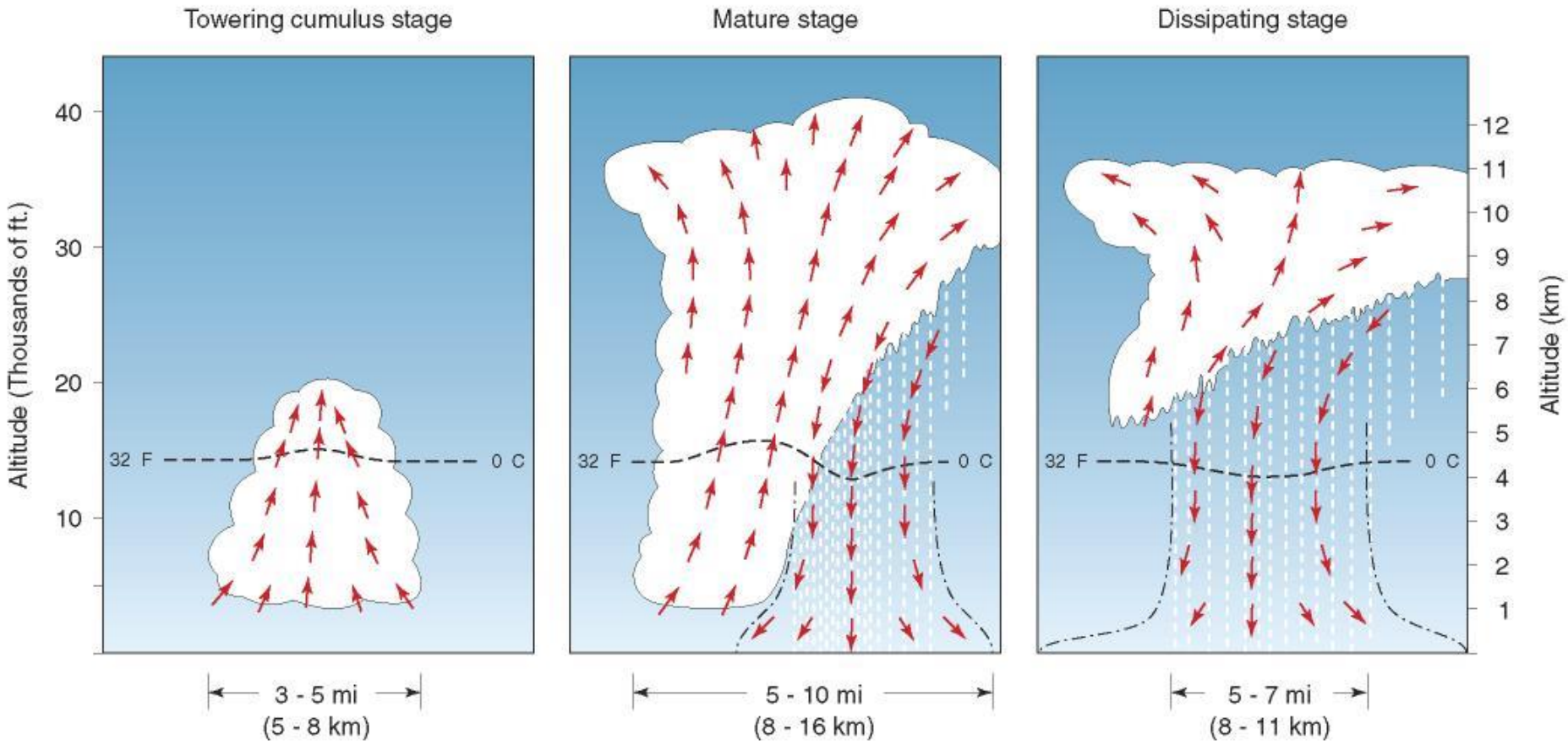
Thunderstorms and Tornadoes

American Meteorological Society

Project ATMOSPHERE

Thunderstorm Cell Life Cycle

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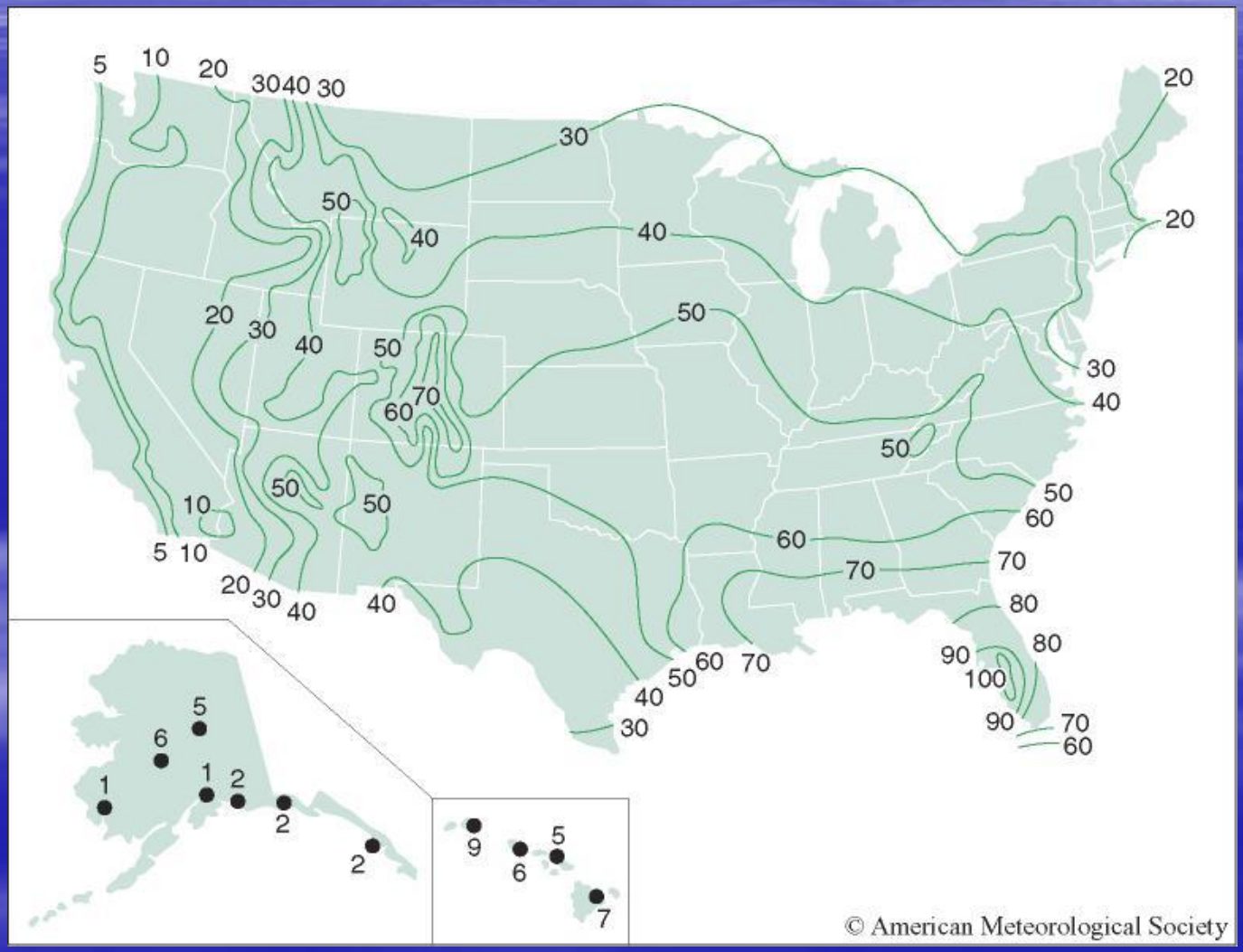
Thunderstorm Genesis

- Maritime tropical (mT) air
- Lifting mechanisms:
  - Fronts
  - Converging surface winds
  - Outflow boundary
  - Mountain ranges

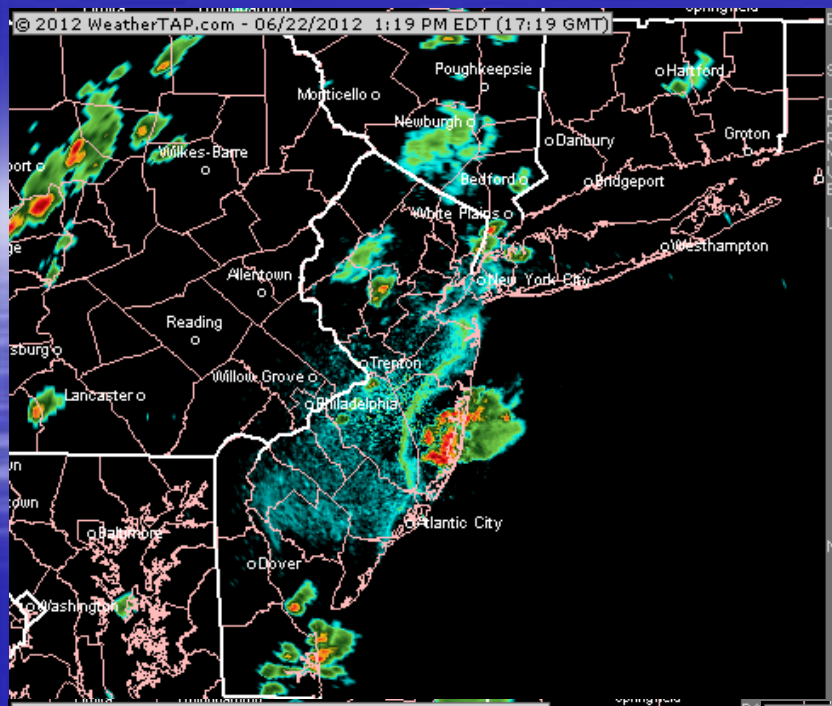
Average Annual Thunderstorm-Days

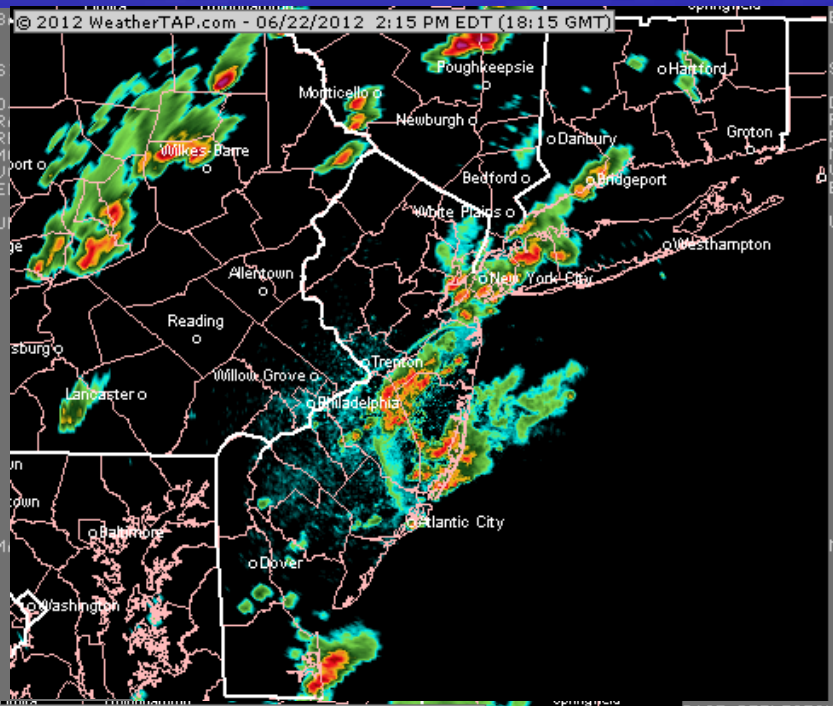


Thunderstorm structure

- Updraft and downdraft
- Overshooting top
- Anvil
- Outflow
- Gust front

Cumulonimbus cloud (cb)





BASE REFLECTIVITY

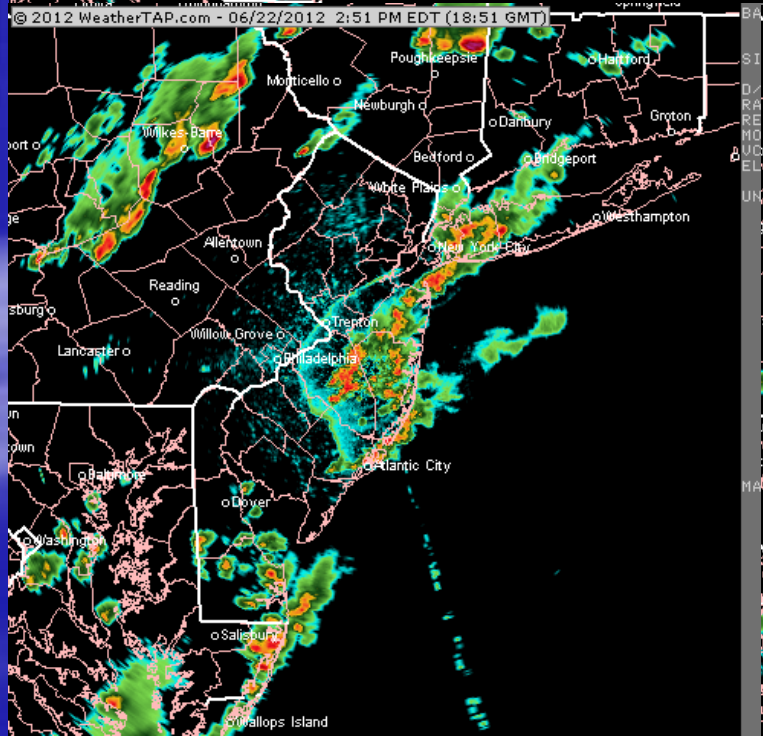
SITE: KDIX

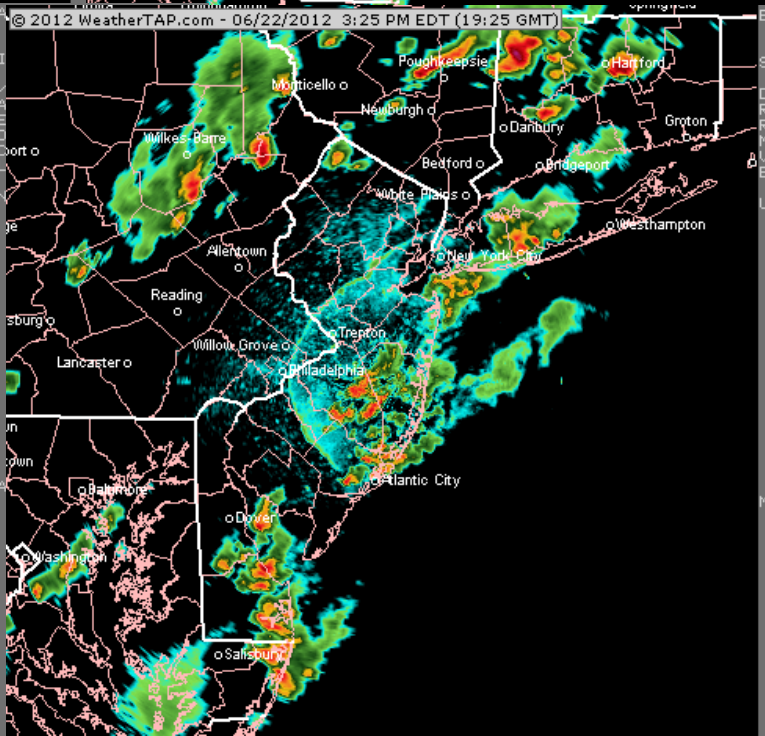
D/T: 06/22/12 1814Z
RANGE: 460 KM
RES: 1KM X 1DEG
MODE: PRECIPITATION
VCP: 12
ELEV: 0.5 DEGREES

UNITS: DBZ

ND
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

MAX DBZ: 67





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MODE: PRECIPITATION
VCP: 12
ELEV: 0.5 DEGREES

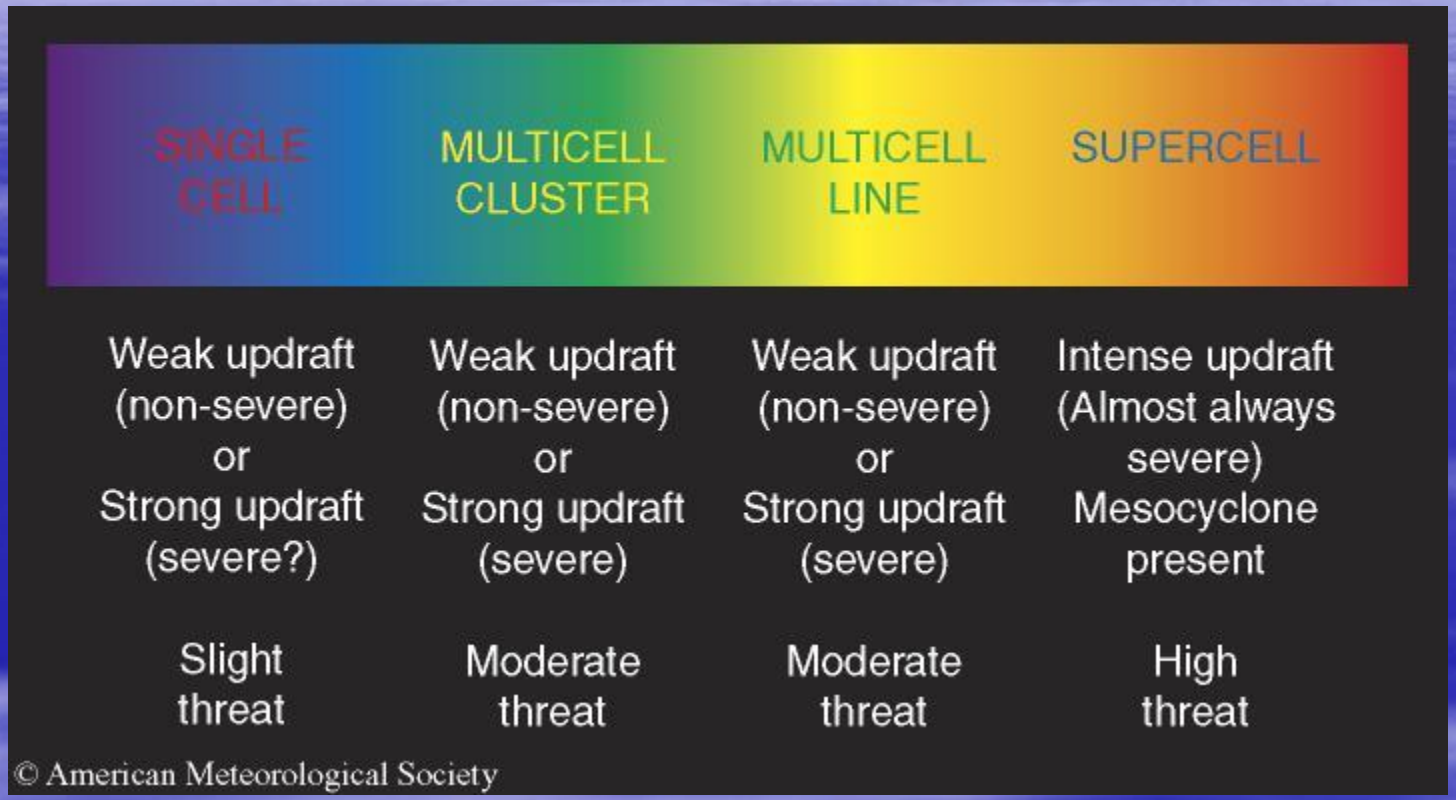
UNITS: DBZ

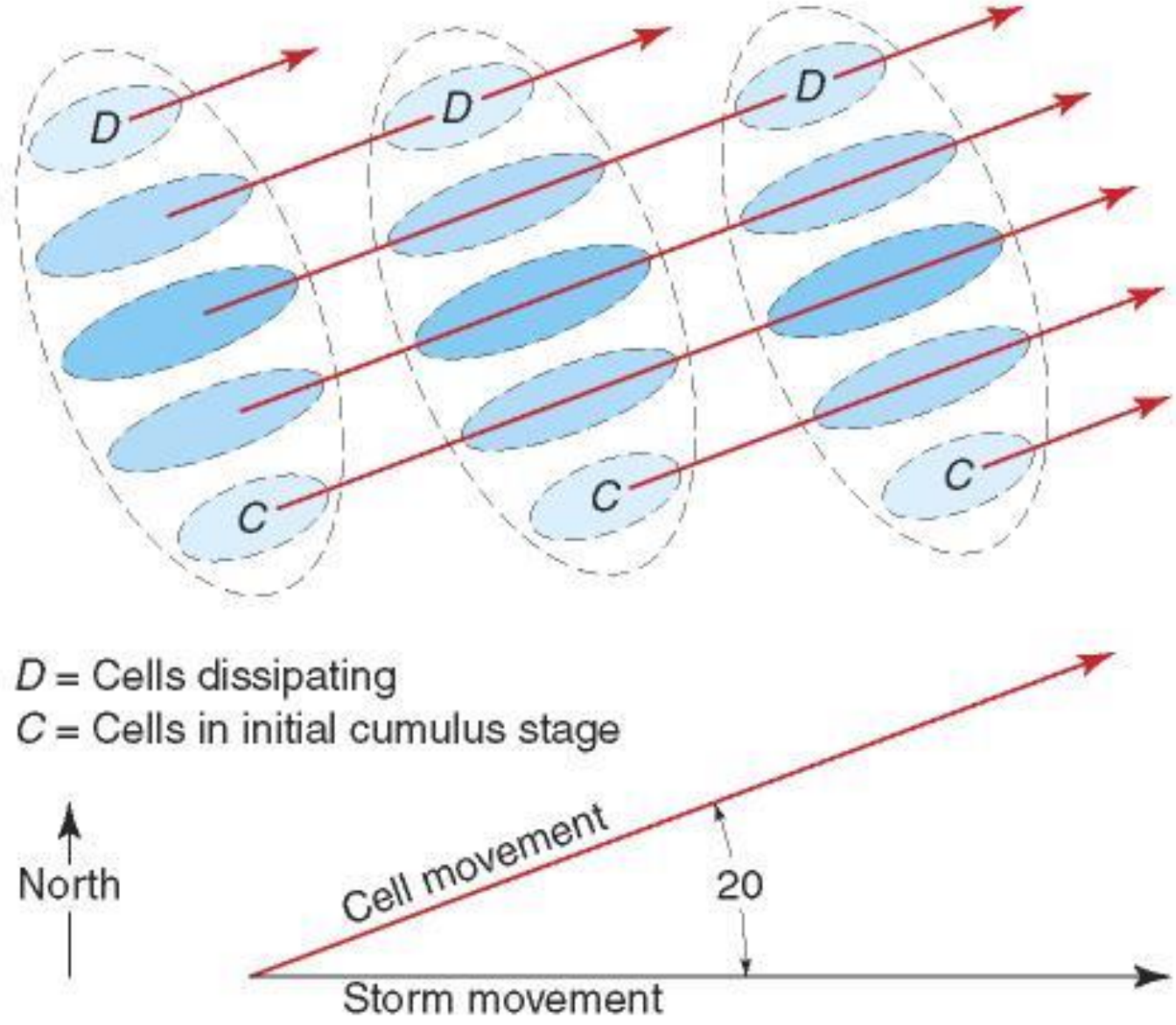
ND
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

MAX DBZ: 60

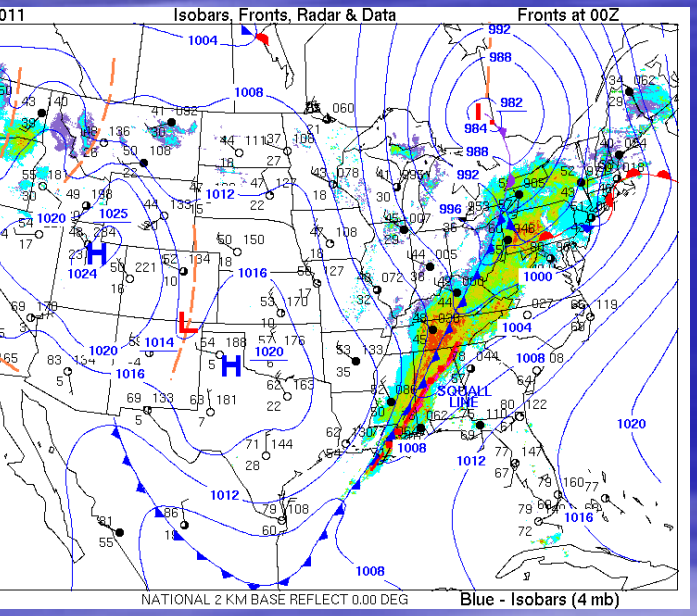
Thunderstorm Classification

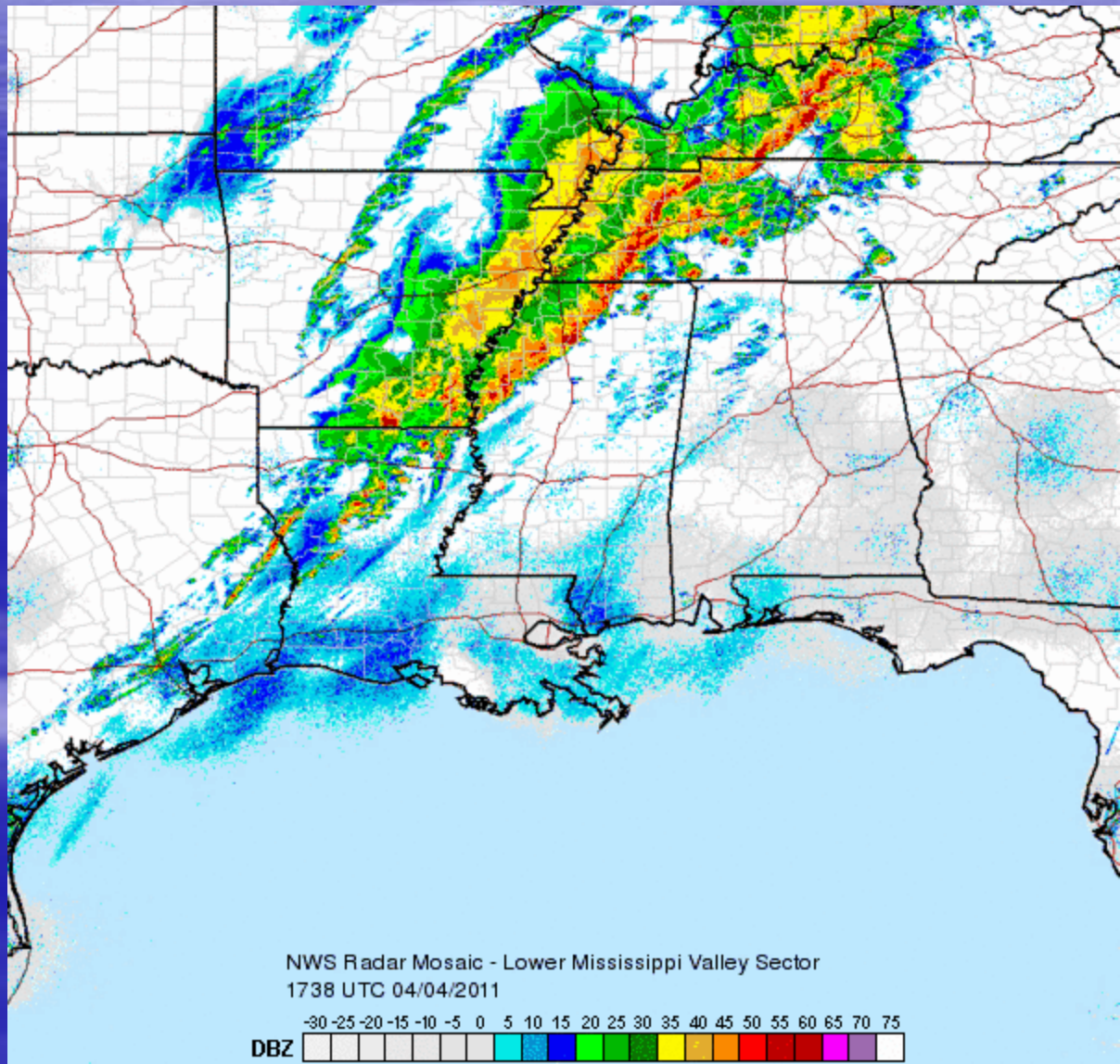
- Single cell
- Multicellular system:
  - Squall line
  - Mesoscale convective complex (MCC)
- Supercell


SINGLE CELL
MULTICELL CLUSTER
MULTICELL LINE
SUPERCELL
Weak updraft (non-severe) or Strong updraft (severe?)
Weak updraft (non-severe) or Strong updraft (severe)
Weak updraft (non-severe) or Strong updraft (severe)
Intense updraft (Almost always severe) Mesocyclone present
Slight threat
Moderate threat
Moderate threat
High threat
© American Meteorological Society



Squall line

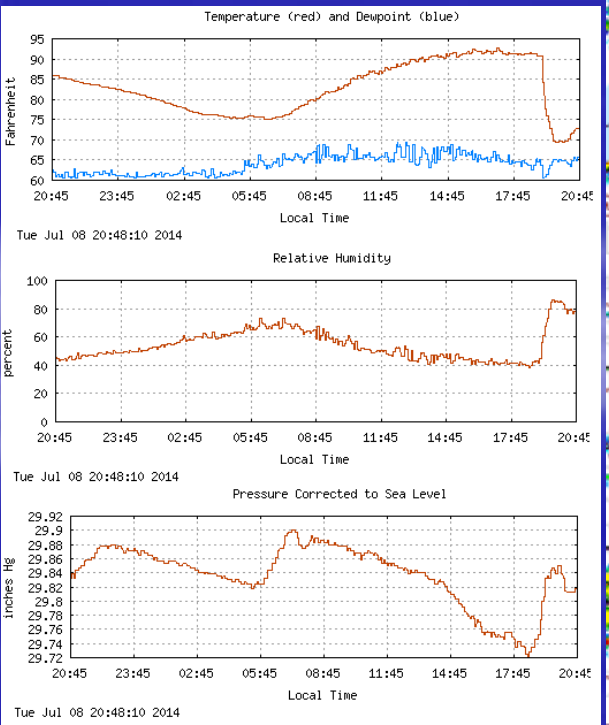

011
Isobars, Fronts, Radar & Data
Fronts at 00Z
SQUALL LINE
NATIONAL 2 KM BASE REFLECT 0.00 DEG
Blue - Isobars (4 mb)

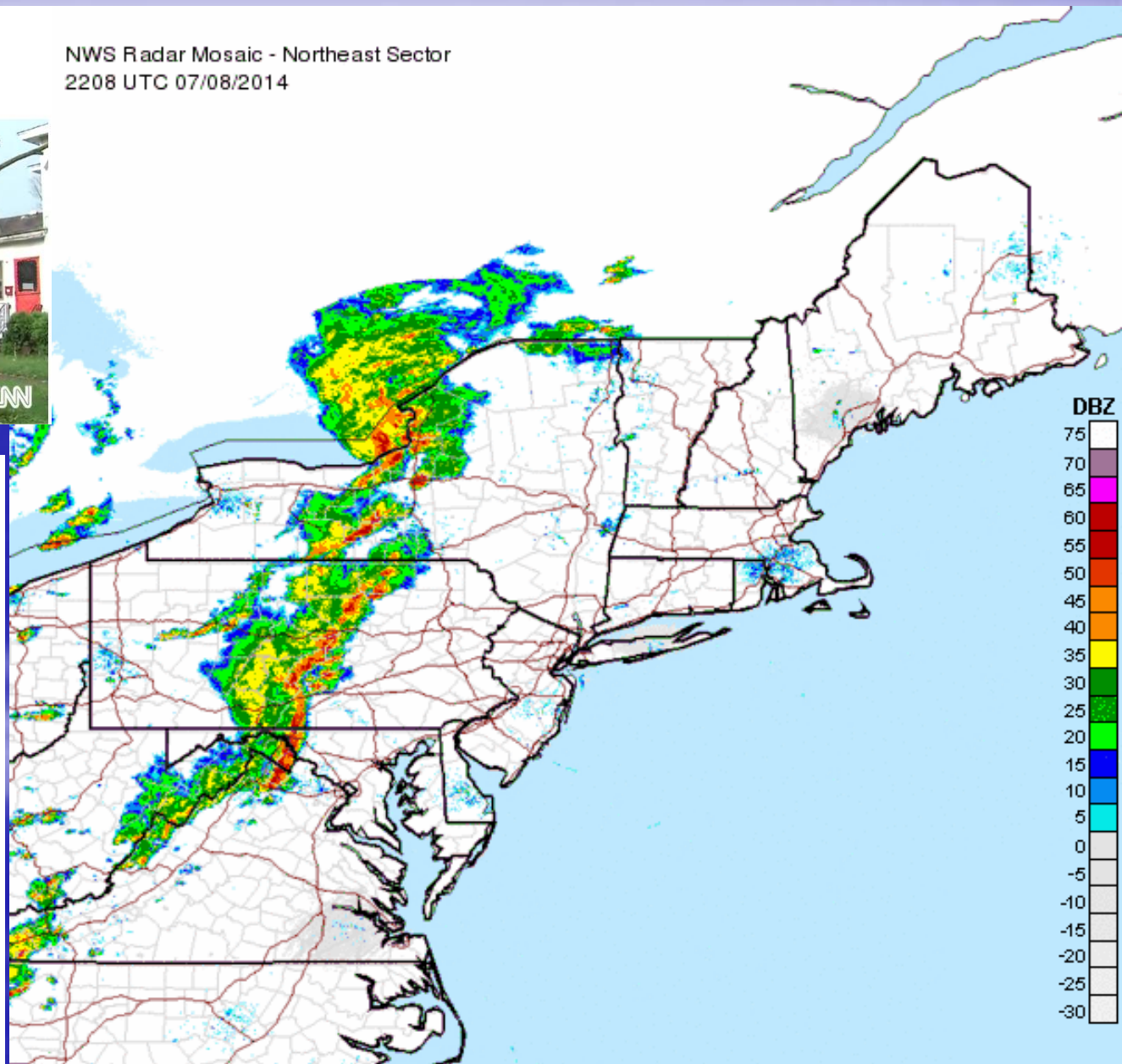

NWS Radar Mosaic - Lower Mississippi Valley Sector
1738 UTC 04/04/2011
DBZ
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

Bow echo

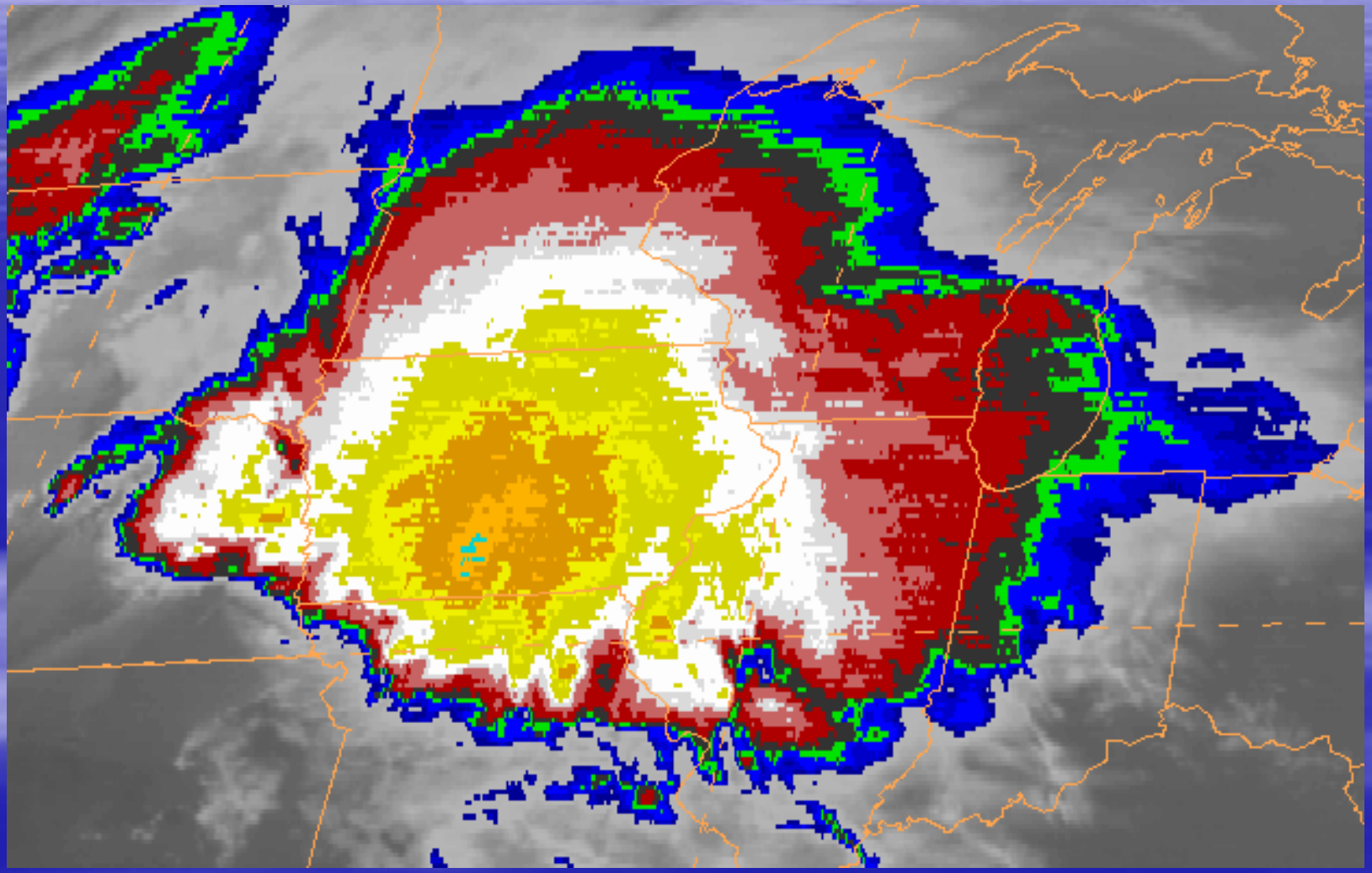
Ferocious storms kill 5, leave about 300,000 without power

By **Holly Yan** and **Dave Alsup**, CNN
updated 9:15 AM EDT, Wed July 9, 2014



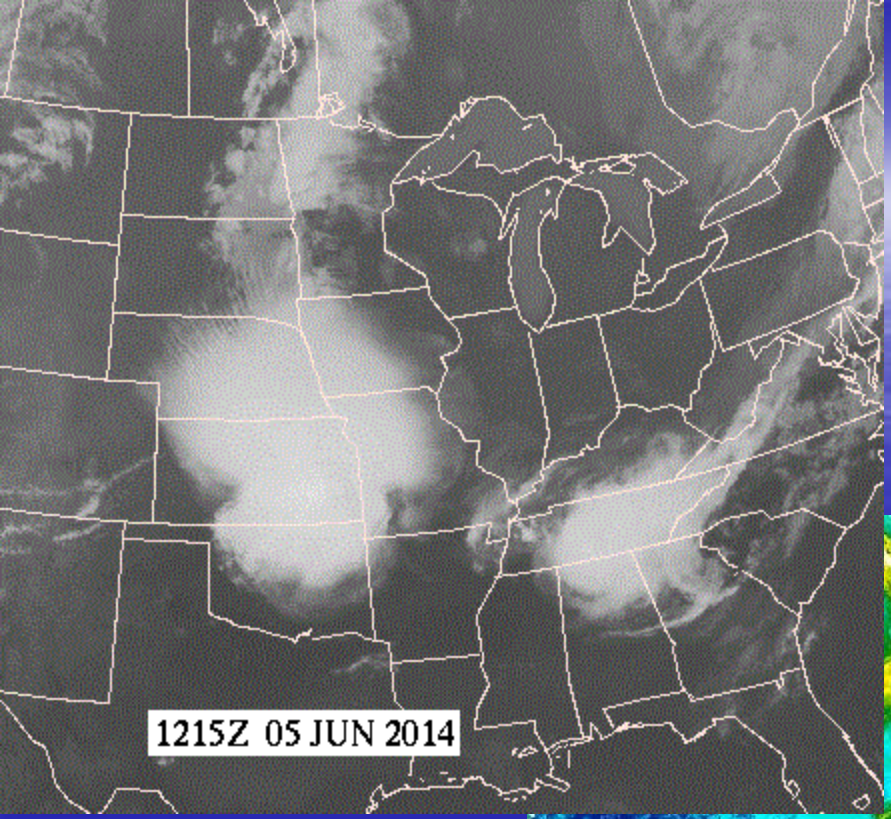


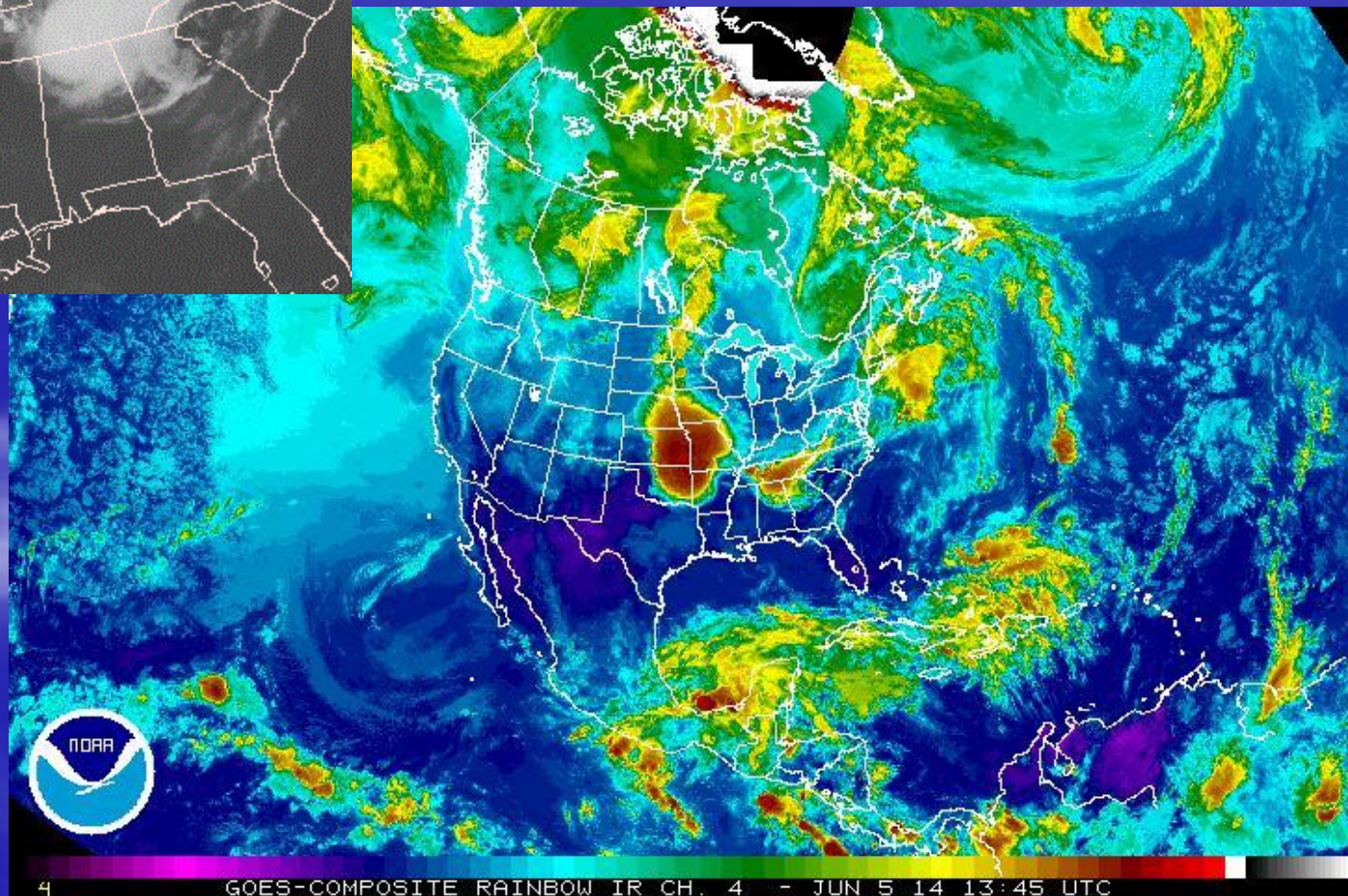
Mesoscale Convective Complex



1245Z 11 May 2002

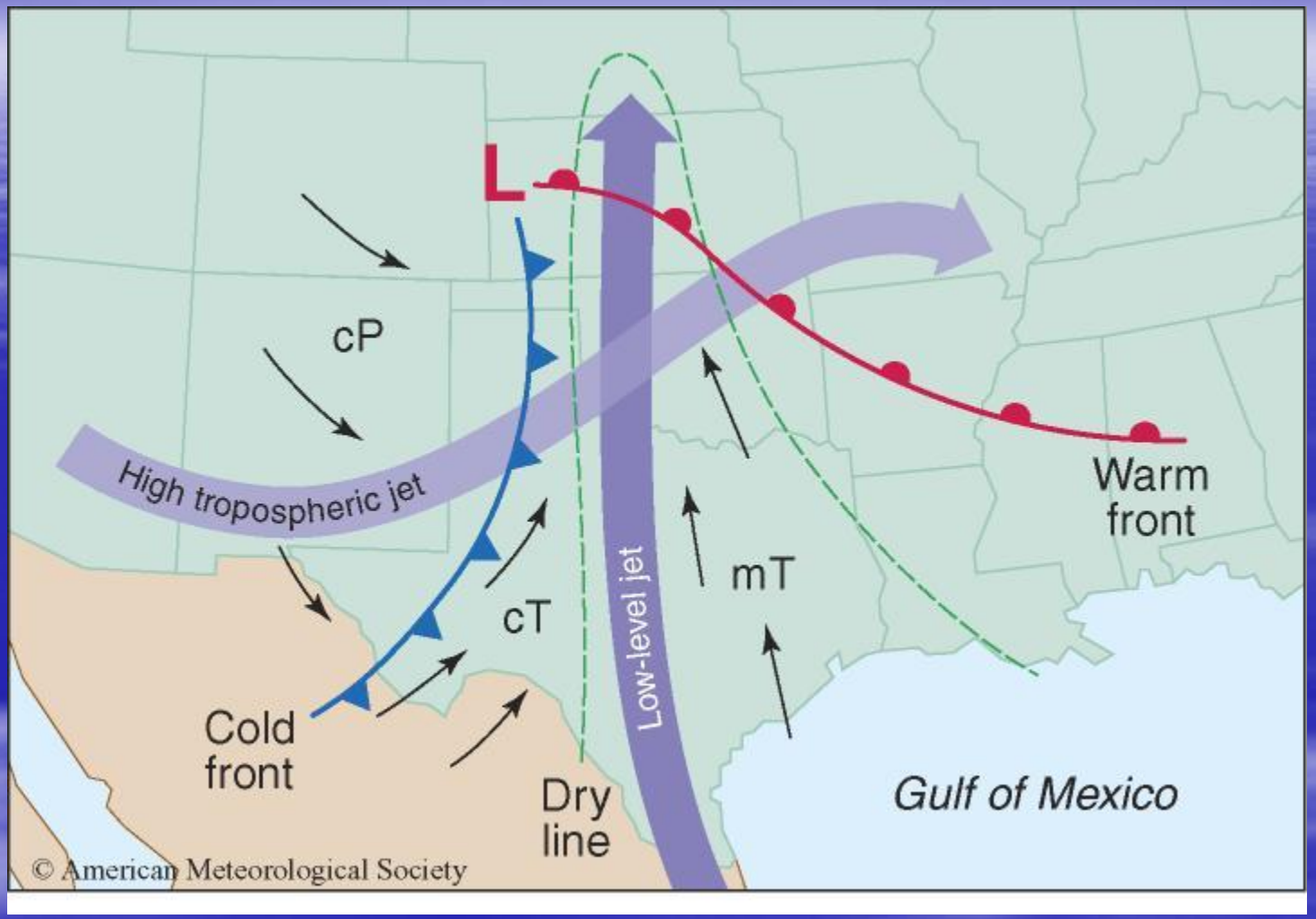
MCC

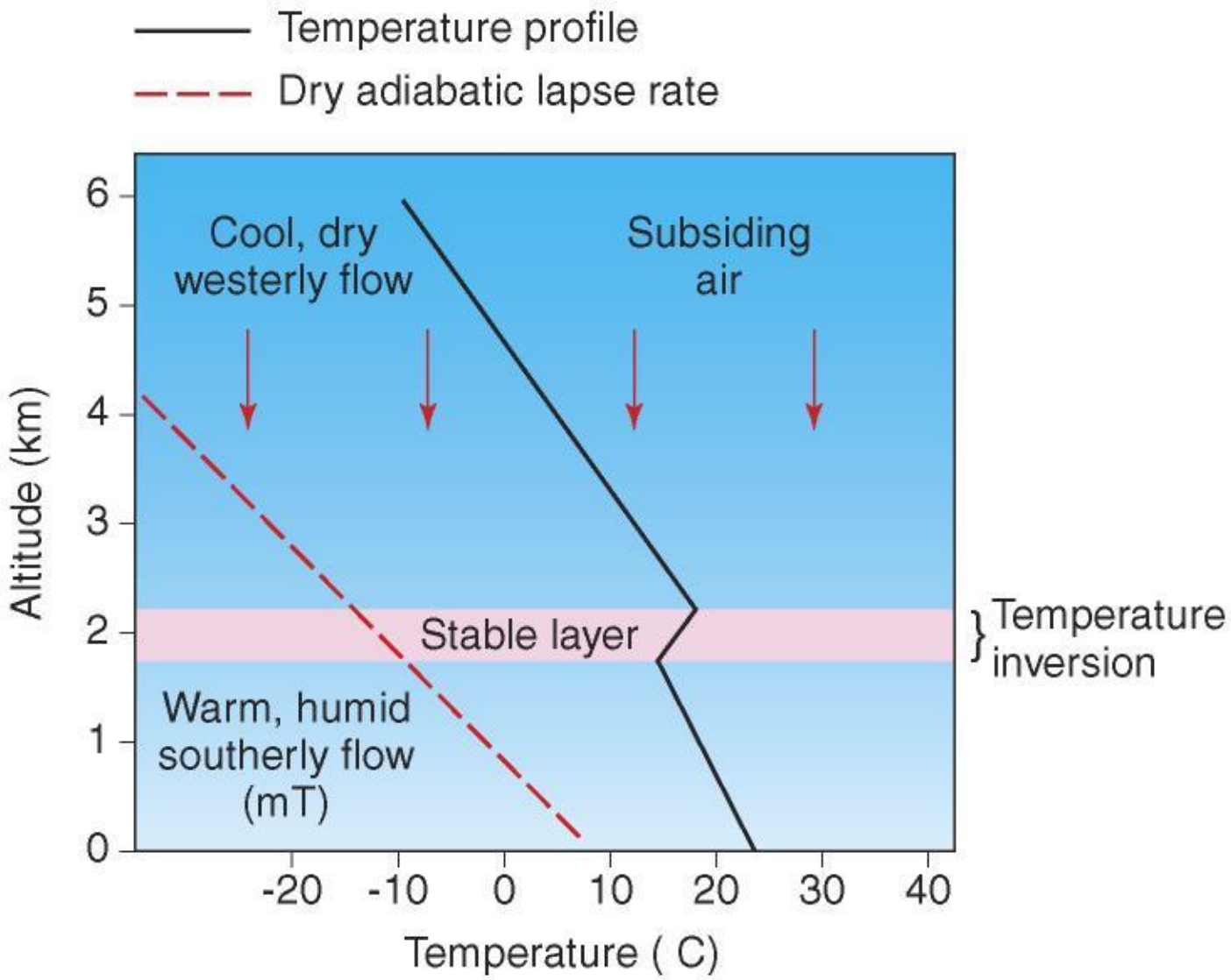

1215Z 05 JUN 2014


NOAA
4
GOES-COMPOSITE RAINBOW IR CH. 4 - JUN 5 14 13:45 UTC

Severe Thunderstorms

- Definition: surface winds >58 mph and/or hail 1.0 in. diameter; flash flooding; tornadoes
- Favorable atmospheric conditions


L
cP
High tropospheric jet
cT
mT
Low-level jet
Warm front
Cold front
Dry line
Gulf of Mexico
© American Meteorological Society

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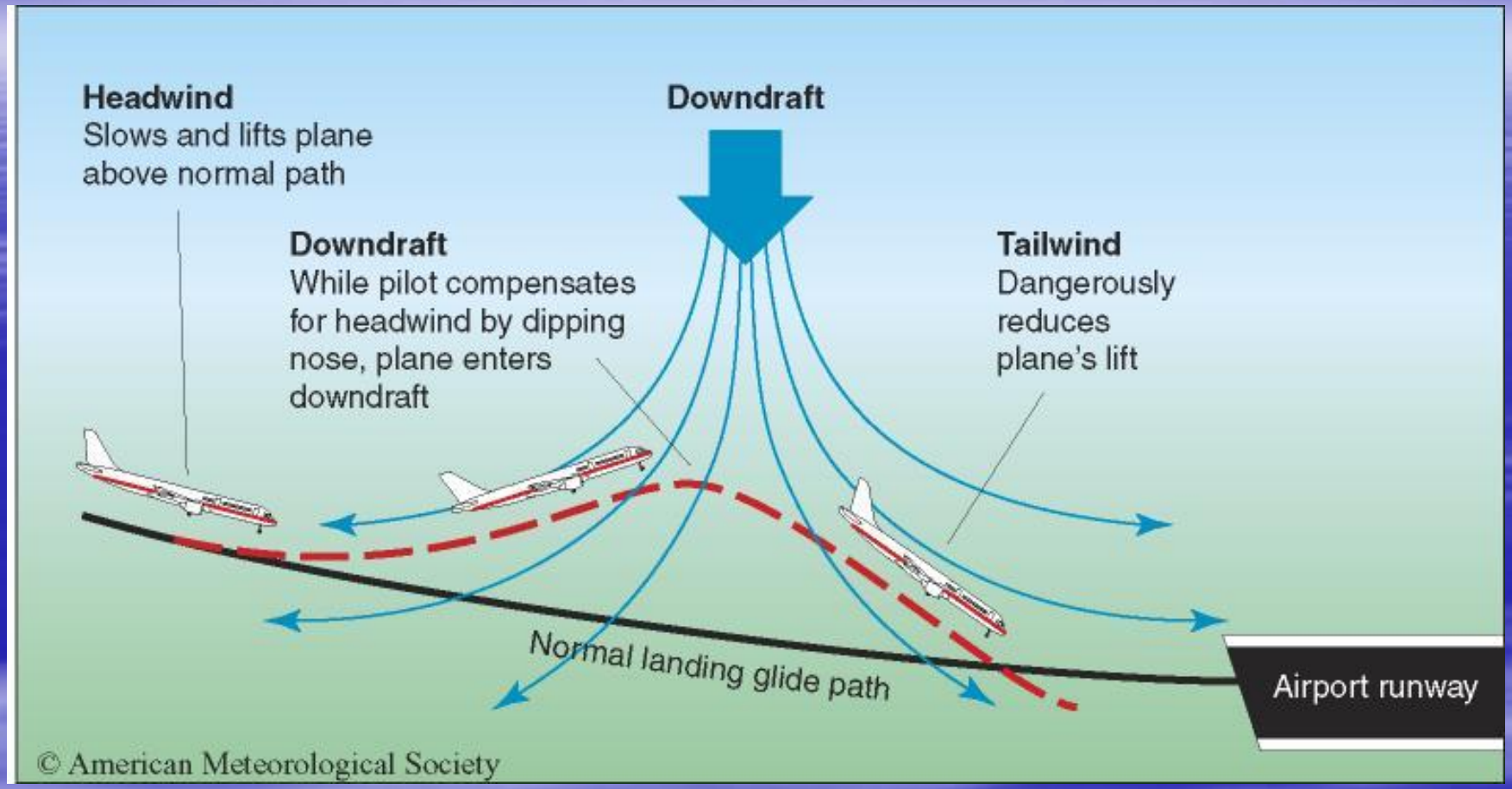
Thunderstorm Hazards

- Lightning
- Downbursts: macrobursts, microbursts
- Derecho
- Flash flooding
- Hail
- Tornadoes

Flash-to-Bang

- 1 kilometer in 3 seconds
- 1 mile in 5 seconds

Microburst



The Washington Post PostTV Politics Opinions Local Sports National World Business

Capital Weather Gang

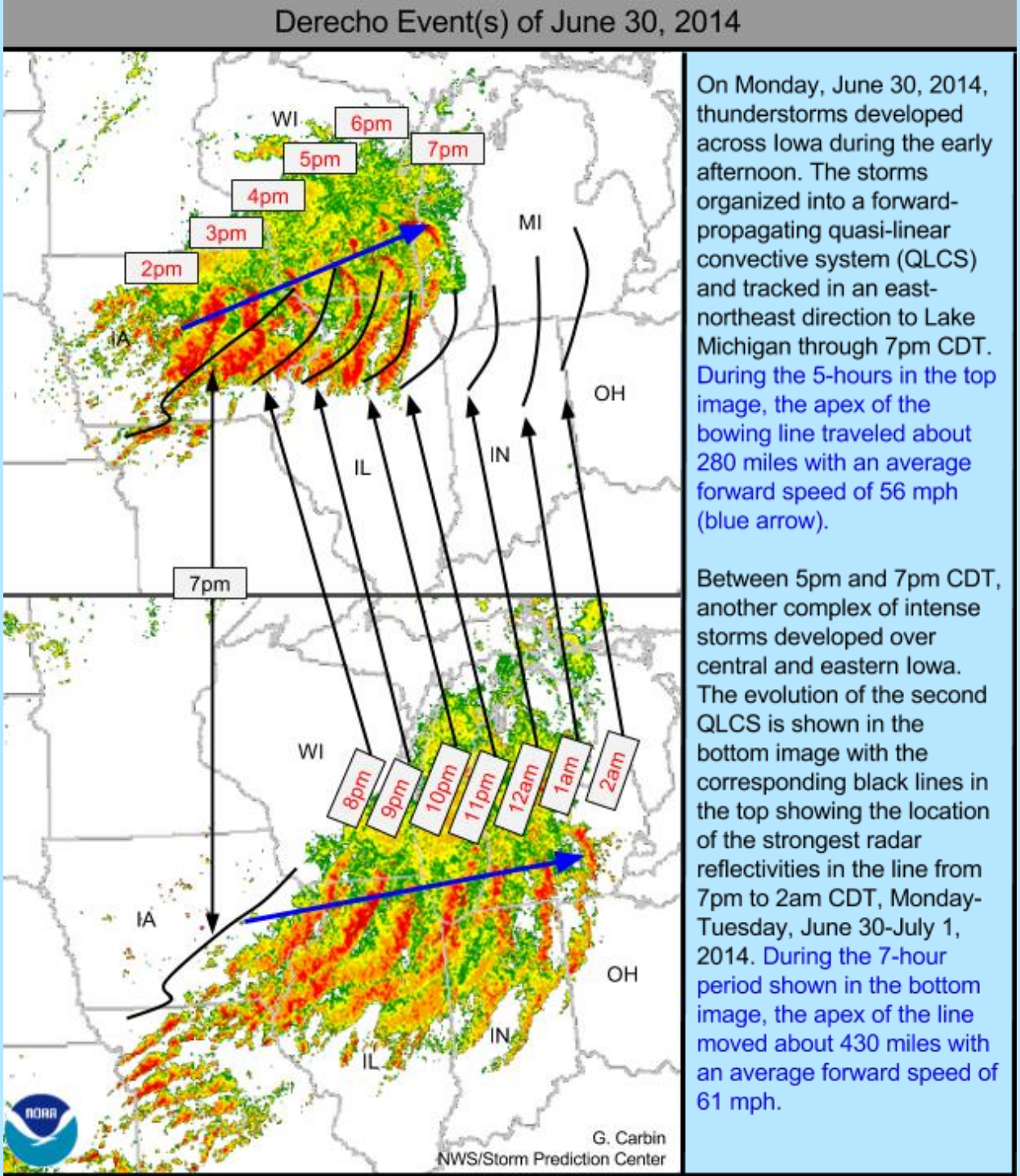
The inside scoop on weather in the D.C. area and beyond

Traffic »

Defeating the downburst: 20 years since last U.S. commercial jet accident from wind shear

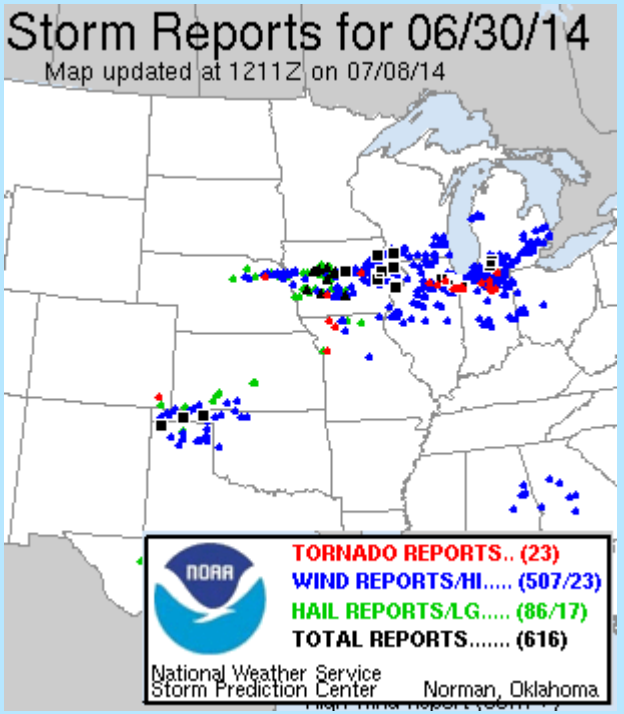
BY MIKE SMITH July 2 at 9:30 am

Derecho



On Monday, June 30, 2014, thunderstorms developed across Iowa during the early afternoon. The storms organized into a forward-propagating quasi-linear convective system (QLCS) and tracked in an east-northeast direction to Lake Michigan through 7pm CDT. During the 5-hours in the top image, the apex of the bowing line traveled about 280 miles with an average forward speed of 56 mph (blue arrow).

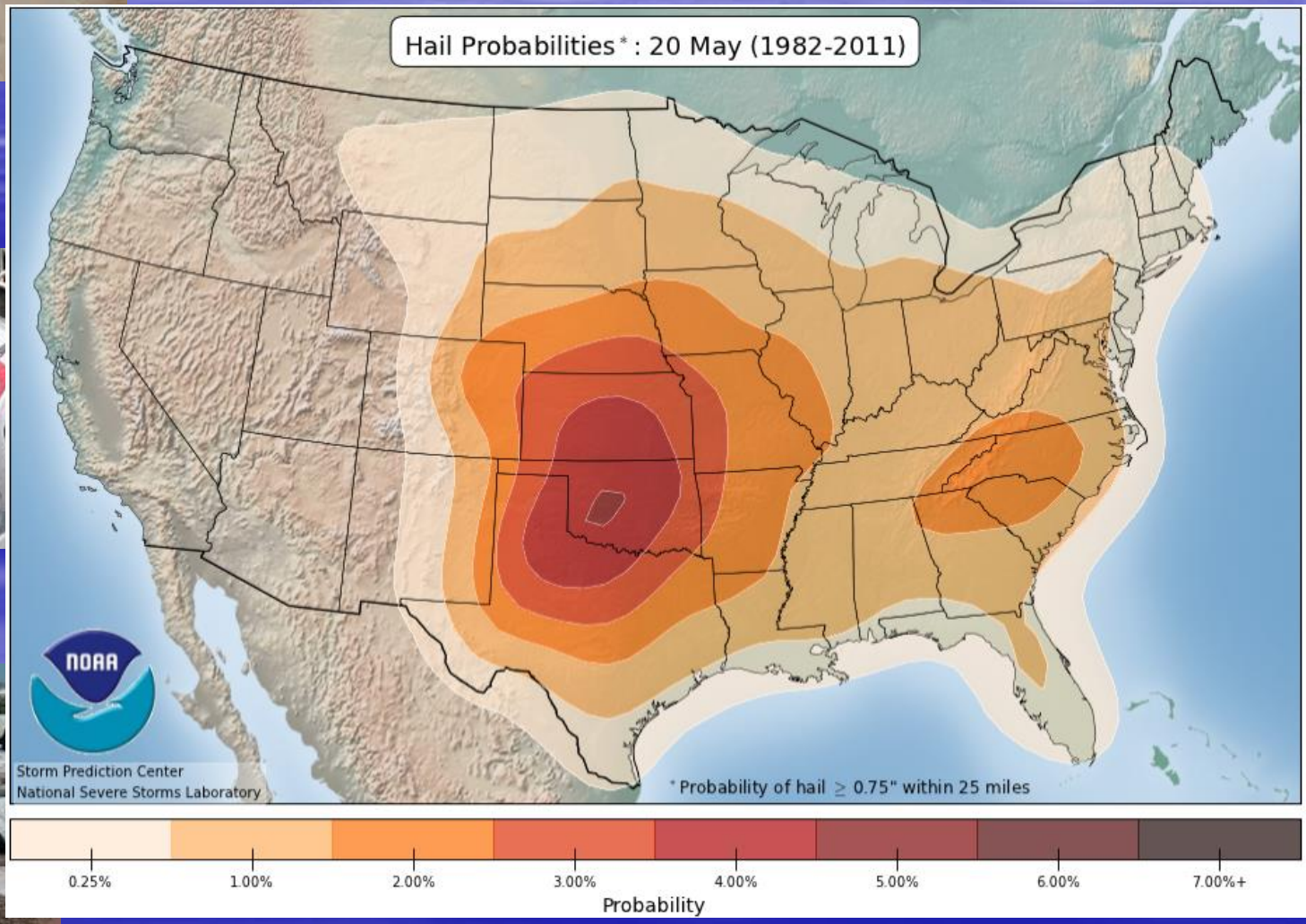
Between 5pm and 7pm CDT, another complex of intense storms developed over central and eastern Iowa. The evolution of the second QLCS is shown in the bottom image with the corresponding black lines in the top showing the location of the strongest radar reflectivities in the line from 7pm to 2am CDT, Monday-Tuesday, June 30-July 1, 2014. During the 7-hour period shown in the bottom image, the apex of the line moved about 430 miles with an average forward speed of 61 mph.

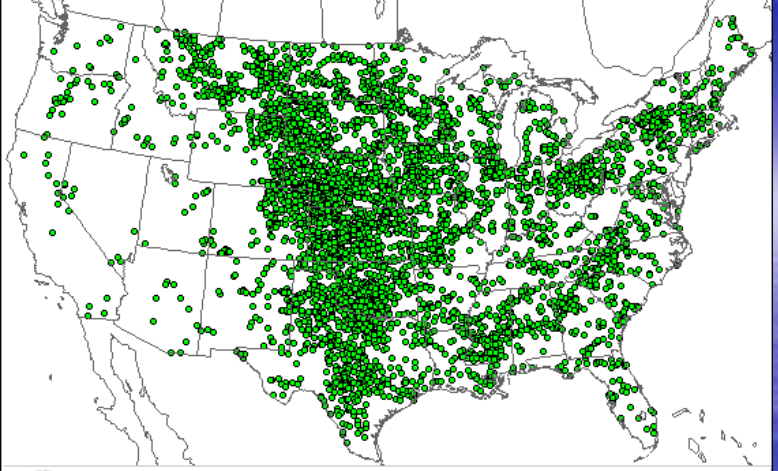


Numerous gusts ≥ 70 mph
Several ≥ 80 mph

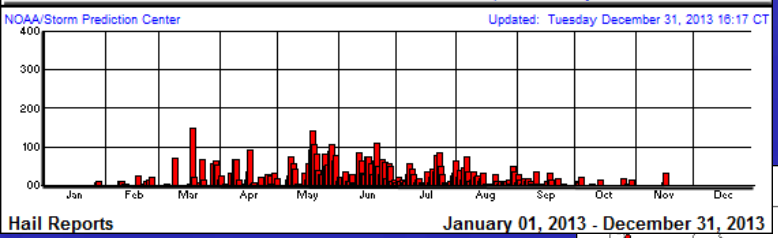
Hail


XL 07 WA


Hail Probabilities* : 20 May (1982-2011)
NOAA
Storm Prediction Center
National Severe Storms Laboratory
* Probability of hail ≥ 0.75" within 25 miles
0.25%
1.00%
2.00%
3.00%
4.00%
5.00%
6.00%
7.00%+
Probability

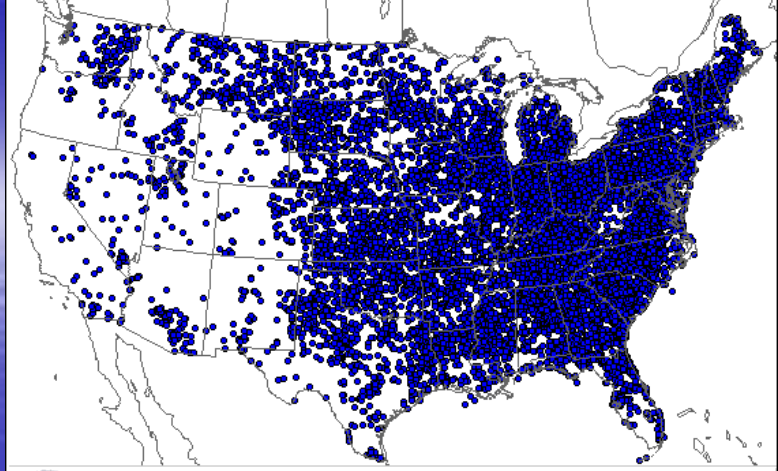


PRELIMINARY SEVERE WEATHER REPORT DATABASE (ROUGH LOG)
NOAA/Storm Prediction Center Norman, Oklahoma
Hail Reports
January 01, 2013 - December 31, 2013
Updated: Tuesday December 31, 2013 16:17 CT

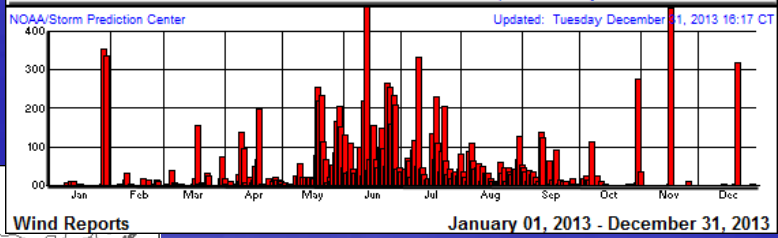


Hail

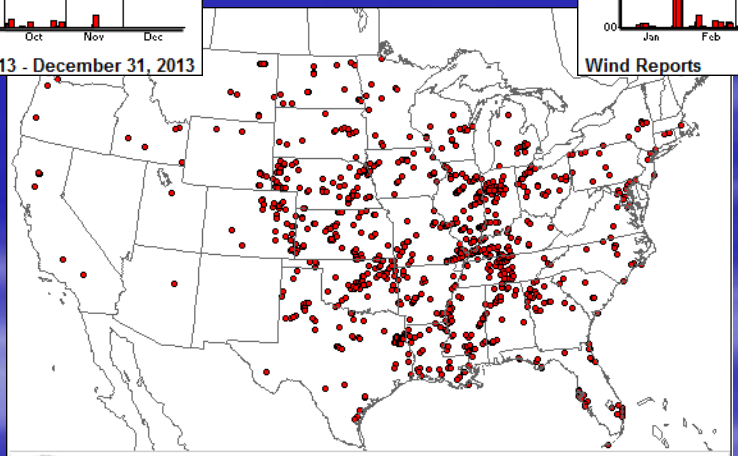
Tornadoes



PRELIMINARY SEVERE WEATHER REPORT DATABASE (ROUGH LOG)
NOAA/Storm Prediction Center Norman, Oklahoma
Wind Reports
January 01, 2013 - December 31, 2013
Updated: Tuesday December 31, 2013 16:17 CT



Wind



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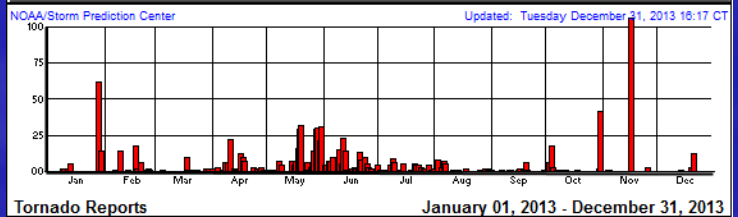


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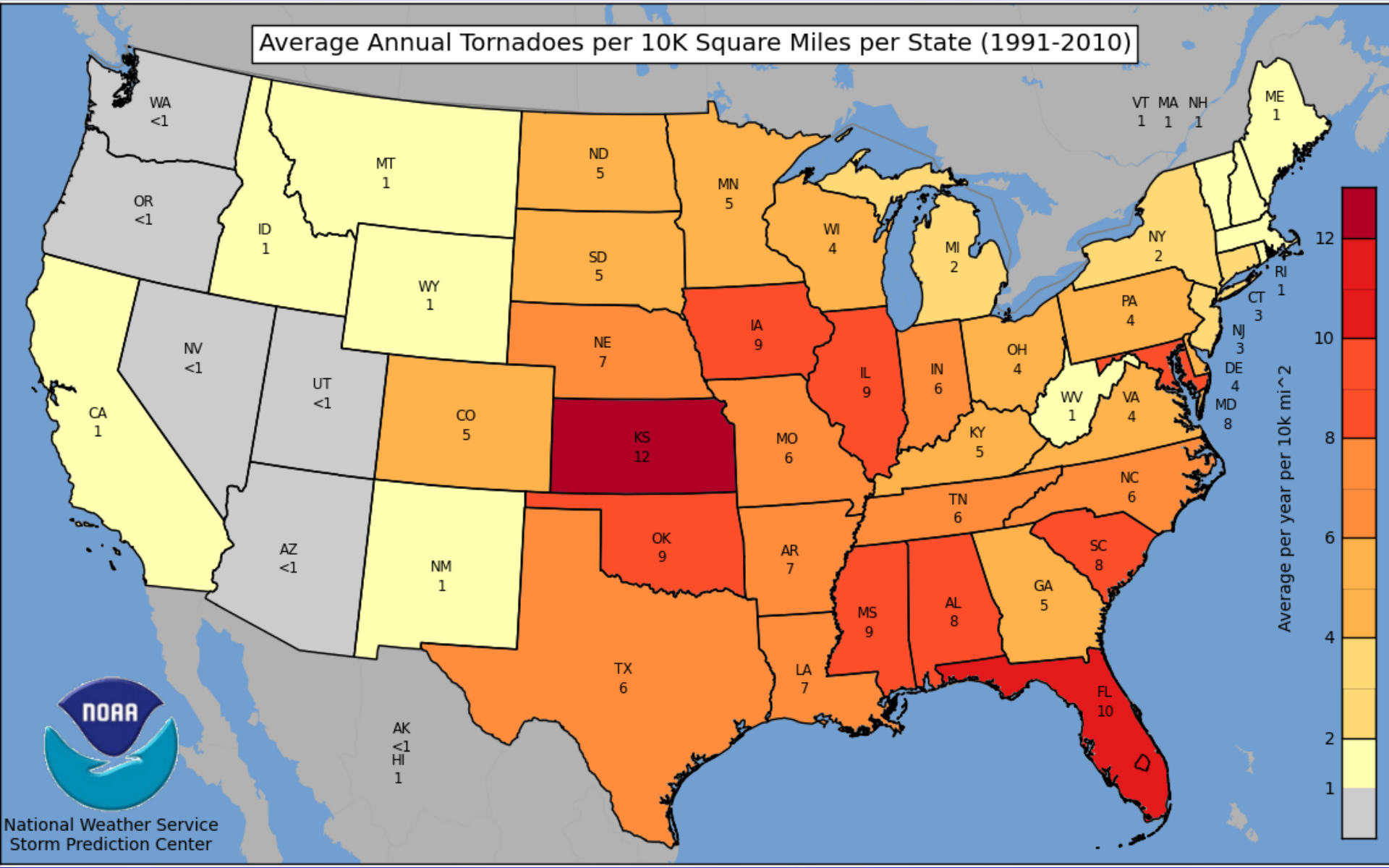
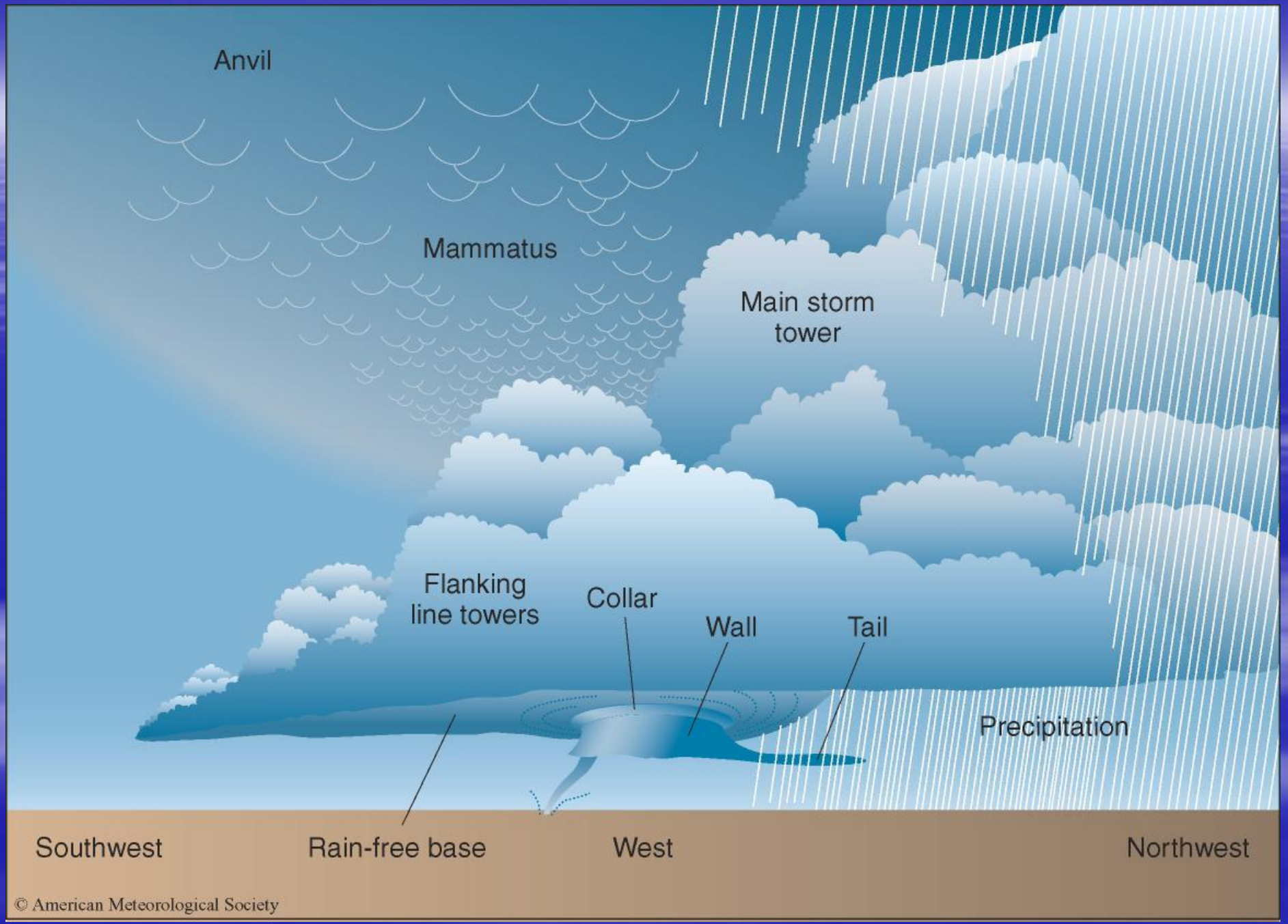
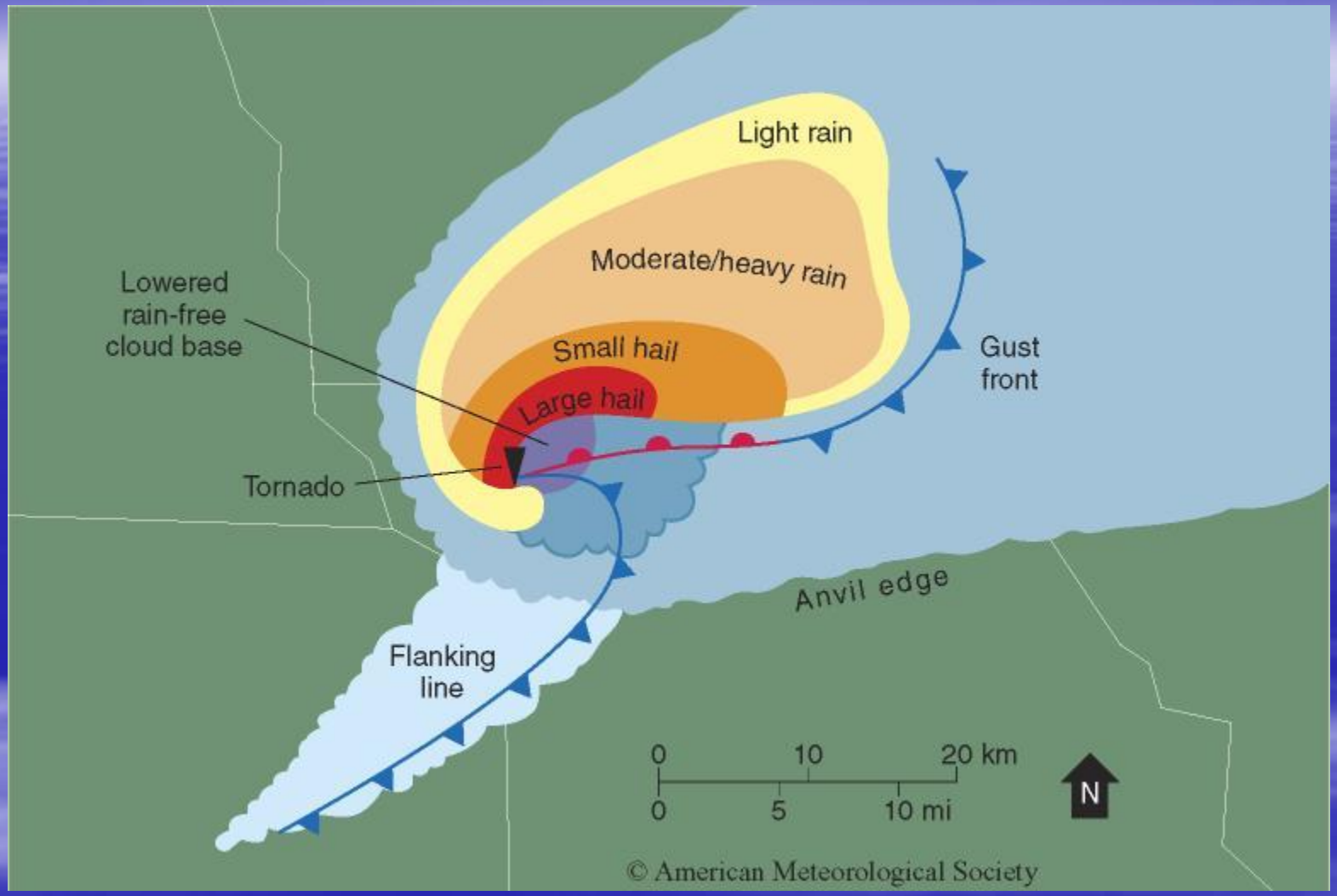
Annual Number of Tornadoes per 10,000 square miles




Anvil
Mammatus
Main storm tower
Flanking line towers
Collar
Wall
Tail
Precipitation
Southwest
Rain-free base
West
Northwest
© American Meteorological Society


Light rain
Moderate/heavy rain
Small hail
Large hail
Lowered
rain-free
cloud base
Tornado
Gust
front
Anvil edge
Flanking
line
0
10
20 km
0
5
10 mi
N
© American Meteorological Society

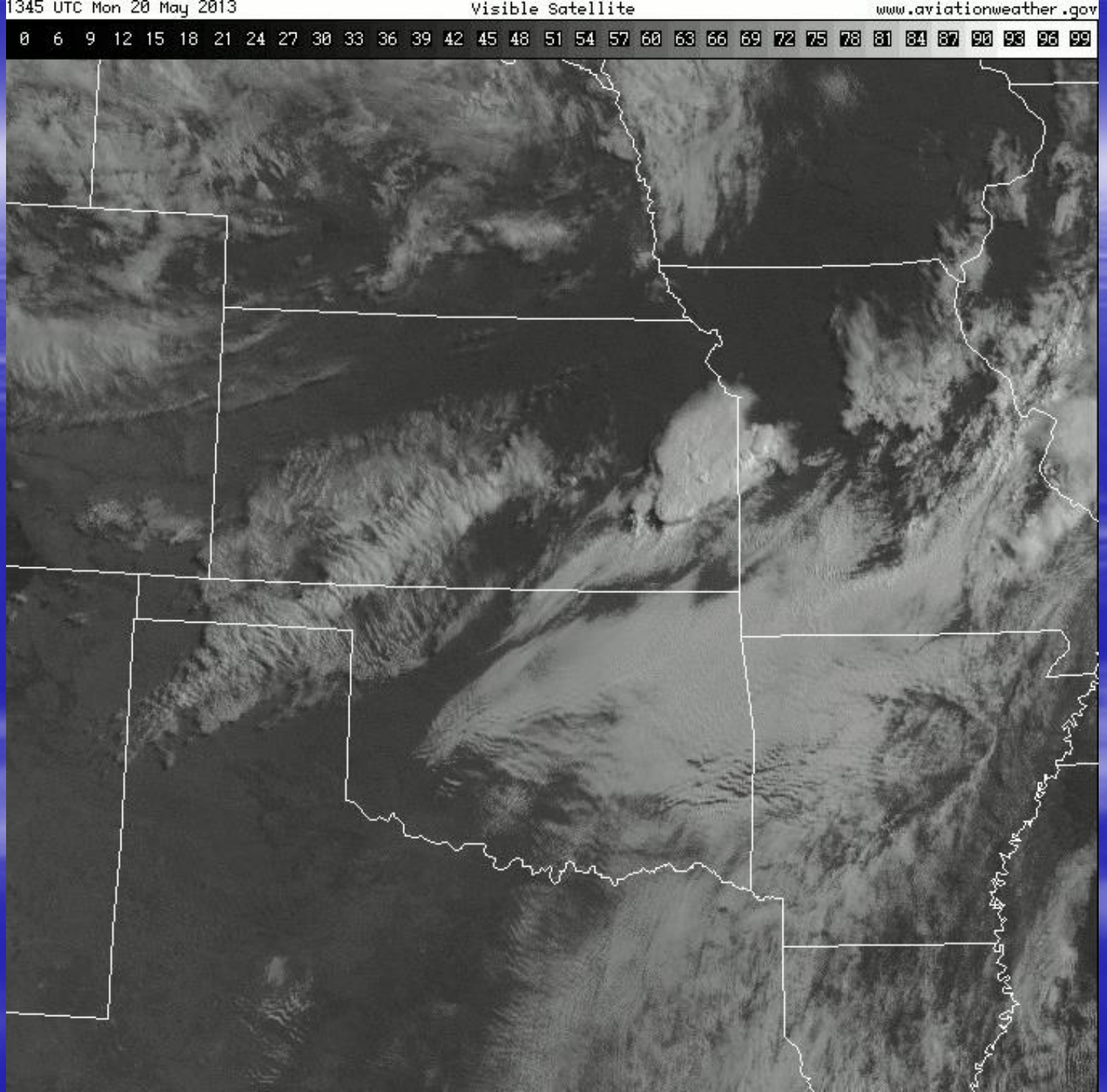
Thunderstorm Wall Cloud

Tornadoes

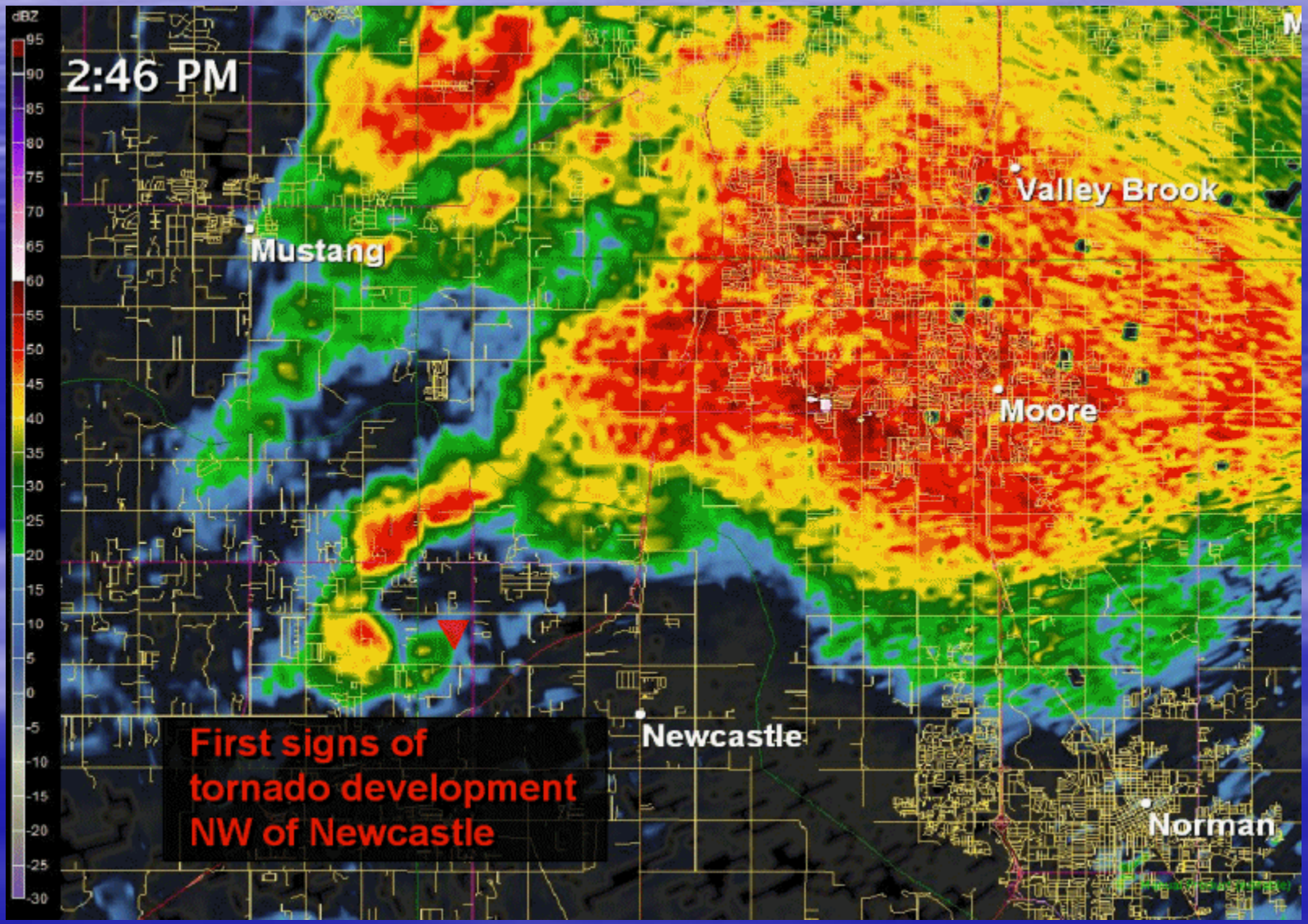
- Funnel cloud
- Size, speed, direction
- Tornado alley
- Seasonality
- Hazards: high wind, updraft, subsidiary vortices, pressure drop

Moore, OK

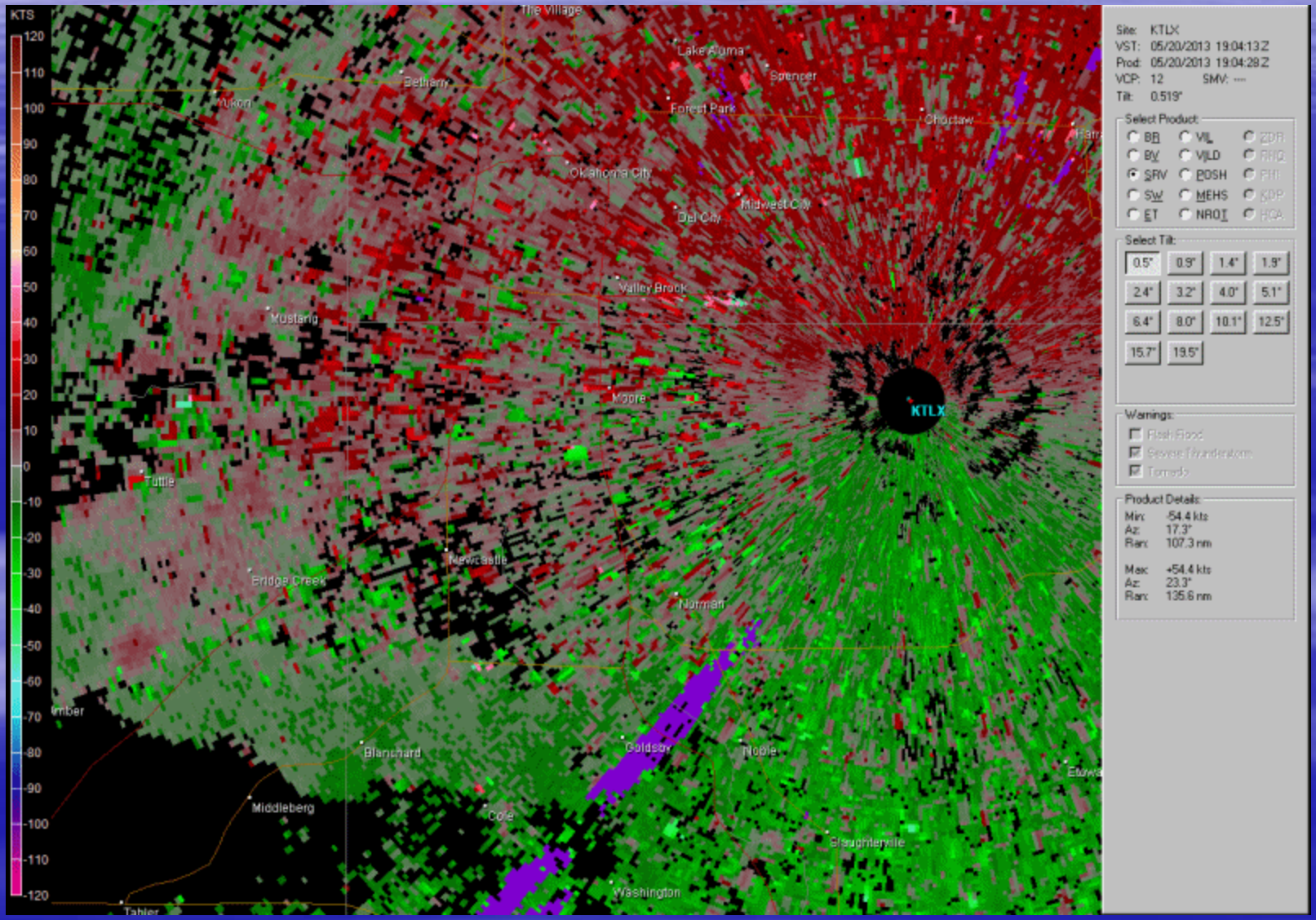
20 May 2013



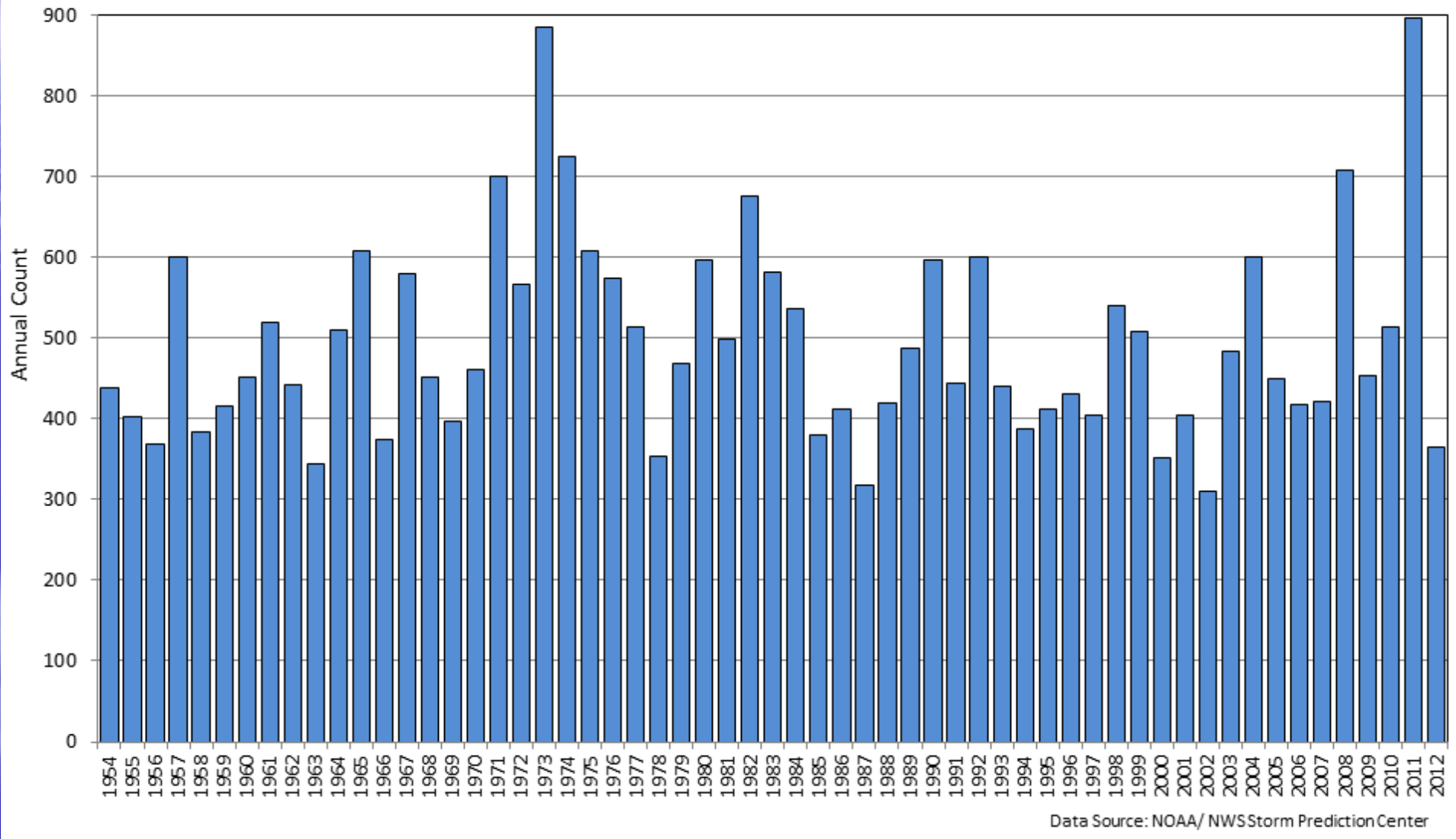
Hook Echo


dBZ
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
2:46 PM
Mustang
Valley Brook
Moore
Newcastle
Norman
First signs of
tornado development
NW of Newcastle

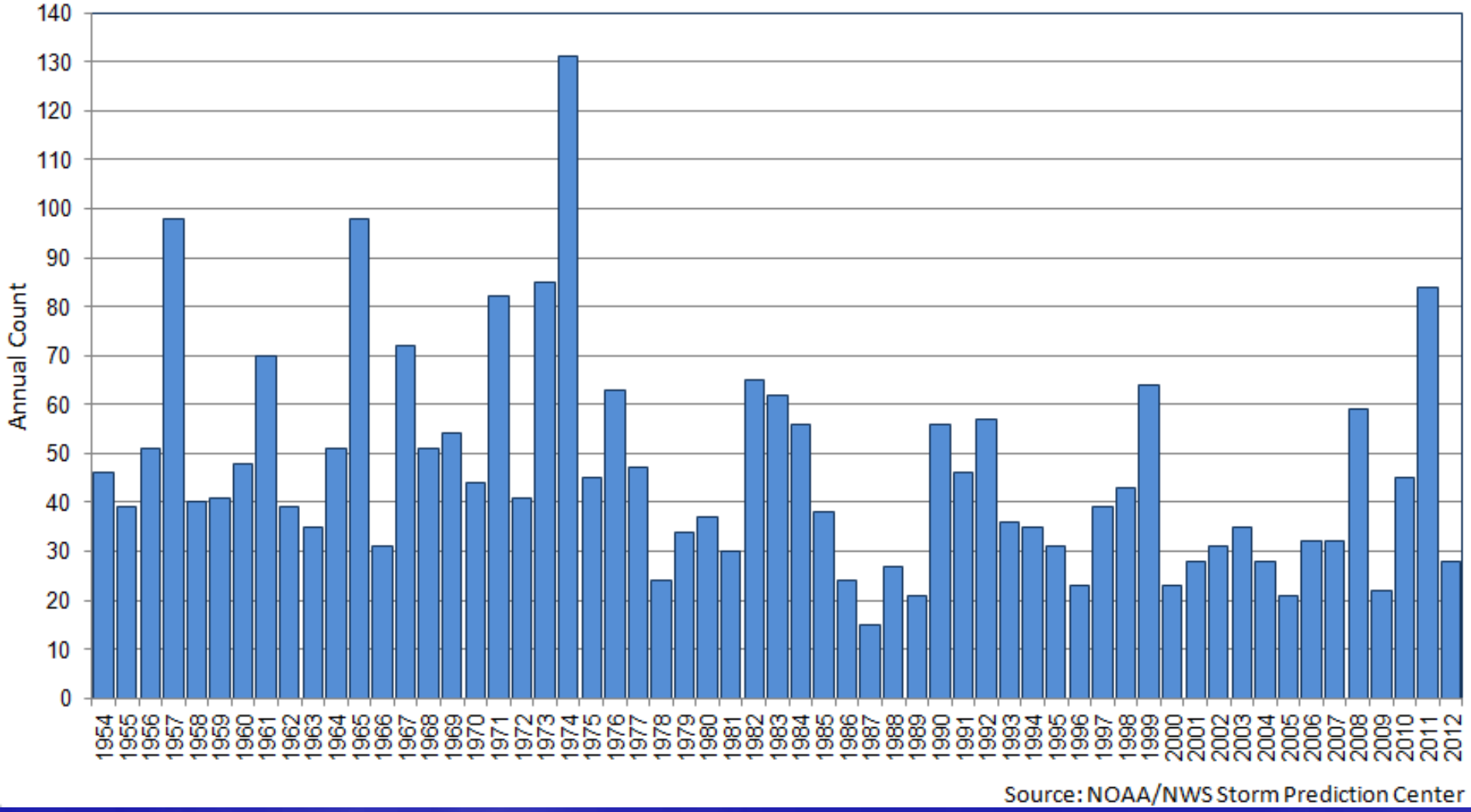
Tornado Vortex Signature



U.S. Annual Count of EF-1+ Tornadoes, 1954 through 2012



U.S. Annual Count of Strong to Violent Tornadoes (F3+), 1954 through 2012



Source: NOAA/NWS Storm Prediction Center

Waterspouts

Questions?