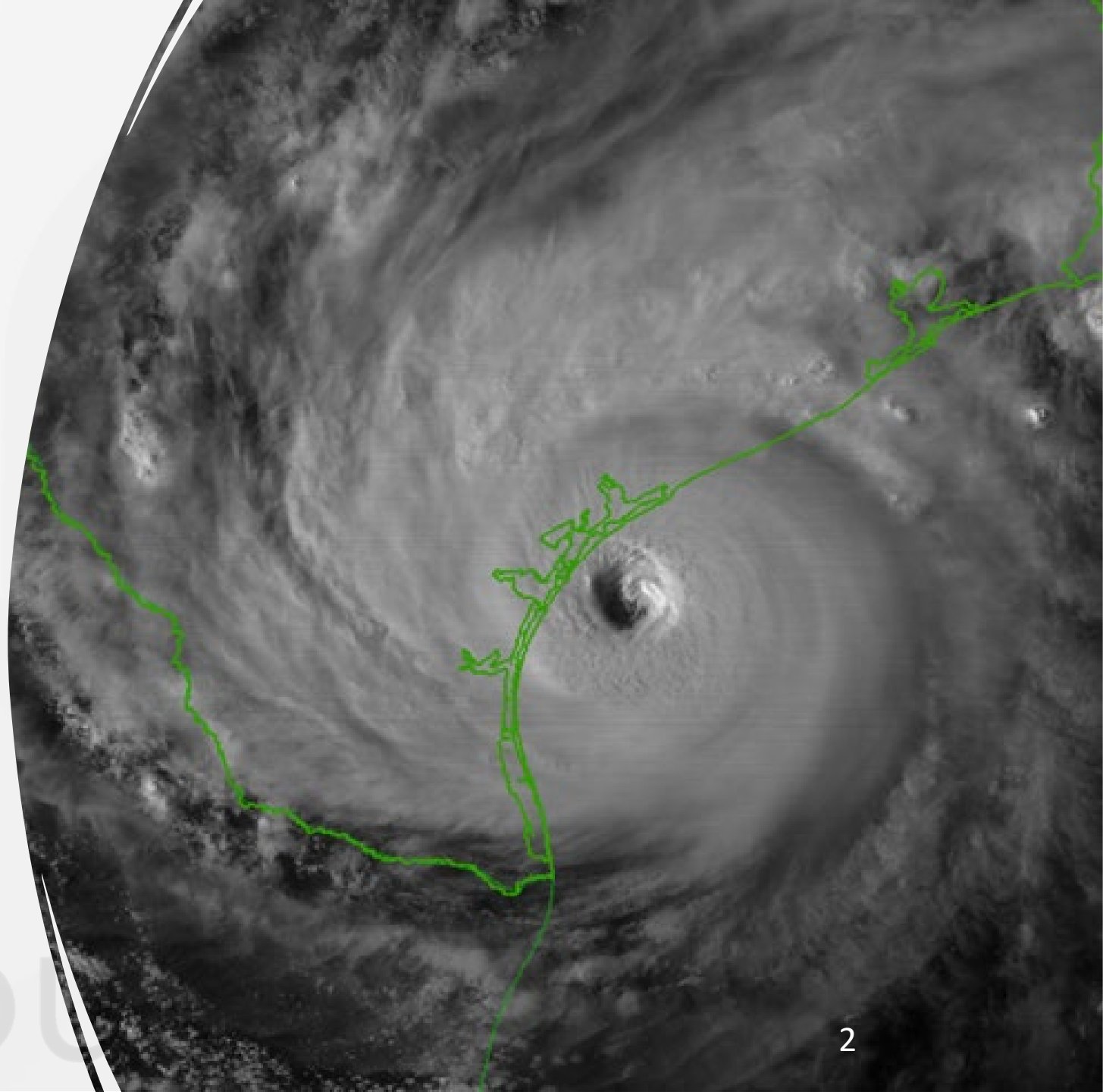


FORENSIC METEOROLOGY

Basics of Forensic Meteorology

- Dan Schreiber, CCM
 - Meteorology Practice Lead



Outline

Severe Convective Storms (Hail/Thunderstorm Wind/Tornadoes)

Named Storms (Hurricanes, etc.)

Windstorms

Flooding

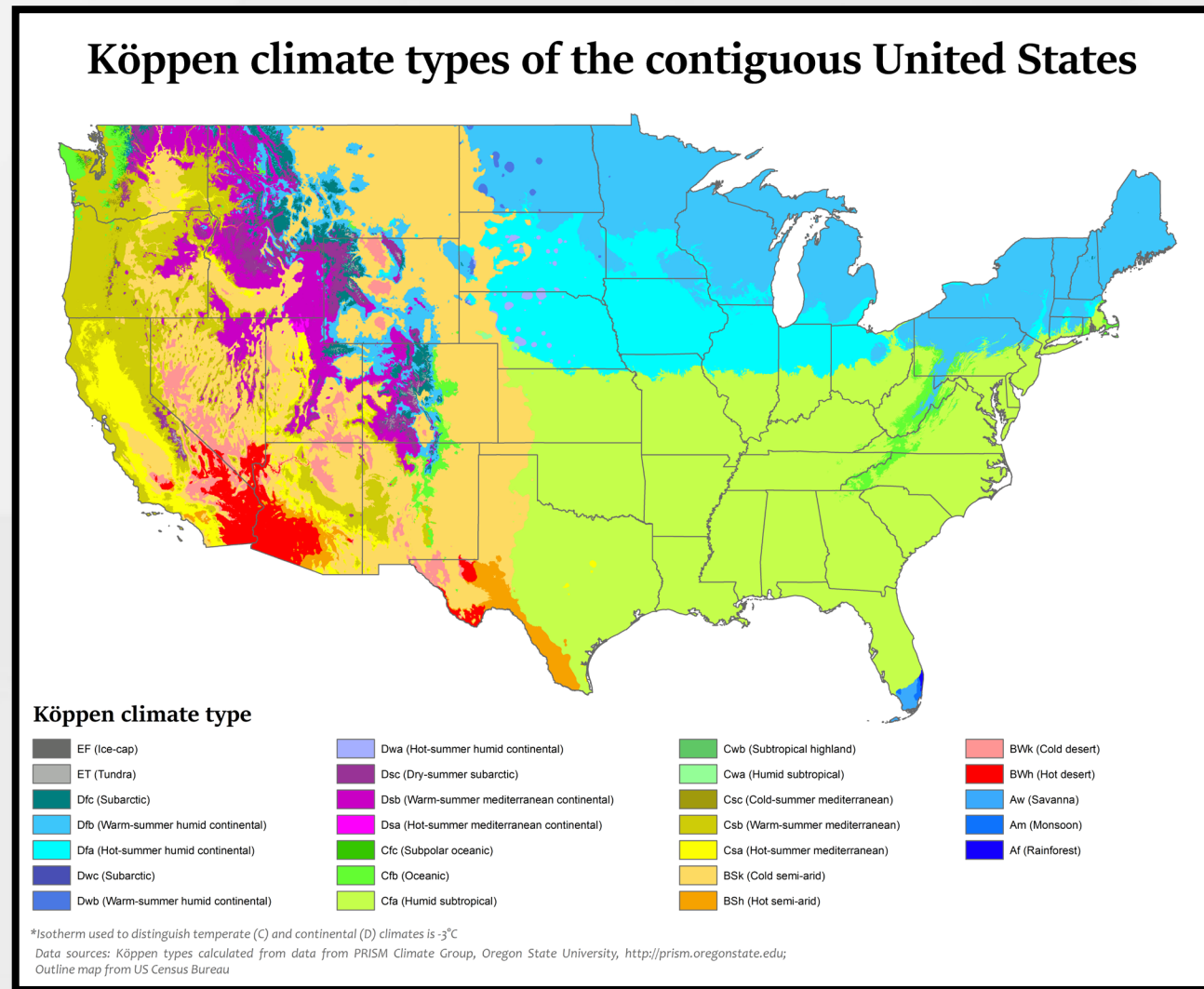
Winter Weather

Where to Find Weather Information (and what to watch out for!)

Q&A

Climate Zones of the Continental United States

Weather behavior is incredibly dependent on climate zones.



Severe Convective Storms

The term “Severe Convective Storm” is **not** found in the National Weather Service (NWS) or American Meteorological Society (AMS) Glossary.

Rather: “Severe Thunderstorm”*

- A thunderstorm that produces a tornado;
- Winds of at least 58 mph (50 knots); and/or
- Hail at least 1" in diameter
- Lightning is implied for "thunderstorm"

Structural wind damage may imply the occurrence of a severe thunderstorm.

**U.S. Definition. Other nations may differ.*



Severe Convective Storms



Common Types of Severe Thunderstorms:

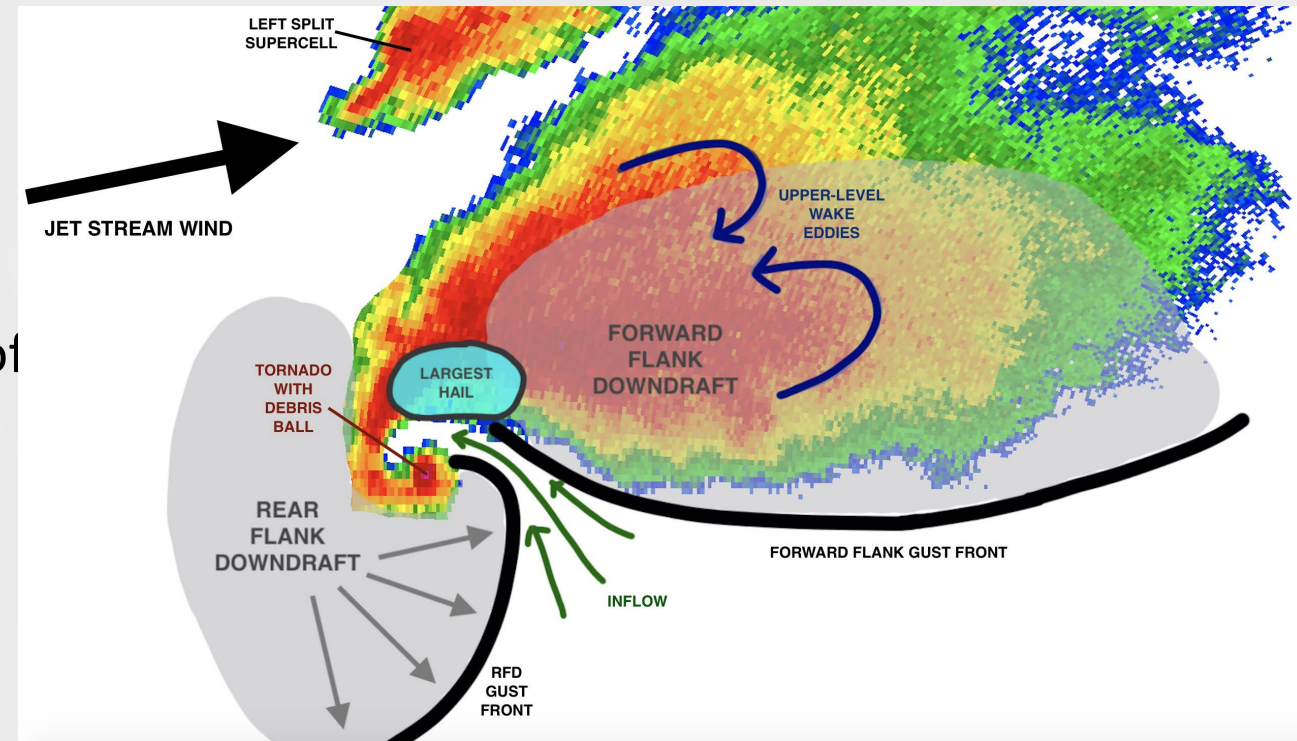
- Derechos (~250 miles/58 MPH+)
- Downbursts (58 MPH+)
- Squall Lines (58 MPH+)

What is **NOT** a Severe Thunderstorm:

- Hail < 1.00 inch (25 mm)
- Wind < 50 knots (58 MPH)
- Lightning (only)
- Flooding or Flash Flooding
- Tropical Cyclones

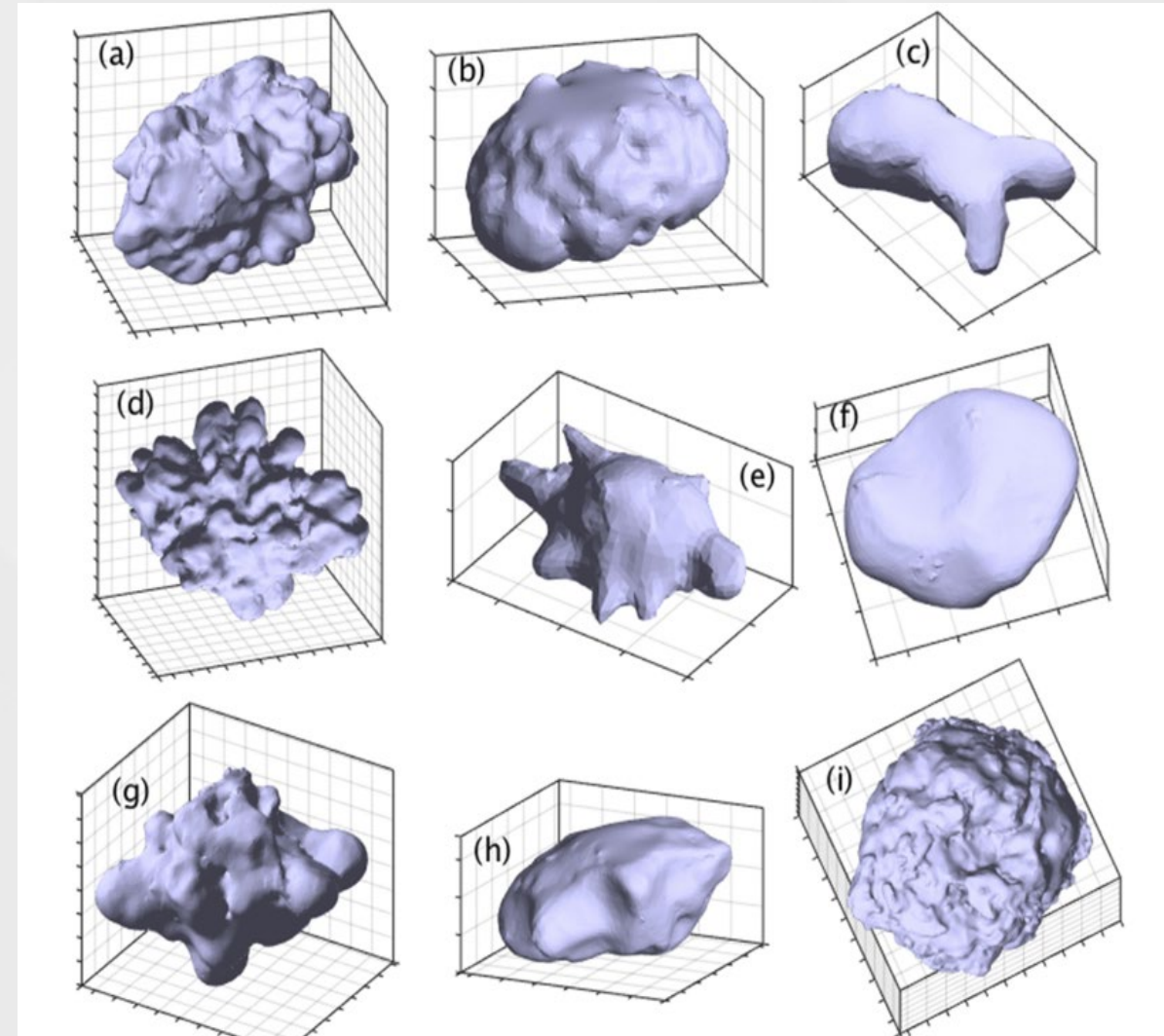
Hailstorms

- Direction of hailfall is not always the direction the storm is moving.
- The largest hail doesn't always fall in the storm center
 - Big hail is known to sometimes fall out of the updraft overhang in areas of very little precipitation
- Storm reports for hail can be misplaced or estimated incorrectly.



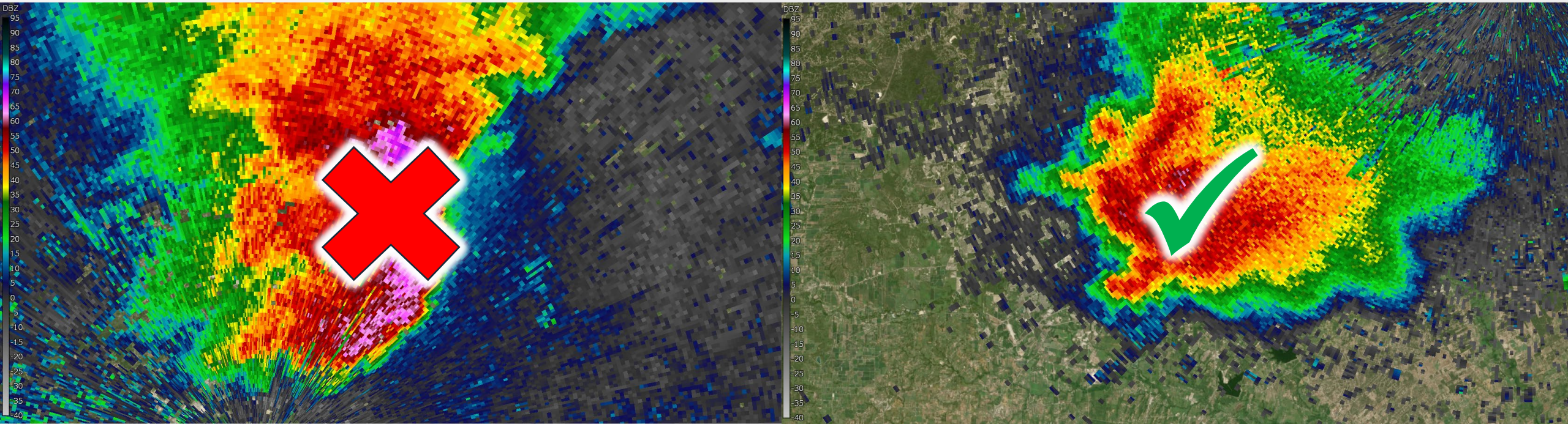
Hailstorms

- **Not all thunderstorms result in hailfall**
 - In hail-producing storms, hailfall is often limited to only a portion of the storm, not the whole storm.
- **“Severe” or “Large” Hail is:**
 - 1.00-inch or greater in diameter (U.S.)
- Various sizes, shapes, and densities of hail often coexist:
 - The same storm can, at the same location:
 - Create different hail sizes
 - Create different hail shapes
 - Result in hail of differing densities
 - Result in hail from different directions

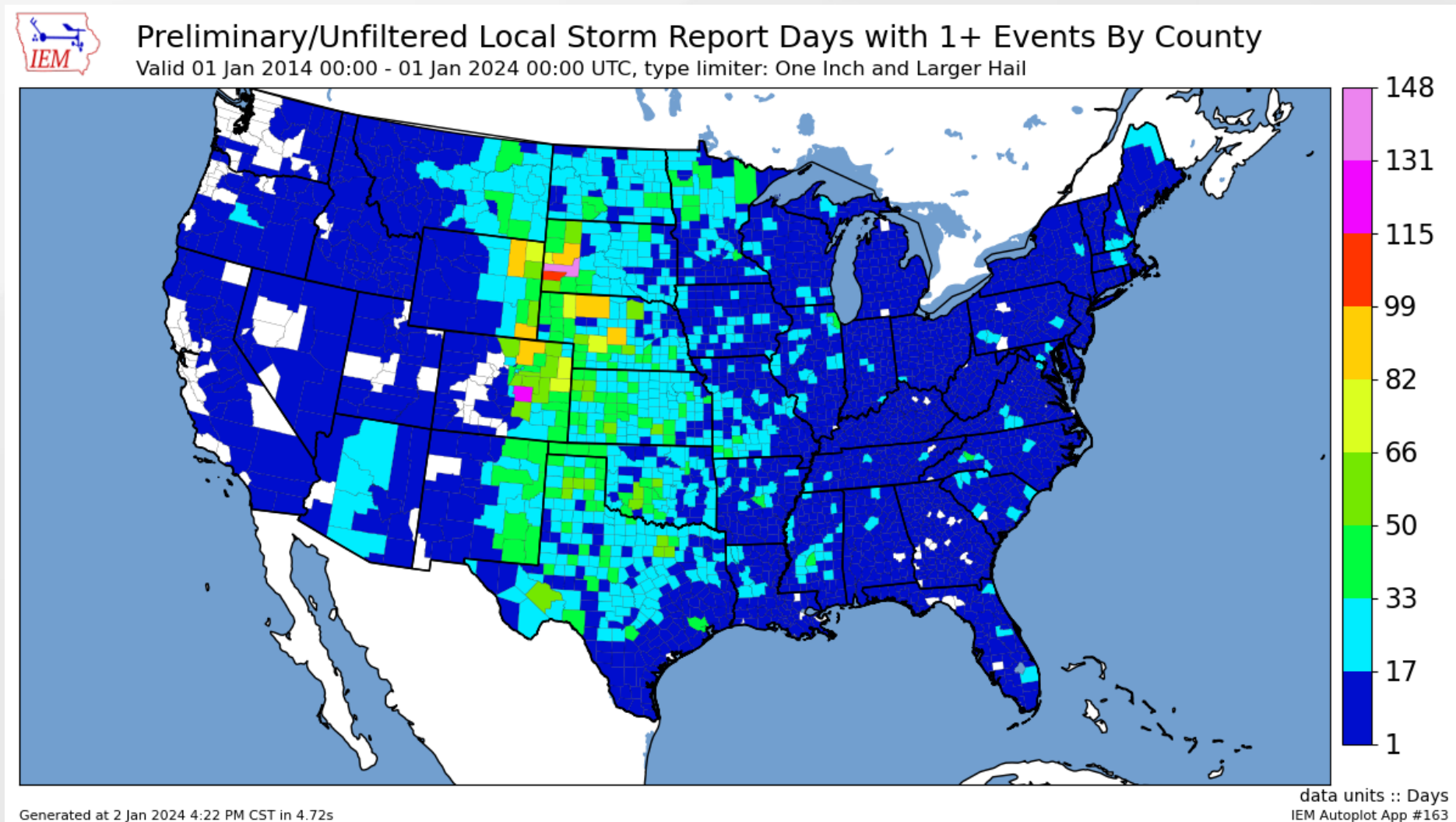


Hailstorms

Which storm resulted in bigger hail?

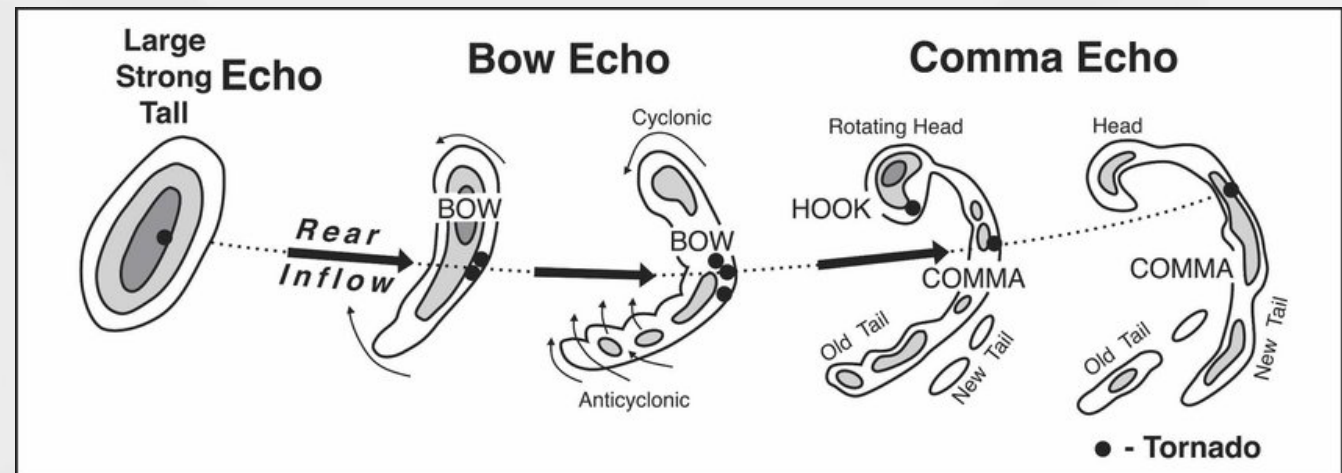
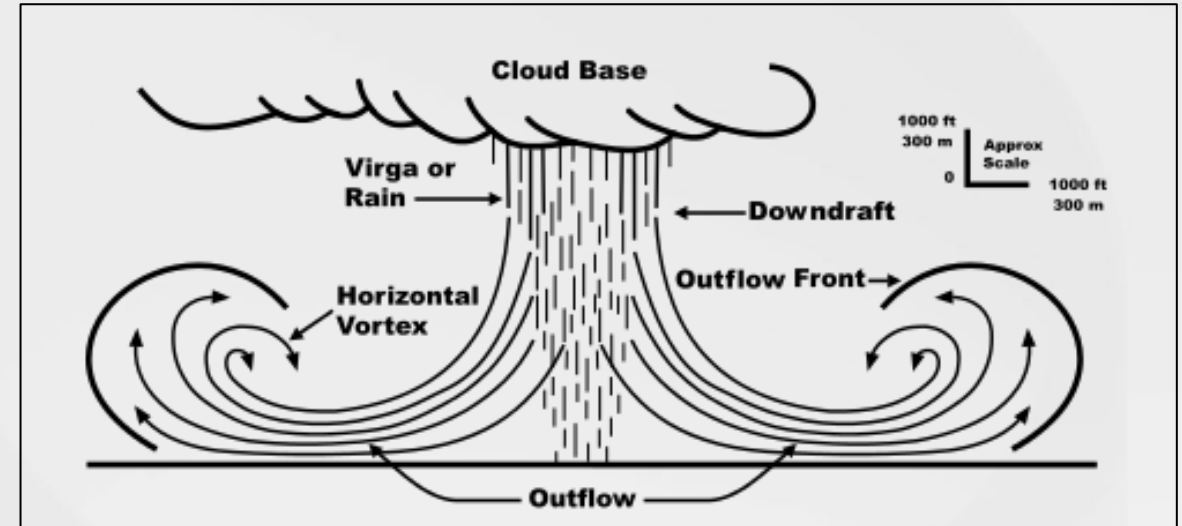


Hail Statistics (10-Year)

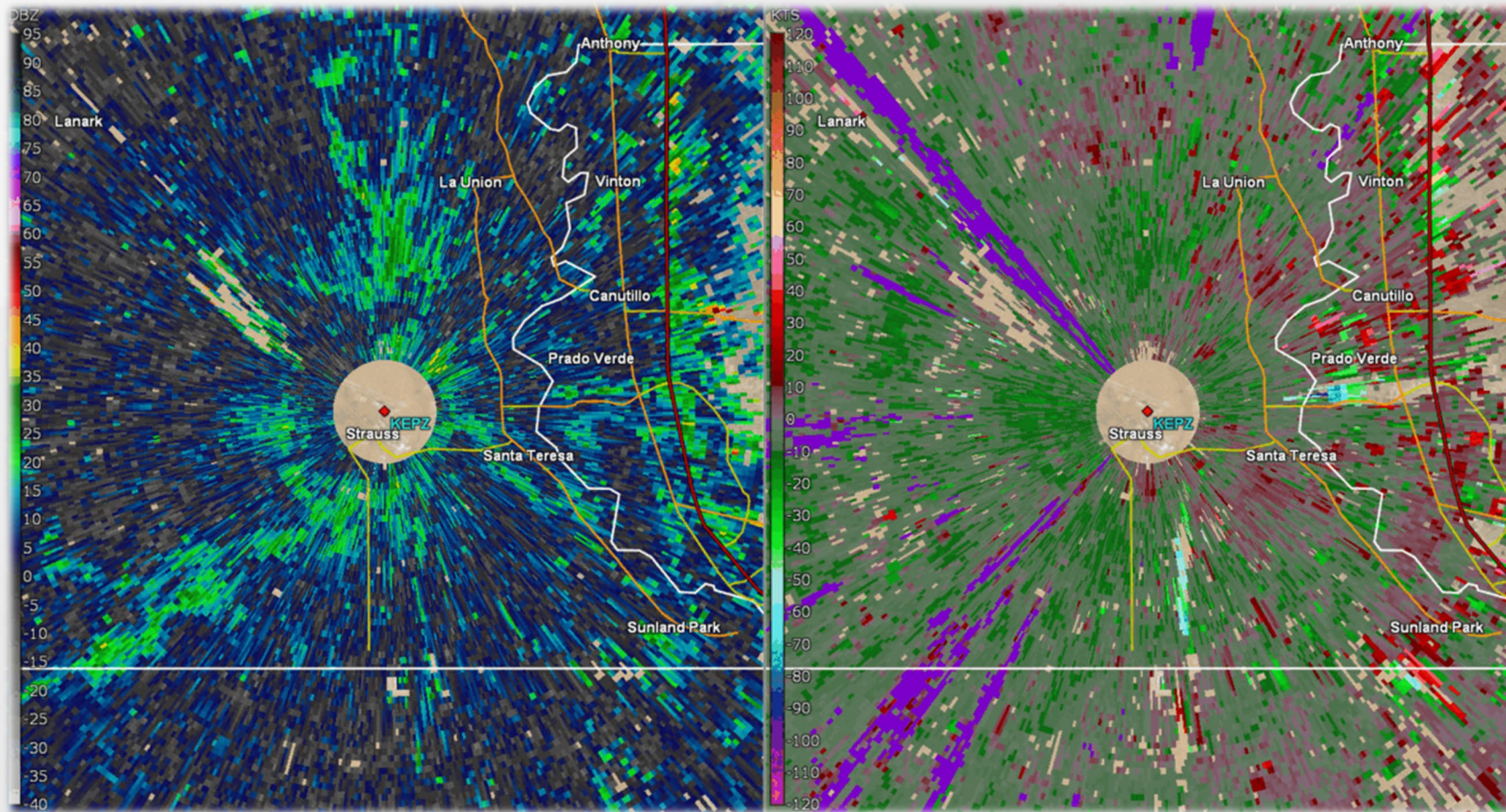


Thunderstorm Wind Events

- **Two main types of thunderstorm winds:**
 - Downburst
 - Linear
 - Hybrid*
 - Tornadoes**
- **Downbursts (Microbursts & Macrobursts):**
 - Wet Microburst
 - Dry Microburst
 - “Heat” Burst
- **Linear Events**
 - Bow Echo
 - Squall Line
 - Derecho

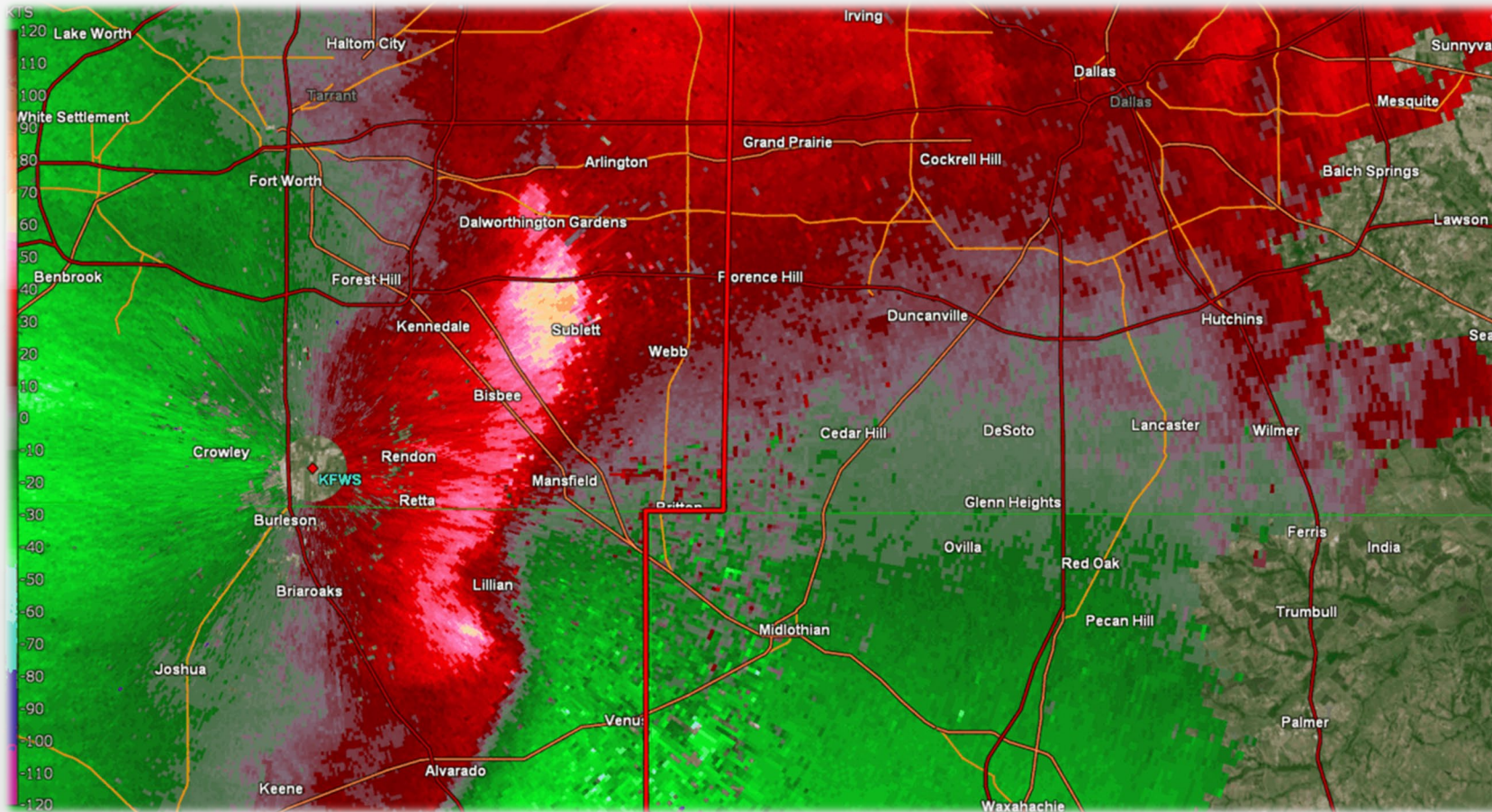


Thunderstorm Winds - Downburst



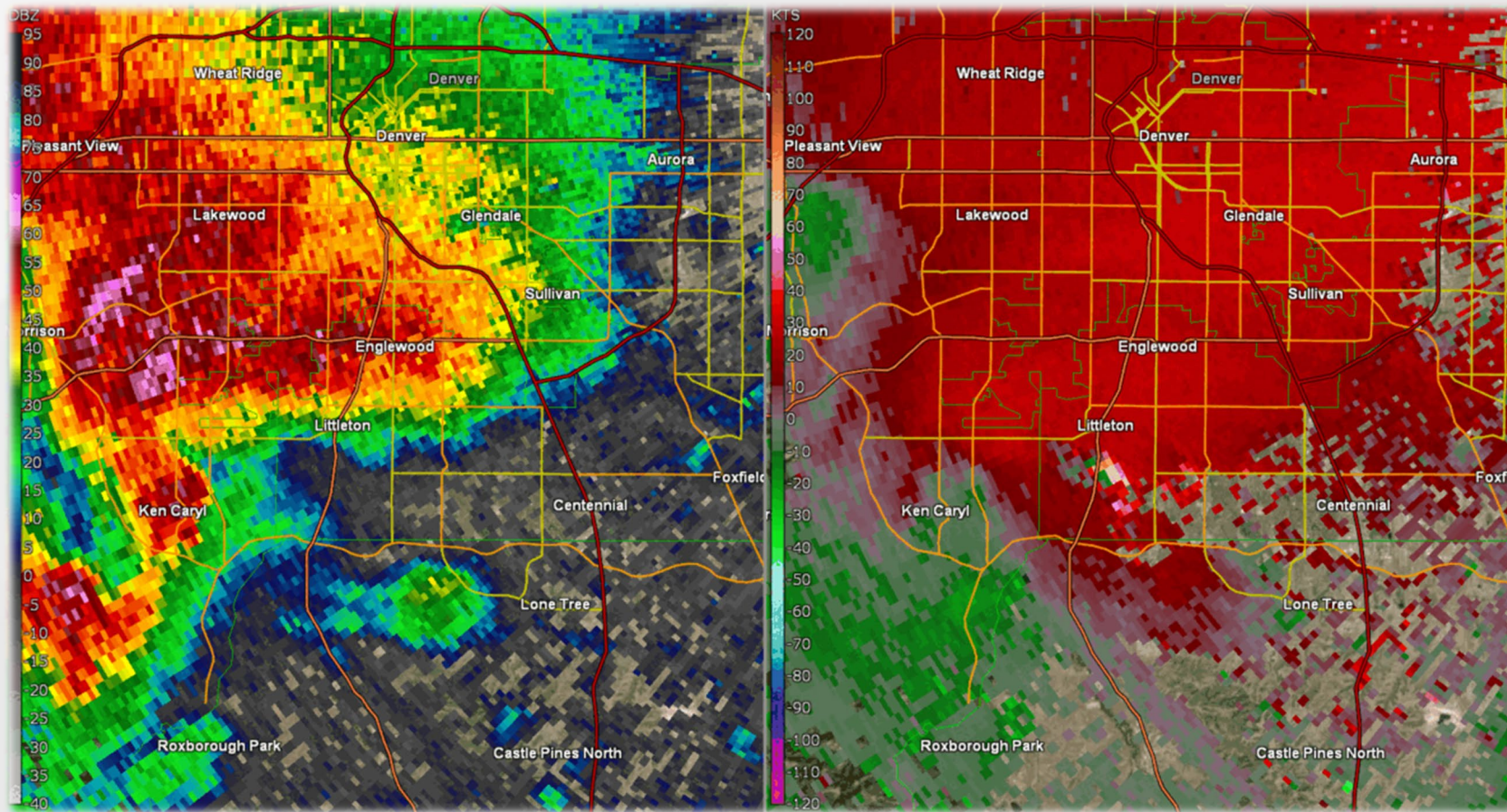
Microbursts can be “Micro”! Downbursts are usually caused by the displacement of air, like the “splash” when a rock is tossed into a pond.

Thunderstorm Winds - Linear



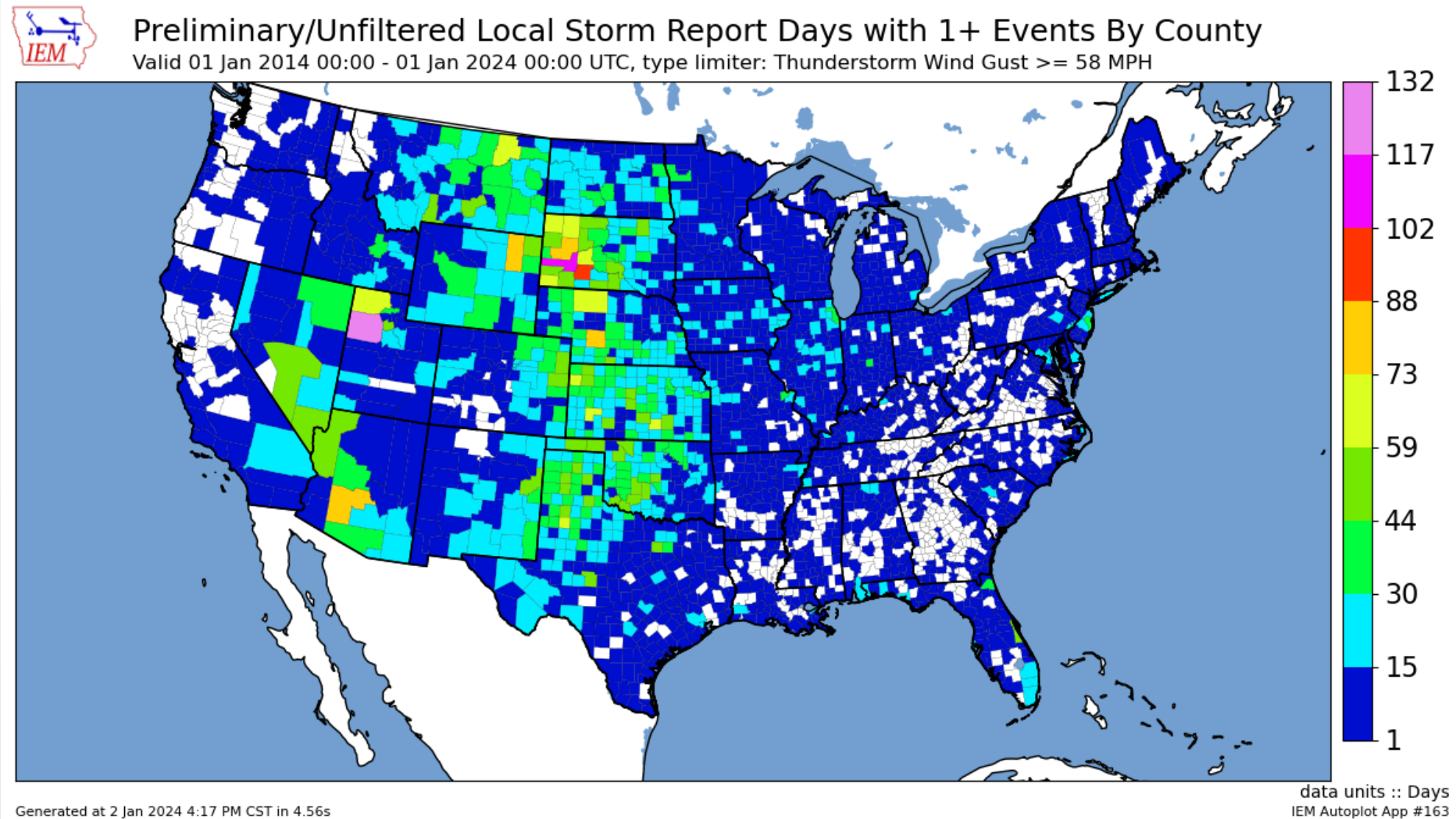
Generally, very strong mid-level forcing winds behind the storm, which plunge toward the surface. Can be combined with downbursts for added effect.

Thunderstorm Winds - Tornadoes

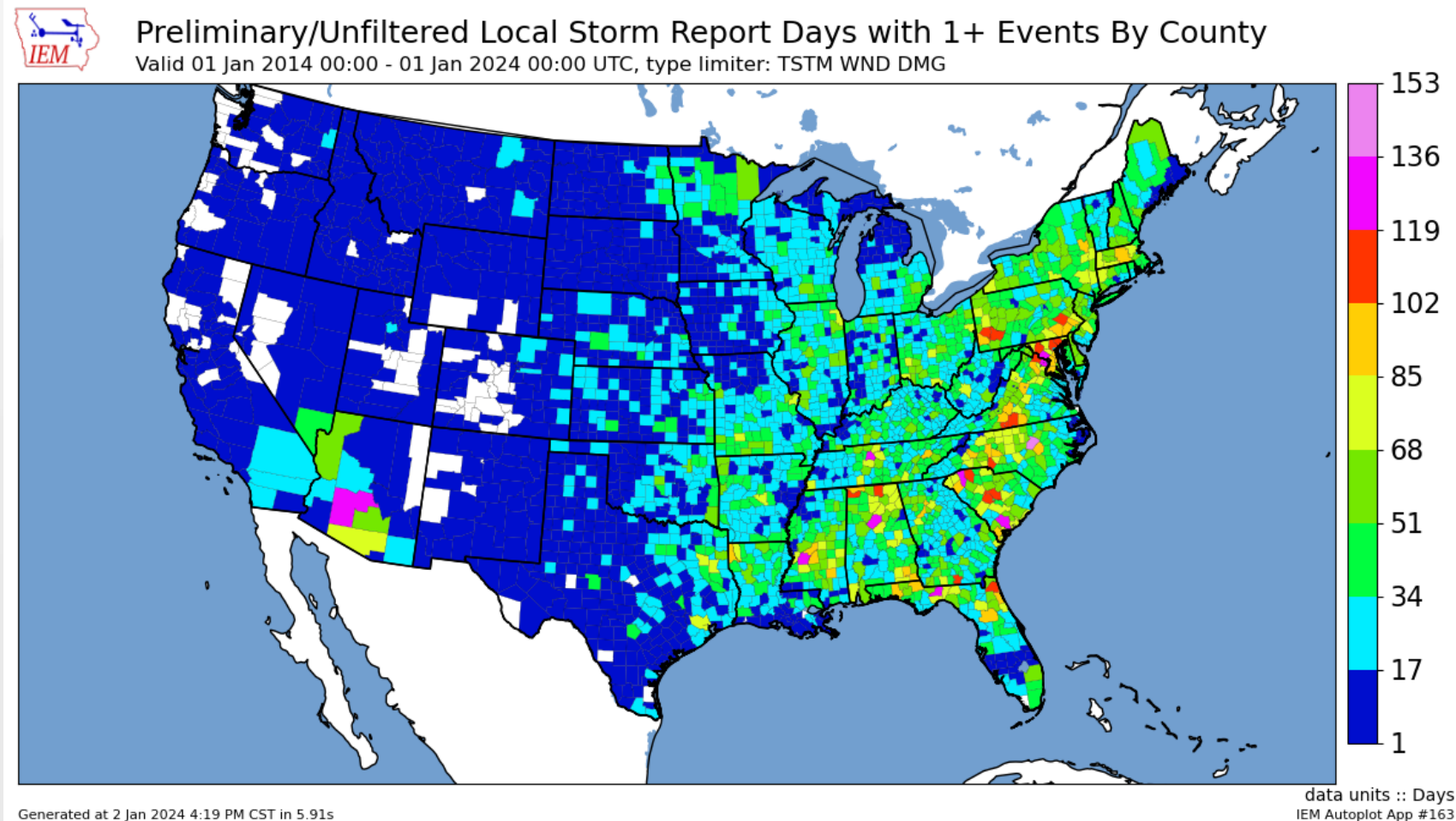


Can occur in supercell thunderstorms, linear thunderstorms, and even tropical cyclones.

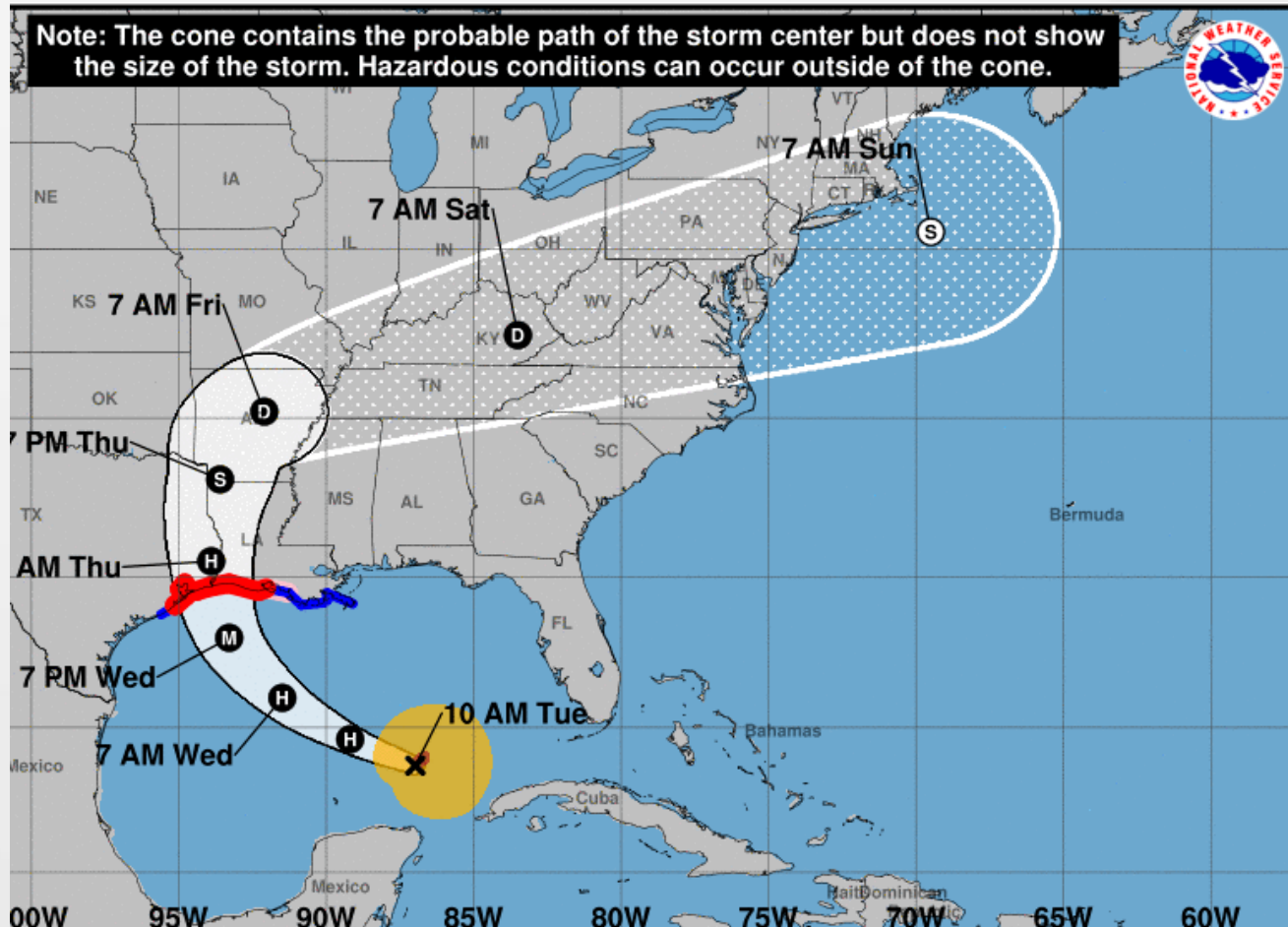
Thunderstorm Winds – Measured Gusts Statistics (10-Year)



Thunderstorm Winds – Measured Wind Damage Statistics (10-Year)



Named Storms



- Generally, refer to Tropical Cyclones, such as Tropical Storms and Hurricanes.
- A tropical depression – when building – may have a number, not a name.
- Some storms are declared as “Potential Tropical Cyclones” and numbered instead.
- Once a storm is named, it usually retains the name until the storm no longer exists, even if it is no longer a “tropical cyclone”.
- There is debate as to whether a “Named Storm” is a “windstorm”

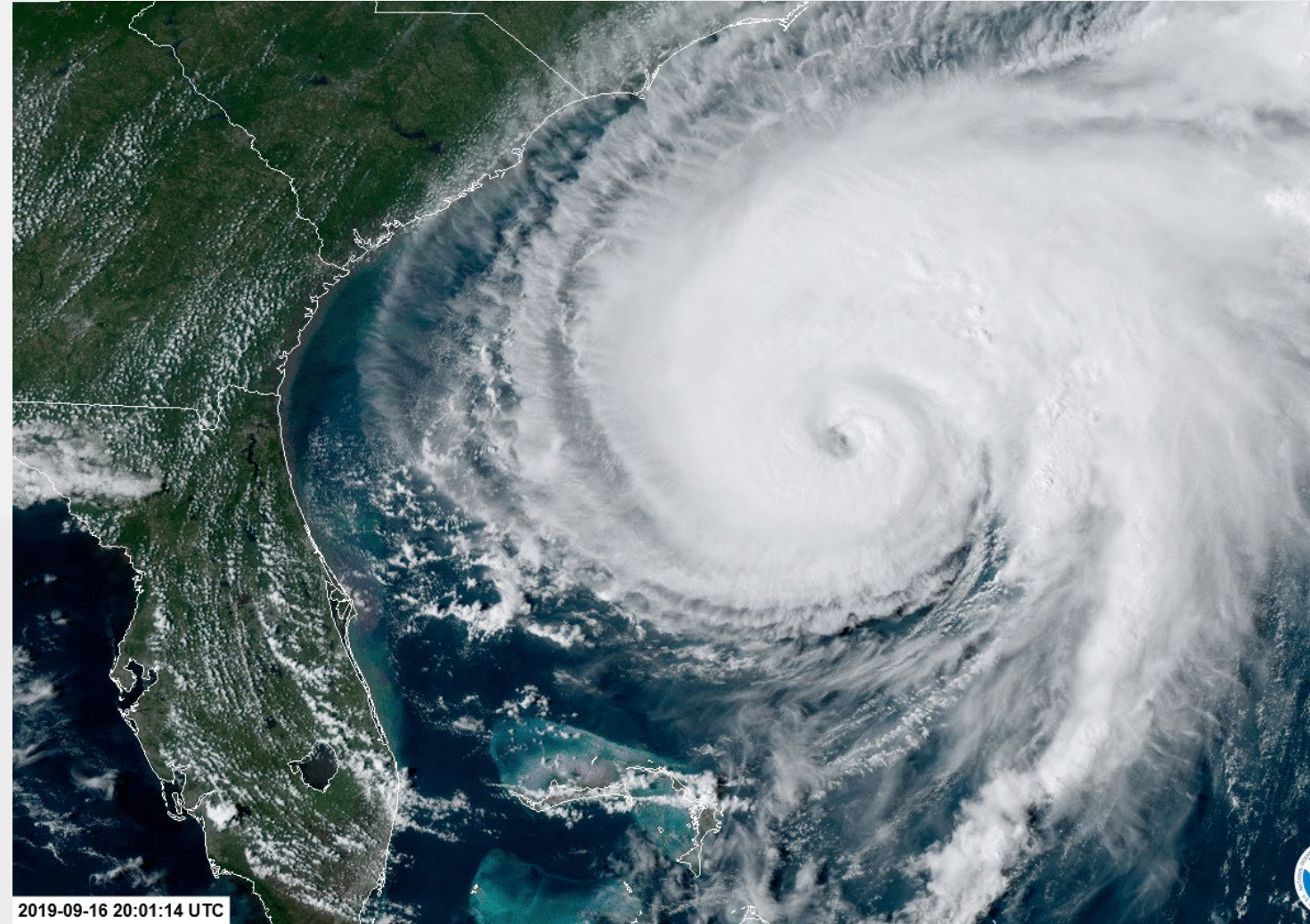
Named Storms

Common Types of Named Storms:

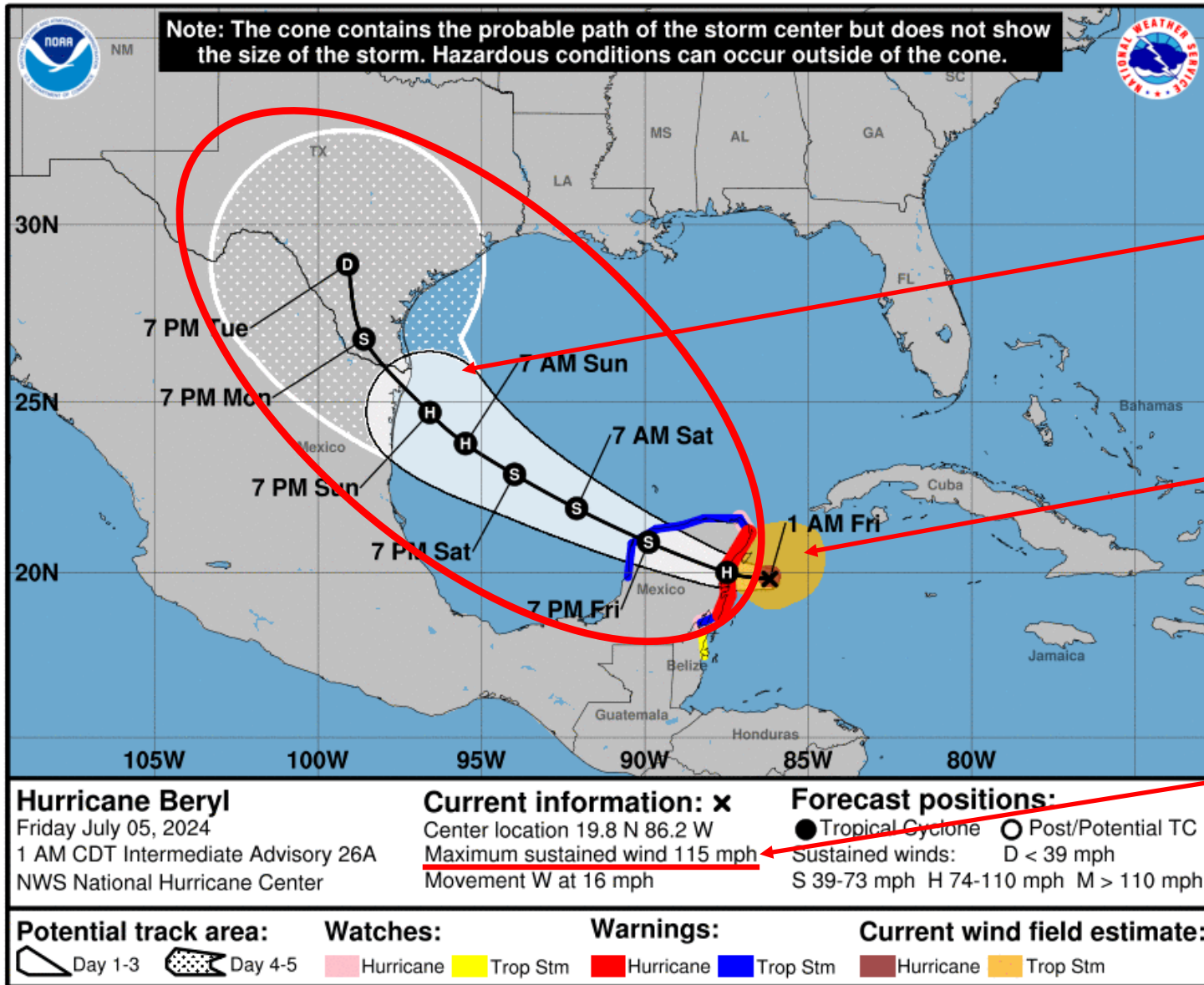
- Hurricanes, Cyclones, Typhoons
- Tropical Storms
- Subtropical Storms
- Tropical Depressions (sometimes)
- Any storm that at one point was at least a Tropical Storm

What is **NOT** a Named Storm:

- Initial Tropical Depression
- Potential Tropical Storm
- Tropical Invest/Tropical Wave



Named Storms



“Cone of Confusion”. This is the statistical probability of the location of the eye, not the extent of the storm’s wind/impacts.

Current Wind Extent. Often not representative of “ground truth”.

Maximum wind at one point somewhere in the storm. This does not mean 115 MPH sustained winds everywhere in the storm, or even at the point of landfall.

Named Storms

NOAA REPORT

Hurricane Ian formed in the central Caribbean Sea on September 23 and moved through the western Caribbean Sea, Gulf of Mexico and Western Atlantic making four separate landfalls. The first landfall was in the Pinar Del Rio Province of Cuba at 0830 UTC on September 27 with maximum sustained winds of 125 mph and a minimum pressure of 952 mb, before emerging into the Gulf of Mexico later that morning. Ian made its second landfall -- and first in Florida -- at 1905 UTC (2:05 PM EST) on September 28 near Cayo Costa with maximum sustained winds of 150 mph and a pressure of 940 mb, before making its third landfall -- and second in Florida -- less than 2 hours later at 2035 UTC (3:35 PM EST) just south of Punta Gorda, near Pirate Harbor with maximum sustained winds of 145 mph and a pressure of 942 mb. Ian made its fourth and final landfall in South Carolina on September 30 at 1805 UTC with maximum sustained winds of 85 mph and a pressure of 977 mb.

DO NOT READ IT AS: Sustained winds in Cayo Costa were 150 mph at landfall...etc etc.

READ IT AS: When the storm made landfall at Cayo Costa, somewhere in the storm (in this case, out at sea) had maximum sustained winds of 150 mph.

Windstorm



- A storm in which winds (that could be damaging) are its most impactful or distinctive aspect.
- Windstorms may be accompanied by precipitation (e.g., during a downburst or a derecho) or not (e.g., during a duststorm or a sandstorm). (AMS Definition)
- This was not defined meteorologically until 2021.

Windstorm

Common Types of Windstorms:

- Derechos
- Downbursts
- Dust Storms & Sand Storms
- Wintertime wind events
- Mountain Downsloping Winds

What may be disputed as a “windstorm”:

- Tropical Cyclones (check case law)
- Tornadoes (check case law)
- Winter Storms (accompanied with precipitation)



Flooding

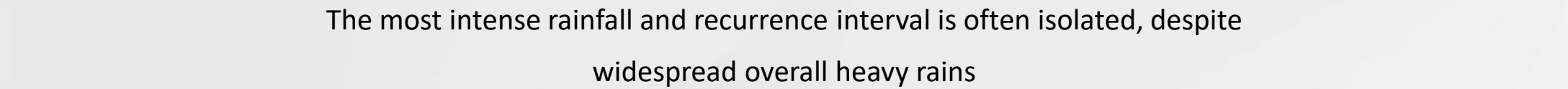
Common Types of Flooding:

- Flash Flooding
- River/Water Body Flooding

What may or may not be considered “flooding”:

- Storm Surge
- Tidal fluctuations
- Wave action & High Surf
- “Coastal Flooding”





Winter Weather



- Winter Storm: Not specifically defined by NWS or AMS.
- However, a Winter Storm Warning is issued when:
 - A winter storm is producing or is forecast to produce heavy snow or significant ice accumulations. The criteria for this warning can vary from place to place.

**WINTER STORMS ARE NOT OFFICIALLY
NAMED IN THE UNITED STATES**

Winter Weather

WINTER STORMS ARE NOT OFFICIALLY NAMED IN THE UNITED STATES

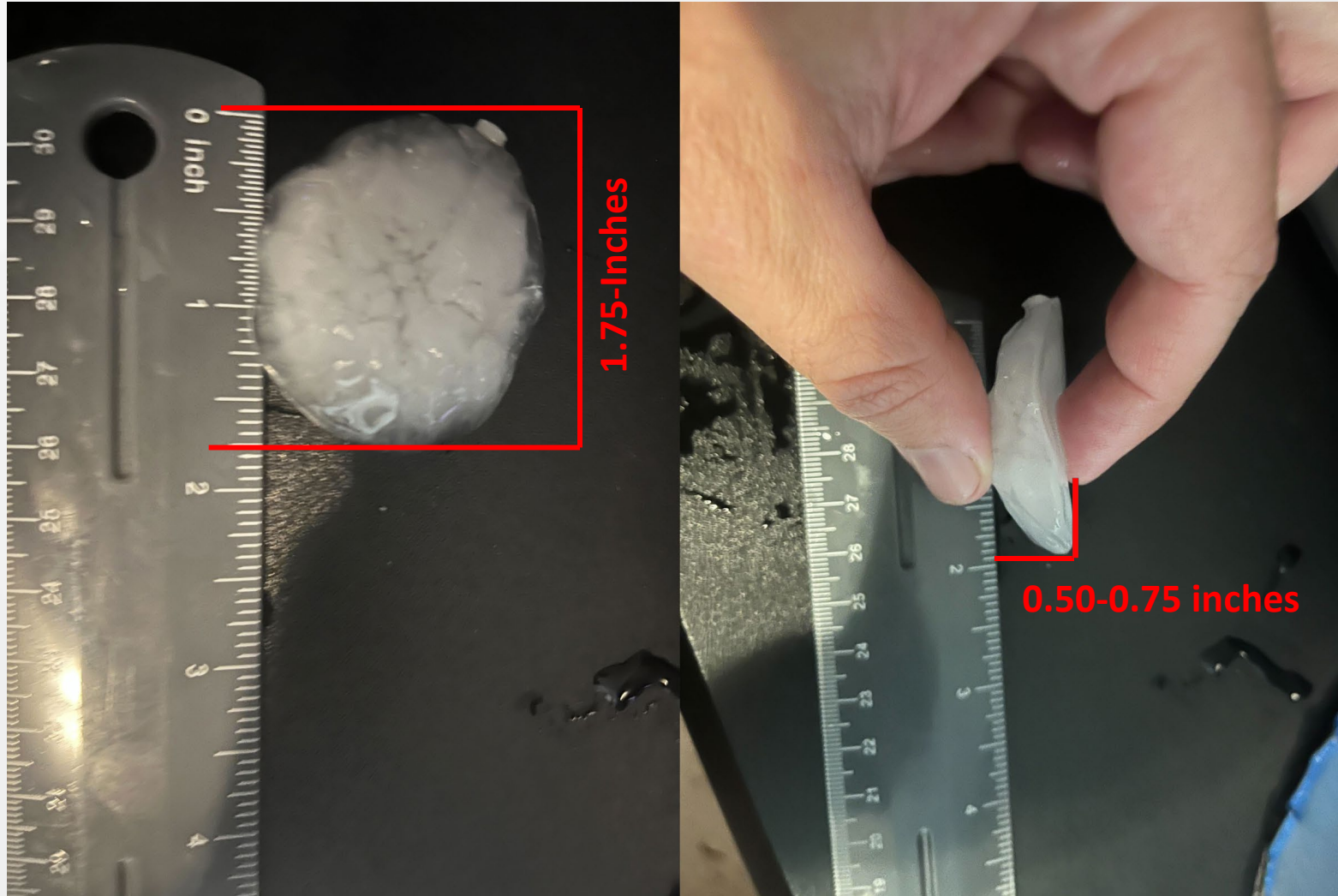


Where to Find Weather Information of Past Events

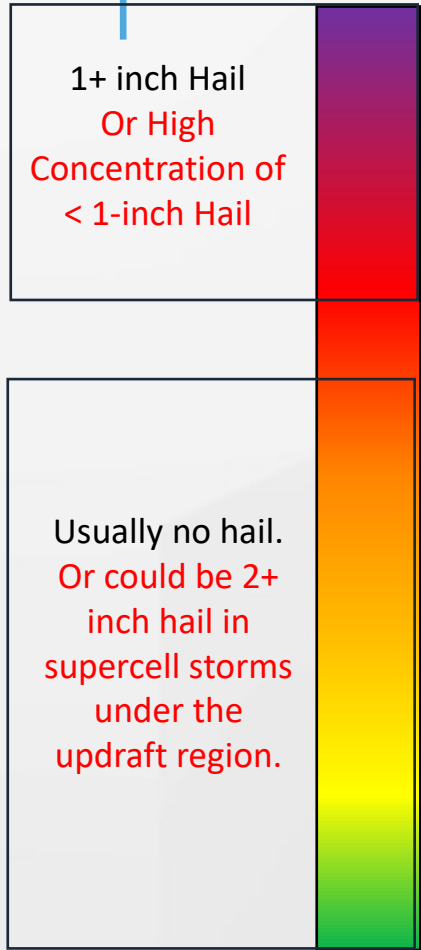
- **NOAA Storm Events Database**
 - Usually delayed by 3-4 months
 - Many reports combined (not geographically precise)
 - Does not include all reports
- **NWS Local Storm Reports**
 - <https://www.wpc.ncep.noaa.gov/exper/lsr/lsr.php>
 - <https://www.spc.noaa.gov/climo/online/>
 - Usually real-time (or close to it)
 - Varying degrees of geographically precise reports
 - Does not include all reports
- **NWS Damage Assessment Toolkit**
 - Only for tornadoes and occasionally major wind events
- **USGS Flood Event Viewer**
 - Usually only for hurricane storm surge
- NHC Tropical Cyclone Reports (TCRs)

The absence of a reported weather event does not guarantee the event didn't happen.
-----AND-----
A nearby report does not guarantee the event happened at your location.

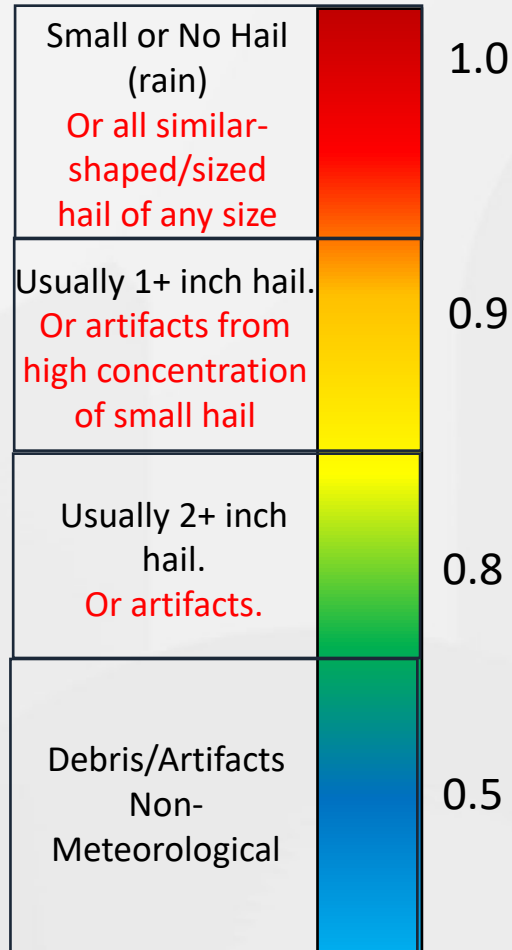
Hail Report (NWS)



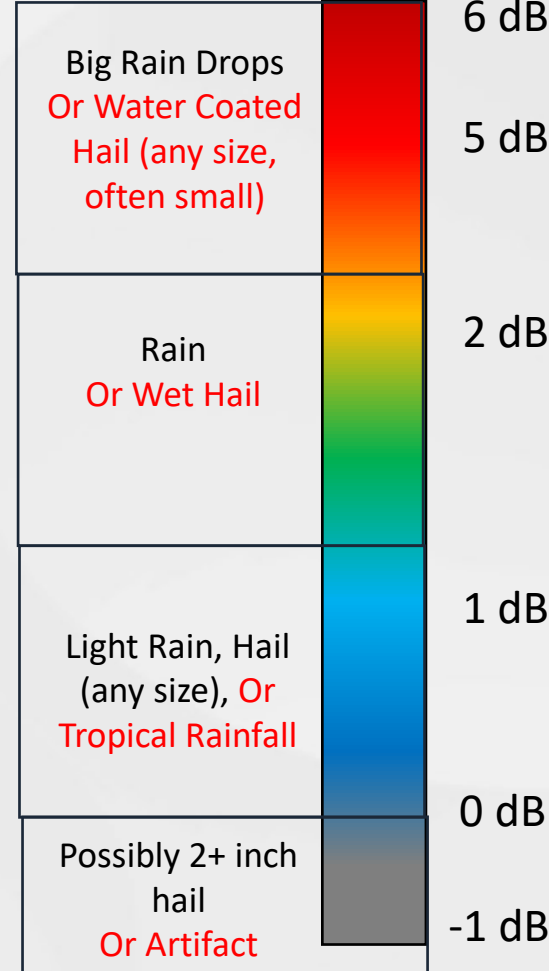
Why Is It So Hard To Automate Hail Reports?



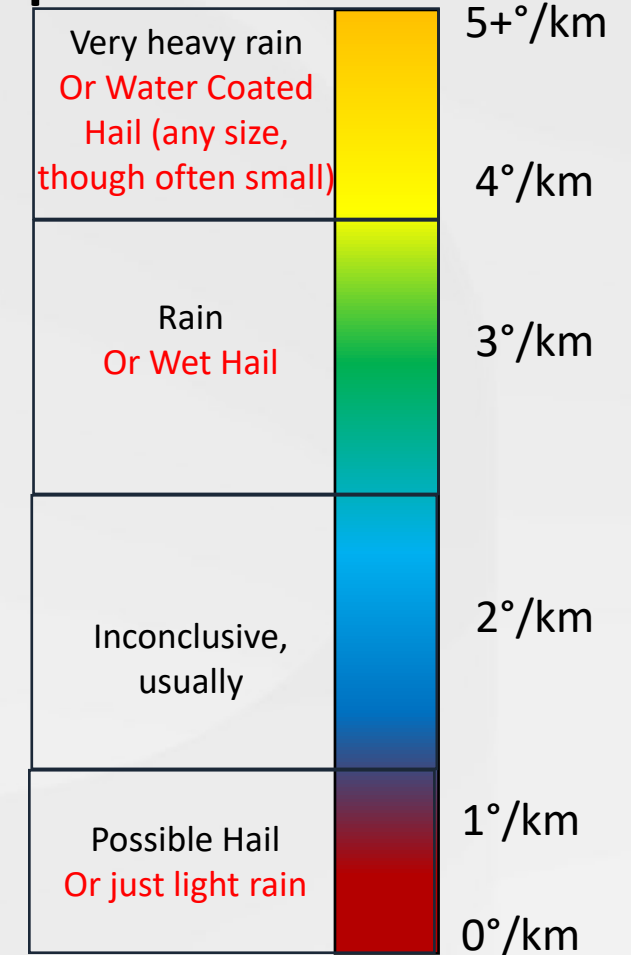
Base Reflectivity
4 Opinions



Correlation Coefficient
7 Opinions



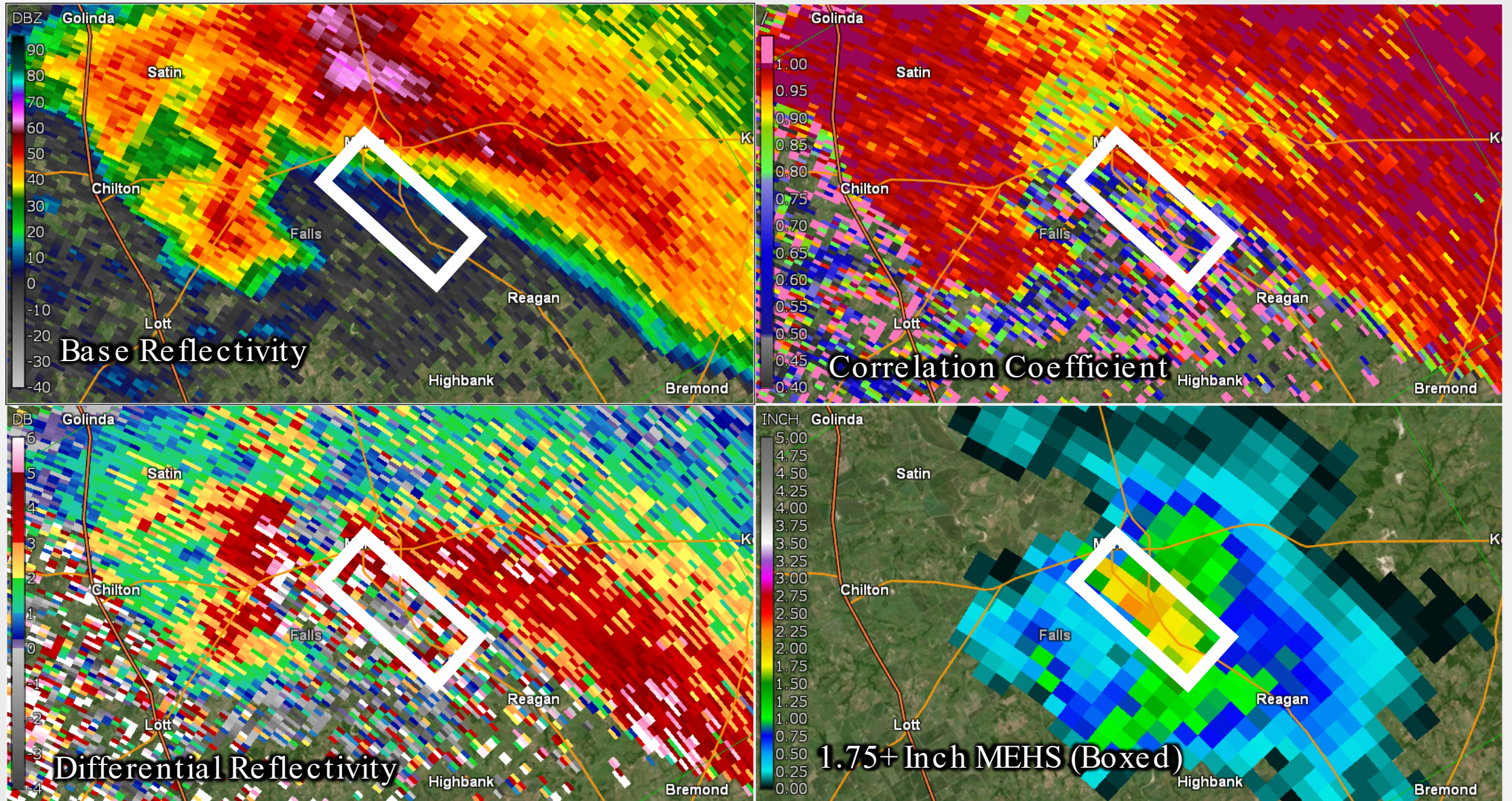
Differential Reflectivity
9 Opinions



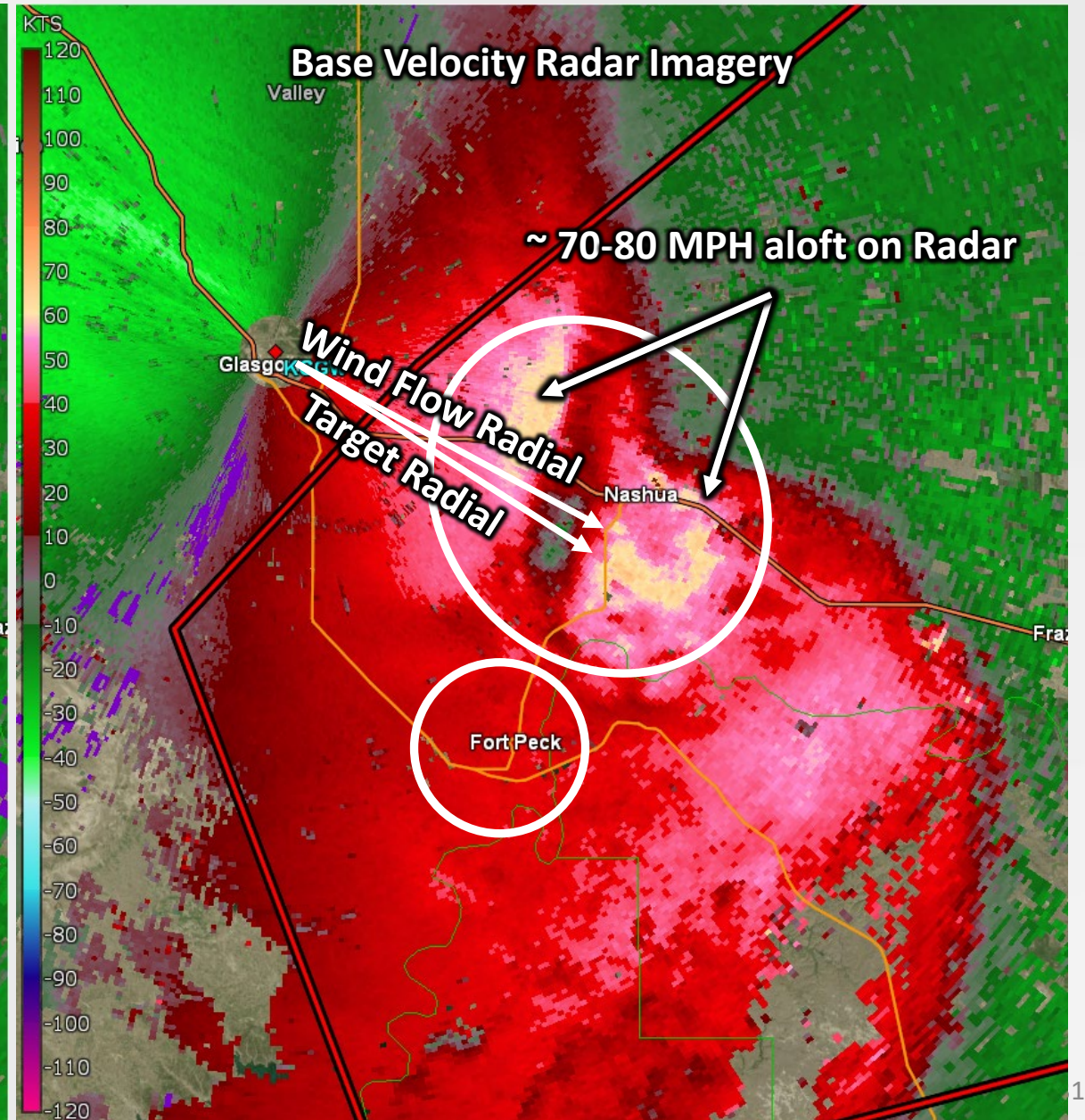
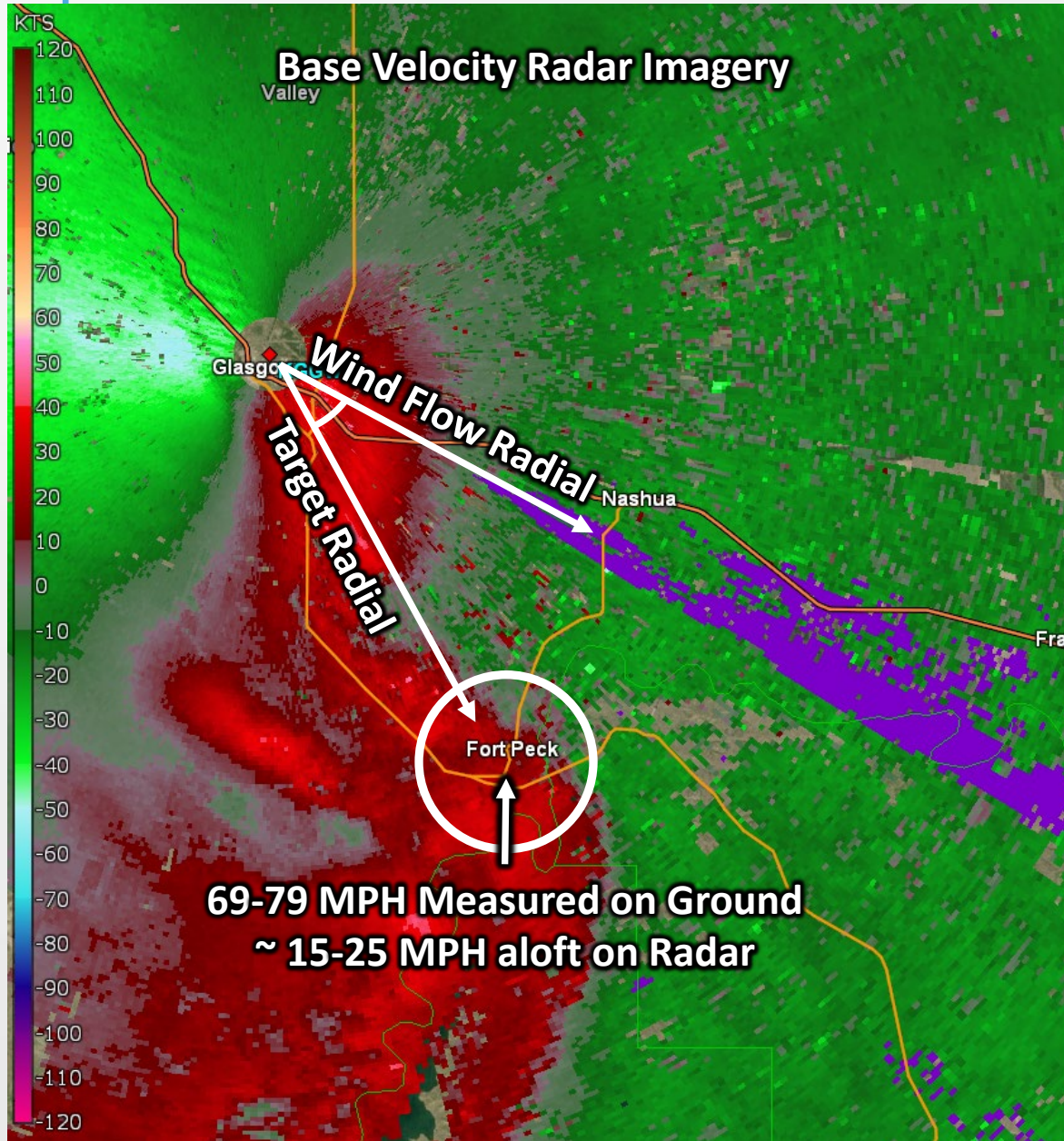
Specific Differential Phase
7 Opinions

Total Possible Independent Opinions: 27. Total Possible Combinations: 1,764

What About “Maximum Estimated Size of Hail” or “Maximum Expected Hail Size”?



Why Is It So Hard To Automate Wind Reports?

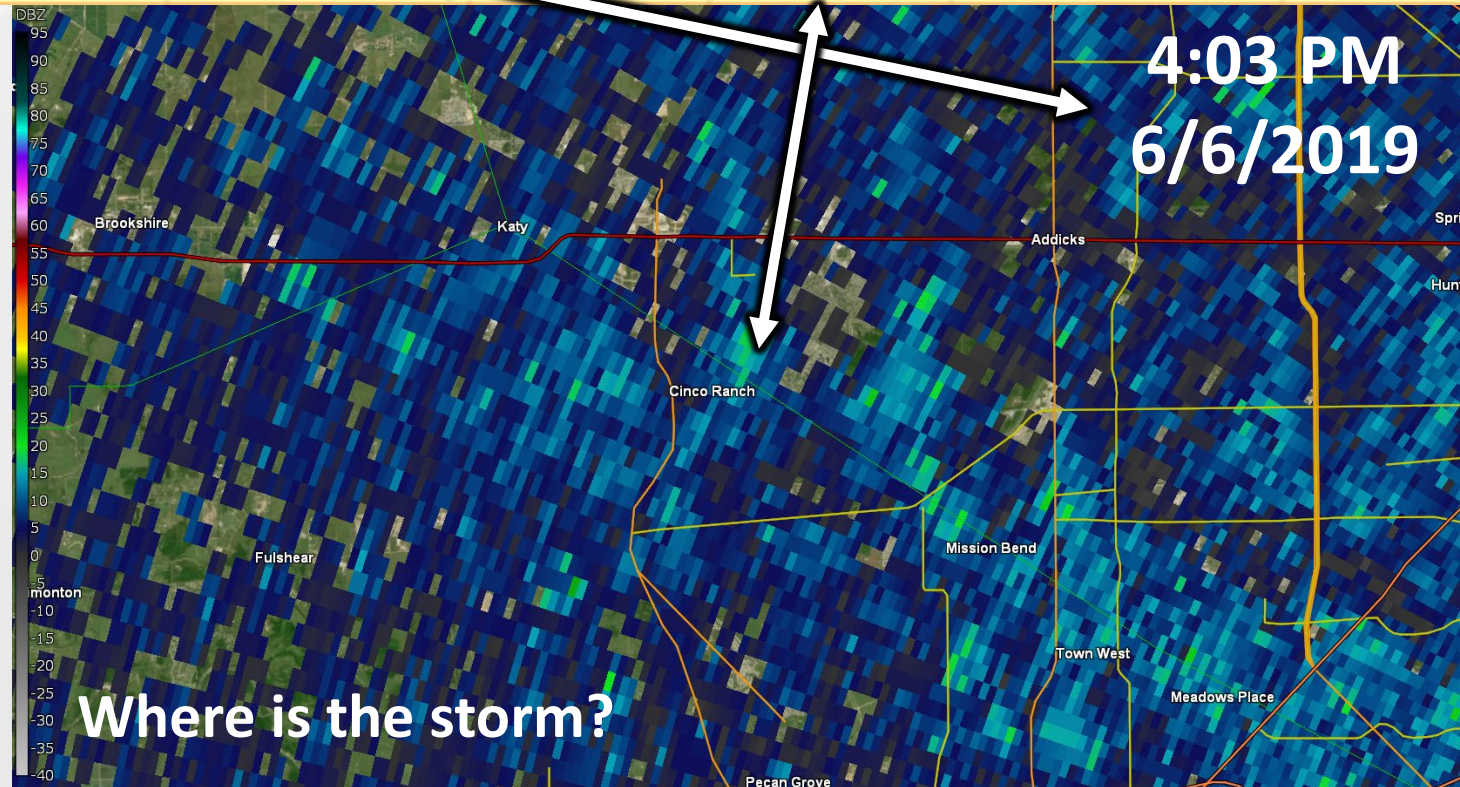


The Real Story:

Historical Storm Activity At Location

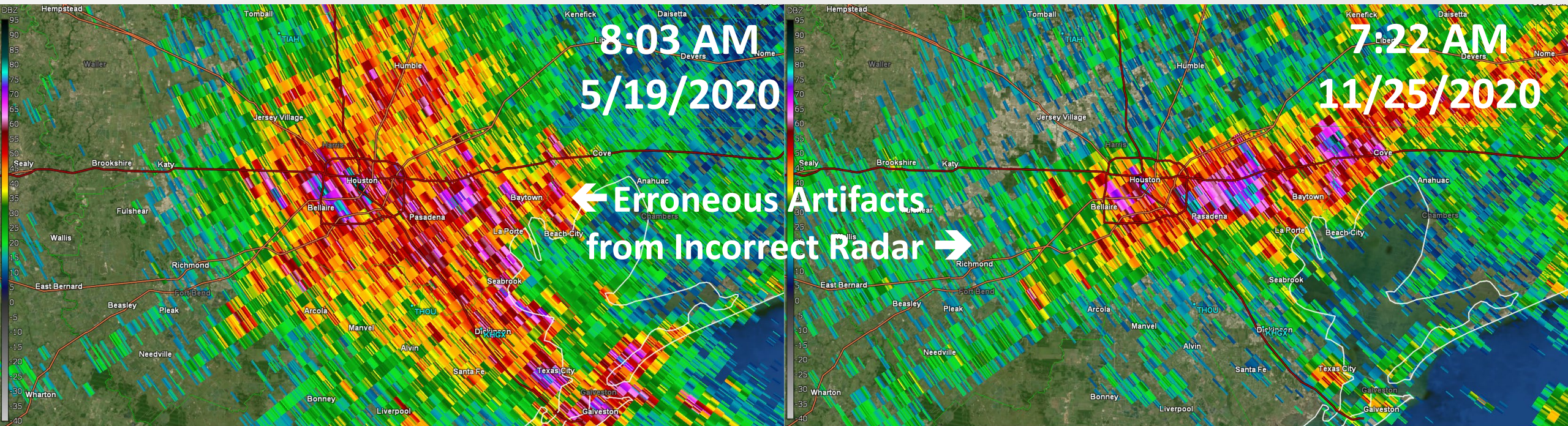
All times in the America/Chicago time zone.

Date of Storm	Storm Start	Intensity	Max Size	Storm Speed	Storm Direction
2019-06-06	04:03 PM	4.5	2.75"	39 MPH	ESE



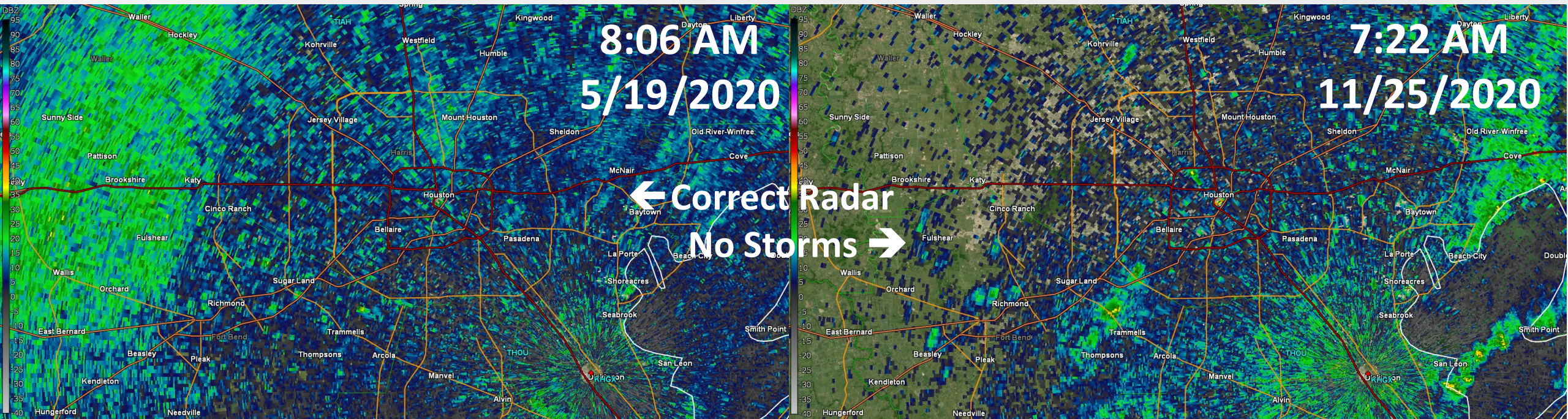
The Real Story:

	Date	At Property Address			Daily Maximum Value Within 1 Mile			Daily Maximum Within 5 Miles		
		Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)	Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)	Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)
2nd Prior Hail Event	19-May-20	0.75	60	< 35	0.75	75	< 35	0.75	95	< 35
1st Prior Hail Event	25-Nov-20	< 0.75	45	< 35	0.75	65	< 35	0.75	95	35



Real Story:

	Date	At Property Address			Daily Maximum Value Within 1 Mile			Daily Maximum Within 5 Miles		
		Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)	Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)	Est. Hail Size (")	Est. Hail Prob (%)	Est. Wind Speed (mph)
2nd Prior Hail Event	19-May-20	0.75	60	< 35	0.75	75	< 35	0.75	95	< 35
1st Prior Hail Event	25-Nov-20	< 0.75	45	< 35	0.75	65	< 35	0.75	95	35

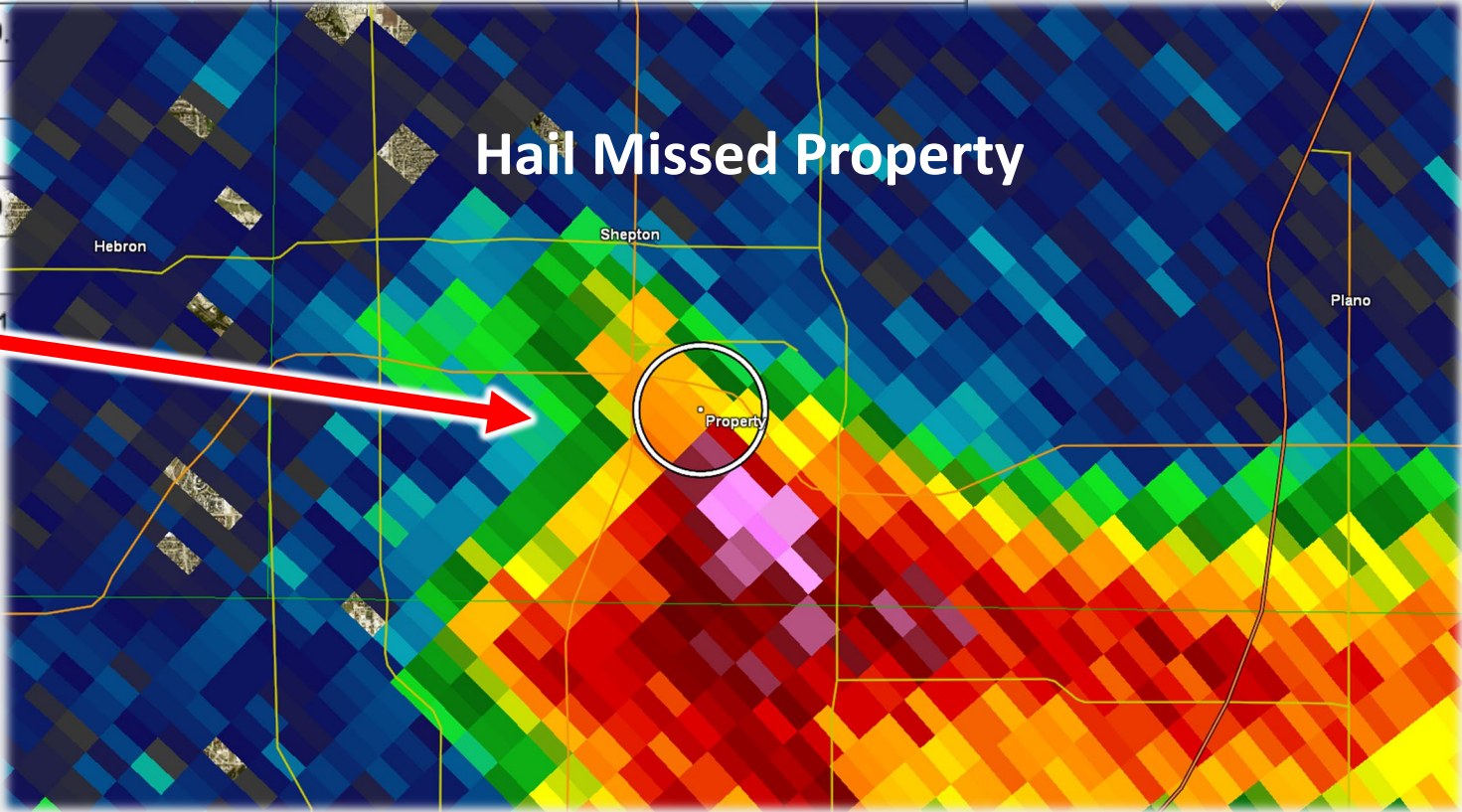


The Real Story:

- ✓ Identical/Nearly Identical Conclusion as meteorologist
- ~ Reasonable conclusion
- ✗ Storm did **not hit property or did not contain high winds at property** when properly analyzed.

Date	Estimated Maximum Windspeed			
	At Location	Within 1 Miles	Within 3 Miles	Within 10 Miles
~ May 11, 2021	68 MPH	69 MPH	70 MPH	71 MPH
✓ Jul 25, 2020	60 MPH	62 MPH	64 MPH	67 MPH
✗ May 8, 2020	68 MPH	69 MPH	70 MPH	71 MPH
✗ Aug 25, 2019	66 MPH	67 MPH	67 MPH	67 MPH
✗ Jun 24, 2019	58 MPH	59 MPH	60 MPH	61 MPH
✗ May 13, 2019	68 MPH	68 MPH	69 MPH	69 MPH

Date	Estimated Maximum Hail Size			
	At Location	Within 1 mi / 1.61 km	Within 3 mi / 4.83 km	Within 10 mi / 16.09 km
Sep 5, 2022	--	--	0.9 in / 2.29 cm	0.9 in / 2.29 cm
Sep 4, 2022	--	--	0.75 in / 1.91 cm	0.9 in / 2.29 cm
May 15, 2022	--	--	0.9 in / 2.29 cm	1.6 in / 4.06 cm
Mar 17, 2022	--	--	0.8 in / 2.03 cm	0.8 in / 2.03 cm
May 3, 2021	--	0.		
Apr 23, 2021	--			
Jun 9, 2019	--			
May 18, 2019	--	0		
Apr 13, 2019	--			
Mar 24, 2019	1.2 in / 3.05 cm	1		



How Bad Was The Storm? – But Watch Out!

Event	Thunderstorm Wind
Magnitude	59 kts.
State	TEXAS
County/Area	BELL
WFO	FWD
Report Source	AWOS
NCEI Data Source	CSV
Begin Date	2022-10-24 19:48 CST-6
Begin Location	1W (TPL)TEMPLE MUNI ARP
Begin Lat/Lon	31.15/-97.41
End Date	2022-10-24 19:48 CST-6
End Location	1W (TPL)TEMPLE MUNI ARP
End Lat/Lon	31.15/-97.41
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	0.00K
Crop Damage	0.00K
Episode Narrative	An upper low and a cold front led to the development of showers and thunderstorms across North and Central Texas on October 24. A few storms developed in the morning as a lead disturbance moved overhead. Most storms occurred in the evening, however, as the front pushed through the area. A few of these storms became severe, producing both large hail and damaging winds.
Event Narrative	The Automated Weather Observation System at the Temple, TX Airport measured a wind gust of 68 MPH.

METAR KTPL 250151Z AUTO 21041**G50KT** 3SM
+TSRA SQ FEW013 SCT055 SCT075 22/19 A2968
RMK AO2 **PK WND 22050**/0150 LTG DSNT ALQDS
TSB30RAB21 PRESRR SLP042 P0017 T02220189

Actual NOAA Data!

50 knots = ~ 58 MPH

59 knots = ~ 68 MPH

How Bad Was The Storm? – But Watch Out!

Google

hail in Evansville, Indiana 5/14/2024

All News Images Shopping More Tools

About 32,400 results (0.69 seconds)

Results for **Evansville, IN** · Choose area

This tea cup sized hail was reported at **8:48:00 PM** CDT on 05/14/2024 about 1 mile from the center of Evansville, Indiana. Evansville has a population of 117429 and has 57065 housing units in the area. 2 days ago

StormerSite.com
<https://www.stormersite.com> › showreport

3.00 Inch Hail Near Evansville, Indiana On 05/14/2024

Evansville

Evansville Hail Report

County, State: Vanderburgh, IN
(marker location is approximate)
Lat.: 37.98, **Lon.:** -87.54
Time: 2024-05-15 **01:48 UTC**
Hail Size: 2.93 IN. DIA.

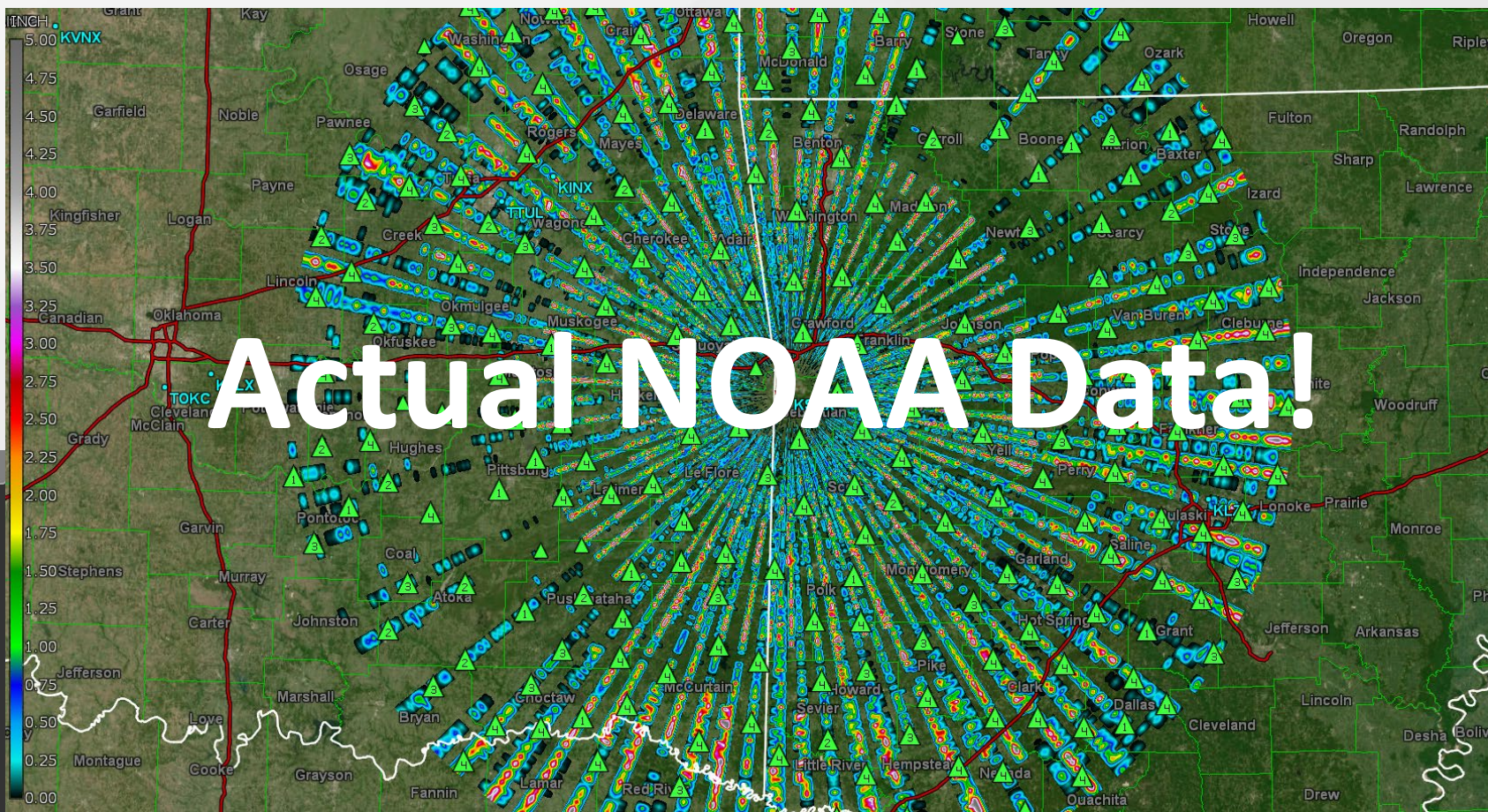
2.93 inches cumulative rainfall from trained spotter on the southeast side of Evansville produced local street and yard flooding. (PAH)

For more info, see NOAA's National Weather Service [Local Storm Reports](#)



Real Story:

Actual NOAA Data!



Time	WSR ID	Cell ID	Probability	Max Size	Severe Probability
2016-10-23T16:06:10Z	KSRX	R5	100	4	100

For More
information

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