June 22, 2021

MEMORANDUM FOR: Russell Vose
Acting-Chief, Climate Monitoring Section,
Climatic Sciences and Services Division
National Centers for Environmental Information

FROM: Aaron A. Treadway, Jon W. Zeitler, Paul Yura
NOAA/NWS Austin-San Antonio, Texas

SUBJECT: SCEC Report for Texas Hailstone 28 April 2021

Summary:

On 12 May 2021, a State Climate Extremes Committee (SCEC) convened to verify / validate several observations related to a hailstone retrieved on 28 April 2021 near the community of Hondo, Texas. The committee considered the validity, meteorological plausibility, and measurement practices associated with the hailstone in question. After reviewing the observational and meteorological evidence, the means and method of measurement, and previously documented stones, the SCEC unanimously agreed that the hailstone retrieved near Hondo on 28 April 2021 would set the inaugural SCEC record for the State of Texas in four metrics. In particular, the committee found that the following were true and valid:

- LOCATION: 1 SSW Hondo, Texas
- DATE: 28 April 2021, approximately 7:35 pm CDT (local time)
- HAIL CIRCUMFERENCE: 19.73 inches
- HAIL DIAMETER: 6.416 inches
- HAIL WEIGHT: 1.26 pounds
- HAIL VOLUME: 40.239 cubic inches

Sequence of Events, Examination & Decision

Background

During the afternoon and evening of 28 April 2021, a shortwave trough and the Serranias del Burro Mountains of Mexico (Fig. 1) initiated thunderstorms that moved east across the lower Rio Grande Plains and into South-Central Texas. In addition to the lifting mechanisms, moisture, instability, and wind shear were conducive for supercell thunderstorms, which are a known modality for this area [Edwards (2007); Weiss and Zeitler (2008)]. Multiple supercells moved east along U.S. Highway 90 from Del Rio to San Antonio, Texas, between 2000 UTC (1500 CDT) 28 April 2021 until 0500 UTC (0000 CDT) 29 April.

The initial supercell developed just southeast of Del Rio. The storm crossed into Val Verde and Kinney counties, producing 2 to 3 inch diameter hail in Del Rio and Brackettville. A second supercell formed and followed a similar path as the first supercell. Both storms continued to produce large hail across Uvalde

County, before merging as they entered Medina County. The combined storm updraft grew larger and continued to move along U.S. Highway 90, with large hail being reported in Sabinal, D'Hanis, Hondo, and Castroville. Storm rotation increased and produced a tornado, which tracked on a 1.8 miles long, 600 yard wide path approximately 5 to 6 miles southeast of Hondo, producing EF-1 damage on the Enhanced Fujita Scale. The storm's rear flank downdraft also strengthened and produced a wide swath of EF-0 to EF-1 wind damage from D'Hanis to Castroville. The storm's mesocyclone temporarily weakened, but strengthened again and produced 1 to 2 inch hail on the northwest side of San Antonio, western New Braunfels, and San Marcos before finally weakening over Austin. The combination of high winds and large hail produced extensive damage from just east of Sabinal to D'Hanis, Hondo, and Castroville, primarily along and south of U.S. Highway 90. A RV park in D'Hanis suffered extensive damage (Fig. 2) from 2.5 inch or larger hail being blown by 75 to 100 mile per hour winds. Another example of the wind-driven hail damage was 1 mile west at a local gas station (Fig.3).

The first gargantuan hailstone reported to local media and NWS Austin-San Antonio was discovered south of U.S. Highway 90 in Hondo. The hailstone (Fig. 4) fell around 0040 UTC April 29 2021 (1940 CDT 28 April) and was estimated between 6 to 7 inch diameter by the finder. Dr. Matthew Kumjian of Penn State University used photogrammetry to estimate the diameter between 6.27 and 6.57 inches. Unfortunately, this hailstone was never measured with a ruler or similar device, and was ultimately used for margaritas according to the person who shared the images. Additional large hailstones (Fig. 5) reportedly fell in the area and pictures were sent to San Antonio local media. While the images show rulers with measurements of 5 to 6 inches in diameter, NWS Austin-San Antonio has been unable to verify the validity of these hailstones, the time they fell, or their location. Other 3 to 4 inch diameter hailstones were reported from the area and preliminary Local Storm Reports were issued, with those reports likely progressing to official status in *Storm Data* (NCEI, 2021) at a later date.

The potential record hailstone discussed in this report fell 1 mile SSW of the center of Hondo, TX. This location is approximately 0.5 mile from the location of the first hailstone mentioned above. Data from the New Braunfels, TX (KEWX) radar and the finder's recollection estimate the hailstone fell at 0035 UTC April 29 2021 (1935 CDT 28 April; Fig. 6). The location of the hailstone is marked by a white dot on the radar images.

Storm Environment & Meteorological Plausibility

The main weather feature across the United States on 28–29 April 2021 was a longwave trough centered on the Arizona–New Mexico border (Fig. 7). 300 hPa winds were oriented southwest to northeast across Texas, with a speed maximum stretching across the Big Bend and into western Oklahoma. At 700 and 850 hPa, a shortwave trough was evident, with moisture streaming northward into west central Texas. Surface dew points ranged from 16 to 21°C (60 to 70°F).

A supplemental sounding was released from Del Rio (DRT, Fig. 8) at 2000 UTC. This sounding represents conditions just before convective initiation in northern Mexico. Notable features include Most Unstable Convective Available Potential Energy (MUCAPE) of 2660 J kg^{-1}, 0–6 km bulk shear of 76 knots, 700–500 hPa lapse rate of 6.0 °C km^{-1}, and Significant Hail Parameter (SHIP) of 0.9. The environment to the east

continued to destabilize, with the SPC mesoanalysis (Fig. 9) showing a pocket of 3000 to 4000 J kg^{-1} MUCAPE in the inflow path of the supercell. SHIP had increased to approximately 2, with 800 to 900 J kg^{-1} of CAPE in the –10 to –30°C layer. The 0000 UTC 29 April 2021 Corpus Christi (CRP) sounding (Fig. 10) also shows this destabilization, with MUCAPE of 4465 J kg^{-1} and 700–500 hPa lapse rate of 8.1 °C km^{-1}. The 0000 UTC DRT 29 April sounding was contaminated by prior convection and/or had a data transfer problem, which made the data unrepresentative of the near storm environment. GOES-16 visible (Channel 1) and infrared (Channel 13) imagery (Fig. 11) show an overshooting top (indicative of extreme updrafts) as the storm passes over Hondo, with cloud top temperatures of –80 to –90°C.

Radar Analysis

The storm was roughly equidistant from NWS WSR-88D radars at Laughlin AFB (KDFX) and New Braunfels (KEWX) when the hailstone fell, with the 0.5° beam centerline being roughly 5500 feet above ground level. KEWX was the primary radar used in this analysis. There are several radar signatures supporting very large hail. The first is a pronounced Bounded Weak Echo Region (BWER) over Hondo (Fig. 12). BWERs are associated with very large hail, as the strong updraft lofts hydrometeors into the upper parts of the storm. Based on the 2000 UTC DRT and 0000 UTC CRP soundings, the freezing level was between 14,000 and 16,000 feet, while the –20°C level was 25,000 feet. KEWX observed reflectivity of 72 dBZ up to 35,000 feet and 64 dBZ up to 42,000 feet over Hondo, indicating an intense updraft capable of maintaining hailstones resident in the hail growth zone for a long period. The Specific Differential Phase (KDP) was very noisy on the 0.5° scan, possibly indicating large hail was mixed with heavy rain. A column of low Correlation Coefficient (CC; between 0.7 and 0.9) was over the western half of Hondo around the time the record hailstone fell. Lower CC extended vertically to 36,000 feet. Other CC artifacts such as a wide Three-Body Scatter Spike (3.1° scan at 0035 UTC) and non-uniform beam filling are also present. KDP was low at higher elevation scans over Hondo, indicating the presence of dry hail in the upper parts of the storm. Echo tops from KEWX and KDFX were estimated at 60,000 feet, another indicator of intense updrafts and a large hail growth zone. The final indicator for very large hail was storm top divergence estimated at 240 knots from both KEWX and KDFX. The storm mesocyclone had a rotational velocity of 63 knots. The Maximum Expected Hail Size (MEHS) GR2Analyst algorithm estimated a largest hail size of 4.29 inches.

Hailstone Collection and Measurement

The initial photograph shows the hailstone was slightly larger when first collected (Fig. 13), compared to six days later on 4 May 2021 (Fig. 14), and when officially measured eight days later on 6 May 2021 (Fig. 15). The finder put the hailstone in a freezer on the evening of 28 April 2021, but did not put it in a Ziploc bag or any other holding container. The picture in Fig. 13 eventually made it to a family member, who brought it to the attention of NWS Austin-San Antonio on 3 May 2021. NWS Austin-San Antonio contacted the finder on 4 May 2021, and asked for the hailstone to be sealed in a plastic bag. NWS Austin-San Antonio also contacted Dr. John Nielsen-Gammon, Texas State Climatologist, which led to subsequent contact with the Insurance Institute for Business and Home Safety (IBHS).

Detailed Analysis from NWS/IBHS Site Visit on 6 May 2021

NWS Austin-San Antonio and IBHS staff traveled to the finder's home on 6 May 2021. They conducted a formal weighing, calipers measurement, 3D analysis, and visual examination of the hailstone (Fig. 15). Using a combination of precise 3D analytical measurements and manual calculations, IBHS determined dimensions for the hailstone below. A final report from IBHS is included in Appendix II.

Hailstone Diameter:	**6.416 in**
Hailstone Mass*:	**569.5 g**
Hailstone Volume:	**40.239 cu in**
Hailstone Circumference:	**19.730 in (at the maximum cross-sectional diameter)**

**The SCEC converted the Mass to Weight and from grams to pounds for the official record. Thus, the official weight of the hailstone was determined to be 1.26 pounds.*

Examination of Previous Events

There is currently no official hail record for the state of Texas.

The largest credibly reported hailstone diameters in Texas prior to the April 28, 2021 storm that produced the candidate Texas state record appear to be:

8 inches, Washington Co., Dec. 6, 1892
7-8 inches, Winkler Co., May 31, 1960
6 inches, Moore Co., June 12, 2010
6 inches, Ward Co., May 10, 1991

The Winkler Co. hailstone was listed as 8 inches in the NCEI Storm Events database as of 2020 but is presently (May 10, 2021) listed as 5 inches. The value in the NCEI Storm Events database should be reexamined and possibly restored to at least 7 inches.

No direct photographic evidence or descriptions of measurements exist for the Washington County and Winkler County hailstones. No other measurements (volume, weight, or circumference) are available for any of the four hailstones listed above.

The Hondo hailstone was initially reported unofficially at 9 inches, but based on its shape in initial photos and at the time of measurement by the Insurance Institute for Business and Home Safety (IBHS) team, a likely initial unofficial size was closer to 7 inches. The IBHS measured diameter was 6.416 inches. The Hondo hailstone therefore appears to qualify as the largest documented hailstone.

See Appendix I for more details on prior Texas hail events.

Finding of Committee

All of the above evidence was reviewed by the SCEC leading to a Zoom call on 12 May 2021. Based upon the documented evidence, the SCEC agreed unanimously, by four separate votes of 4-0, that the above measurements associated with the hailstone retrieved on 28 April 2021 near Hondo, Texas are valid, and **recommends the NCEI Climate Monitoring Chief approve the SCEC action to acknowledge these values as state records for Texas.**

NCEI Climate Monitoring Chief Decision

Approved as recommended in boldface above:	Not approved returned to SCEC with no action taken:
VOSE.RUSSELL.STEPHEN.1365831471 Digitally signed by VOSE.RUSSELL.STEPHEN.1365831471 Date: 2021.06.24 10:48:37 -04'00'	

Voting Members of the State Climate Extremes Committee:

- Jon Zeitler, Science and Operations Officer, NWS Austin-San Antonio, TX
- Victor Murphy, NWS Southern Region Climate Services Program Manager
- Dr. John Nielsen-Gammon, Director, Southern Regional Climate Center & Texas State Climatologist
- Karin Gleason, National Centers for Environmental Information, Asheville, NC

Also Participating in the Verification:

- Paul Yura, Warning Coordination Meteorologist, NWS Austin-San Antonio, TX
- Aaron Treadway, Senior Meteorologist, NWS Austin-San Antonio, TX
- Tamara Houston, National Centers for Environmental Information, Asheville, NC

References

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Doan-Crider, D. L., 2003: Movements and spaciotemporal variation in relation to food productivity and distribution, and population dynamics of the Mexican black bear in the Serranias del Burro, Coahuila, Mexico. Ph.D. Dissertation, Texas A&M University, College Station, TX, 129 pp. Available online at: [www.researchgate.net/publication/34024278_Movements_and_spaciotemporal_variation_in_relation_to_food_productivity_and_distribution_and_population_dynamics_of_the_Mexican_black_bear_in_the_Serranias_del_Burro_Coahuila_Mexico]

Edwards, R., 2006: Supercells of the Serranias del Burro (Mexico). *23rd Conf. on Severe Local Storms*, St. Louis, MO, Amer. Meteor. Soc., P6.2. Available online at: [www.spc.noaa.gov/publications/edwards/delburro.pdf]

National Centers for Environmental Information (NCEI), 2021: *Storm Data*. Asheville, NC. Available online at: [www.ncdc.noaa.gov/stormevents/].

Weiss, J. D. and J. W. Zeitler, 2008: Supercells of the Serranias del Burro. *24th Conf. on Severe Local Storms*, Savannah, GA, Amer. Meteor. Soc., 17A.4. Available online at: https://ams.confex.com/ams/pdfpapers/141558.pdf]

Figures

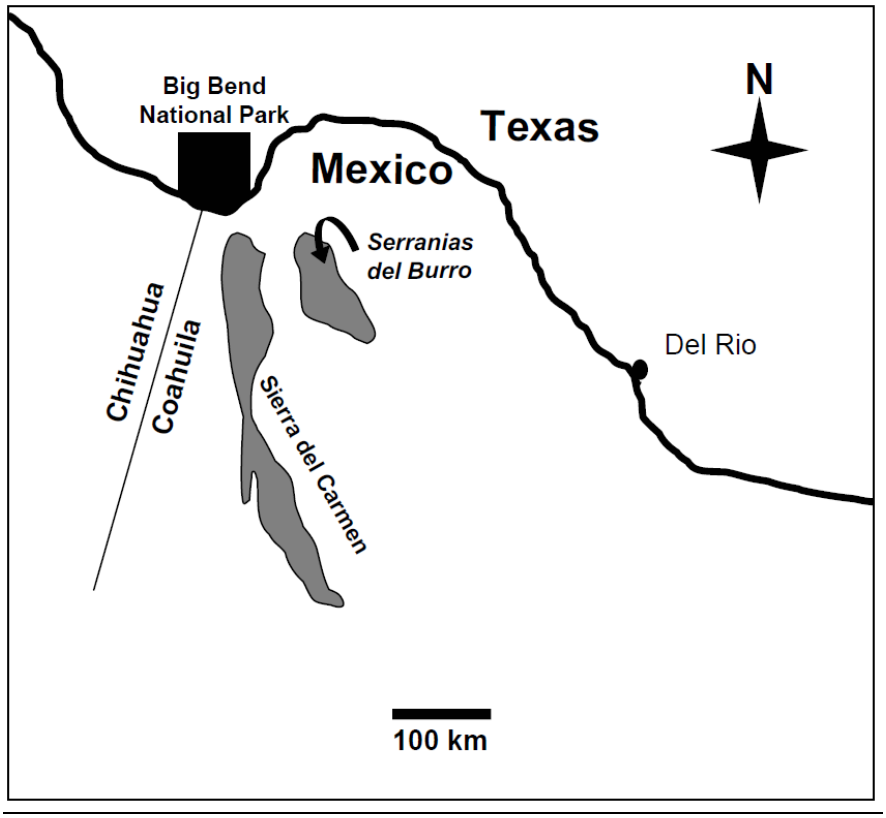


Figure 1. Map of the Big Bend region of Texas, showing the location of the Serranias del Burro mountain range. Adapted from Doan-Crider (2003).

Figure 2. Extensive Damage at an RV Park in D'Hanis, TX, due to wind-driven hail. Photo by NWS Austin-San Antonio.

Figure 3. Extensive Damage to a Stripes Gas Station in D'Hanis, TX. Photo by NWS Austin-San Antonio.

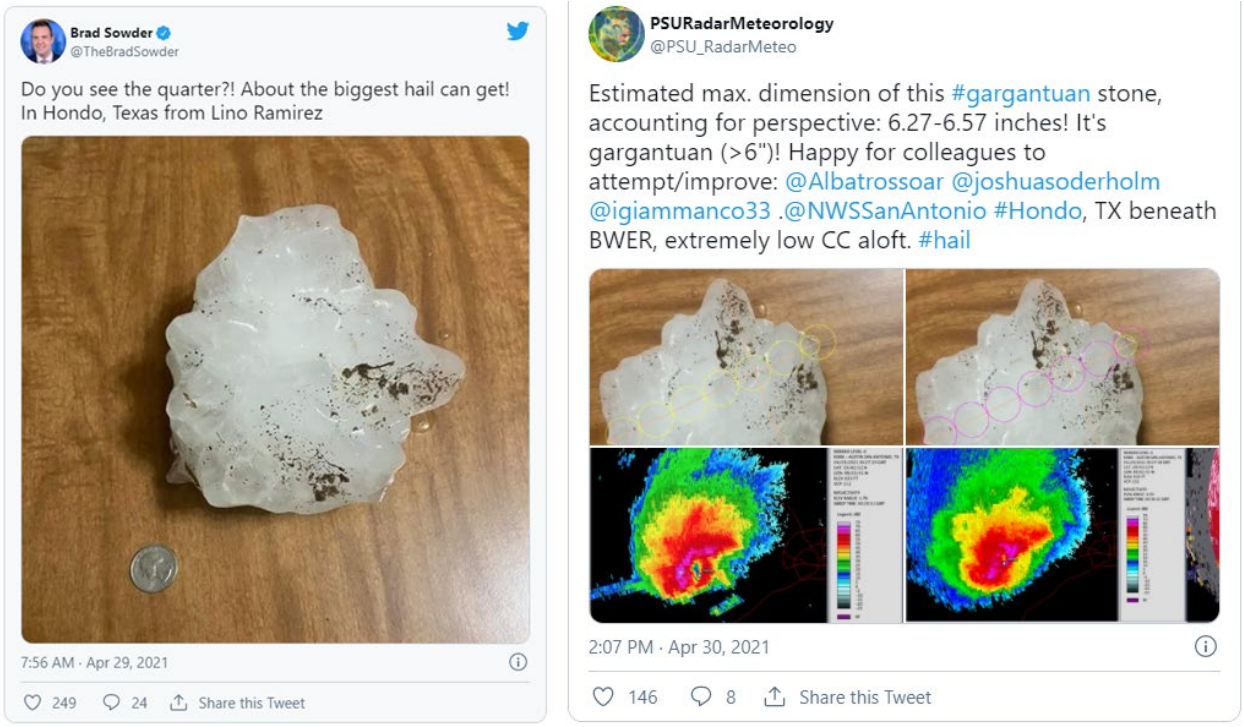


Figure 4. Large Hailstone found on Social Media. Estimated by Dr. Matthew Kumjian (Penn State University, Twitter: @PSU_RadarMeteo)

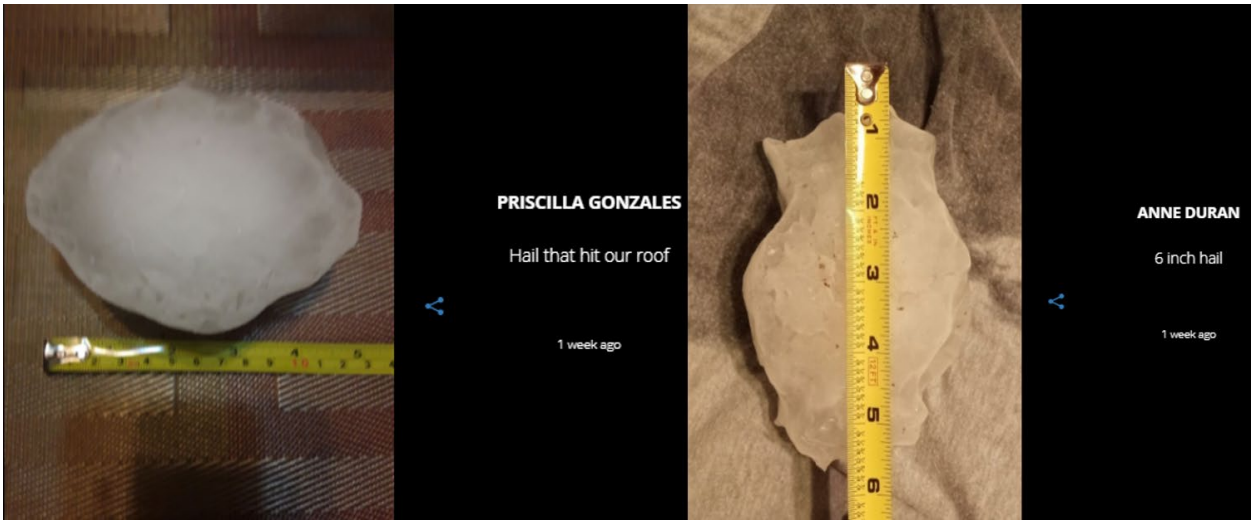


Figure 5. Two large hailstones reported to News4 San Antonio's "Chime In" portion of their website.

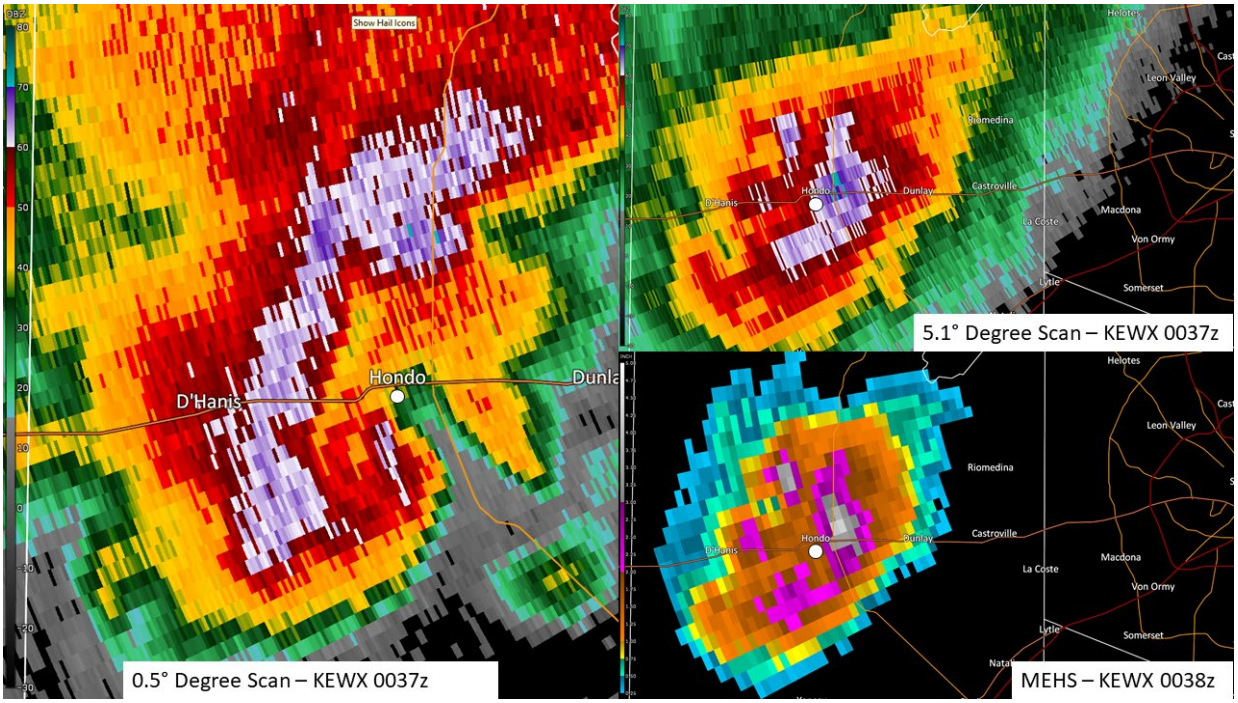


Figure 6. 0.5° base reflectivity image, 5.1°base reflectivity image, and Max Expected Hail Size (MEHS) from KEWX at 0037–0038 UTC 29 April 2021.

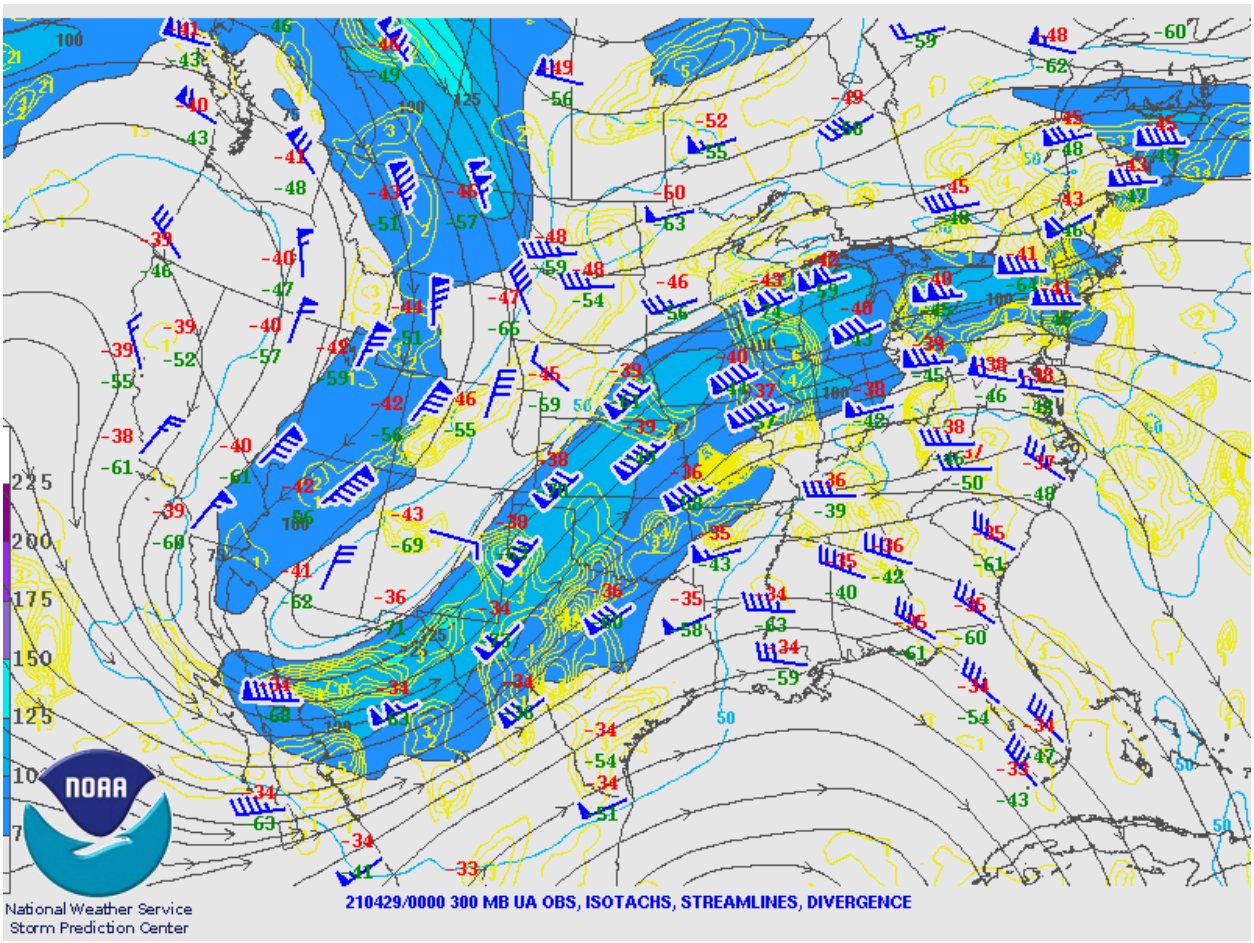


Figure 7. 300 hPa analysis at 0000 UTC 29 April 2021. Standard units for United States analyses.

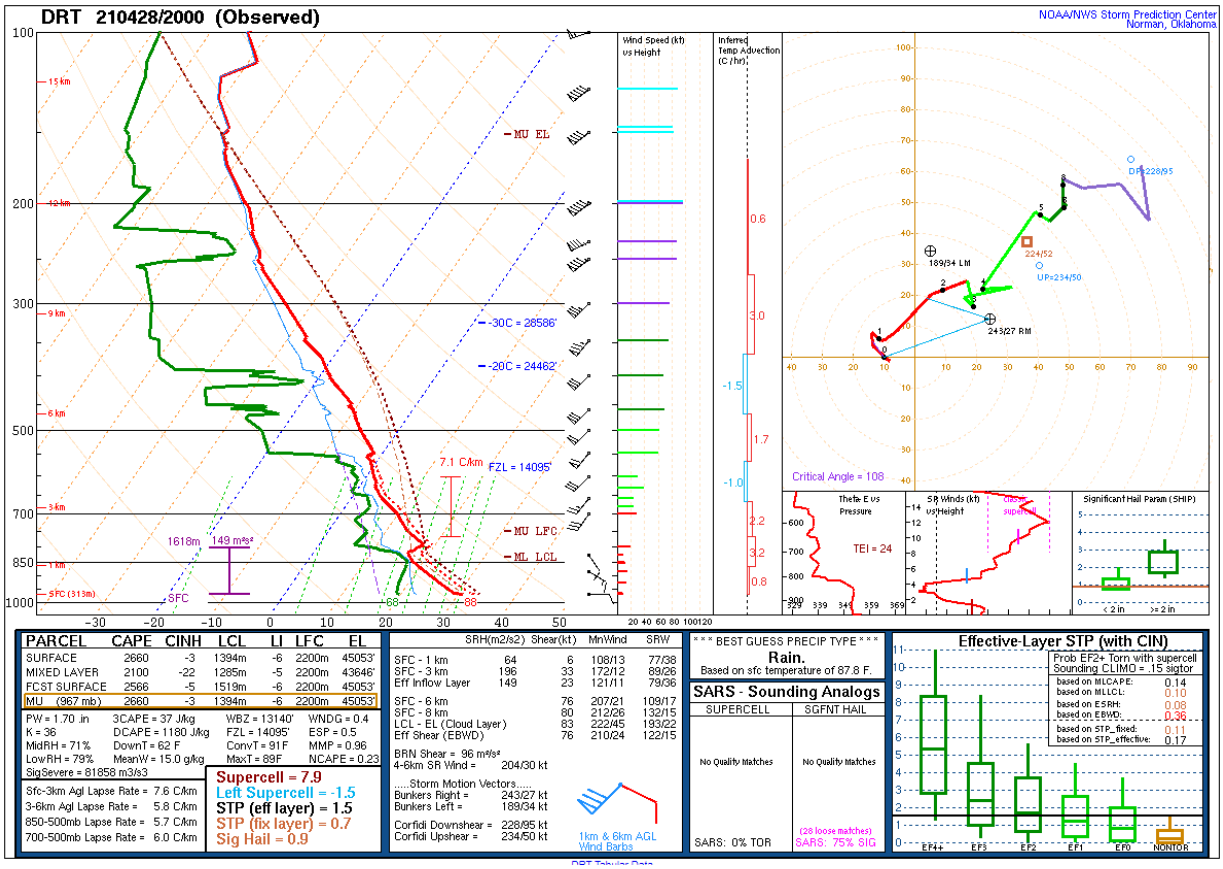


Figure 8. Supplemental sounding from Del Rio, Texas, (DRT) at 2000 UTC 28 April 2021.

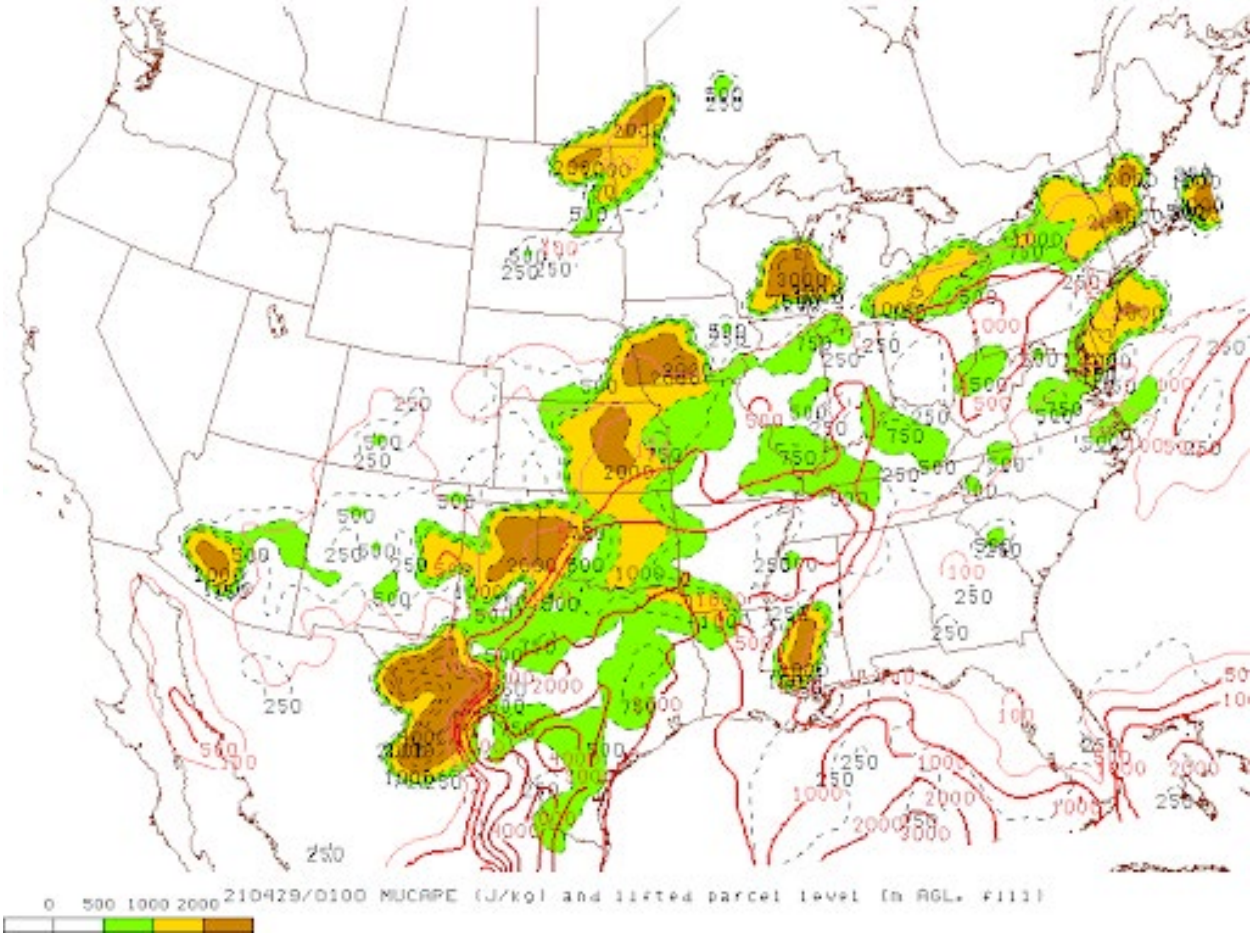


Figure 9. Most Unstable CAPE (MUCAPE) analysis at 0100 UTC 29 April 2021.

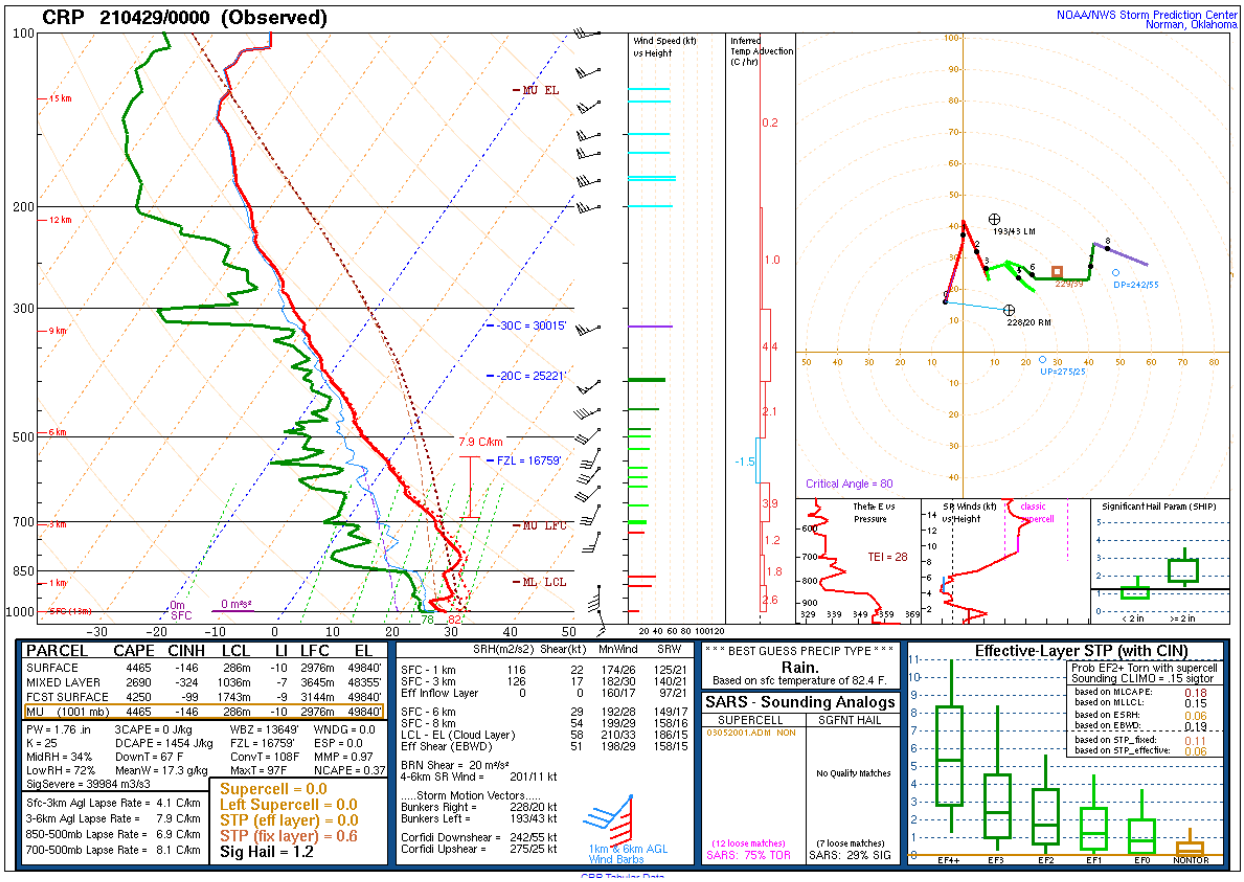


Figure 10. Synoptic sounding from Corpus Christi, Texas, (CRP) at 0000 UTC 29 April 2021.

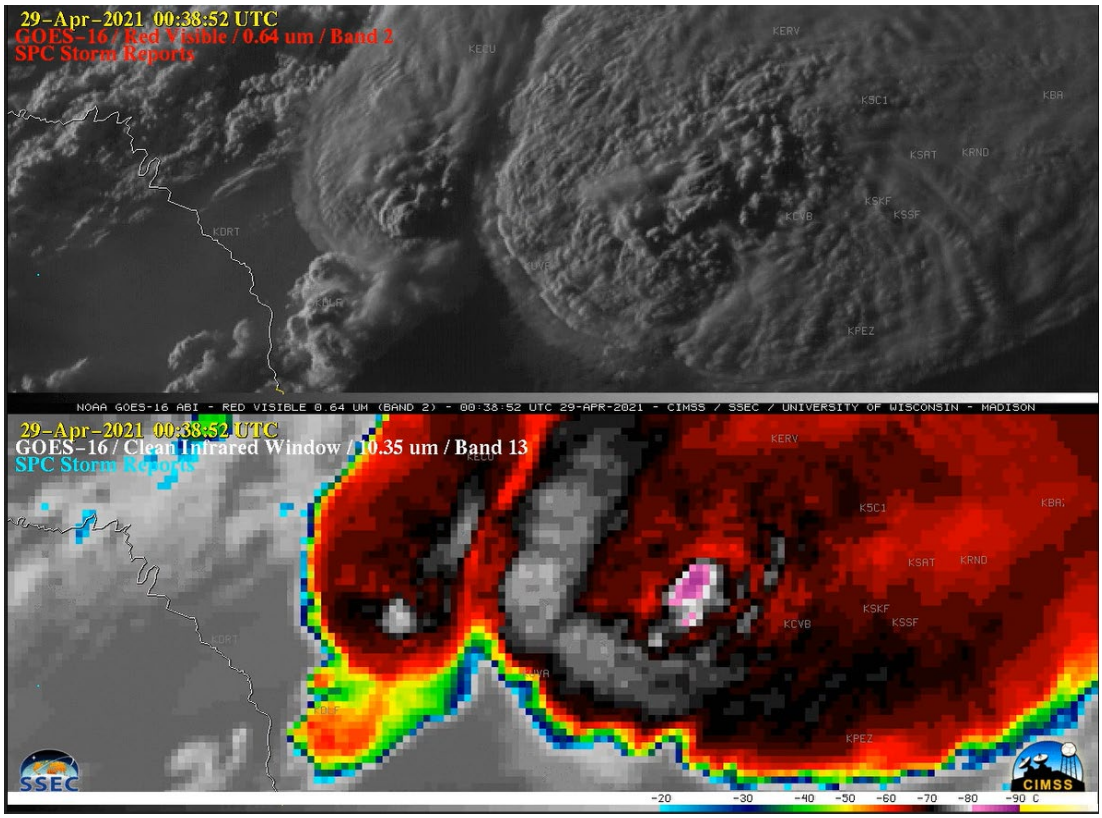


Figure 11. GOES-16 0.47 µm (Channel 1, "Blue," Visible. top) and 10.3 µm (Channel 13, "Clean Infrared," bottom) satellite images at 0038:52 UTC 29 April 2021, the closest scan to the approximate time the gargantuan hailstone fell in Hondo (CIMSS, 2021).

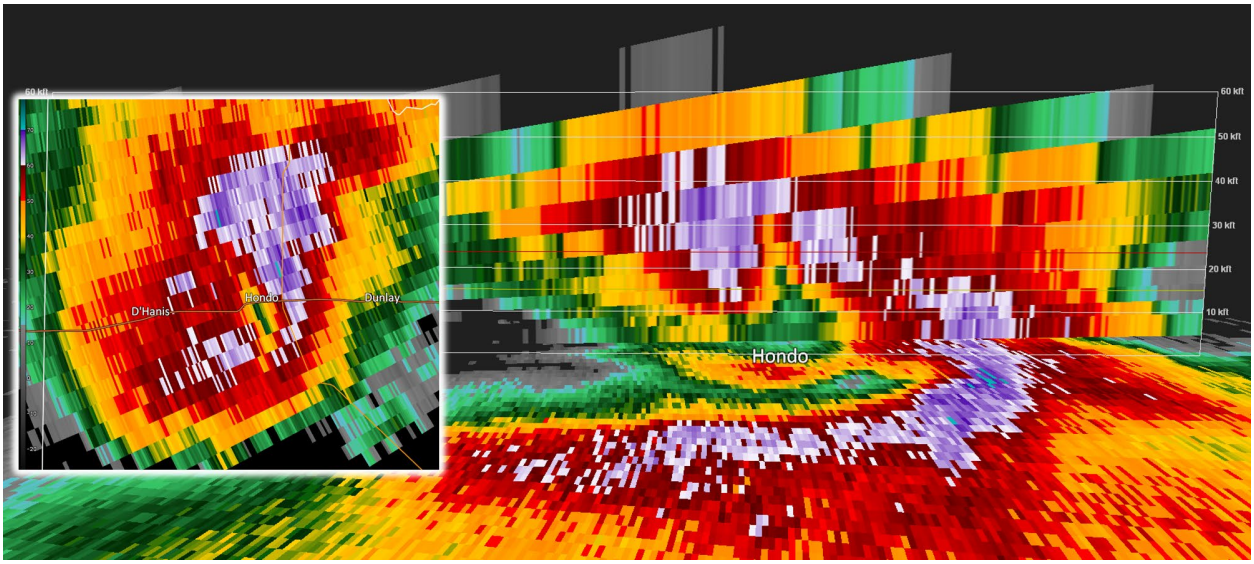


Figure 12. Pronounced Bounded Weak Echo Region (BWER) from KEWX at 0035 UTC 29 April 2021.

Figure 13. Gargantuan hailstone that fell at approximately 0035 UTC 29 April 2021 at 1SSW Hondo, Texas. This photo was taken between approximately 0100 to 0130 UTC (30-60 minutes after the hailstone fell).

Figure 14. Gargantuan hailstone that fell at approximately 0035 UTC 29 April 2021 1SSW Hondo, Texas. Picture taken by the finder on 4 May 2021, six days after it fell and had been stored unbagged in a standard home freezer.

Figure 15. The gargantuan hailstone was scanned and analyzed by IBHS and NWS Austin-San Antonio staff on 6 May 2021 at the finder's home in Hondo, Texas. Photo by NWS Austin-San Antonio.

Appendix I - Assessment of prior documented hail events across Texas provided by Dr. John Nielsen-Gammon

On occasion of a large hailstone in Burkburnett (Wichita Co.) on May 22, 2020, Doug Speheger (NWS Norman) contacted me to inquire about the official Texas state record for hailstones.

At that point, there was no official state record. The largest stones listed in NCEI's Storm Events Database were:

8", Winkler Co., May 31, 1960
7.5", Young Co., April 14, 1965
7.05", Burleson Co., December 17, 1995
6", Ward Co., May 10, 1991
6", Moore Co., June 12, 2010

Also noted by Christopher Burt (https://www.wunderground.com/cat6/record-hailstorms-and-hailstones-us dated April 27, 2018 and accessed May 11, 2021) is
8", Washington Co., Dec. 6, 1892

Based on the analysis of Doug, me, and two high school students Ethan Clark and Olivia Dugger, the following values should be treated as unofficial but apparently credible for these six events:

8", Washington Co., Dec. 6, 1892
7", Winkler Co., May 31, 1960
6", Ward Co., May 10, 1991
6", Moore Co., June 12, 2010
2.4" Young Co., April 14, 1965
0.75", Burleson Co., December 17, 1995

What follows is a detailed analysis of each of the six hail reports.

Washington: Burt presents an image of a news item in *The New York Times*, apparently reprinted from the *Galveston Daily News*:

THE BIGGEST OF HAILSTONES.

TEXAS REPORTS THEM EIGHT INCHES IN DIAMETER.

Gay Hill (Texas) Letter to the Galveston News.

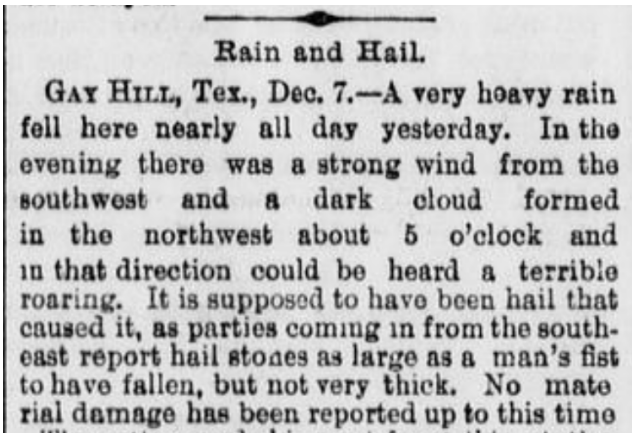
The recent hailstorm near Gay Hill occurred about 4:30 P. M. Tuesday, 6th inst. About 2 P. M. heavy clouds appeared in the west, and as they slowly approached, a roaring sound was heard, such as usually indicates a coming hailstorm. Lightning, accompanied by distant thunder, suggested an unusual storm. About six miles distant from my point of observation the clouds divided. A light-colored cloud passed out from the more dense cloud toward the southeast, while the latter continued its course toward the east. This cloud brought with it a deluge of rain, but far above it at a high altitude was another cloud of a pinkish cast, which moved also toward the east.

A few minutes after the rain commenced small hailstones fell, and each moment larger ones fell than the preceding, until they reached the size of small hen eggs. After falling for about fifteen minutes the hail and rain ceased for probably two minutes. Then it commenced again to rain heavily and continued for probably ten minutes, with a higher wind, and it was during this interval that the wonderfully large hailstones fell.

This remarkable hail fell in large lumps, ranging from 3 to 6 inches in diameter. I heard of one piece, 8 inches in diameter, which weighed four pounds. They were, as a rule, spherical in form, but some were somewhat flat, and nearly all were covered with oval knobs. They fell in small areas about two feet apart, while in other places only one would fall in a space 20 feet square. The average under my observation was about one hailstone to every 3 feet square. The earth was thoroughly saturated with water, and some of the large pieces penetrated the ground in soft places about three inches.

Source: New York Times, December 27, 1892. Image by Christopher Burt.

The *Galveston Daily News* on December 8, 1892 reported on a tornado ("cyclone") said to have touched down 5 miles NE of Brenham, or about 8 miles ESE of Gay Hill, moving east, with a damage swath 10 miles long and 100 to 400 yards wide. This track would plausibly have put Gay Hill beneath the hail core of the associated supercell thunderstorm a few minutes prior to touchdown. Also on December 8 the *Galveston Daily News* reported for Gay Hill:



Rain and Hail.

GAY HILL, Tex., Dec. 7.—A very heavy rain fell here nearly all day yesterday. In the evening there was a strong wind from the southwest and a dark cloud formed in the northwest about 5 o'clock and in that direction could be heard a terrible roaring. It is supposed to have been hail that caused it, as parties coming in from the southeast report hail stones as large as a man's fist to have fallen, but not very thick. No material damage has been reported up to this time

Source: Galveston Daily News, December 8, 1892, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

Editions from December 9 and 10 were not readily available online. *Monthly Weather Review* for December 1892 reports tornadoes on December 6 in northeast Texas (Gay Hill is in southeast Texas).

The report on the storm in *The New York Times* is detailed and reports 6" diameter hail firsthand and a secondhand report of 8" diameter hail. A sphere of solid ice 8" in diameter would weigh approximately 8 lb., so a 4 lb. weight is plausible given the likely irregular shape of the hailstone and the possible incorporation of air bubbles.

No details are provided as to the means of measurement, and no photographic evidence is known to exist. I judge this report to be credible but unverifiable.

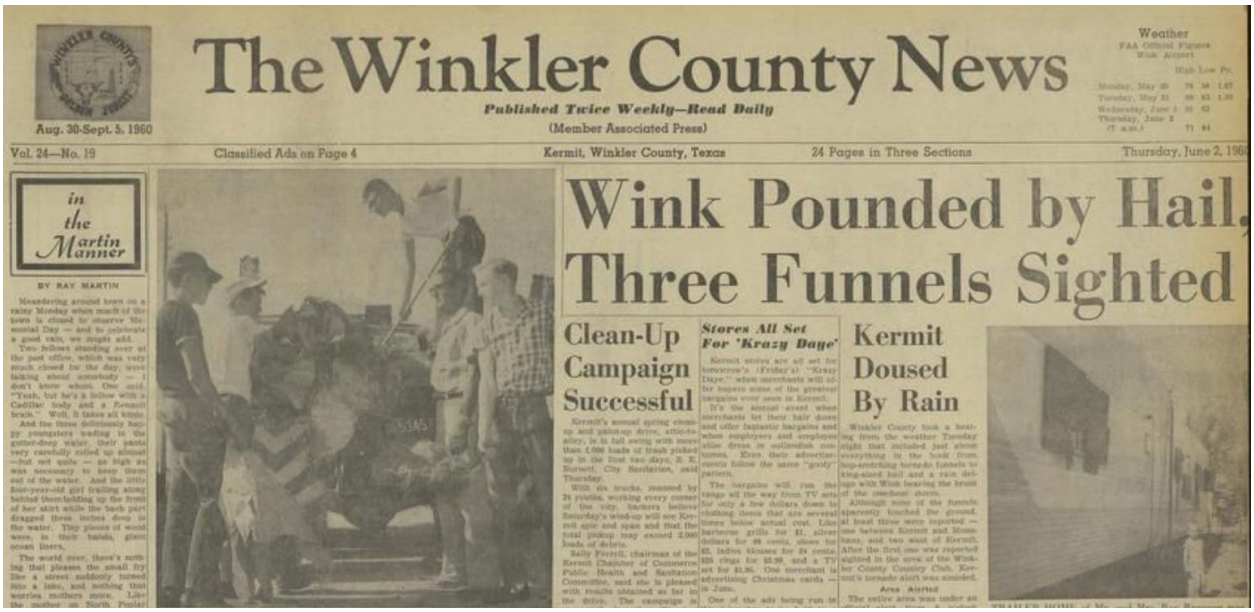
Winkler: The Storm Data listing is:

Winkler & Ward Counties	31	7:20 to 9:40 pm	40 to 50	15 to 20	0	0	5	0	Hail
Moved from NW to SE. Average diameter of stones 5", largest stones 7" to 8". Cities hardest hit by hail were Monahans & Wink. At Wink hail fell for nearly an hour. Roof, windows, autos, awnings, north side of buildings badly damaged. Winds of 56 mph with gusts to 95 mph at Monahans, accompanying heavy rain, much lightning.									

Source: Storm Data, May 1960, NCEI

This detailed report seems credible.

The storm was the lead article in the *Winkler County News* on June 2, 1960.



The Winkler County News

Published Twice Weekly—Read Daily
(Member Associated Press)

Aug. 30-Sept. 5, 1960

Weather
FAA Official Figures
Wink Airport

	High	Low	Pr.
Monday, May 30	78	56	1.67
Tuesday, May 31	88	65	1.09
Wednesday, June 1	91	62	
Thursday, June 2	77	64	

Vol. 24—No. 19 | Classified Ads on Page 4 | Kermit, Winkler County, Texas | 24 Pages in Three Sections | Thursday, June 2, 196

in the Martin Manner

BY RAY MARTIN

Meandering around town on a rainy Monday when much of the town is closed to observe Memorial Day — and to celebrate a good rain, we might add.

Two fellows standing over at the post office, which was very much closed for the day, were talking about somebody — I don't know whom. One said, "Yeah, but he's a fellow with a Cadillac body and a Renault brain." Well, it takes all kinds.

And the three deliriously happy youngsters wading in the gutter-deep water, their pants very carefully rolled up almost —but not quite — as high as was necessary to keep them out of the water. And the little four-year-old girl trailing along behind them holding up the front of her skirt while the back part dragged three inches deep in the water. They pieces of wood were, in their hands, giant ocean liners.

The world over, there's nothing that pleases the small fry like a street suddenly turned into a lake, and nothing that worries mothers more. Like the mother in North Ponta[illegible]

Wink Pounded by Hail, Three Funnels Sighted

Clean-Up Campaign Successful

Kermit's annual spring clean-up and paint-up drive, attic-to-alley, is in full swing with more than 1,000 loads of trash picked up in the first two days, R. E. Burnett, City Sanitarian, said Thursday.

With six trucks, manned by 24 youths, working every corner of the city, backers believe Saturday's wind-up will see Kermit spic and span and that the total pickup may exceed 2,500 loads of debris.

Sally Fryrer, chairman of the Kermit Chamber of Commerce Public Health and Sanitation Committee, said she is pleased with results obtained so far in the drive. The campaign is

Stores All Set For 'Krazy Daze'

Kermit stores are all set for tomorrow's (Friday's) "Krazy Daze," when merchants will offer buyers some of the greatest bargains ever seen in Kermit.

It's the annual event when merchants let their hair down and offer fantastic bargains and when employees and employers alike dress in outlandish costumes. Even their advertisements follow the same "goofy" pattern.

The bargains will run the gamut all the way from TV sets for only a few dollars down to clothing items that are several times below actual cost. Like barbecue grills for $1, silver dollars for 98 cents, shoes for $2, ladies blouses for 94 cents, $25 rings for $2.99, and a TV set for $2.95. One merchant is advertising Christmas cards — in June.

One of the ads being run in

Kermit Doused By Rain

Winkler County took a beating from the weather Tuesday night that included just about everything in the book from hop-scotching tornado funnels to king-sized hail and a rain deluge with Wink bearing the brunt of the onslaught alone.

Although none of the funnels apparently touched the ground, at least three were reported — one between Kermit and Monahans, and two west of Kermit. After the first one was reported sighted in the area of the Winkler County Country Club, Kermit's tornado alert was sounded.

Area Alerted

The entire area was under an

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

Kermit Doused By Rain

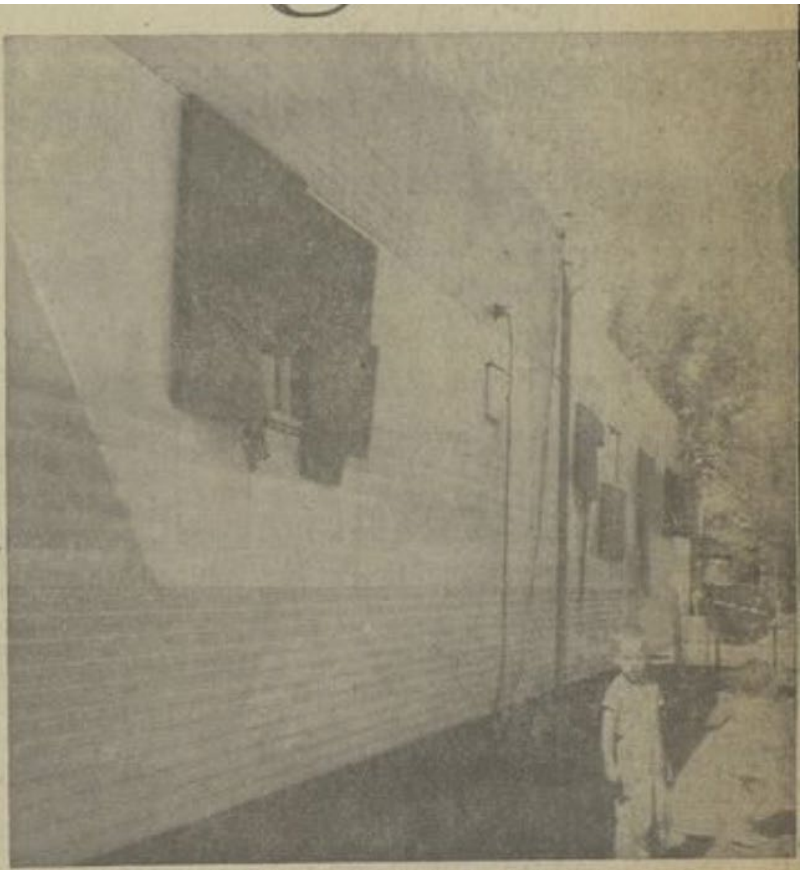
Winkler County took a beating from the weather Tuesday night that included just about everything in the book from hop-scotching tornado funnels to king-sized hail and a rain deluge with Wink bearing the brunt of the one-hour storm.

Although none of the funnels aparently touched the ground, at least three were reported — one between Kermit and Monahans, and two west of Kermit. After the first one was reported sighted in the area of the Winkler County Country Club, Kermit's tornado alert was sounded.

Area Alerted

The entire area was under an official alert from 8 o'clock Tuesday night until 2 o'clock Wednesday morning.

Greatest damage in this area apparently was caused by the hail which hurled stones larger than baseballs on Wink. Dozens of homes were drenched by rain which poured into the houses through broken windows, and for more than an hour the town was left without power. The FAA station at Wink officially measured the rainfall at 1.30 inches Tuesday night, in addition to Monday's 1.67 inches.



TRAILER HOME of Mr. and Mrs. Ray Brannon was left a sodden mess after hail broke the windows out on the north side. Shown beside the trailer are Danny Waller, 4 and Cathey Waller, 2, children of Mrs. Lola Waller, Tucumcari, N. M.,who were visiting the Brannons.

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

of homes were drenched by rain which poured into the houses through broken windows, and for more than an hour the town was left without power. The FAA station at Wink officially measured the rainfall at 1.30 inches Tuesday night, in addition to Monday's 1.67 inches.

Windshields Broken

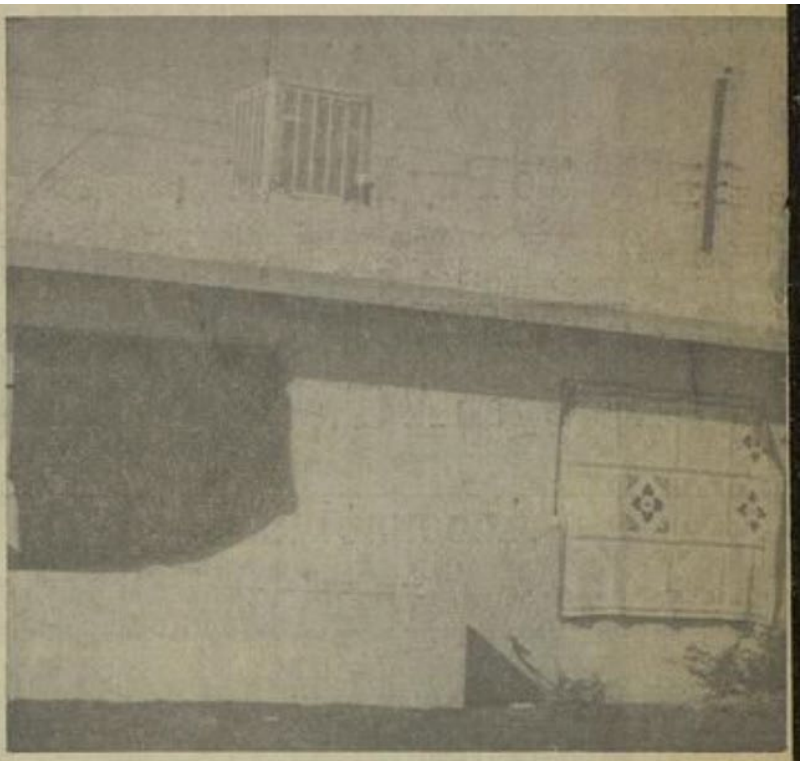
Automobile windshields and roofs also fared badly, with losses running into the thousands of dollars in Wink.

As is usually the case, the storm reports included many freakish acts. Mrs. Edwin McCollums, 115 Airfield Road in Wink, said a garden hose lying in the back yard was cut in two in two places by the hailstones, and a large stone which smashed through a picture win-

(Continued on Page 2)

K-Band Offers '59-'60 Records

Kermit High School band, recognized as one of the outstanding High School musical organizations of West Texas, is offer-



BLANKETS AND QUILTS serve in lieu of window glass in many Wink homes. This is the new home of Mr. and Mrs. Edwin McCollums in Wink. One hailstone crashed through the window, bounced across the room and struck a mirror.

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

HERE'S ONE OF THE Bigger stones that was kept in an ice box by Mrs. F. M. Ballard. Holding the stone is Gary Warren, 8, son of James A. Warren. Some stones were reported to have measured five inches in diameter.

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

MANY WINDSHIELDS in Wink were broken. Here Mrs. Leo Hoskins points to a big hole left in the windshield of the Hoskins' automobile. Mrs. Hoskins says she is going to build a storm cellar "right away". (All Staff Photos).

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

Wink Pounded by Hail . . .

(Continued from Page 1)

low of her home bounced across the room and struck a dresser mirror.

The Ray Brannan's home trailer at Page Trailer Court was flooded after all the windows on the north side of the trailer were smashed. Interior of the trailer was listed as almost a total loss. Mr. and Mrs. Brannan were away from home at the time.

Roof Leaked

Mrs. U. V. Carman said the roof at their home "leaked in so many places it kept us busy putting holes in the ceiling to let the water through to save our furniture."

Mrs. Leo Hoskins who lives on Pyote Road at Wink pointed to a hole in the windshield of their automobile the size of a baseball. "We're starting to dig a storm cellar right today," Mrs. Hoskins said. "If I have to dig it myself."

O. O. Wallace's home lost all its northside windows.

Many homes in Wink also were flooded by the downpour which accompanied the hail.

Awnings Give Protection

Downtown buildings, protected by awnings, seemed to fare better than homes, although a large slat-type metal awning in front of Carley's grocery was marred by the storm.

After striking in the Wink-Kermit area, the storm moved south and poured two inches of rain and hail on Monahans. Wind damage there apparently was greater when gales reached an unofficial speed of 84 miles an hour.

Source: The Winkler County News, June 2, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

The Wink news article does not mention Monahans, but an article from June 1, 1960 in the *Levelland Daily Sun News* reports baseball-sized hail in Monahans and 5" hail in Wink.

HAIL, RAINS LASH REGION

Nine twisters in West Texas

Tornadoes roared over West Texas Tuesday night while giant hail stones smashed windows in some towns and rains of more than three inches caused flooding in Boham.

It was a night of violent weather and numerous Weather Bureau warnings of tornadoes, hail, damaging winds and severe thunderstorms.

The first day of June was calmer than the last hours of May, but thunderstorms hit Waco, Dallas, Fort Worth and other North Central Texas cities early Wednesday.

Jim Morris of Monahans said residents of that West Texas city spotted at least nine tornadoes about 9 p.m. Tuesday. None touched ground. The city was hit by hailstones as big as baseballs, he said, and winds gusted at 95 m.p.h. Hail smashed windows in cars and buildings.

At Wink, just northwest of Monahans, hail and violent winds knocked out telephone service and filled the streets with rubble, said Deputy Sheriff Earl Hill of Winkler County. Hundreds of windows were smashed by the hail and roofs damaged. Hail at Wink measured 5 inches in diameter.

A 90-minute rain dropped 3.25 inches of water on Bonham sending creeks out of banks. Water rose shoulder deep in the western part of the Northeast Texas city. Several inches of water covered the floors in about 30 homes and two small food stores.

Flooding also occurred at Greenville where a sudden downpour dropped about 4 inches of rain between 2:15 and 3 p.m. in the south part of the city which is 30 miles south of Bonham.

Lightning started a fire in a duplex and it destroyed one side of the residential building. High water blocked streets on Greenville's east side for a time. The official rainfall total was only one inch.

The only rainfall reported to the Weather Bureau before 6 p.m. Tuesday was .28 inch at Alpine, .04 at Dalhart and a heavy rain at Pampa.

The violent weather hit after a day in which temperatures soared to 105 at Presidio in far West Texas. Most other readings were in or near the 90s. Galveston had the low maximum for the day, an 84.

AT DALLAS

Source: The Levelland Daily SunNews, June 1, 1960, archived by the Texas Digital Newspaper Program, https://texashistory.unt.edu

News reports quote 5" hail in Wink. The Storm Report implies multiple hailstones exceeding 7". I cannot think of a scenario in which the report from the NWS of 7" to 8" hail could be a technical error, and hailstones of such a size are plausible in this event. However, it's not clear whether the expressed range means that some stones were about 7" and some were about 8", or that some storms exceeded

7" but did not exceed 8". Because of the ambiguity of the (unofficial) measurement, a conservative minimum diameter of 7" for the largest hailstones seems the best approach.

For unknown reasons, the hail diameter for this event in the NCEI Storm Events Database was changed from 8" to 5" sometime in the past several months. I recommend that it be restored to at least 7".

Young: Doug noted that the Storm Data report for this report listed 2.4" diameter and 7.5" circumference.

Graham Young Co.	14	4:30 p	20	*5	0	0	?	?	Hailstorm A hailstorm damaged between 50 and 75 percent of the roofs of homes in Graham. The downtown business section was hardest hit by the hailstones which measured up to 7½ inches in circumference (2.4 inches in diameter). Twenty windows were broken at the Graham General Hospital. The ground was entirely covered with hailstones to a depth of two inches in places. The area of hail damage extended from Murray, about 20 miles west of Graham, through the city of Graham.

Source: Storm Data, April 1965, NCEI

He suggested, and I agree, that the circumference was likely mistakenly entered as a diameter.

Burleson: Doug noted that the largest hailstones listed elsewhere were 1.75" and there was no narrative indicating extremely large hail. So, despite the Storm Data report:

TEXAS, Central Southeast							
Burleson County	**17**	**0210CST**	**0**	**0**	**5K**	**0**	**Hail (7.05)**
Grimes County							
Anderson	**17**	**0325CST**	**0**	**0**	**5K**	**0**	**Hail (1.00)**
Montgomery County							
FM 1097 & HWY 105	**17**	**0400CST**	**0**	**0**	**5K**	**0**	**Thunderstorm Winds**
	Several cars were blown off the road.						
Willis	**17**	**0423CST**	**0**	**0**	**30K**	**0**	**Thunderstorm Winds**
	A roof of a barn was blown off and a carport was destroyed.						
San Jacinto County							
Coldspring	**17**	**0515CST**	**0**	**0**	**5K**	**0**	**Hail (1.00)**
Coldspring	**17**	**0515CST**	**0**	**0**	**500K**	**0**	**Thunderstorm Winds**
	Roof of high school and nearby homes had parts blown off.						

Source: Storm Data, December 1995, NCEI

...it seems likely, as suggested by Doug, that the 7.05 was a typographical error and was intended to be 0.75".

Ward: The Storm Data report includes narrative that supports the 6" value.

Ward County								
Pyote	10	1520CST	0	0	2	1	Hail (1.75)
Pyote	10	1528CST	0	0	1	1	Hail (1.75)
Pyote	10	1613CST	0	0	2	2	Hail (2.00)
Pyote	10	1628CST	0	0	5	2	Hail (6.00)

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STORM DATA AND UNUSUAL WEATHER PHENOMENA

MAY 1991

PLACE	DATE	TIME LOCAL STANDARD	LENGTH OF PATH (MILES)	WIDTH OF PATH (YARDS)	NO. OF PERSONS KILLED	NO. OF PERSONS INJURED	ESTIMATED DAMAGE PROPERTY	ESTIMATED DAMAGE CROPS	CHARACTER OF STORM
TEXAS, Western Cont'd									
2 N Monahans	10	1652CST			0	0	1	1	Hail (0.75)
3 E Monahans	10	1711CST			0	0	3	2	Hail (4.50)
Monahans	10	1724CST			0	0	5	3	Hail (2.75)
Wickett	10	1746CST			0	0	3	1	Thunderstorm Winds
Monahans	10	1819CST			0	0	2	1	Hail (1.75)
Monahans	10	1830CST			0	0	1	1	Hail (1.75)

Recurrent supercell thunderstorms over Ward County produced a swath of very large hail from Pyote to Monahans. Hail, up to cantaloupe size, was reported by SKYWARN spotters, the Ward County Sheriff's Office, and the public. Damage to roofs, windows, and windshields was extensive. Downburst winds damaged the roof of a grocery store in Wickett, according to the public.

Source: Storm Data, May 1991, NCEI

However, it is not known whether the 6" value was a measurement or was an estimate based on the description of "cantaloupe size". So, while the 6" value is plausible, it would be superseded by a more accurately measured hailstone.

Moore: The storm report lists several large hailstones.

Moore County							
6 SW Sunray	12	1423CST	0	0	0.00K	0.00K	Hail (4.00)
Moore County							
3 W Sunray	12	1425CST	0	0	0.00K	0.00K	Hail (3.25)
Moore County							
7 SW Sunray	12	1427CST					
		1430CST	0	0	2.00K	0.00K	Hail (5.50)
	The large hail came through the window of the vehicle which the storm chaser was driving and caused minor cuts to the driver.						
Moore County							
2 E Sunray	12	1428CST					
		1430CST	0	0	0.00K	0.00K	Hail (2.75)
Moore County							
7 SW Sunray	12	1432CST					
		1434CST	0	0	0.00K	0.00K	Hail (6.00)
Moore County							
4 WSW Sunray	12	1432CST					
		1434CST	0	0	0.00K	0.00K	Hail (2.50)
Moore County							
1 SE Sunray	12	1440CST					
		1442CST	0	0	0.00K	0.00K	Hail (4.00)

Source: Storm Data, June, 2010, NCEI

In addition to the storm reports, there is a description and link to some photographs (of 4.7" hail) here: http://ldctstormchaser.blogspot.com/2010/06/killer-hailstones-92l.html. Note that the large hailstone photo at the beginning of the blog post is the famous Aurora, Nebraska hailstone from 2003.

The report seems plausible; the event is recent enough that it should be possible to follow up with the Amarillo NWS office or the persons mentioned in the blog post if further documentation is needed.

Appendix II - IBHS Final Report

IBHS Hail Quick Response Survey: Hondo, Texas Gargantuan Hailstone

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Ross Maiden

Christina Gropp

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Event Background

During the evening of 28 April 2021, two supercells developed west of Del Rio, TX and moved eastward across the United States/Mexico border (Figure 1). The two supercells continued eastward passing very near Uvalde, Texas prior to 00 UTC. By 00 UTC the trailing supercell began to merge into the rear-flank of the lead supercell before reaching Hondo, Texas.

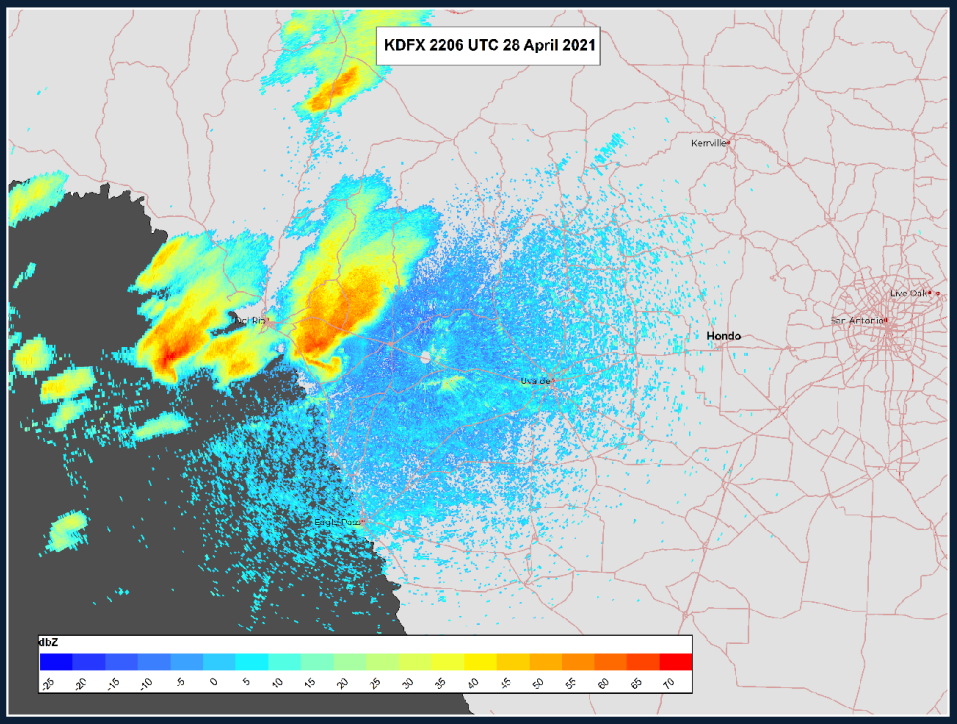

Figure 1: KDFX reflectivity at 2206 UTC 28 April 2021.

By 0022 UTC, the merger was complete, and a single, large high precipitation supercell emerged. The supercell moved roughly along US Highway 90 and passed over Hondo, Texas shortly after 0033 UTC. Radar observations indicated a well-defined area of Z_{DR} values near zero and a co-located reduction in correlation coefficient indicating the presence of large hail. The hydrometeor classification algorithm also indicated the presence of very large hail.

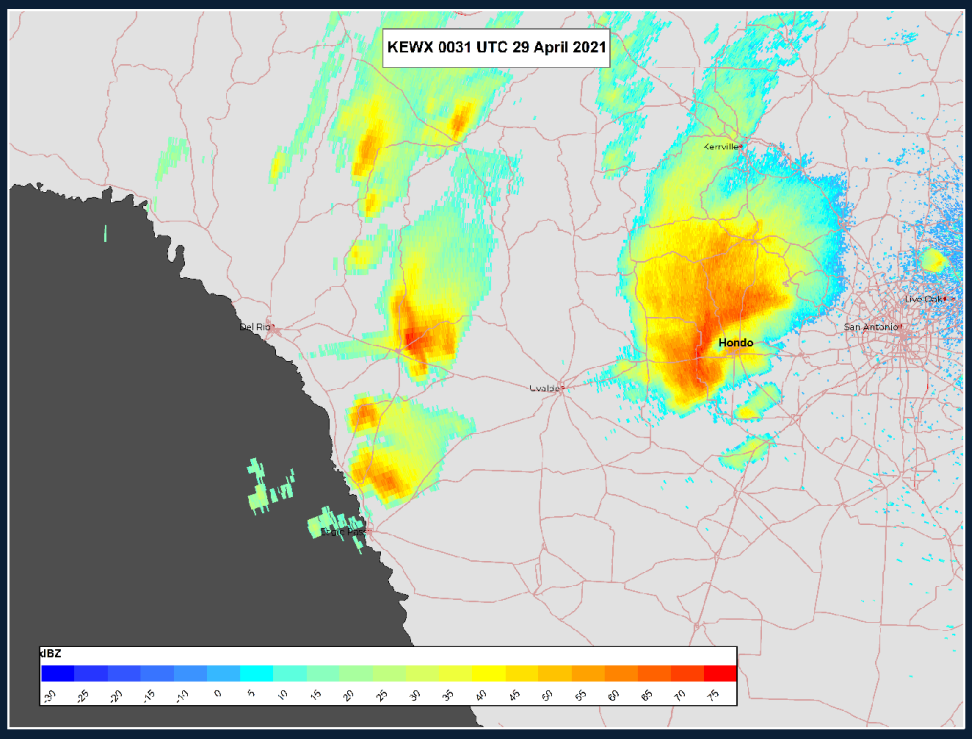

Figure 2: KEWX reflectivity at 0031 29 April 2021. Note the hail-producing supercell approaching Hondo, Texas.

Shortly after the passage of this supercell, images of large to giant and possibly gargantuan hail (> 6 in.) [1] began to circulate across social media platforms. Significant hail damage to vehicles, buildings and crops were reported because of this damaging hailstorm. An observant homeowner collected the hailstone that this investigation is focused on, in Hondo, Texas very near US Hwy 90. It was handled some, likely causing some melting, before being placed a freezer. The homeowner contacted the National Weather Service Weather (NWS) Forecast Office in San Antonio. The hailstone was initially placed in a freezer, un-bagged; however, after consulting NWS meteorologists, the hailstone was placed in a "zip-lock" bag for storage and preservation[2]. This is the IBHS recommendation for preserving hailstones in a typical freezer. The homeowner described to the IBHS and NWS

[1] Kumjian, M.R. and co-authors, 2020: Gargantuan hail in Argentina, *Bull. Amer. Meteor. Soc.*, **101** (8), 1241-1258. https://doi.org/10.1175/BAMS-D-19-0012.1

[2] For IBHS best practices on how to properly measure and preserve hailstones click HERE

survey team that the hailstone did fall through a tree in the front yard but based on images it did not appear to cause any significant fracturing of the hailstone. This likely reduced the fall-speed some, helping to keep the hailstone intact when it impacted the ground.

IBHS contacted the NWSFO in San Antonio to inquire about surveying this hailstone and digitally persevering it using 3D laser scanning. The NWS, IBHS, and the Texas State Climatologist were able to coordinate a joint survey. The IBHS team deployed with meteorologists from the San Antonio NWS Forecast Office on 6 May 2021 to investigate this gargantuan hailstone.

IBHS Survey

The IBHS quick response team and the NWS team arrived at approximately 2:15 pm CDT on 6 May 2021 to conduct their survey. IBHS engineer, Ross Maiden is the quick response team's 3D scanner expert and operator. IBHS has pioneered the use of 3D laser scanning to capture precision digital models of hail[3]. The quick response team has documented two state record hailstones using this method: Walter, Alabama in 2018 and Bethune, Colorado in 2019 and investigated one other that was not found to be a state record (Vandervoort, Arkansas in 2019). The hailstone scan was conducted using a Creaform HandySCAN EXAscan™system, shown in Figure 2. The unit is calibrated prior to use and was calibrated shortly before scanning this hailstone. The system has a resolution of 0.008 cm. with an accuracy of ±0.004 cm. From the digital model, the maximum diameter, minimum diameter, and volume were obtained. The diameters are defined as the maximum (minimum) distance on a line through the center of the hailstone (based on the 3D volume) to two points on the surface. The IBHS field team also weighed the hailstone. The scale was calibrated at the IBHS research center on May 5 before the team departed for Texas. The measurements of the hailstone are summarized in Table 1 and the digital model is shown in Figure 4.

The hailstone was quite oblate for such a large hailstone with an axis ratio (minimum to maximum diameter) of 0.44 but does fall within the typical range described by Shedd et al. (2021)[4] The volume obtained from the 3D scan coupled with the

[3] Giammanco, I.M., B.R. Maiden, H.E. Estes, and T.M. Brown-Giammanco, 2017: Using 3D laser scanning technology to create digital models of hailstones, *Bull. Amer. Meteor. Soc.*, **98** (7), 1341-1347. http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00314.1

[4] Shedd, L., M.R. Kumjian, I.M. Giammanco, T.M. Brown-Giammanco, and B.R. Maiden, 2021: Hailstone Shapes, *J. Atmo. Sci.*, https://doi.org/10.1175/JAS-D-20-0250.1

measured mass yielded a bulk density of 0.864 g $cm.^{-3}$, which is well within the range of typical hailstones. The circumference of the hailstone from the 2 points on the surface of the hailstone from which the maximum diameter was obtained was 19.730 in. (50.114 cm.) which is nearly the circumference of a perfect sphere with the same diameter.

Figure 3: Photograph (left) of IBHS engineer Ross Maiden laser scanning the Hondo, TX hailstone, (top-right) photograph showing the laser plane tracking across the hailstone, and (bottom-right) the hailstone on the scanner mount. Photographs by Christina Gropp.

Table 1. Measurement summary from the Hondo, TX gargantuan hailstone digital model. The mass of the hailstone was determined shortly before the hailstone was 3D scanned.

Maximum Diameter (cm.)	Maximum diameter (in.)	Minimum diameter (cm.)	Minimum diameter (in.)	Volume ($cm.^3$)	Volume ($in.^3$)	Mass (g)	Circumference (cm.)	Circumference (in.)
16.297	6.416	7.221	2.843	659.399	40.239	569.50	50.114	19.730

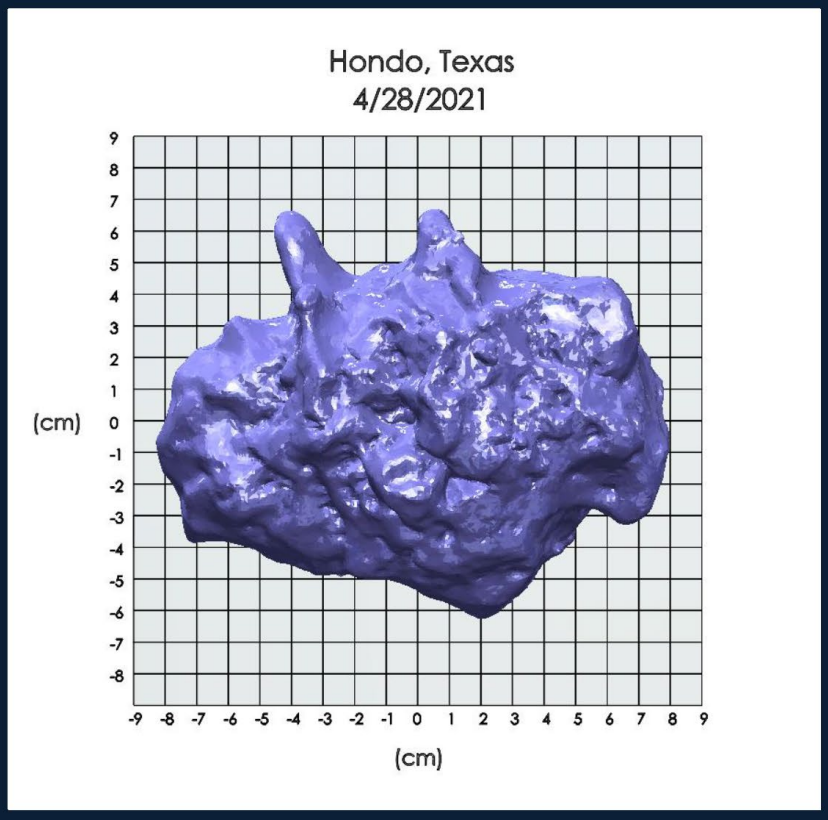

Figure 4: 3D digital model rendering of the Hondo, Texas hailstone.