NOTE: THIS SAMPLE REPORT IS MEANT TO SHOW YOU WHAT OUR REPORTS GENERALLY LOOK LIKE. EACH REPORT WILL BE CATERED SPECIFICALLY TO YOUR CASE. NAMES AND LOCATIONS HAVE BEEN CHANGED TO PRESERVE CONFIDENTIALITY.

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FORENSIC WEATHER INVESTIGATION OF THE WEATHER CONDITIONS, WIND GUSTS AND HAIL OCCURRENCES ON MARCH 23, 2016, APRIL 11, 2016 AND APRIL 6, 2018 AT 123 COUNTY ROAD 4 IN LAVON, TEXAS

December 18, 2020

CASE NAME:	"Lavon Transportation & Shipping"
PREPARED FOR:	Mr. Bob Berger, Esq.
COMPANY:	Berger PLLC

This written report and all of the tables, graphs, findings, data and opinions contained in it has been prepared for use with this specific case only. Use of any of this information for any other matter, claim or case other than what is indicated above, including for use in expert disclosures in other cases, is strictly prohibited.

ASSIGNMENT:

This case was assigned to me by Berger PLLC. I was asked to perform an in-depth weather analysis and forensic weather investigation at 123 County Road 4 in Lavon, Texas in order to determine what the weather conditions were on March 23rd, 2016, April 11th, 2016 and April 6th, 2018. I was then asked to prepare a written report of the weather conditions that occurred at 123 County Road 4 in Lavon, Texas on April 6th, 2018.

Studies to determine if and when hail occurred at an incident location, the size of the hail that fell, the wind speeds, or if a tornado occurred should only be conducted by a qualified Certified Consulting Meteorologist (CCM) who is an expert in the field, who has the education, training and experience, and who employs the correct methodology and accepted practices normally relied upon by meteorologists in these investigations.

METHODOLOGY:

Forensic Weather Consultants, LLC uses various reliable sources of weather information in order to conduct a reliable weather analysis. In order to accurately determine the weather conditions that existed leading up to and including the time of the incident, a detailed search was performed to find the closest, official weather stations to the incident location. Using the computer program "Google Earth", weather station locations provided by the National Centers for Environmental Information (NCEI) and MesoWest were plotted and are indicated by a yellow pushpin. MesoWest is a cooperative project that was started at the University of Utah in 1996 with a goal of providing access to current and archived weather observations from across the United States through internet-based resources. While not all of the weather data can be certified by the NCEI, the majority if not all of the data is housed and maintained on National Oceanic and Atmospheric Administration websites including ncei.noaa.gov and raws.wrh.noaa.gov and are the records that meteorologists rely upon during the normal course of business to conduct these kinds investigations.

GENERAL REVIEW OF WEATHER DATA SOURCES

Many different types of weather data are gathered and analyzed as part of our investigations. While some, but not necessarily all, of these weather data sources were utilized for this case, we are providing a list of the different types of stations for informational purposes.

The Automated Surface Observing Systems (ASOS) program is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA), and the Department of Defense (DOD). The ASOS systems serve as the nation's primary surface weather observing network. The ASOS systems compile various weather observations, often more than once per hour, called Local Climatological Data (**LCD**) that are reviewed, maintained, and stored by NOAA.

Through the National Weather Service (NWS) Cooperative Observer Program (**COOP**), more than 10,000 volunteers take daily weather observations at National Parks, seashores, mountaintops, and farms as well as in urban and suburban areas. COOP data usually consists of

daily maximum and minimum temperatures, snowfall, and 24-hour precipitation totals ending at a specific time, such as 7:00 a.m. in many locations.

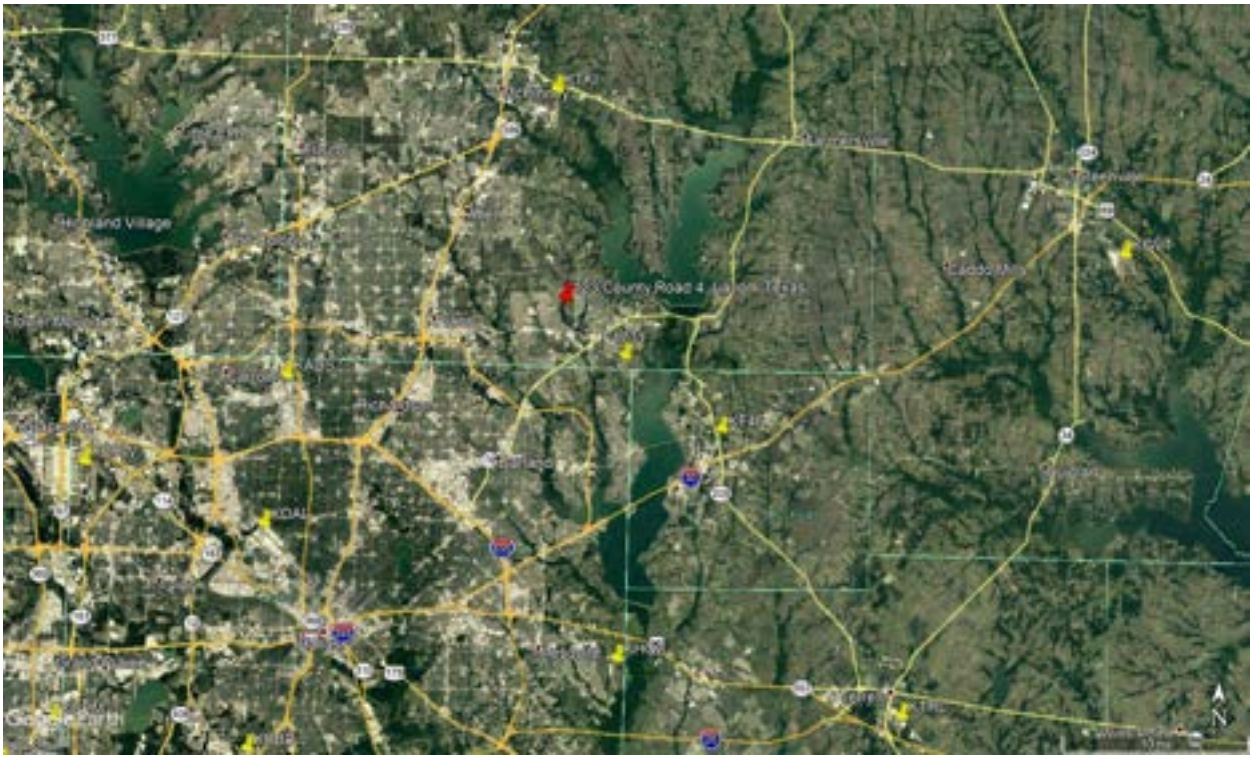
The Community Collaborative Rain, Hail and Snow Network (**CoCoRaHS**) is a network consisting of volunteer weather observers across the United States, Canada and the Bahamas. These volunteers take daily precipitation measurements and report them to a centralized data store online, where this data is heavily utilized by the NWS, meteorologists, emergency managers and city utilities. CoCoRaHS data is particularly useful in situations where storm systems produce sharp precipitation gradients.

The Citizen Weather Observer Program (**CWOP**) is a network of privately-owned electronic weather stations in the United States and in over 150 countries. These stations are part of a network that allows volunteers with computerized weather stations to send automated surface weather observations to the National Weather Service by way of the Meteorological Data Ingest System (MADIS).

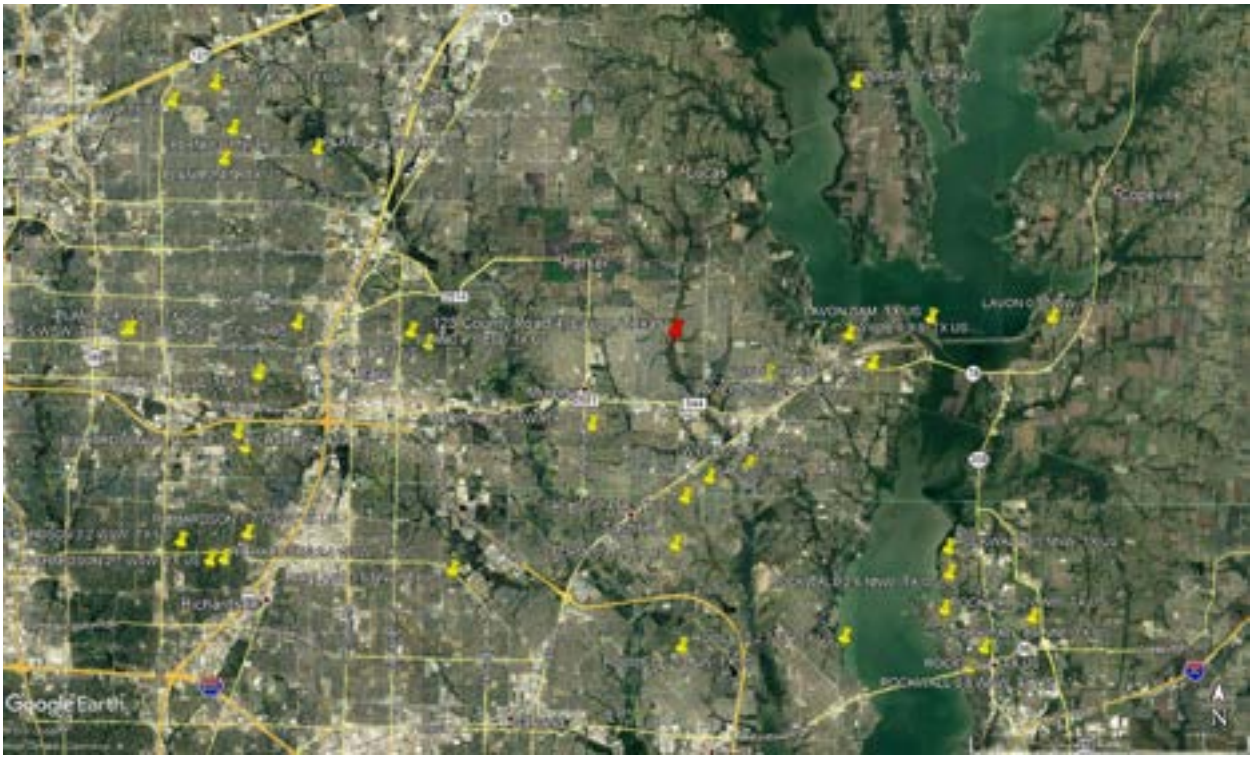
One of the most effective tools to detect precipitation is radar. Radar, which stands for RAdio Detection And Ranging, has been utilized to detect precipitation, and especially thunderstorms, since the 1940's. The radar used by the National Weather Service is called the WSR-88D, which stands for Weather Surveillance Radar - 1988 Doppler (the prototype radar was built in 1988). As its name suggests, the WSR-88D is a **Doppler radar**, meaning it can detect motions toward or away from the radar as well as the location of precipitation areas. There are 155 WSR-88D Doppler radar in the nation, including the U.S. Territory of Guam and the Commonwealth of Puerto Rico, operated by the National Weather Service and the Department of Defense.

The National Weather Service offices around the country issue a multitude of weather alerts, advisories, warnings and bulletins every day and these are also utilized in our investigations.

The incident location was plotted by our office and is indicated by a red pushpin. The following map will help give you an approximate location of the Hourly Surface Weather Observations stations and Citizen Weather Observer Program (CWOP) stations we used in this study and their proximity to the incident location.



The following map will help give you an approximate location of the Cooperative Observer (COOP) and Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) stations we used in this study and their proximity to the incident location.



In order to perform my analysis of the weather conditions that existed, I obtained and reviewed official copies of the following weather records (the distance from the incident location and each weather station is also provided):

a. National Weather Service Hourly Surface Weather Observations/ Local Climatological Data (LCD) from the Ralph M Hall/Rockwall Municipal Airport in Rockwall, Texas (approximately xxxx miles south-southeast of the incident location).

b. National Weather Service Hourly Surface Weather Observations/ Local Climatological Data (LCD) from the McKinney National Airport in Dallas, Texas (approximately xxxx miles northwest of the incident location).

c. National Weather Service Hourly Surface Weather Observations/ Local Climatological Data (LCD) from the Addison Airport in Dallas, Texas (approximately xxxx miles west of the incident location).

d. National Weather Service Hourly Surface Weather Observations/ Local Climatological Data (LCD) from the Majors Airport in Greenville, Texas (approximately xxxx miles east of the incident location).

e. Citizen Weather Observer Program (CWOP) station reports from K5TWC in Wylie, Texas (approximately xxxx miles west-southwest of the incident location).

f. Cooperative observer weather station reports from Lavon Dam, Texas (approximately xxxx miles northwest of the incident location).

g. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Lavon 0.7 NNW, Texas (approximately xxxx miles north-northeast of the incident location).

h. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Wylie 1.6 SSE, Texas (approximately xxxx miles west of the incident location).

i. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Wylie 0.9 S, Texas (approximately xxxx miles west-northwest of the incident location).

j. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Rockwall 3.1 NNW, Texas (approximately xxxx miles south-southwest of the incident location).

k. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Rockwall 1.6 NNE, Texas (approximately xxxx miles south of the incident location).

l. Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports from Rockwall 2.0 NW, Texas (approximately xxxx miles south-southwest of the incident location).

m. Online Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) reports for Dallas County in Texas, Collin County in Texas, Rockwall County in Texas, and Hunt Count in Texas.

n. The publication entitled "Storm Data" for Texas in March 2016, April 2016 and April 2018.

o. Super-resolution Reflectivity Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

p. Super-resolution Velocity Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

q. Differential Reflectivity Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

r. Correlation Coefficient Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

s. Reflectivity Cross Section Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

t. Differential Reflectivity Cross Section Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

u. Specific Differential Phase Doppler Radar images from the Dallas/Fort Worth, Texas radar site that were zoomed in over the incident location.

v. Atmospheric sounding numerical data from Fort Worth, Texas on March 23, 2016, April 11, 2016 and April 6, 2018.

w. Various weather bulletins, advisories and statements that were issued by the National Weather Service (NWS) in Fort Worth/Dallas, Texas.

x. Forensic Weather Consultants Severe Weather History Database.

y. Forensic Weather Consultants "Hail Impact Report" from Www.HailRecords.Com

z. CoreLogic Hail Verification Report.

aa. Iowa Environmental Mesonet (IEM) Archived Warnings issued by the NWS in Fort Worth/Dallas, Texas.

bb. United States Surface Analysis images from the Weather Prediction Center (WPC).

cc. Storm Events Database from the National Centers for Environmental Information (NCEI) for Dallas County, Texas, Collin County, Texas, Rockwall County, Texas and Hunt County, Texas.

The weather data and Climatological records used for this analysis are the official records that Meteorologists rely upon every day during the normal course of business and are either kept in our office or at the National Centers for Environmental Information. The findings in this report utilize the weather records that were available at the time of data retrieval for this case. Any additional weather records and data that become available at a later date may be incorporated into this report in the future.

In addition to the weather records and climatological data listed above, I also reviewed the following information that was provided to me:

- Expert, LLC report by xxxxxxx dated xxxxxxx
- PowerPoint titled "*Lavon Transportation & Shipping v. The Insurance Group*"
- Engineer Report by xxxxxxx dated xxxxxxxx
- Letter from xxxxxxxx dated xxxxxxxx

Super-resolution Doppler radar images and several other types of weather records were used in this study. Doppler radar images are useful for locating precipitation. As the radar unit sends a pulse of energy into the atmosphere and if any precipitation is intercepted by the energy, part of the energy is scattered back to the radar. These return signals, called "radar echoes", are assembled to produce radar images. The location of the colored radar echoes indicates where precipitation is falling and the various colors indicate the intensity of the precipitation through the color code key on the right side of the radar image itself. Doppler radar images are received approximately every 6 minutes and can determine if precipitation was falling at the incident location and if so, when it started and stopped.

Doppler radar images were processed by the Dallas/Fort Worth, Texas radar site. These images were zoomed in over the incident location which I manually plotted using a red "dot" on the radar map. Using the program Gibson Ridge Analyst Edition (GRAE), which is widely used by other consulting meteorologists and National Weather Service Offices nationwide, different radar and dual polarization data over the incident location was obtained.

It should be noted that the radar image date and time stamps that are given on the Doppler radar images are given in "GMT", which is Greenwich Mean Time. In order to convert "GMT" to Central Daylight Time (CDT), a subtraction of 5 hours is necessary. Additionally, the hourly surface weather observations / Local Climatological Data are given in "Local Standard Time" which requires a one-hour forward time adjustment to obtain "Central Daylight Time (CDT)". The only exception to this is that <u>some</u> of the remarks themselves are given in GMT. The findings in this report have incorporated and converted all of these times correctly.

HAIL FORMATION OVERVIEW

Thunderstorms contain significant amounts of energy in the form of updrafts and downdrafts. The vertical wind speeds of the updrafts can reach over 100 Miles Per Hour. As the updraft becomes stronger, the thunderstorm grows taller, allowing water droplets in the updraft to reach altitudes where temperatures are well below freezing. This allows some of the water-droplets to freeze while others will remain in a liquid state event though temperatures are below freezing (these droplets are called super-cooled droplets). Eventually, some of the frozen water-droplets will get into the downdraft, melting slightly as they fall. Some of these frozen water-droplets will be lifted back up into the updraft where they will rapidly rise. During this time, they will freeze on contact with other ice crystals, other super-cooled water droplets, or dust forming even larger droplets. This repeated cycle can occur several times depending on the strength of the updraft and these processes allow the hail stone to accumulate more layers of ice. This continues until the hailstone becomes too heavy for the updraft to support it. At that time, the hailstone will fall to the earth's surface.

Hailstones often consist of different layers. These layers are caused by the different rates of accumulation and freezing of supercooled water, as the hailstone forms. When there is a great deal of supercooled liquid in the air through which the hailstone falls, water accumulates faster than it can freeze, so a coat of liquid forms. This becomes a layer of clear ice when it does freeze. When a hailstone falls through air with a smaller amount of liquid, the liquid freezes on contact with the hailstone, forming small air bubbles in the opaque layers. The more

supercooled water a hailstone makes contact with, the larger and heavier the stone is likely to become.

Not all hail events, wind gusts and storm damage is reported to the National Weather Service (NWS) and the National Centers for Environmental Information (NCEI). These are the entities that compile these reports. There are number of reasons why storm reports may not be listed. Some include the time of day, if the storm occurred during the overnight hours when most people were sleeping, how populated an area is, if communications were interrupted, if the NWS logged each storm report that was received, or if the general public even knew how to submit such a report. For these reasons and others, just because hail, wind or tornado reports were not listed near the location of an incident does not mean it didn't occur. In order to determine what the weather conditions were at the incident location, a Certified Consulting Meteorologist should conduct a detailed analysis using the most reliable data sources and industry accepted methodology and practices.

Numerous studies and research have been conducted which led to the accepted methodologies, standards and practices that I employed during this study. These best practices and standards are based on documented research, accepted practices and principles that experienced meteorologists utilize in these kinds of investigations. Some of the many different guidelines can be found in online National Weather Service modules located at (https://training.weather.gov/wdtd/courses/rac/severe/svr-hail/presentation_html5.html), and they are utilized by NWS offices nationwide.

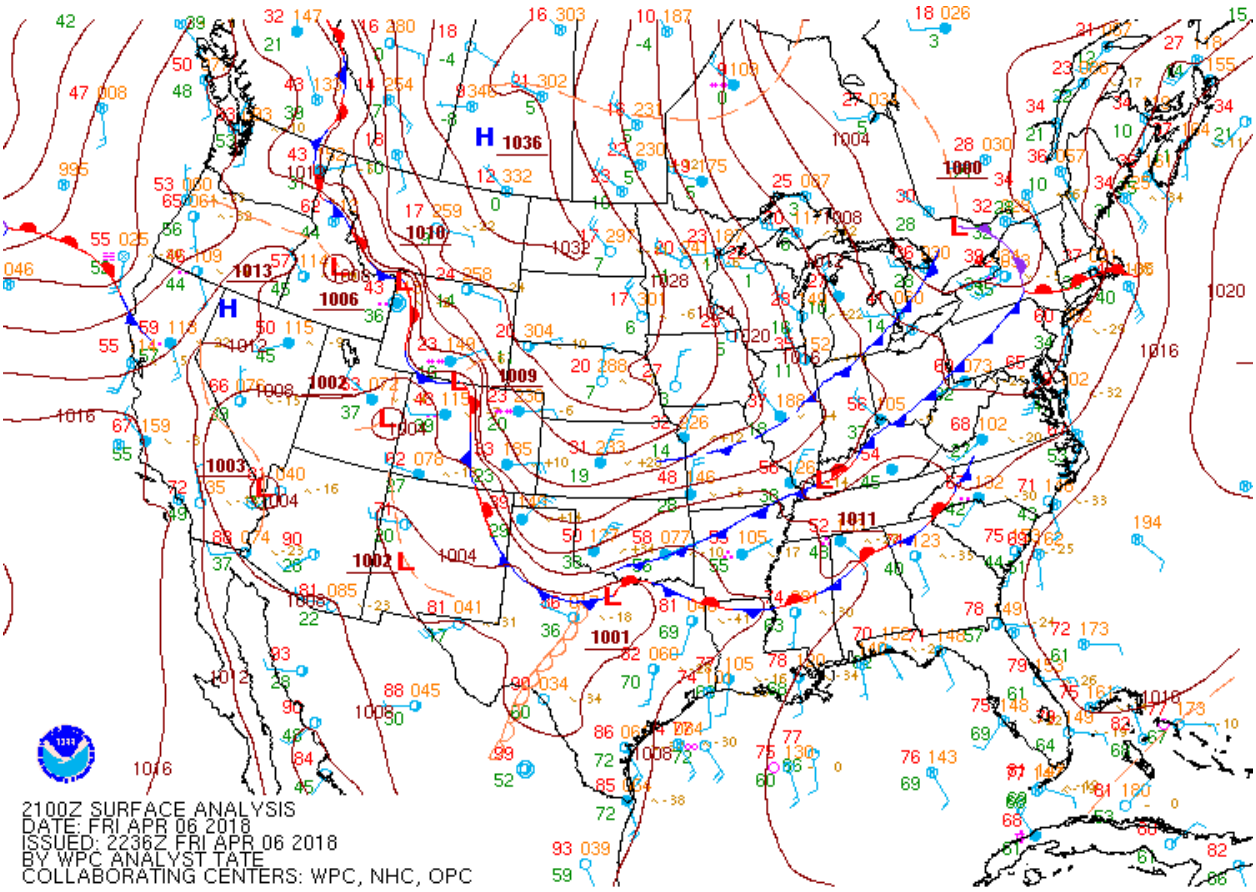
These methods and procedures, among many others, were also taught by the National Weather Service's Warning Decision Training Branch and the University Oklahoma Meteorology department as part of the "Decision-Making Using Dual Polarization Radar" course that I completed and received certification for in 2015. These courses and the live on-site training that I participated in at the NWS training division in Oklahoma taught how various Doppler radar and Dual Polarization values, thresholds and signatures can indicate hail, very large hail, giant hail, plain rain, and non-precipitation areas among other things.

As part of my analysis, the incident location was manually plotted on each Doppler radar image in order to determine the intensity and values of the different radar products. In addition, I manually centered the Doppler radar cross-section images over the incident location in order to determine the vertical profile of the thunderstorms over the incident location. Using this methodology, I was able to determine the many different radar values and reflectivity heights that are contained in my report. These, along with the other weather records and data were used to complete my meteorological analysis.

The methodology, practices and principles I employed researching, analyzing and determining the weather information contained in this report is the industry-accepted way to determine the presence of hail, hail size, wind speeds, tornadoes and other weather conditions at a specific incident location. My findings, including extrapolation of the radar data and weather records, are all based on sound, scientific principles, practices and accepted methodology in the field of meteorology.

METEOROLOGICAL ANALYSIS FOR APRIL 6, 2018

The following is a surface analysis map of the contiguous United States at 4:00 p.m. CDT on April 6th, 2018 that was prepared by the Weather Prediction Center (WPC), a division of the National Weather Service. This surface map indicated that an area of low pressure was located in north-central Texas. A dryline extended to the south-southwest of this area of low pressure into Mexico. A stationary front extended to the east of this low pressure through northern Louisiana and then all the way into North Carolina.



At the surface, air temperatures were in the low 80's during the late afternoon and early evening and dew points were near 65 degrees. The combination of instability, a lifting mechanism and other favorable atmospheric conditions led to the formation of strong to severe thunderstorms.

Doppler radar images that were zoomed in over the incident location and other information indicated that strong thunderstorms affected the incident location from approximately 5:45 p.m. through 7:46 p.m.

During this time, the thunderstorms were most intense between approximately 6:17 p.m. and 6:29 p.m. with reflectivity values as high as 64 dBZ at the incident location. These thunderstorms generally moved toward the southeast. The Doppler radar beam was located at approximately 4,162 Feet above the ground over the incident location.

A "Tornado Warning" was in effect from 5:37 p.m. through 6:15 p.m. on April 6th, 2018. This warning stated that hail up to 2.50" in diameter was expected and radar indicated a severe thunderstorm capable of producing a tornado. The National Weather Service in Fort Worth/Dallas, Texas issued also issued a "Severe Thunderstorm Warning" that was in effect from 6:13 p.m. to 7:30 p.m. on April 6th, 2018. This warning stated that hail up to 2.75" in diameter and wind gusts in excess of 60 MPH were expected. This warning also stated that a tornado was possible. After review of the weather records and radar data, it was determined that a tornado did not affect the incident location on April 6th, 2018.

Base Reflectivity, Base Velocity, Differential Reflectivity and Correlation Coefficient Radar

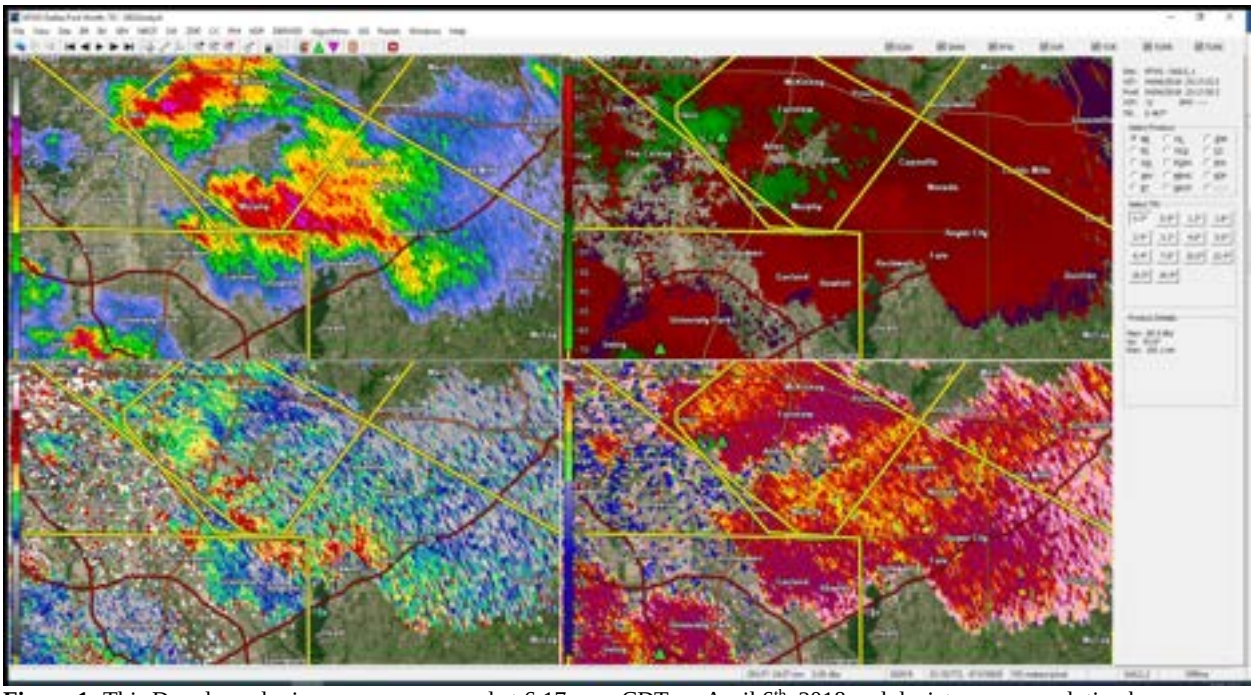


Figure 1: This Doppler radar image was processed at 6:17 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

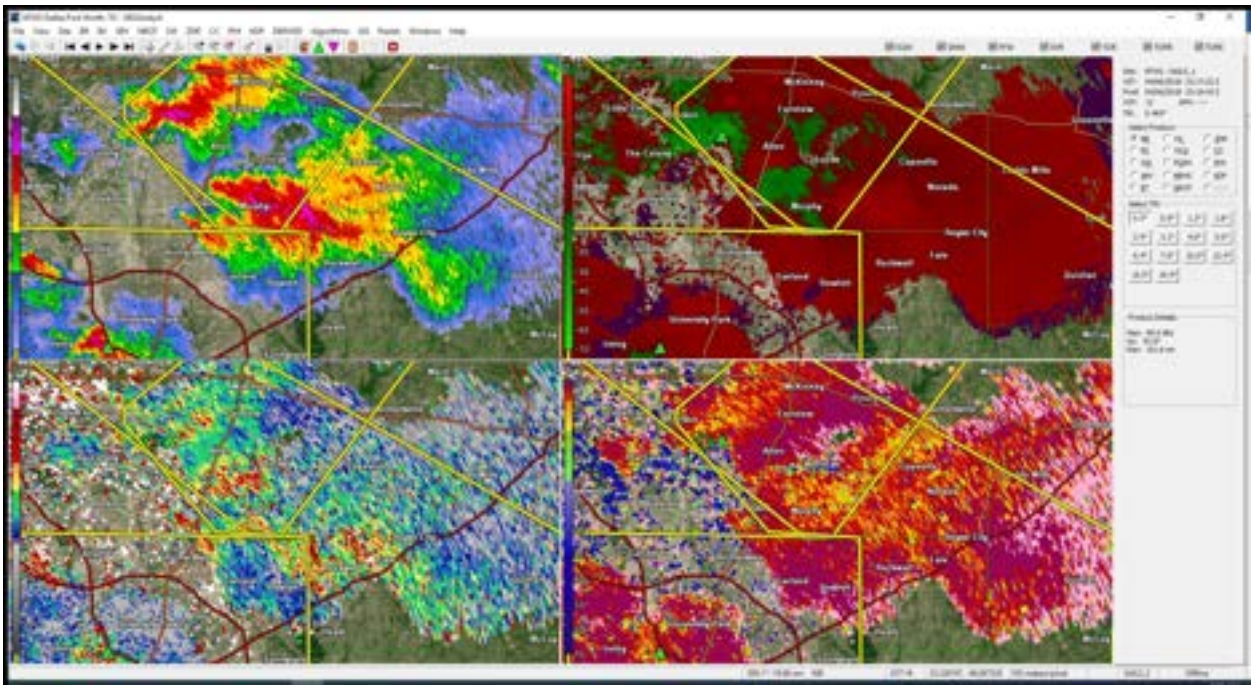


Figure 2: This Doppler radar image was processed at 6:19 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

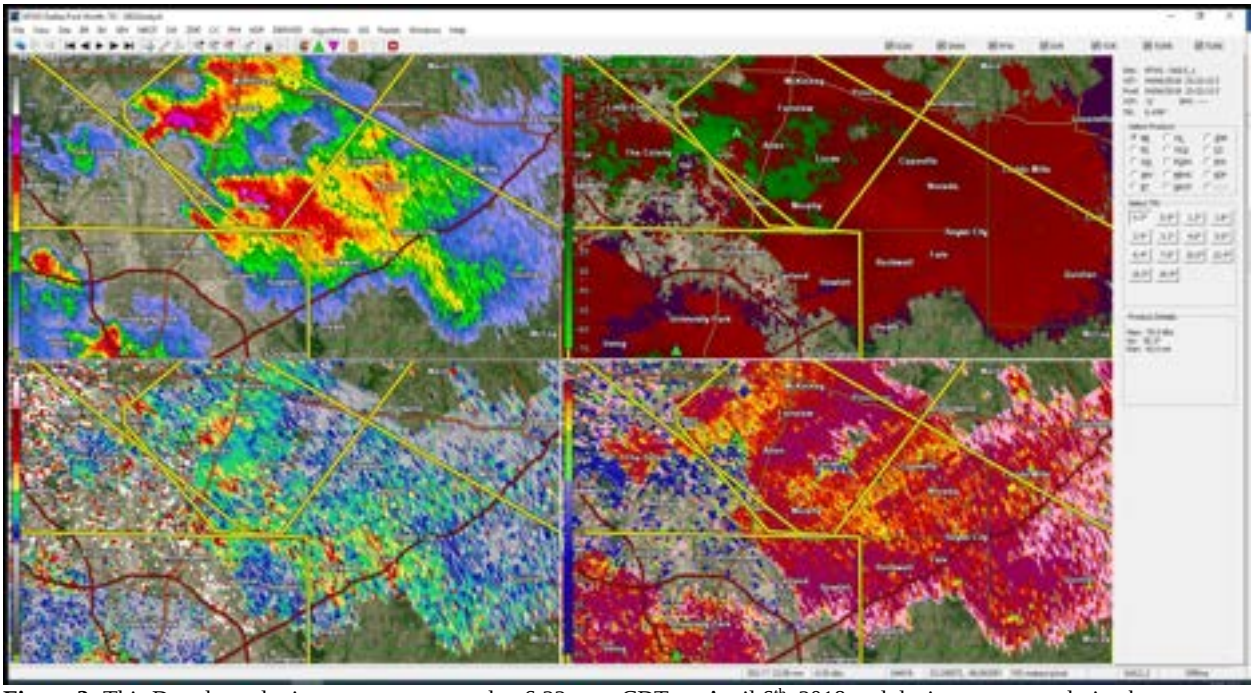


Figure 3: This Doppler radar image was processed at 6:22 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

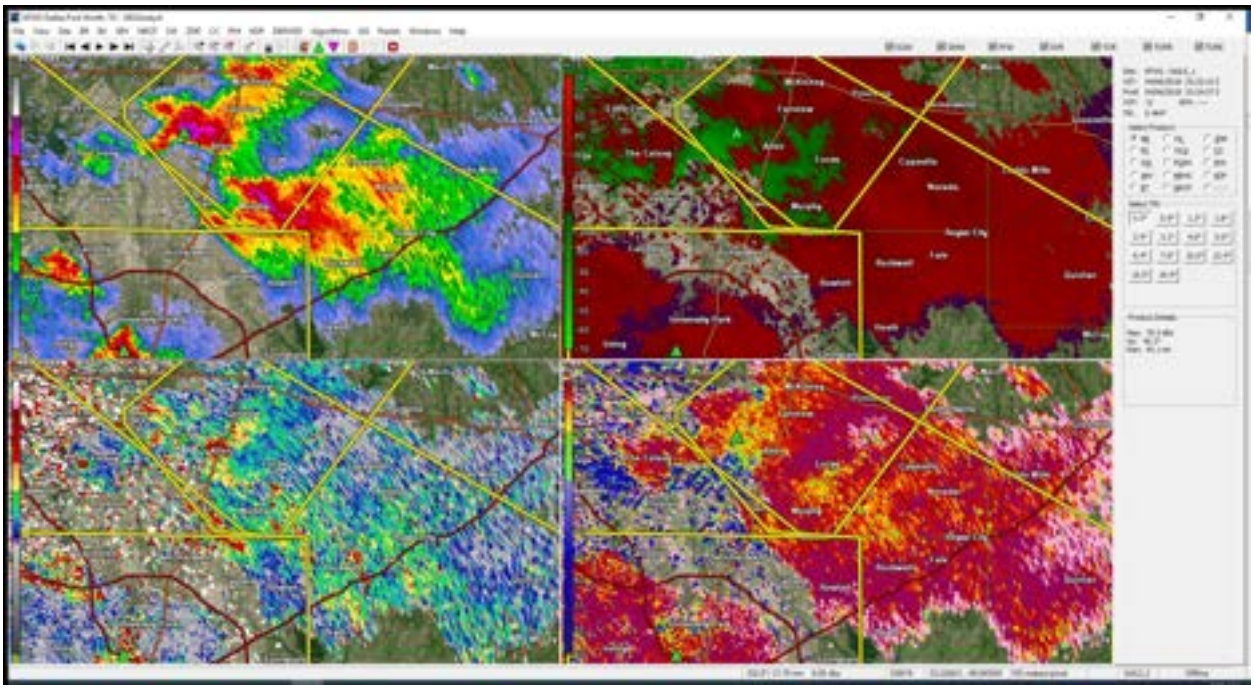


Figure 4: This Doppler radar image was processed at 6:24 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

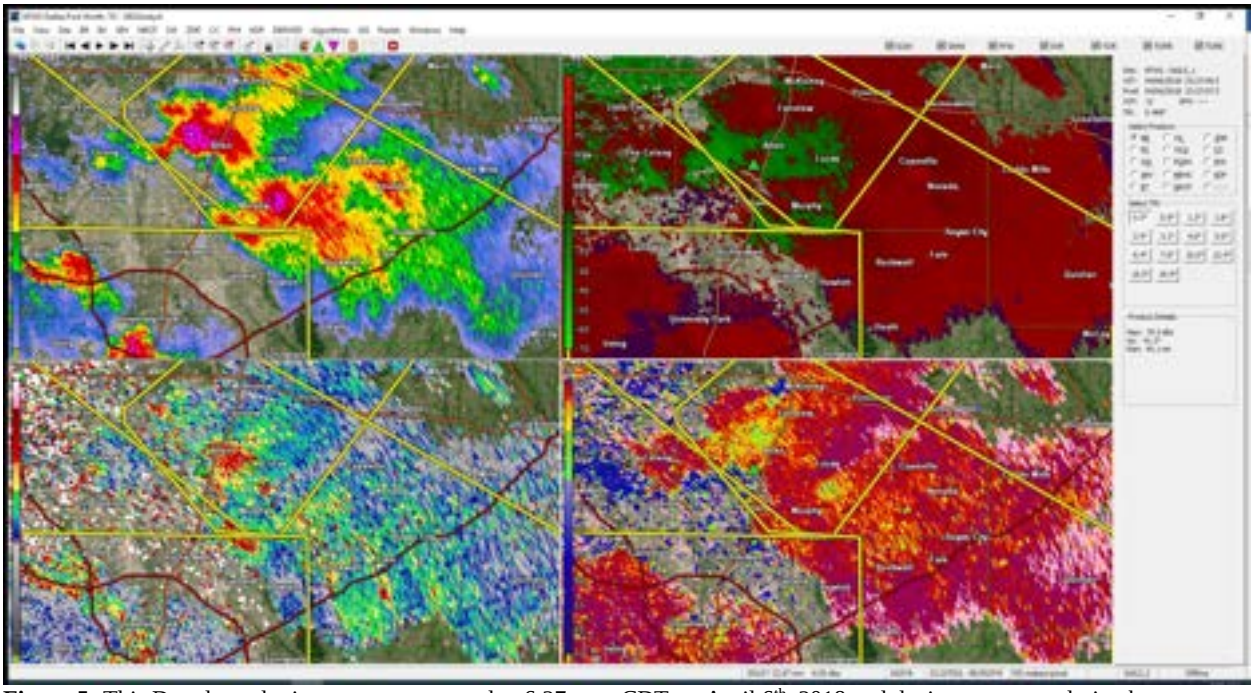


Figure 5: This Doppler radar image was processed at 6:27 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

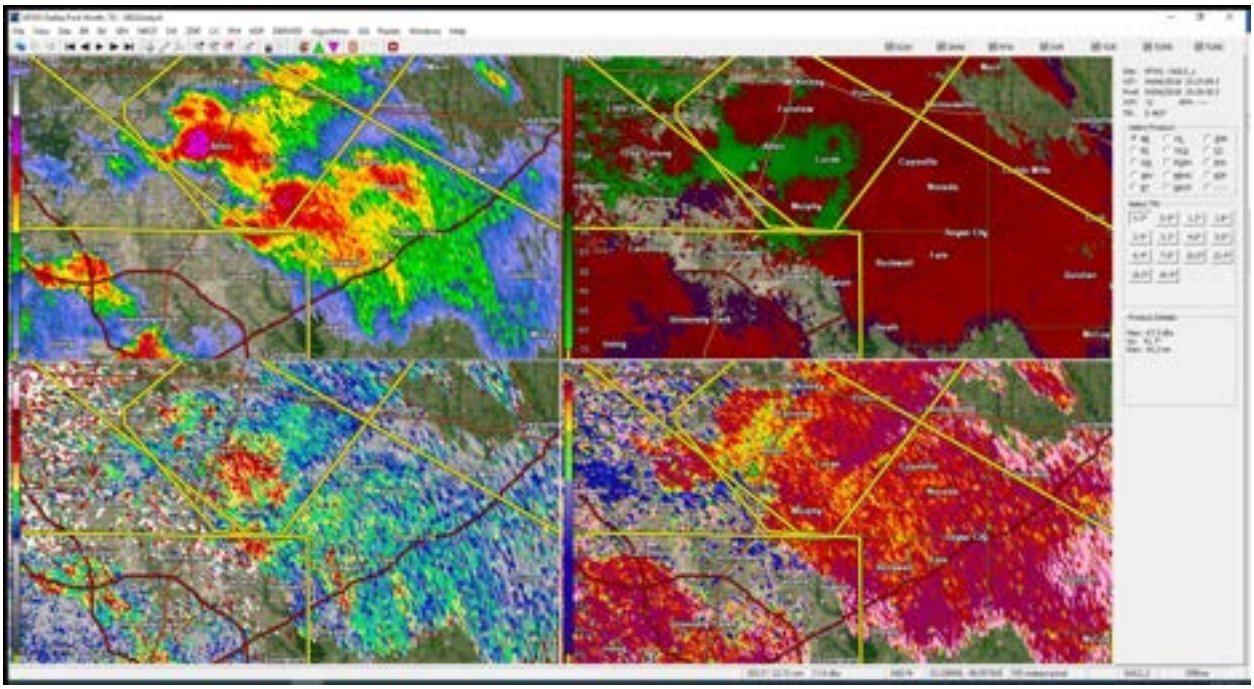


Figure 6: This Doppler radar image was processed at 6:29 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

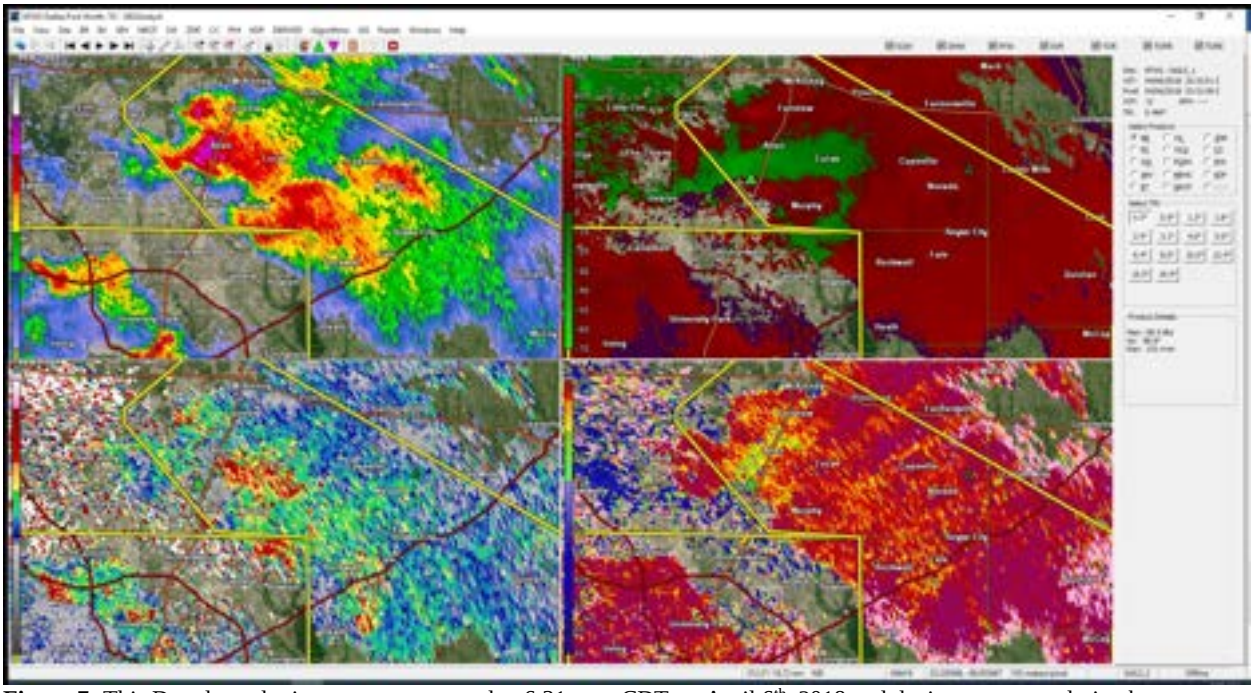
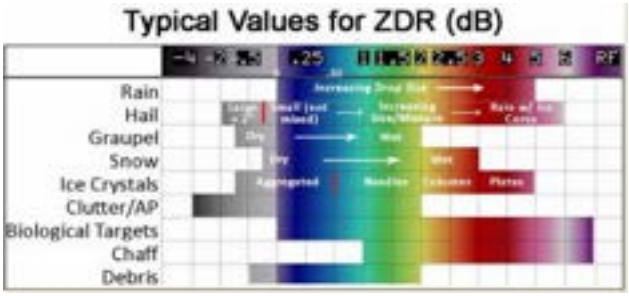


Figure 7: This Doppler radar image was processed at 6:31 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (top left), super-resolution base velocity (top right), differential reflectivity (bottom left), and correlation coefficient (bottom right).

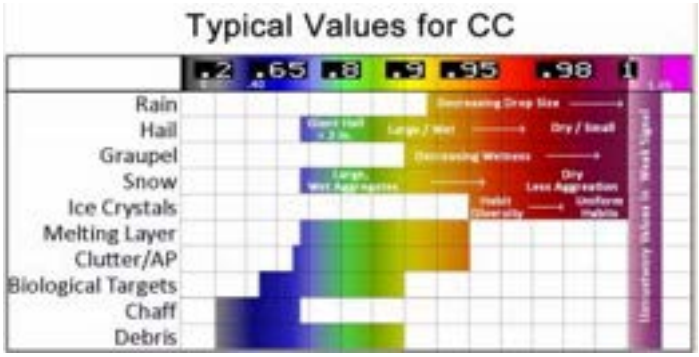
Differential Reflectivity (ZDR)

Differential reflectivity (ZDR) is the difference between the horizontal and vertical reflectivity values observed by Doppler radar. ZDR is useful in determining the shape of the hydrometeor and identifying hail compared to a raindrop. **At the incident location, differential reflectivity values were as low as -0.50 dB. According to the WSR-88D Dual Polarization Guide for "ZDR" that can be found below, this correlates to Large Hail greater than 2 inches.**



Correlation Coefficient (CC)

Correlation Coefficient (CC) is a measure of how similar the horizontal and vertical pulses are behaving from pulse to pulse. CC is useful for identifying large hail, tornadic debris aloft, rain versus snow, and irregular hydrometeor shapes. **At the incident location, Correlation coefficient values were as low as 84.2%. According to the WSR-88D Dual Polarization Guide below for "CC" that can be found below, this correlates to Giant Hail greater than 2 inches.**



Specific Differential Phase Radar

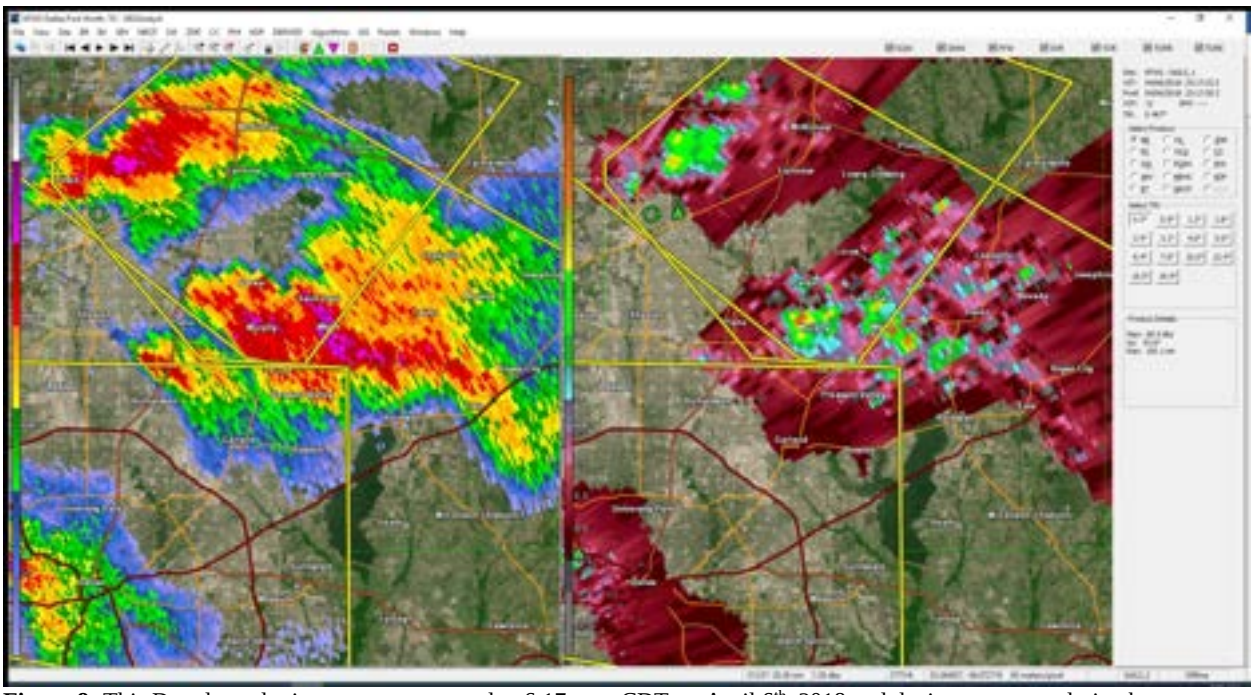


Figure 8: This Doppler radar image was processed at 6:17 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

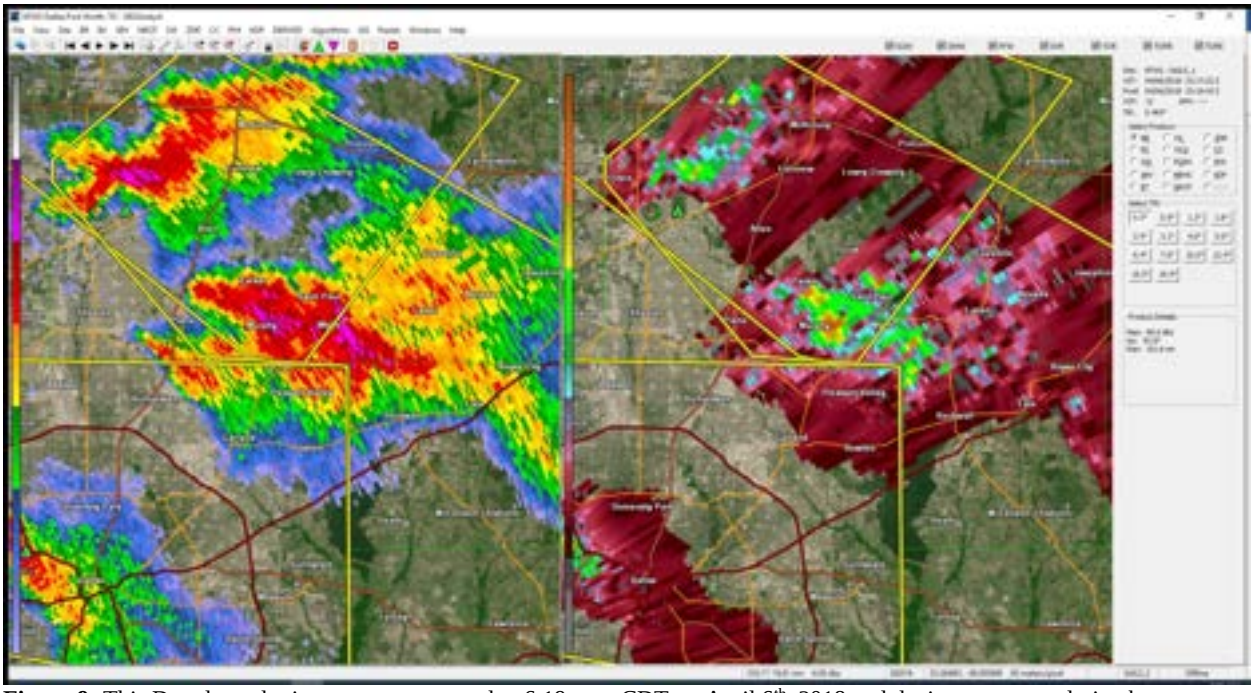


Figure 9: This Doppler radar image was processed at 6:19 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

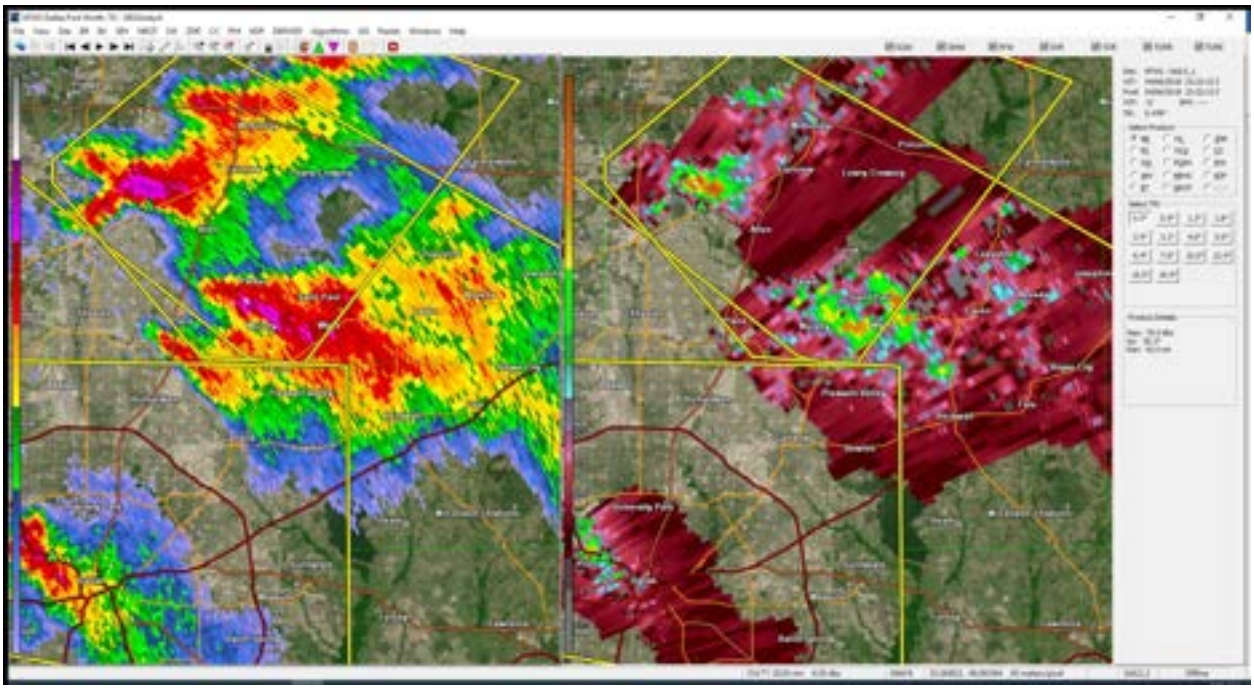


Figure 10: This Doppler radar image was processed at 6:22 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

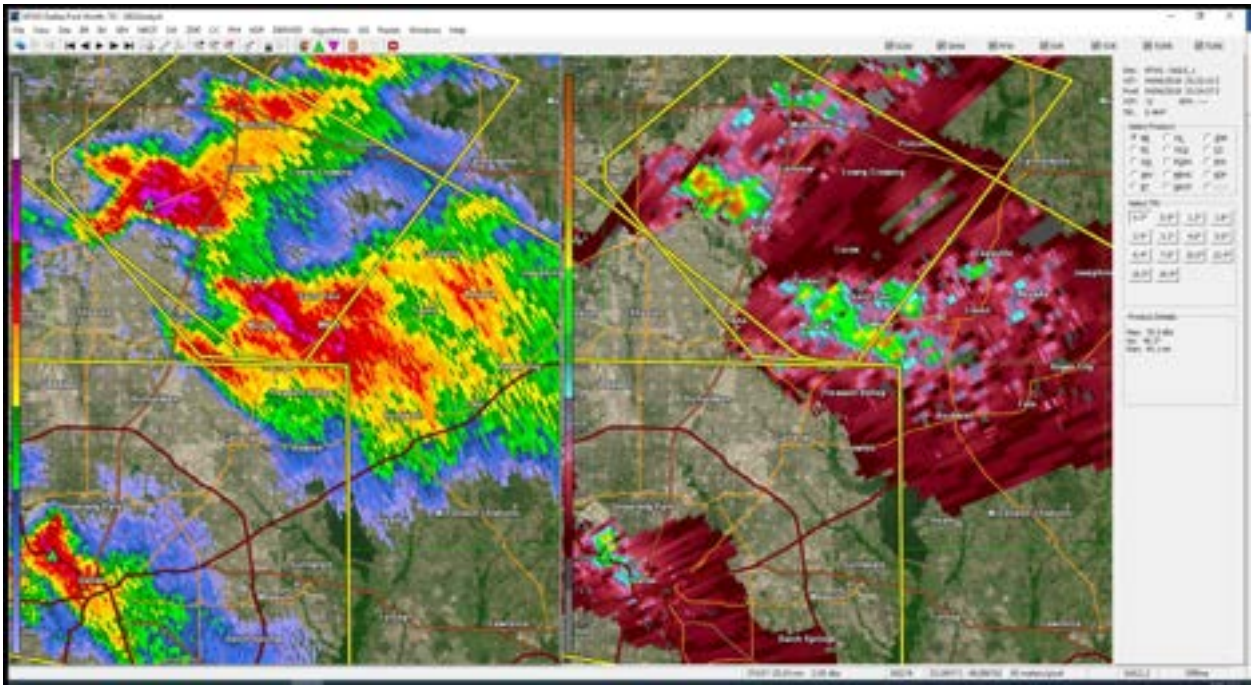


Figure 11: This Doppler radar image was processed at 6:24 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

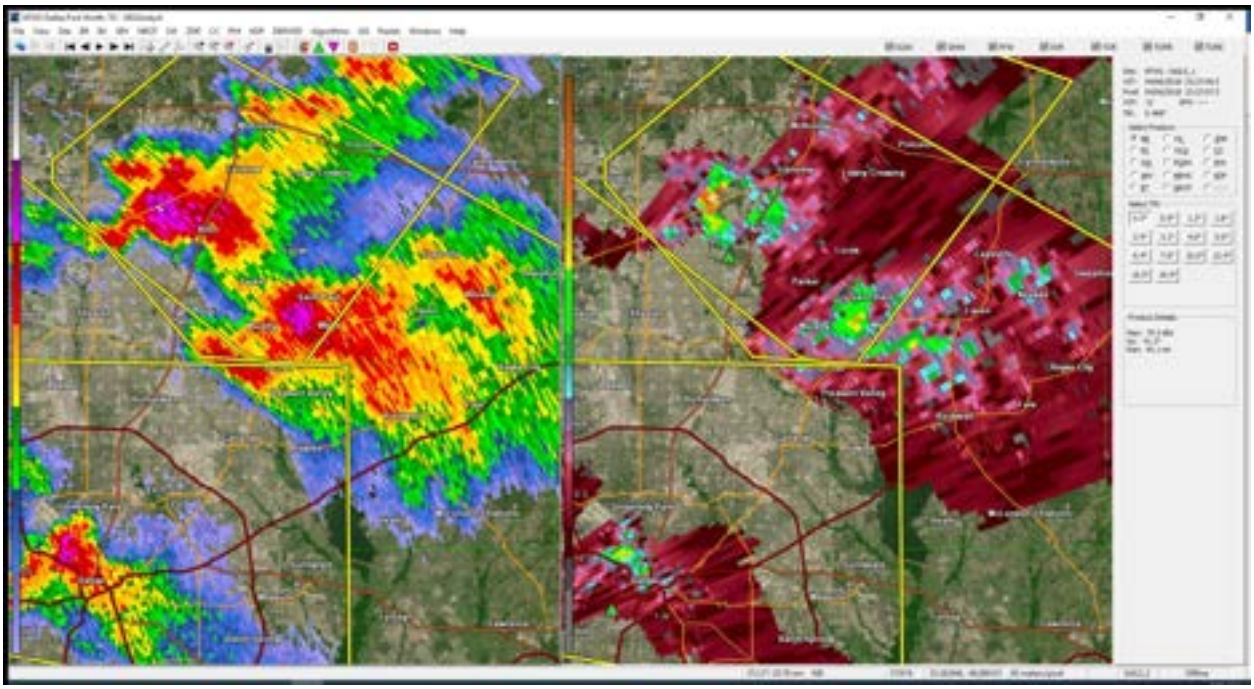


Figure 12: This Doppler radar image was processed at 6:27 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

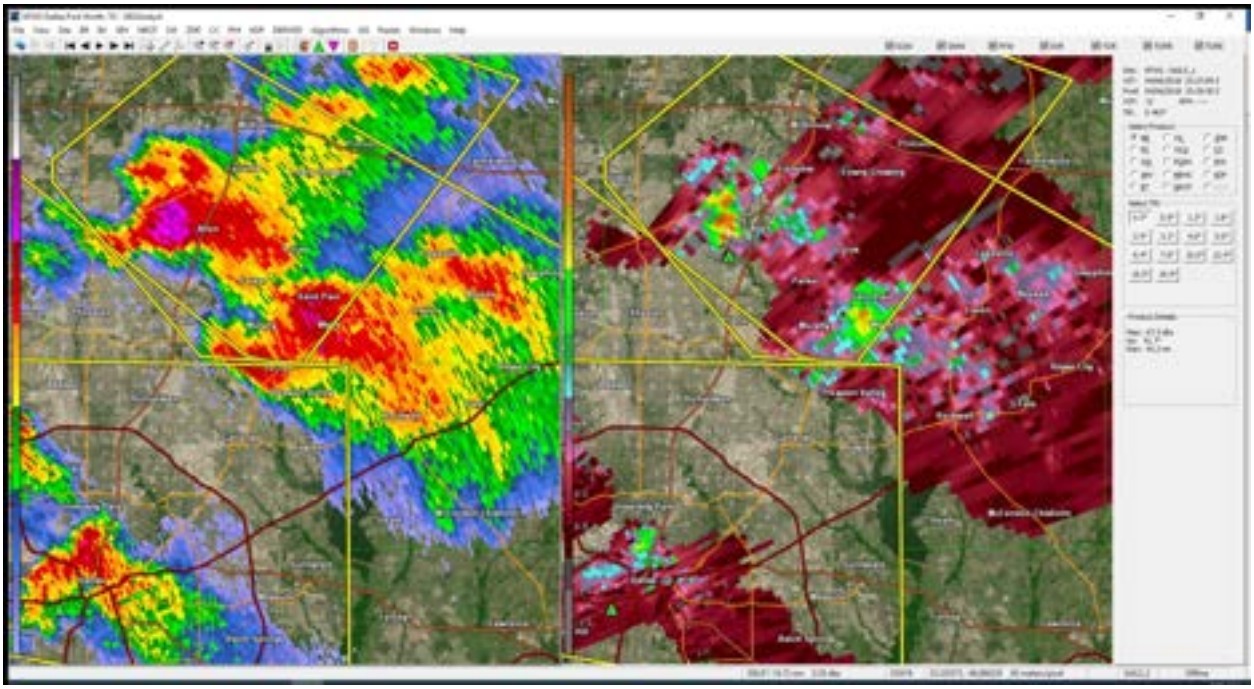
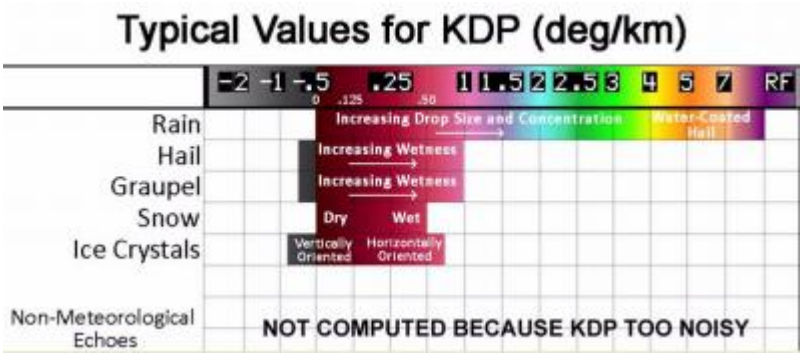


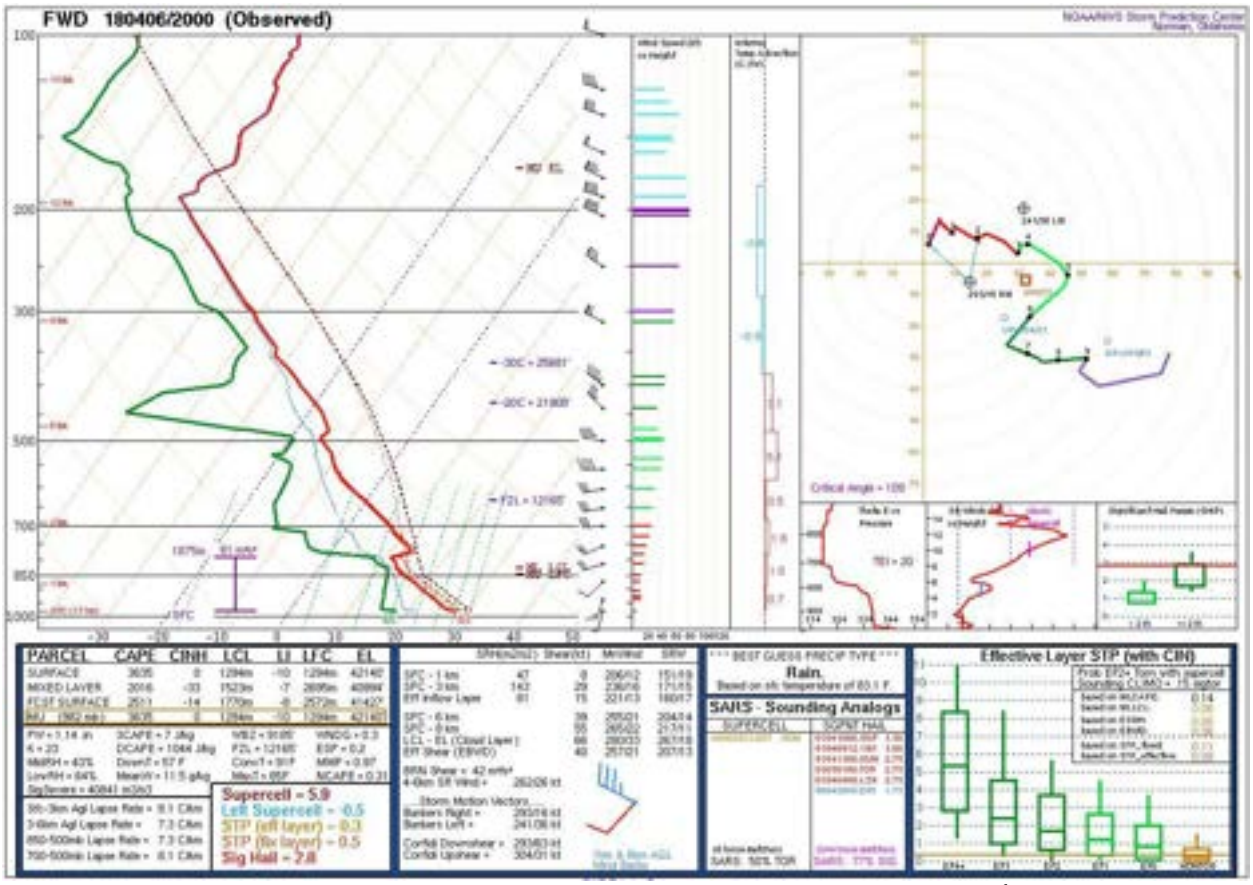
Figure 13: This Doppler radar image was processed at 6:29 p.m. CDT on April 6th, 2018 and depicts super-resolution base reflectivity (left) and specific differential phase (right).

Specific Differential Phase (KDP)

Specific Differential Phase (KDP) is a range derivative of the differential phase shift between horizontal and vertical pulses. It is useful in identifying solid hail, melting hail and rain. **At the incident location, Specific Differential Phase values were as low as 0.80 degrees per kilometer when the higher reflectivity values occurred. According to the WSR-88D Dual Polarization Guide that can be found below, this indicates that the hail was partially water-coated**.



Radiosonde (Balloon Launch) Observations



According to this radiosonde image (balloon launch) from 3:00 p.m. CDT on April 6th, 2018, the Environmental Freezing Level (0 degrees Celsius Level) was located at approximately 12,165 Feet above the ground, and the -20 Degree Celsius Level was located at approximately 21,908 Feet above the ground.

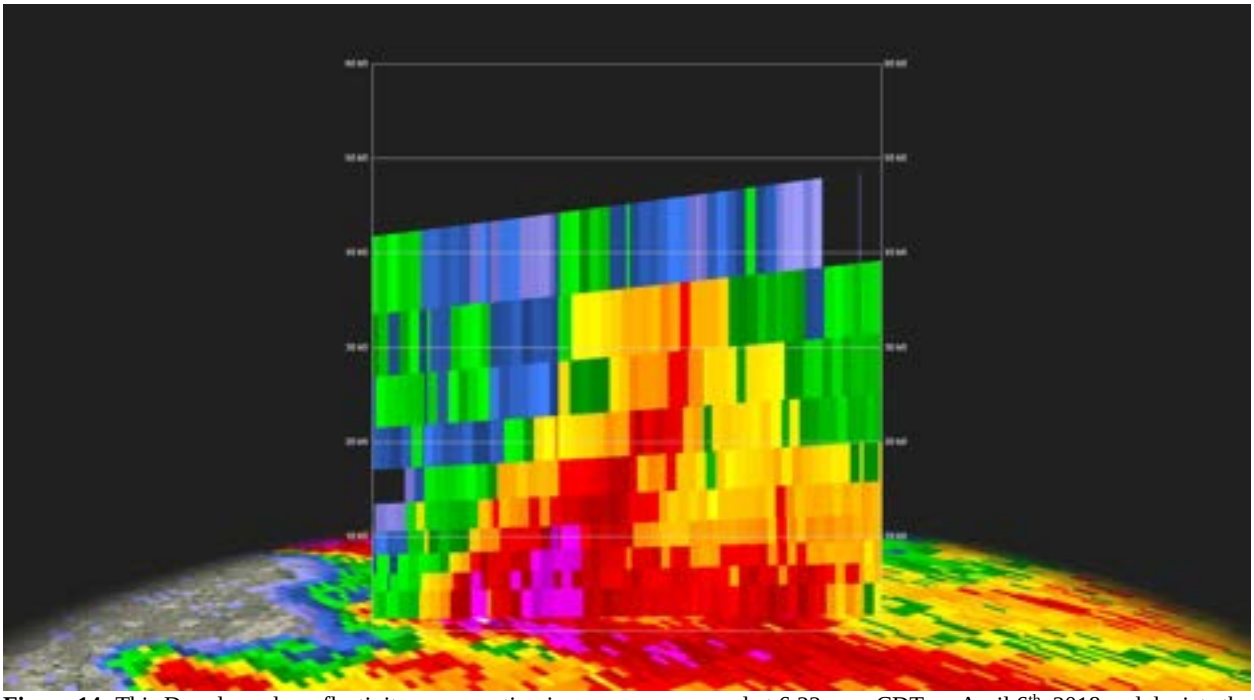


Figure 14: This Doppler radar reflectivity cross-section image was processed at 6:22 p.m. CDT on April 6th, 2018 and depicts the vertical structure of the thunderstorm over the incident location. The incident location is located at the bottom center of the vertical cross-section box. Thus, this image depicts what the radar was observing from near the ground up.

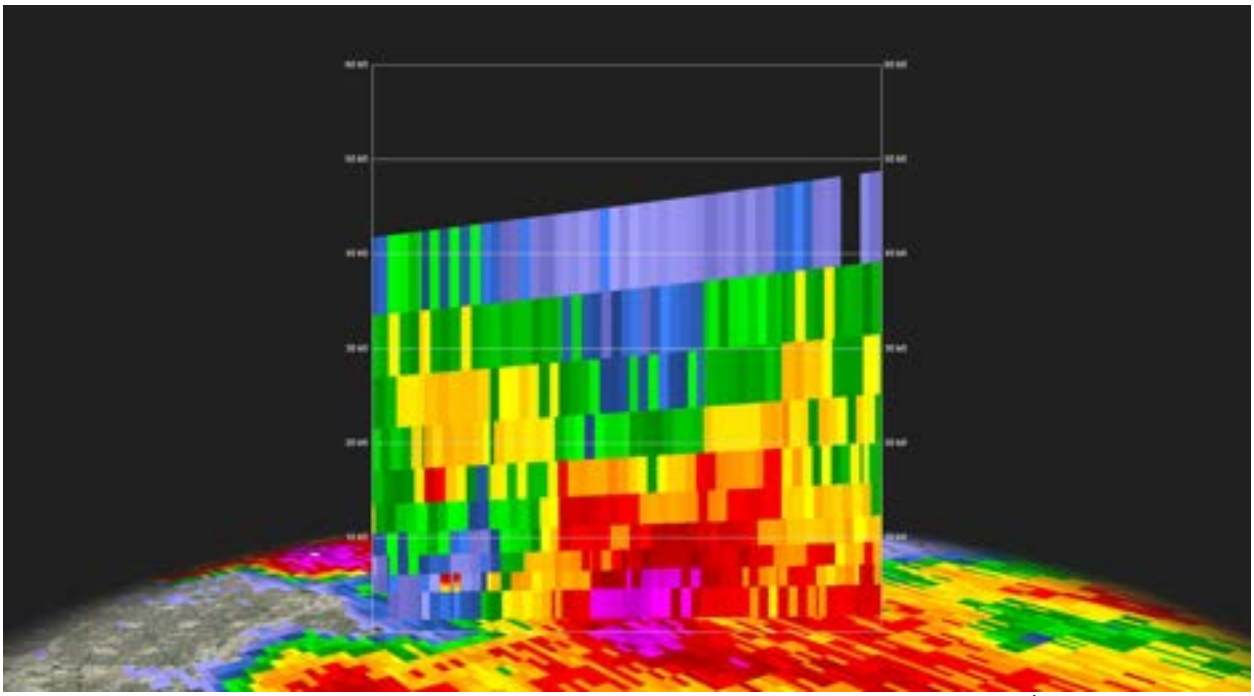


Figure 15: This Doppler radar reflectivity cross-section image was processed at 6:27 p.m. CDT on April 6th, 2018 and depicts the vertical structure of the thunderstorm over the incident location. The incident location is located at the bottom center of the vertical cross-section box. Thus, this image depicts what the radar was observing from near the ground up.

The following images were processed between 6:22-6:27 p.m. and depict differential reflectivity cross sections which show a differential reflectivity channel moved over the incident location.

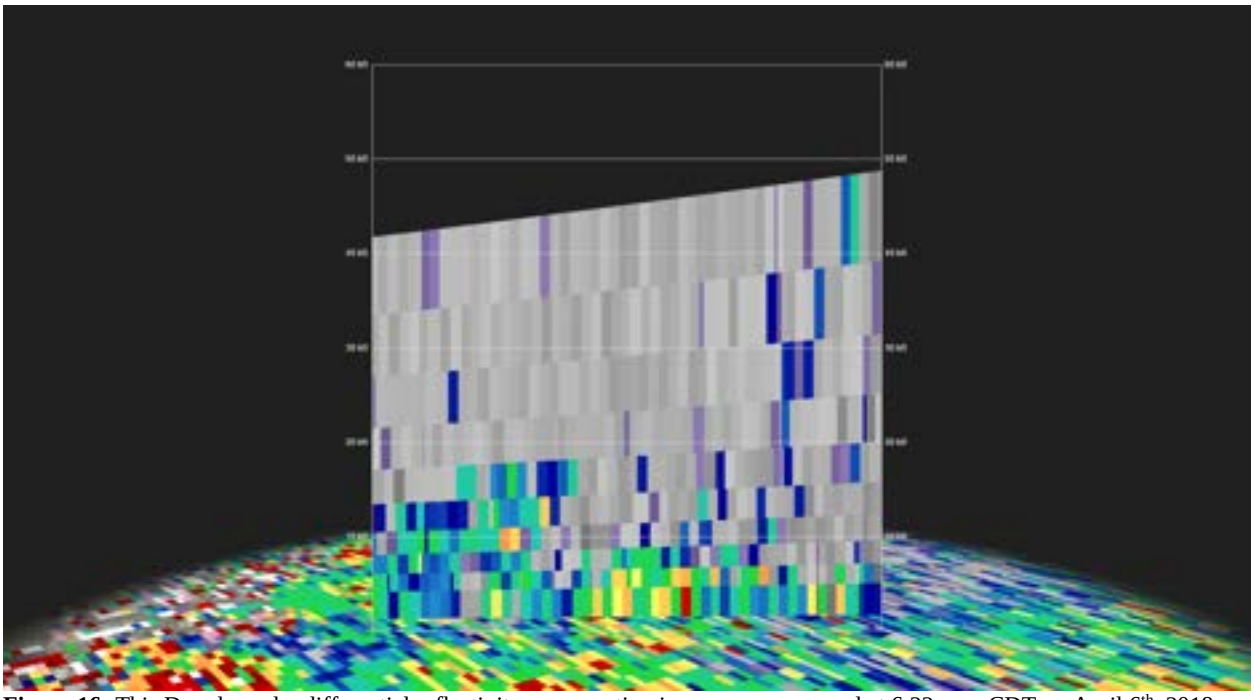


Figure 16: This Doppler radar differential reflectivity cross-section image was processed at 6:22 p.m. CDT on April 6th, 2018 and depicts the vertical structure of differential reflectivity within the thunderstorm from the ground up. The incident location is located at the bottom center of the vertical cross-section box.

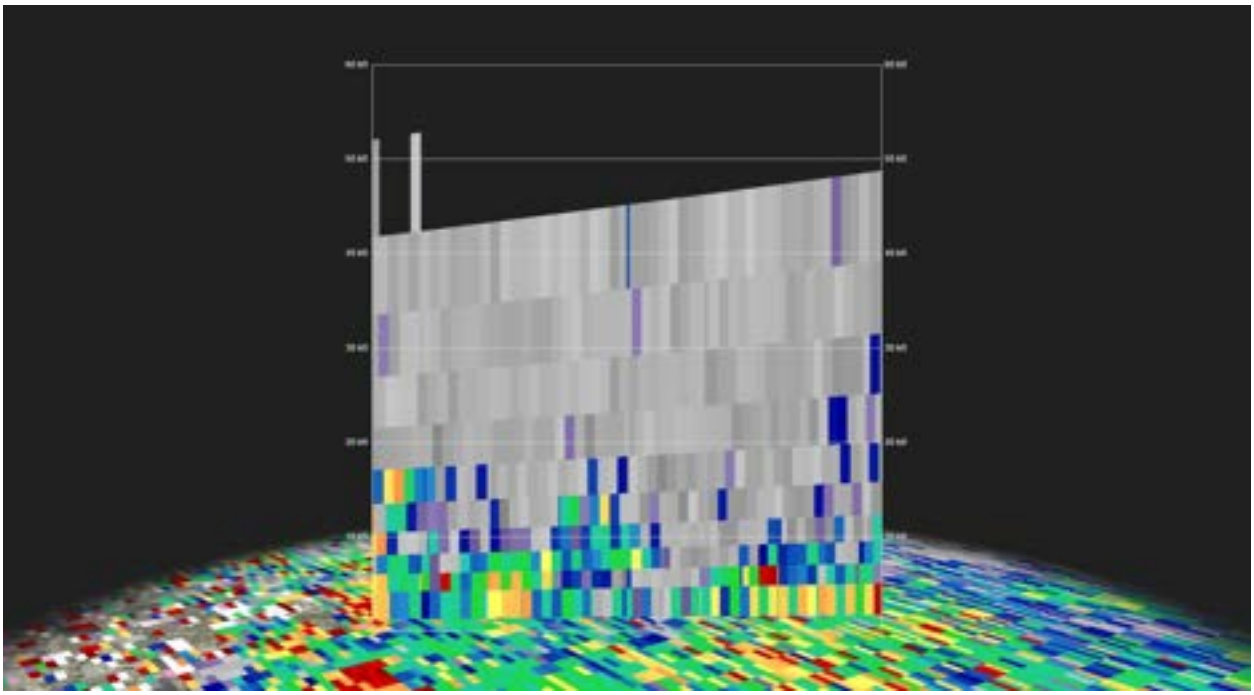


Figure 17: This Doppler radar differential reflectivity cross-section image was processed at 6:27 p.m. CDT on April 6th, 2018 and depicts the vertical structure of differential reflectivity within the thunderstorm from the ground up. The incident location is located at the bottom center of the vertical cross-section box.

NATIONAL WEATHER SERVICE BULLETINS, WARNINGS AND ADVISORIES

The following are publicly issued warnings and severe weather statements from the National Weather Service in Fort Worth/Dallas, Texas which included the incident location and surrounding areas.

At 5:37 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Tornado Warning" that was in effect for Collin County through 6:15 p.m. on April 6th, 2018:

```
Tornado Warning
National Weather Service Fort Worth TX
537 PM CDT FRI APR 6 2018
The National Weather Service in Fort Worth has issued a
* Tornado Warning for...
  Collin County in north central Texas...
* Until 615 PM CDT.
* At 536 PM CDT, a severe thunderstorm capable of producing a tornado
  was located near Prosper, or near Frisco, moving southeast at 25
  mph.
  HAZARD...Tornado and tennis ball size hail.
  SOURCE...Radar indicated rotation.
  IMPACT...Flying debris will be dangerous to those caught without
           shelter. Mobile homes will be damaged or destroyed.
           Damage to roofs, windows, and vehicles will occur.  Tree
           damage is likely.
* This dangerous storm will be near...
  McKinney around 540 PM CDT.
  Plano around 550 PM CDT.
  Allen, Fairview and Parker around 600 PM CDT.
  Lucas and Lowry Crossing around 605 PM CDT.
  Richardson, Sachse and Murphy around 610 PM CDT.
  Wylie around 615 PM CDT.
Other locations impacted by this tornadic thunderstorm include
Josephine, New Hope, Lavon, St. Paul and Nevada.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
TAKE COVER NOW! Move to an interior room on the lowest floor of a
sturdy building. Avoid windows. If you are outdoors, in a mobile
home, or in a vehicle, move to the closest substantial shelter and
protect yourself from flying debris.
&&
LAT...LON 3311 9630 3298 9630 3298 9664 3310 9684
      3329 9684 3332 9682
TIME...MOT...LOC 2236Z 300DEG 23KT 3319 9677
TORNADO...RADAR INDICATED
HAIL...2.50IN
```

At 5:55 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Weather Statement" for the "Tornado Warning" that was in effect for Southern Collin County through 6:15 p.m. on April 6th, 2018:

```
Severe Weather Statement
National Weather Service Fort Worth TX
555 PM CDT FRI APR 6 2018
TXC085-062315-
/O.CON.KFWD.TO.W.0008.000000T0000Z-180406T2315Z/
Collin TX-
555 PM CDT FRI APR 6 2018
...A TORNADO WARNING REMAINS IN EFFECT UNTIL 615 PM CDT FOR SOUTHERN
COLLIN COUNTY...
At 553 PM CDT, a severe thunderstorm capable of producing a tornado
was located over Allen, moving southeast at 25 mph.
HAZARD...Tornado and ping pong ball size hail.
SOURCE...Radar indicated rotation.
IMPACT...Flying debris will be dangerous to those caught without
```

```
        shelter. Mobile homes will be damaged or destroyed. Damage
        to roofs, windows, and vehicles will occur.  Tree damage is
        likely.
This potentially tornadic circulation will be near...
  Parker and Lowry Crossing around 605 PM CDT.
  Murphy and Lucas around 610 PM CDT.
  Dallas, Richardson, Wylie and Sachse around 615 PM CDT.
The hail core will remain north and east of the circulation's track.
Other locations impacted by this thunderstorm include
Josephine, New Hope, Lavon, St. Paul and Nevada.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
Motorists should not take shelter under highway overpasses.
&&
LAT...LON 3311 9630 3298 9630 3298 9664 3307 9679
      3321 9676 3325 9664
TIME...MOT...LOC 2253Z 305DEG 21KT 3313 9667
TORNADO...RADAR INDICATED
HAIL...1.50IN
```

At 6:13 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Thunderstorm Warning" that was in effect for Southern Collin County through 7:30 p.m. on April 6th, 2018:

```
Severe Thunderstorm Warning
National Weather Service Fort Worth TX
613 PM CDT FRI APR 6 2018
The National Weather Service in Fort Worth has issued a
* Severe Thunderstorm Warning for...
  Rockwall County in north central Texas...
  Southwestern Hunt County in north central Texas...
  Northern Kaufman County in north central Texas...
  Southern Collin County in north central Texas...
* Until 730 PM CDT.
* At 612 PM CDT, a severe thunderstorm was located over Wylie, moving
  southeast at 25 mph.
  HAZARD...Golf ball size hail and 60 mph wind gusts.
  SOURCE...Radar indicated.
  IMPACT...People and animals outdoors will be injured. Expect hail
           damage to roofs, siding, windows, and vehicles. Expect
           wind damage to roofs, siding, and trees.
* Locations impacted include...
  Plano, McKinney, Frisco, Richardson, Allen, Rowlett, Wylie,
  Rockwall, Sachse, Terrell, Forney, Murphy, Royse City, Fairview,
  Heath, Princeton, Fate, Lucas, Parker and Farmersville.
This includes the following interstates...
 Interstate 20 between mile markers 486 and 503.
 Interstate 30 between mile markers 65 and 86.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
Prepare for large hail and damaging winds. People outside should move
immediately to shelter inside a strong building. Stay away from
windows.
If on or near Lake Ray Hubbard and Lake Lavon, get away from the
water and move indoors or inside a vehicle. Do not be caught on the
water in a thunderstorm. High winds and waves can capsize boats.
&&
LAT...LON 3284 9605 3284 9608 3270 9608 3266 9652
      3298 9652 3299 9668 3315 9684 3317 9684
      3328 9668 3296 9603
TIME...MOT...LOC 2312Z 316DEG 22KT 3304 9655
HAIL...1.75IN
WIND...60MPH
```

At 6:15 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Weather Statement" for the expiration of the "Tornado Warning" that was in effect:

```
Severe Weather Statement
National Weather Service Fort Worth TX
615 PM CDT FRI APR 6 2018
TXC085-062322-
/O.EXP.KFWD.TO.W.0008.000000T0000Z-180406T2315Z/
Collin TX-
615 PM CDT FRI APR 6 2018
...THE TORNADO WARNING FOR SOUTHERN COLLIN COUNTY WILL EXPIRE AT 615
PM CDT...
Although spotters continue to observe rotation, the tornado threat
has diminished with the storm in Collin County. However, large hail
and damaging winds will still be possible with the storms within the
ongoing Severe Thunderstorm Warning.
```

At 6:25 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Weather Statement" for the "Severe Thunderstorm Warning" that was in effect for Southern Collin County through 7:30 p.m. on April 6th, 2018:

```
Severe Weather Statement
National Weather Service Fort Worth TX
625 PM CDT FRI APR 6 2018
TXC085-231-257-397-070030-
/O.CON.KFWD.SV.W.0057.000000T0000Z-180407T0030Z/
Rockwall TX-Hunt TX-Kaufman TX-Collin TX-
625 PM CDT FRI APR 6 2018
...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT UNTIL 730 PM CDT
FOR ROCKWALL...SOUTHWESTERN HUNT...NORTHERN KAUFMAN AND SOUTHERN
COLLIN COUNTIES...
At 622 PM CDT, severe thunderstorms were located near Wylie and near
Frisco. Both were moving southeast at 25 mph.
HAZARD...Golf ball size hail and 60 mph wind gusts.
SOURCE...Radar indicated.
IMPACT...People and animals outdoors will be injured. Expect hail
         damage to roofs, siding, windows, and vehicles. Expect wind
         damage to roofs, siding, and trees.
Golf ball size hail will be possible with both of these storms.
These severe storms will be near...
  Rowlett and Rockwall around 630 PM CDT.
  Fate around 635 PM CDT.
  Royse City and Mobile City around 640 PM CDT.
  Heath and Lucas around 645 PM CDT.
  Murphy around 650 PM CDT.
  Sachse around 655 PM CDT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
For your protection stay inside a sturdy structure and keep away from
windows.
&&
LAT...LON 3284 9605 3284 9608 3270 9608 3266 9652
      3298 9652 3299 9668 3315 9684 3317 9684
      3328 9668 3296 9603
TIME...MOT...LOC 2322Z 336DEG 21KT 3299 9651 3314 9675
HAIL...1.75IN
WIND...60MPH
```

At 6:41 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Weather Statement" for the "Severe Thunderstorm Warning" that was in effect for Southern Collin County through 7:30 p.m. on April 6th, 2018:

```
Severe Weather Statement
National Weather Service Fort Worth TX
641 PM CDT FRI APR 6 2018
TXC085-231-257-397-070030-
```

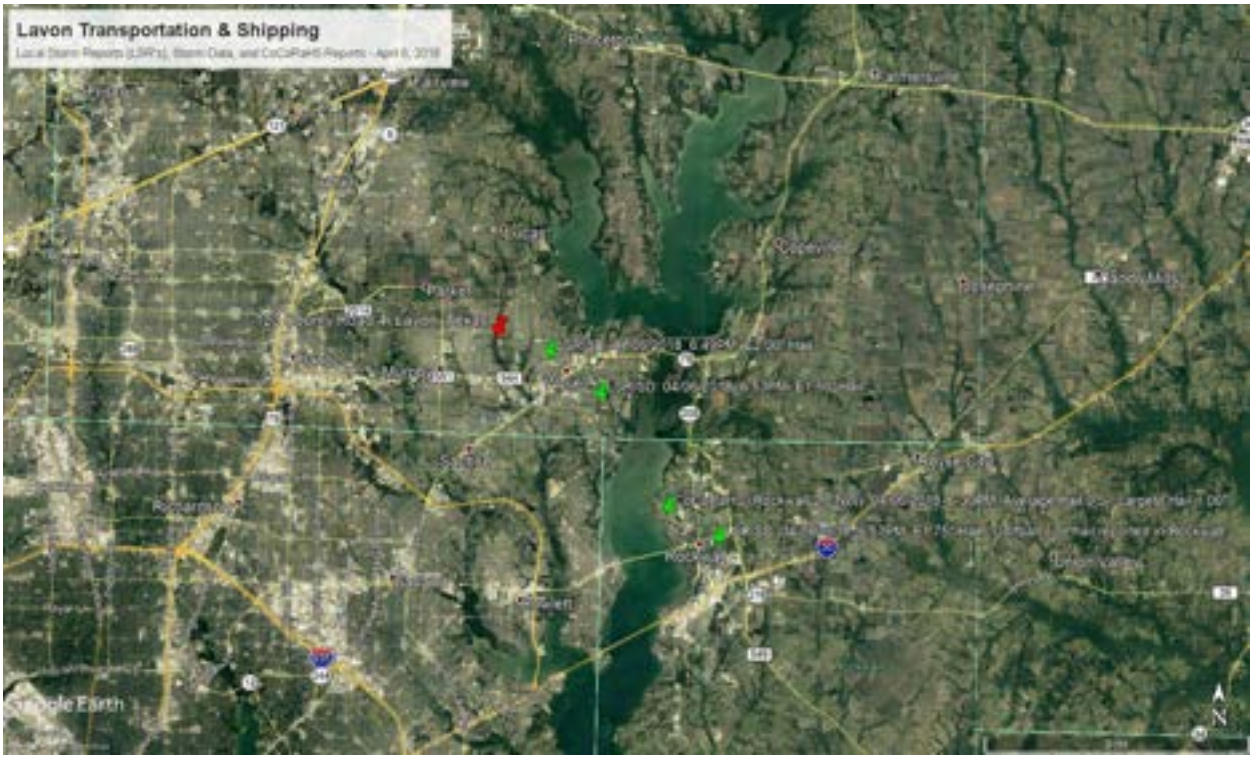
```
/O.CON.KFWD.SV.W.0057.000000T0000Z-180407T0030Z/
Rockwall TX-Hunt TX-Kaufman TX-Collin TX-
641 PM CDT FRI APR 6 2018
...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT UNTIL 730 PM CDT
FOR ROCKWALL...SOUTHWESTERN HUNT...NORTHERN KAUFMAN AND SOUTHERN
COLLIN COUNTIES...
At 640 PM CDT, a severe thunderstorm was located over Parker, or near
Allen, moving southeast at 20 mph.
This is a very dangerous storm.
HAZARD...Baseball size hail and 60 mph wind gusts.
SOURCE...Radar indicated.
IMPACT...People and animals outdoors will be severely injured.
         Expect shattered windows, extensive damage to roofs,
         siding, and vehicles.
This severe storm will be near...
  Parker around 645 PM CDT.
  Murphy and Lucas around 650 PM CDT.
  Wylie around 655 PM CDT.
  Sachse around 700 PM CDT.
  Rowlett around 710 PM CDT.
  Rockwall around 720 PM CDT.
  Fate around 725 PM CDT.
Hail to 3 inches in diameter was reported with this storm in Allen.
LAT...LON 3284 9605 3284 9608 3270 9608 3266 9652
      3298 9652 3299 9668 3309 9678 3313 9678
      3320 9665 3320 9652 3296 9603
TIME...MOT...LOC 2340Z 320DEG 18KT 3307 9667
HAIL...2.75IN
WIND...60MPH
```

At 6:57 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued a "Severe Weather Statement" for the "Severe Thunderstorm Warning" that was in effect for Southern Collin County through 7:30 p.m. on April 6th, 2018:

```
Severe Weather Statement
National Weather Service Fort Worth TX
657 PM CDT FRI APR 6 2018
TXC085-231-257-397-070030-
/O.CON.KFWD.SV.W.0057.000000T0000Z-180407T0030Z/
Rockwall TX-Hunt TX-Kaufman TX-Collin TX-
657 PM CDT FRI APR 6 2018
...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT UNTIL 730 PM CDT
FOR ROCKWALL...SOUTHWESTERN HUNT...NORTHERN KAUFMAN AND SOUTHERN
COLLIN COUNTIES...
At 656 PM CDT, a severe thunderstorm was located near Rockwall,
moving southeast at 30 mph. This is a very dangerous storm.
HAZARD...Baseball size hail and 60 mph wind gusts.
SOURCE...Radar indicated.
IMPACT...People and animals outdoors will be severely injured.
         Expect shattered windows, extensive damage to roofs,
         siding, and vehicles.
This severe storm will be near...
  Fate around 700 PM CDT.
  Royse City around 705 PM CDT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
This storm is producing large hail. SEEK SHELTER NOW inside a sturdy
structure and stay away from windows.
&&
LAT...LON 3284 9605 3284 9608 3270 9608 3266 9652
      3298 9652 3299 9668 3309 9678 3313 9678
      3320 9665 3320 9652 3296 9603
TIME...MOT...LOC 2356Z 301DEG 28KT 3294 9644
TORNADO...POSSIBLE
HAIL...2.75IN
WIND...60MPH
```

NATIONAL WEATHER SERVICE STORM DATA, LOCAL STORM REPORTS AND COCORAHS REPORTS

After determining if Local Storm Reports were received by the National Weather Service, if edited storm reports were included in storm data from the National Centers for Environmental Information, and if hail was reported at CoCoRaHS sites on April 6th, 2018, I quality-controlled and plotted these reports using the program Google Earth. The following map depicts the reports that were received within the vicinity of the incident location. The text bulletins themselves are listed out after the storm reports map.



At 6:50 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued the following "Preliminary Local Storm Report" which included Collin County in Texas:

```
PRELIMINARY LOCAL STORM REPORT
NATIONAL WEATHER SERVICE FORT WORTH TX
650 PM CDT FRI APR 06 2018
..TIME...   ...EVENT...      ...CITY LOCATION...     ...LAT.LON...
..DATE...   ....MAG....      ..COUNTY LOCATION..ST.. ...SOURCE....
            ..REMARKS..
0649 PM     HAIL             WYLIE                   33.02N  96.55W
04/06/2018  E2.00 INCH       COLLIN             TX   AMATEUR RADIO
```

At 6:58 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued the following "Preliminary Local Storm Report" which included Rockwall County in Texas:

```
PRELIMINARY LOCAL STORM REPORT
NATIONAL WEATHER SERVICE FORT WORTH TX
658 PM CDT FRI APR 06 2018
..TIME...   ...EVENT...      ...CITY LOCATION...     ...LAT.LON...
..DATE...   ....MAG....      ..COUNTY LOCATION..ST.. ...SOURCE....
            ..REMARKS..
0657 PM     HAIL             ROCKWALL                32.93N  96.45W
04/06/2018  E1.75 INCH       ROCKWALL           TX   AMATEUR RADIO
            GOLFBALL SIZE HAIL REPORTED IN ROCKWALL.
```

At 6:59 p.m. on April 6th, 2018, the National Weather Service in Fort Worth/Dallas, Texas issued the following "Preliminary Local Storm Report" which included Dallas County in Texas (It should be noted that this report actually occurred in Collin County in Texas):

```
PRELIMINARY LOCAL STORM REPORT
NATIONAL WEATHER SERVICE FORT WORTH TX
659 PM CDT FRI APR 06 2018
..TIME...   ...EVENT...      ...CITY LOCATION...     ...LAT.LON...
..DATE...   ....MAG....      ..COUNTY LOCATION..ST.. ...SOURCE....
            ..REMARKS..
0653 PM     HAIL             3 ENE SACHSE            33.00N  96.52W
04/06/2018  E1.50 INCH       DALLAS             TX   TRAINED SPOTTER
```

"STORM DATA" PUBLICATION

The publication "Storm Data" from the National Centers for Environmental Information contained the following entries within 10 miles of the incident location for the April 6th, 2018 storms. It should be noted that the report from 3 ENE Sachse actually occurred in Collin County.

Collin County
2 Wylie
06 1749CST
0 0 10.00K 0.00K Hail (2.00)
Amateur radio reported hen-egg sized hail in the city of Wylie, TX.

Dallas County
3 ENE Sachse
06 1753CST
0 0 0.00K 0.00K Hail (1.50)
A trained spotter reported ping pong ball sized hail approximately 3 miles east-northeast of the city of Sachse, TX.

Rockwall County
Rockwall
06 1757CST
0 0 10.00K 0.00K Hail (1. 75)
Amateur radio reported golf ball sized hail in the city of Rockwall, TX.

CoCoRaHS Hail Reports

Station Number: TX-RK-11
Station Name: Rockwall 2.0 NW
Date: 4/6/2018 6:30 PM

Submitted: 4/07/2018 7:21 AM
Taken at registered location: True
Largest Size: 1" Quarter Size
Average Size: 1/2" Grape
Smallest Size: 1/4" Pea Size Stone
Consistency: Mixed, White Ice
Duration Minutes: 30
Duration Accuracy: 3min
Timing: Intermittent
More Rain than Hail: True
Hail Started: After rain
Largest Hail Started: After smaller hail
Damage: shredded leaves, car dents

HAIL SIZE AT THE INCIDENT LOCATION

Local Storm Reports (LSR's) that were transmitted by the National Weather Service indicated measured hail of 1.50" in diameter was reported xxx miles west-southwest of the incident location. Where this 1.50" hail was measured, Doppler radar base reflectivity values were as high as 65 dBZ. Measured hail of 2.00" was also reported xxx miles west of the incident location. Where this 2.00" hail was measured, base reflectivity values were as high as 64 dBZ. Measured hail of 1.75" was also reported xxx miles south of the incident location. Where this 1.75" hail was measured, base reflectivity values were as high as 64 dBZ.

At the incident location, base reflectivity values as high as 64 dBZ occurred. Based on the weather records and radar data studied during my analysis, it is my opinion that hail up to 2.00" in diameter occurred at the incident location.

Hail Size Descriptions

The following is a traditional object-to-size conversion chart for assessment and translation of hail reports. This chart was provided by the Storm Prediction Center (a division of the NWS).

HAIL SIZE (in.)	OBJECT ANALOG REPORTED
.50	Marble, moth ball
.75	Penny
.88	Nickel
1.00	Quarter
1.25	Half dollar
1.50	Walnut, ping pong
1.75	Golf ball
2.00	Hen egg
2.50	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Softball
4.50	Grapefruit

CONCLUSIONS

In conclusion, it is my opinion that:

- On April 6th, 2018, strong thunderstorms affected the incident location between approximately 5:45-7:46 p.m. The thunderstorms were most intense between 6:17-6:29 p.m. with reflectivity values reaching 64 dBZ over the incident location.
- Dual polarization differential reflectivity images indicated values as low as -0.50 dB which correlates to Large Hail greater than 2 inches.

- Dual pol correlation coefficient values at the incident location were as low as 84.2% which correlates to Giant Hail greater than 2 inches.
- Using sound, scientific principles, and accepted methodologies in the field of meteorology, it is my opinion that hail of 2.00" in diameter occurred at the incident location.
- The National Weather Service in Fort Worth/Dallas, Texas issued a "Tornado Warning" that was in effect for the incident location from 5:37-6:15 p.m. on April 6th, 2018.
- The National Weather Service in Fort Worth/Dallas, Texas also issued a "Severe Thunderstorm Warning" that was in effect for the incident location from 6:13-7:30 p.m. on April 6th, 2018.

CERTIFICATION

I certify that the above information contained in this report is true and accurate to the best of my ability and that all of my opinions, findings, estimations and interpolations expressed in this report were made with accuracy as a professional meteorologist within a reasonable degree of meteorological certainty.

By: _____
Certified Consulting Meteorologist

Certified Consulting Meteorologist
Awarded by the American Meteorological Society.

_____