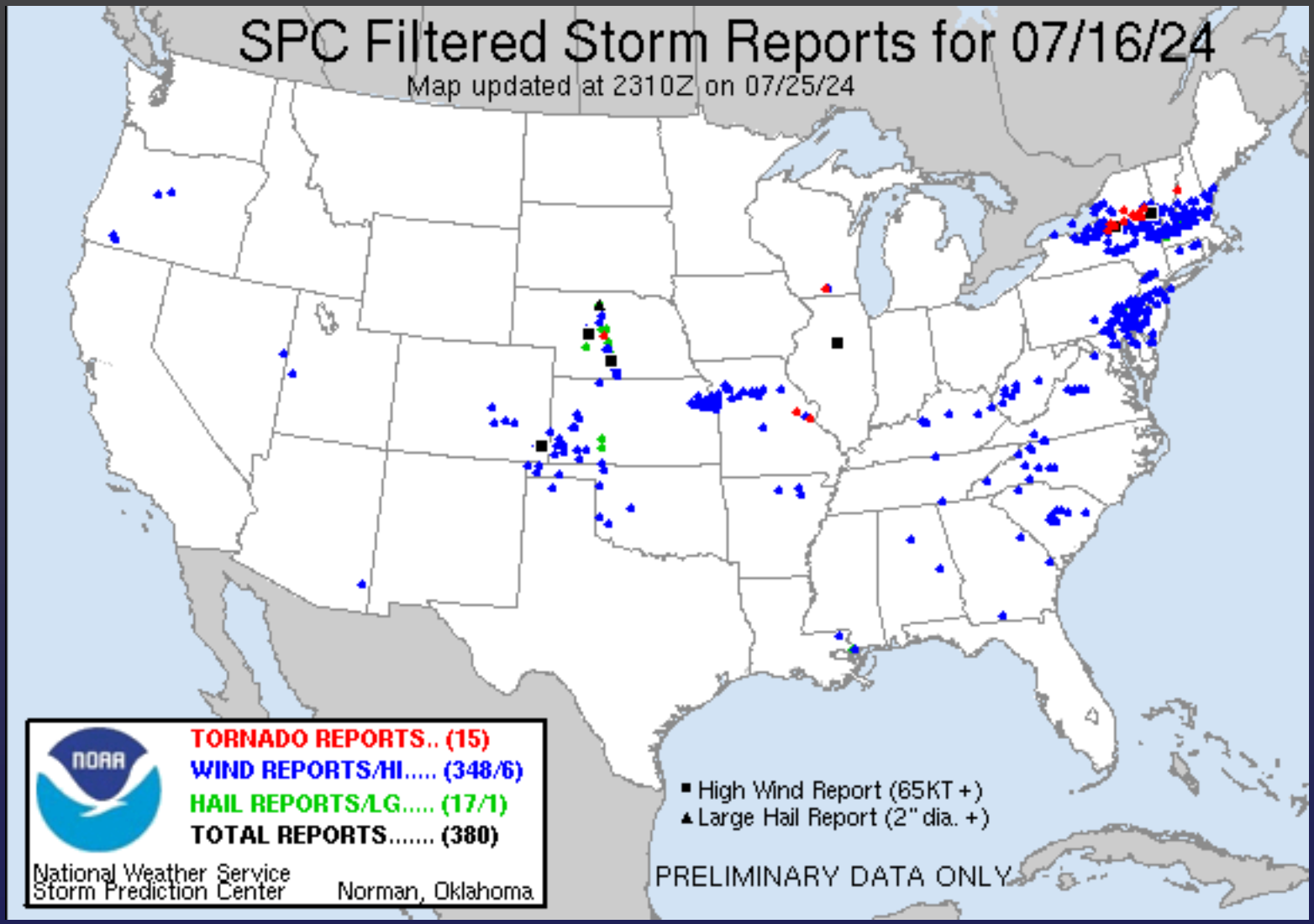
From RadarScope, courtesy of Erik Creighton

July 10

Arkwright, NY

Eden, NY

July 16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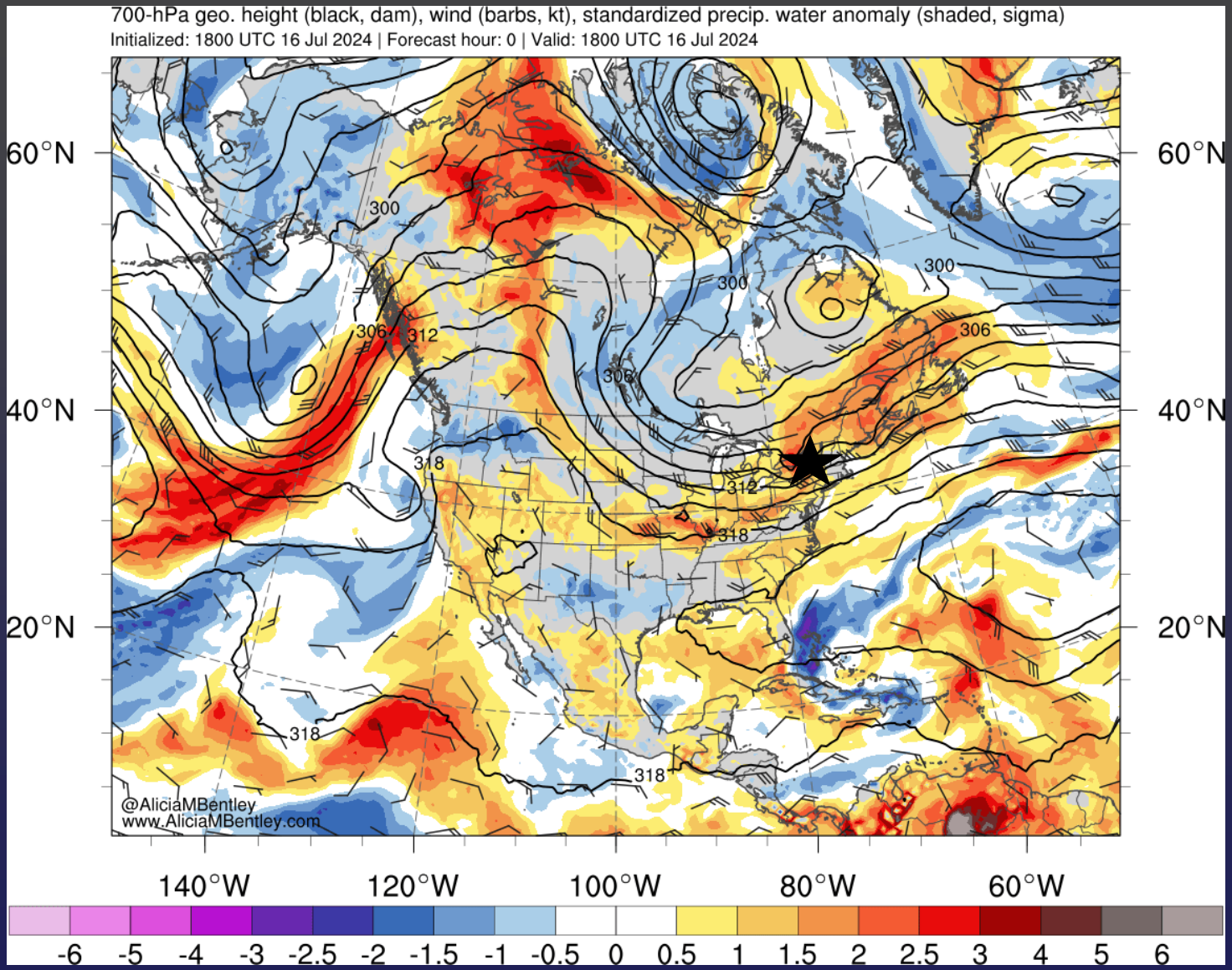
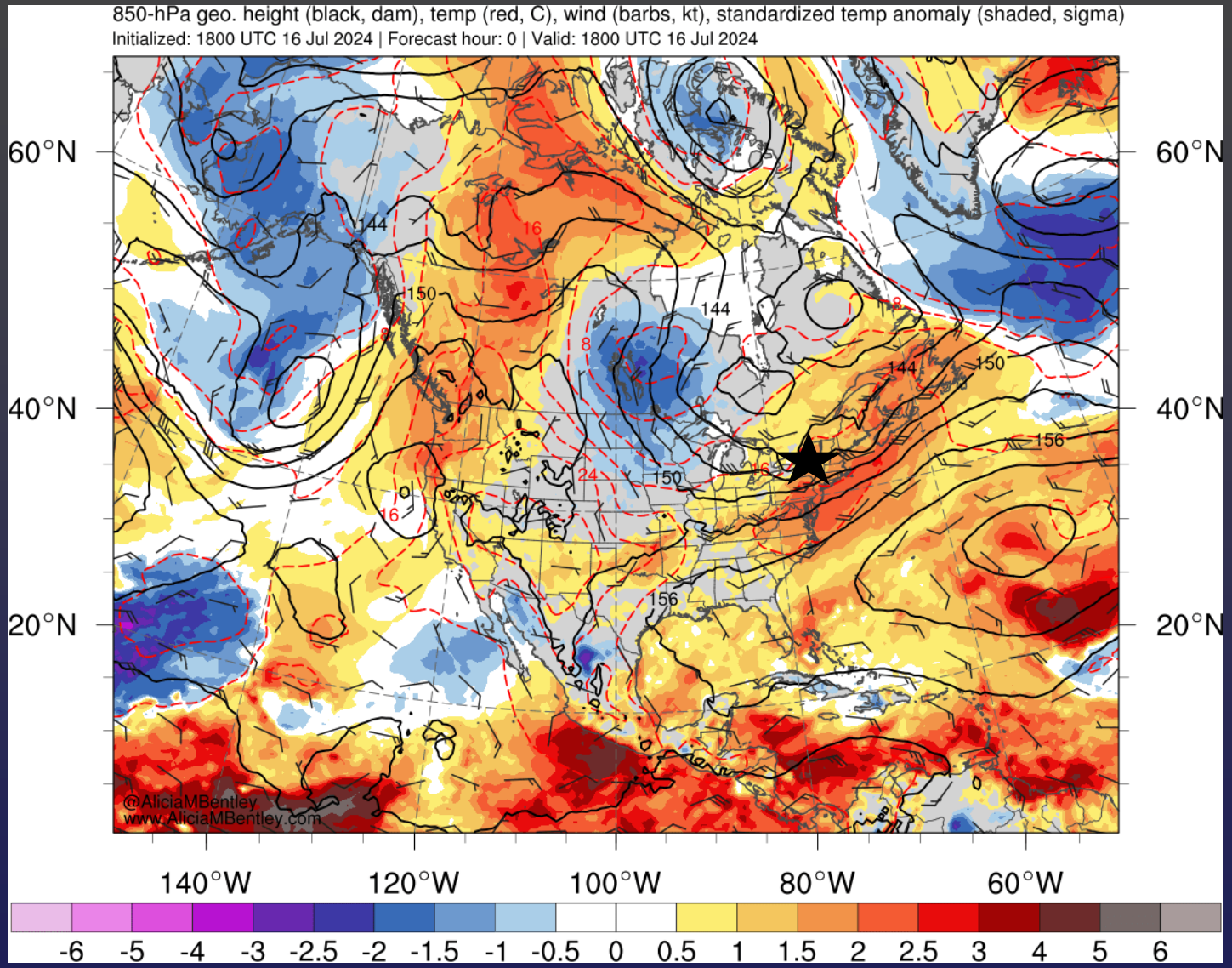
July 16



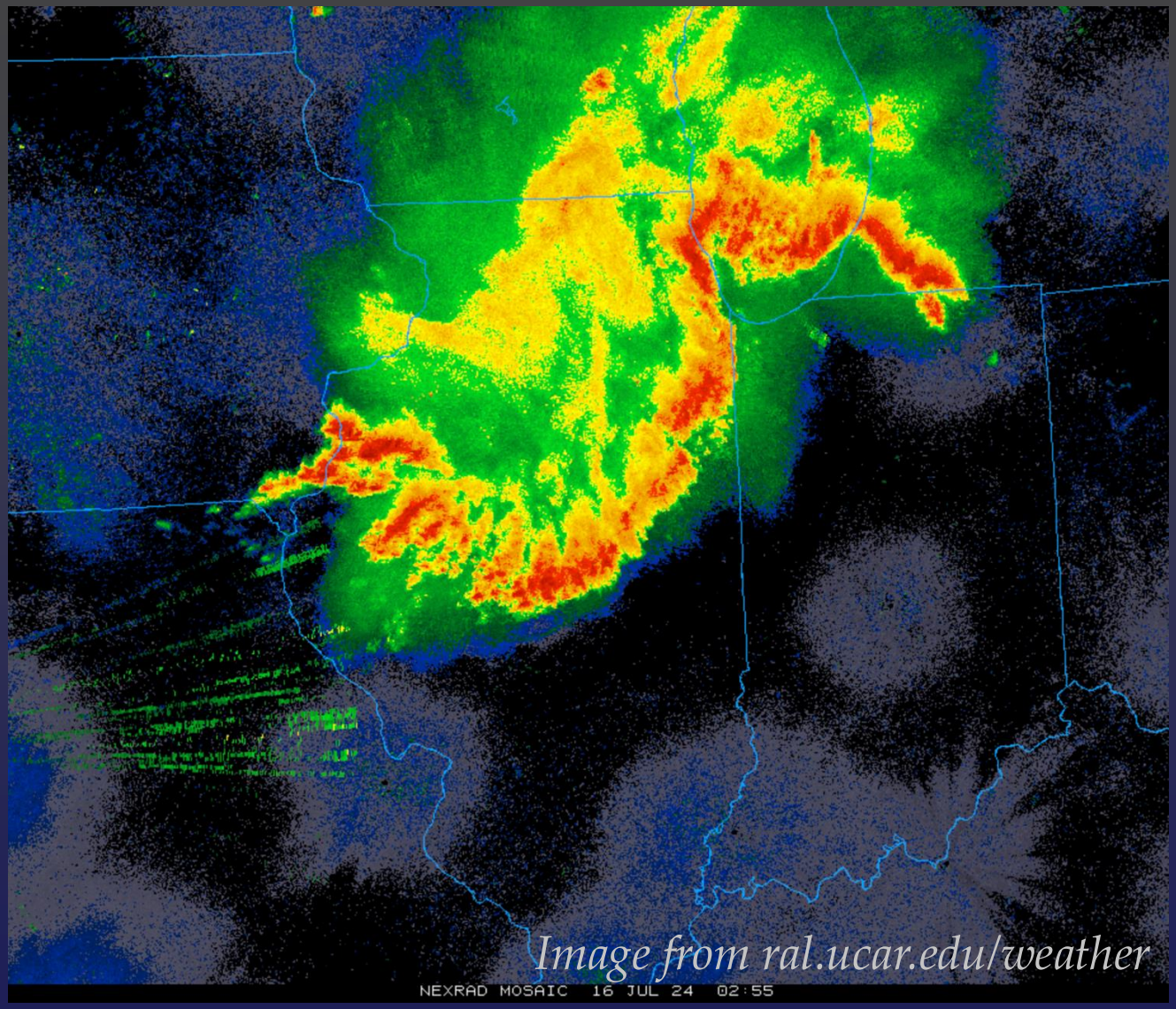
Anomalously high moisture available

July 16



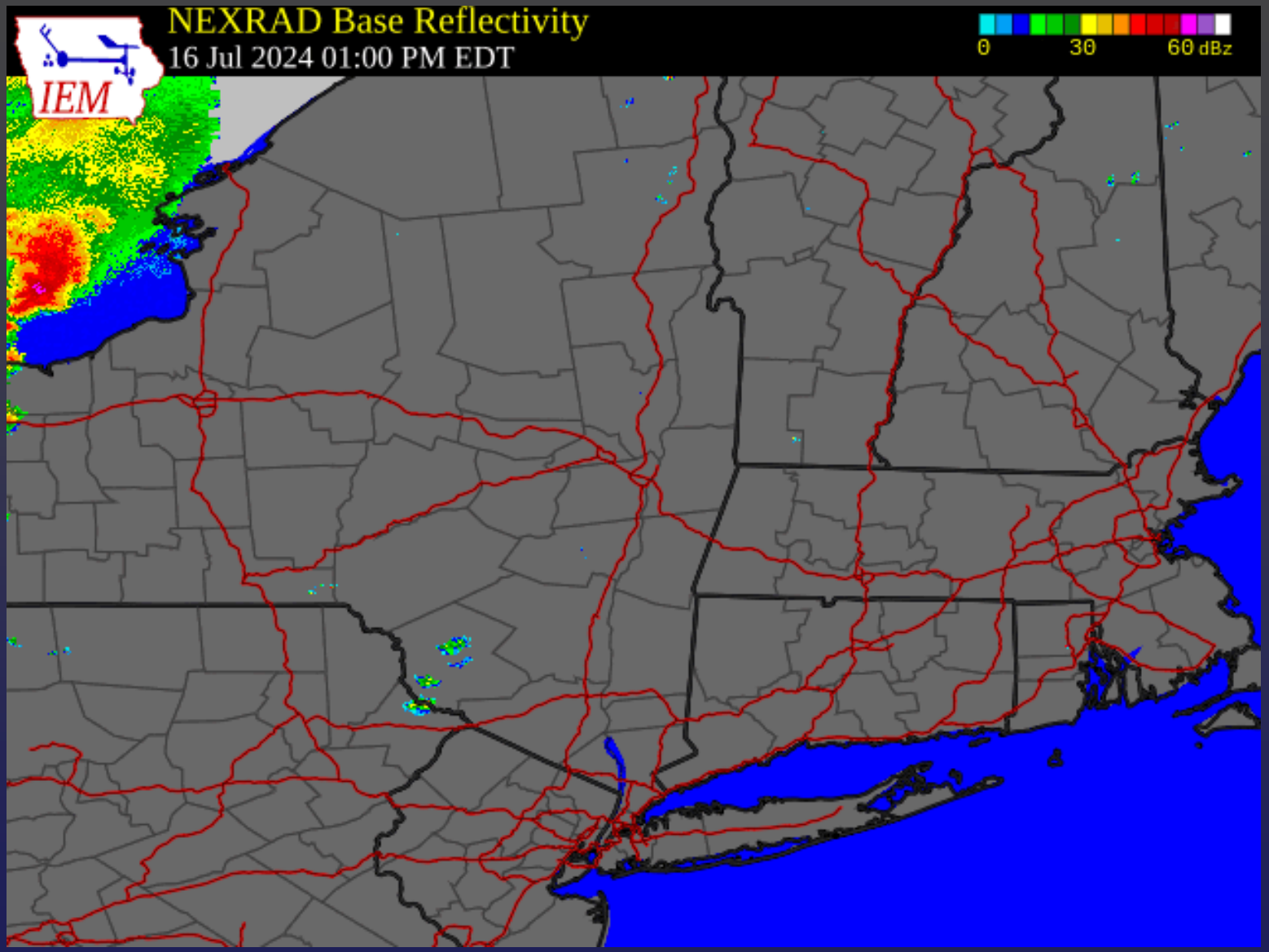
Anomalously warm temperatures

July 16



Previous evening: Midwest thunderstorm complex

July 16



From NWS–Albany

July 16

Oxbow Lake, NY EF-1

From NWS–Albany

Summary

- 2024 was a record-breaking year, with **32 tornadoes** confirmed in New York State
  - Max intensity EF-2, Rome
- 2024 NYS tornadoes were primarily a result of two significant events
  - ”Forcing”
  - Wind shear
  - Instability

Questions?