Texas and Oklahoma's Greatest Hits

The most significant weather events to strike Texas and Oklahoma

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This compilation identifies (through purely subjective means) the most significant weather events to strike Texas and Oklahoma since the keeping of regular weather records. This information first appeared in Nielsen-Gammon's monthly column for *The Cattleman* magazine. Weather events are divided into thirteen categories, and the key weather events in each category are listed and described.

In all, 94 weather events are listed, some in more than one category. The earliest was the Indianola hurricane of 1875, and the most recent was the San Antonio flood of 2002. At the rate of a bit less than once per year, major weather events will continue to occur in Texas and Oklahoma, so addenda will be posted when appropriate.

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Section 1: Drought and Heat

Drought builds on itself. The worst droughts last several years as surface and subsurface moisture is steadily depleted.

The worst drought spanned the period 1950 to 1957. Much has been written about this drought; among the more impressive statistics from this period is Texas's statewide average precipitation for the month of October 1952: 0.02 inches. Close on its heels is the Dust Bowl drought of 1932-1939, which had a bigger impact in Oklahoma than the 1950s drought but spared a large part of Texas.

Harder to remember are the occasional droughts from 1909-1918. This span included Oklahoma's driest year ever (1910) and Texas's driest year ever (1917). After the 1910s, 1930s, and 1950s, as well as 1893 when Texas received less than half its annual average, it was easy to see why people began expecting a 20-year drought cycle. The 1970s broke the pattern, but we have had a few dry years in the late 1990s and early 2000s.

Dry weather and hot weather often go hand in hand. Dry soil heats up more, so the air becomes hotter too.

The hottest summer was 1936. The record highest temperature for Oklahoma (120F) was set on July 18 in Alva and was tied once on July 19 (Altus) and twice on August 12 (Altus and Poteau). Not to miss out on the fun, Texas set its all-time record of 120F on August 12 also (Seymour).

The deadliest summer was 1980. Extended heat (50 days over 100F in Oklahoma City, 10 consecutive days over 110F in Wichita Falls) led to over 70 deaths in Texas and 37 deaths in Oklahoma.

Other exceptional heat waves:

* July/August 1954, Oklahoma: The temperature reached 100F everywhere at some time, with 99 out of 129 stations reaching 110F.

* July 1934, Oklahoma: The statewide average high was 102.8F.

* July 1998, Texas and Oklahoma: This summertime drought and heat wave cost over \$2B dollars to agriculture.

* July 27, 1994, Texas and Oklahoma: The statewide records (120F) were tied in Monahans, TX and Tipton, OK.

* Sept. 5, 2000, Texas: Most of the central and eastern parts of the state exceeded 110F.

* July 1901, Oklahoma: Temperatures exceeded 100F somewhere in the state every day, reaching 110F on ten of those days.

Section 2: Hail and High Winds

Tornadoes are the marquee weather event for severe weather: they make the headlines and get all the press. But for farmers and ranchers, hail has a much bigger economic impact.

In the history of Texas and Oklahoma, the most high-impact hail events have been those that strike major cities. With damage to every car and roof within the hail swath, the economic losses add up quickly.

The worst on record was the thunderstorm that struck Dallas-Fort Worth on May 5, 1995. This was the "perfect storm" of hailstorms: a supercell, a squall line, an outdoor festival, and sunset all came together to maximize the impact.

It started with a supercell forming out near Mineral Wells in late afternoon. It marched east and intensified, dropping baseball-sized hail in downtown Fort Worth during their May festival and causing numerous injuries (and one death) from people caught out in the open being struck by hail. As the storm moved to Dallas, a squall line caught up with it and the combined rainfall produced a flash flood just after dark. The resulting street flooding killed another 19 persons. Overall there were 109 injuries and an estimated \$2 billion dollars in damage.

Other exceptional hail events:

* August 24, 1979, Texas: This late summer High Plains hailstorm destroyed 150,000 acres of crops and damaged another 550,000, for a total of \$200 million in damage.

* April 17, 1935, Oklahoma: Hail from this thunderstorm covered an area 40 miles long and 80 miles wide, including the town of Braman. Some stones were 13"-14" in circumference.

* May 10, 1996, Texas: A hailstorm in Howard County injured 48 with stones up to 5".

* April 5, 2003, Texas: A single supercell thunderstorm produced hail up to 4.5" diameter in 16 north-central counties, along with 5 tornadoes. Preliminary estimates indicate \$800 million in damage.

* Nov. 13, 1985, Oklahoma: Baseball-sized hailstones driven by 60 mph winds battered parts of Tulsa County. Damages exceeded \$37 million.

* August 17, 1994, Oklahoma: The hail from this storm stretched from Manchester to Minco, a distance of 120 miles. The biggest stone measured 4.5" by 6.5". The Oklahoma Mesonet anemometer at Lahoma recorded a peak gust of 113 mph before succumbing to hail.

* May 16, 1917, Texas: Hail covered the ground up to 3 feet deep in Ballinger, reportedly taking seven days to clear.

Section 3: Flash Floods

Floods come in many shapes and sizes. A flash flood, as the name implies, develops quickly, and can be over just as fast. This makes flash floods the most dangerous type of flood. Fortunately, the speed implies a limited area. Flash floods usually affect one or a handful of drainages.

In order to represent the full range of heavy rain events that take place in this part of the country, I am coining two other terms. I will refer to floods which are caused by several days of rain and whose primary impact is well downstream of the rain area as river floods. The third category, area floods, occupy the middle ground. (Or should I say the high ground?) They are floods which are caused by sudden heavy rains over a wide area, in essence triggering many flash floods at once. I'll discuss infamous area floods and river floods in other sections.

Like many significant weather events in Texas and Oklahoma, flash floods can change history. Without the most significant flash flood, San Angelo might not exist. That flood was the Ben Ficklin flood of August 23-24, 1882. Heavy thunderstorms upstream of the town of Ben Ficklin, the seat of Tom Green County, sent a rapidly-rising mass of water into the unsuspecting town at night. The town was destroyed, and an estimated 45 persons lost their lives. Rather than rebuild in what appeared to be a flood-prone location, the county seat was moved to San Angelo.

Other exceptional flash floods:

* August 1-4, 1978, Texas: Remnants of Hurricane Amelia drifted north across Texas, and conditions were just right for serial thunderstorm development in Albany. Thirty inches of rain later, 27 persons were dead and \$50 million in damage was recorded.

* June 11, 1965, Texas: The Sanderson (West Texas) flash flood killed 26 persons and caused \$2.7 million in damage.

* May 26-27, 1984, Oklahoma: The Memorial Day Flood, caused by a foot or more of rain overnight, damaged or destroyed 5,500 homes and 7,000 vehicles in Tulsa, and 14 persons were killed.

* May 24-25, 1981, Texas: Five and a half inches of rain in one hour in Austin leads 13 deaths, 100 injuries, and \$40 million in damage.

* June 22-23, 1948, Oklahoma: As much as 20 inches of rain in west-central Oklahoma floods Route 66 near Hydro, killing 11.

* Oct. 11, 1973, Oklahoma: Flash flooding in north-central Oklahoma and southern Kansas killed 9. At the peak of the deluge, Enid received 12" in 3 hours.

Section 4: Hurricanes and Tropical Storms

This weather phenomenon impacts Texas more than Oklahoma. Almost half of the hurricanes that strike Texas do move on up to Oklahoma, but the hurricane-force winds rarely make it that far north and the storm surge never does.

Picking the greatest hurricane was a no-brainer. The 1900 Galveston hurricane killed untold numbers of people (6,000 to 10,000) and wiped out a large portion of the city of Galveston on 8-9 September. Calling it the most significant hurricane to strike Texas is an understatement: the Galveston hurricane was the greatest natural disaster in the history of the United States.

Several factors came together to make the storm so exceptional. The population of the barrier island of Galveston had exploded, while hurricane protective measures had barely been considered. The hurricane made a direct hit, and it was exceeded in strength by only two or three Texas hurricanes over the past 120 years. It even caused considerable flooding in eastern Indian Territory, so even Oklahoma was affected.

Other great storms:

* Alicia, August 15-21, 1983: Alicia was the second most devastating strike on a metropolitan area, behind Andrew. Approximately 1800 injuries and \$3B in damage were left in its wake.

* Indianola, Sept. 16, 1875: If this hurricane and another 11 years later hadn't nearly wiped this burgeoning port city off the map at Matagorda Bay, people might have been here in 1900 rather than Galveston.

* Corpus Christi, Sept. 14, 1919: This direct hit on Corpus Christi left 284 dead.

* Allison, June 40-10, 2001: \$5.2B damage and 48,000 destroyed homes proved that strong winds are not a prerequisite to heavy rainfall.

* Galveston, August 16-19, 1915: Although 275 lost their lives, the seawall and elevated central city did their job to prevent another 1900.

* *Carla, Sept. 8-14, 1961: The strongest hurricane ever recorded to hit Texas had bad aim: "only" 34 lost their lives.*

* Sabine, Oct. 12, 1886: Another 19th century Texas port city suffers; this time, 150 dead.

* Celia, August 3-5, 1970: 11 deaths and 466 injuries, with \$450M in property damage.

* Beulah, Sept. 18-23, 1967: At least 115 tornadoes, the most ever from a hurricane worldwide. Up to 36 inches of rain flooded 1,400,000 acres.

* Claudette, July 25-26, 1979: This storm didn't even make hurricane status, but like Allison, it produced massive rainfall in the Houston area, causing \$750M in damage.

Section 5: Area Floods

Rivers in Texas and Oklahoma run for hundreds of miles but drain relatively narrow swaths of the countryside. Some of the most significant floods in Texas and Oklahoma did not affect an entire river basin but instead involve a small segment of a river, a pair of rivers, or a set of tributaries. Rainfall can be so intense that it doesn't really matter whether you're considering a river, a draw, or a ditch: anything that holds water starts to flood. I call these events "area floods" because they affect a sizable area without regard to river drainages.

Such floods normally occur during the warm season, but otherwise they're not picky. More often than not the flood is produced by a tropical disturbance at the beginning or end of hurricane season.

The all-time king of area floods took place smack during the middle of hurricane season: the Sept. 8-10, 1921 Central Texas flood. This flood set all kinds of records, some of which still stand. A few miles up the road from Taylor, Texas, in Thrall, an unofficial observer measured 32 inches in 12 hours. In half a day, Thrall received more rainfall than most states have received in a month. Still it kept raining, giving Thrall a 24-hour total of 38.2 inches. A total of 215 people perished in the 1921 flood, a rather large total for a time when most people either had the sense not to drive into water or lacked the vehicle with which to do so.

Other outstanding area floods:

* June 4-10, 2001, Texas: Tropical Storm Allison produced so much rain in southeast Texas that at least one entire drainage filled to overflowing. Over \$5.2B dollars in damage makes this storm one of the costliest weather events ever.

* Oct. 17-19, 1998, Texas: Up to 30 inches of rain brought the main channel of the Guadalupe river outside the 100-year flood plain, destroying 3000 homes.

* April 22-29, 1966, Texas: Rainfall totals of over 2 feet in northeast Texas caused 33 deaths.

* Oct. 15-19, 1994, Texas: Houston experienced many of the biblical plagues, as water surrounded the city on most sides and leaking oil caught fire on top of the river.

* Sept. 11, 1952, Texas: Over 20 inches in 24 hours fell on the thin soil and rugged topography of the Llano area. The resulting flash flood killed 5 and set high water marks in many areas.

* June 30-July 6, 2002, Texas: Several days of sustained heavy rain in the San Antonio area caused one reservoir to fill its emergency spillway and another reservoir to nearly overtop its dam.

Section 6: Rainfall Totals

Outsiders think of Texas and Oklahoma as near-deserts, and some parts of them are rather arid. But the two states can also lay claim to some rather impressive rainfall totals.

Texas is more likely to get extremely heavy rainfall than Oklahoma because it can receive a direct feed of tropical moisture from the Gulf of Mexico. Only air masses that aren't quite so unstable or so humid can make it all the way to Oklahoma.

The all-time United States record for rainfall in a 24-hour period was set in Texas on July 26, 1979. This broke the record set in 1921 in the flood described on the previous page. The current record holder is Alvin, Texas. Alvin doesn't have any dramatic topography to trigger precipitation. It just happened to be in the wrong place at the wrong time.

The event was Tropical Storm Claudette. Not the Claudette that made landfall in July 2003, but the one that made landfall in July 1979. The storm moved slowly inland over southeast Texas, causing about \$750M in property and crop damage. The highest rainfall total at an official site was a remarkable 40" in 24 hours, but a nearby unofficial site, confirmed by the National Weather Service, recorded 43" in 24 hours.

That's an impressive amount of rain no matter how you look at it. Normally you would have to put a garbage can under the storm gutter of a house to have any hope of filling it up during a rainstorm. But with Claudette the trash can could have been left out in the open and it still would have filled up.

Other outstanding rainfall totals:

* Sept. 8-10, 1921, Texas: The Central Texas flood gave Thrall 32" in 12 hours and 38.6" in 24.

* Oct. 11, 1973, Oklahoma: 15.68" of rain set the Oklahoma state record for daily rainfall. All of the rain fell in 13 hours, and 12" of it fell in only 3 hours.

* May 18, 1923, Texas: A hefty little downpour left Beaumont with 12.8" in 4.5 hours.

* June 26-27, 1954, Texas: 27" along the Pecos River led to massive flooding on the Rio Grande.

* May 24-24, 1981, Texas: A downpour of 5.5" in one hour in Austin produced a flash flood that left 13 dead and 100 injured.

* Sept. 3-4, 1940, Oklahoma: Sapulpa recorded 15.5", the second highest gauge total ever in Oklahoma for a 24-hour period. The heavy rain was so localized that only one river gauge, at Tulsa, reported flood stage.

* April 3-4, 1934, Oklahoma: During the Dust Bowl, floods in Hammon, near Cheyenne, were caused by 14" of rain in 6 hours.

Section 7: Ice

Compared to other types of disastrous weather events, ice storms are relatively poorly reported in the climate record. I think that this is an indication of changes in our society. The major impacts of ice storms are on transportation and on electric power. Prior to the 1930s, electric power was not widely distributed, so ice storms couldn't cause blackouts. For obvious reasons, ice storms also caused little impact when they shut down airports or major highways. As we have become more dependent on electricity and the telephone, we have become more sensitive to ice storms.

I don't know if it was the most severe ice storm on record, but the two ice storms in December 2000 in northeast Texas and southeast Oklahoma rank as the most devastating ice storms on record in the region. The first storm struck Dec. 11-13, and the second came only two weeks later. Both storms produced up to 6" of ice accumulation, which is an unusually large amount sure to cause widespread devastation.

Combined damages in the two states exceeded \$300M. There were at least 27 fatalities, and 120,000 homes lost power in Oklahoma alone as power lines broke under the weight of ice or tree limbs broke and took power lines down with them. Power was out so long in places that water supplies were disrupted.

Ice storms are caused by rain falling through a shallow layer of cold air near the ground. Suspended water droplets do not freeze immediately once they drop below freezing, but if they then come in contact with a cold surface, they will freeze onto that surface immediately. Western Texas and Oklahoma are susceptible to ice storms when cold air is trapped against the Rocky Mountains. In eastern Texas and Oklahoma, freezing rain is most common north of a warm or stationary front ahead of a developing low pressure center.

Other memorable ice storms:

* Jan. 30-31, 2002, Oklahoma: A widespread ice storm in northeastern OK led to the largest power outage in Oklahoma's history.

* mid-Jan., 1956, Texas: Sleet and freezing rain affected the entire northern half of the state, leaving 4 dead.

* Jan. 14-15, 1888, Texas: A rare South Texas ice storm coated the lower valley with 1" of ice.

* Dec. 25-27, 1987, Oklahoma: A double whammy in Tulsa: 1"-2" of ice within a 40mile wide swath of Oklahoma, with flooding just southeast of the ice.

* Jan. 6-12, 1937, Texas: This ice storm in northeast Texas was the worst to date.

* Jan. 8, 1977, Texas: Up to 3" of ice north of a Waco-Longview line caused 5 deaths.

Section 8: Cold

We have to go back over 100 years to find the most memorable cold snap on record in Texas and Oklahoma: Feb. 12, 1899. On that day, all of Oklahoma got below -10F, and over half of Texas was below 0F. Ice reportedly covered most of Galveston Bay. The Texas state record for coldest temperature was set that day at Tulia, which got down to -23F.

To get such a cold wave, as with all extreme events, everything has to be working just right. First, a large, cold air mass probably drifted over Canada from Siberia via the Arctic Ocean. This air mass, once in place over Canada, would have remained there until an upperlevel dip in the jet stream would have brought the air southward with a cold front. The air would need to move quickly, so as not to warm up much on its way to lower latitudes. Finally, high pressure would then have to cover the area, ensuring light winds and perfect nighttime radiative conditions.

Most promising cold waves disappoint because the cold air moves too far east, or the air mass becomes cloudy, or the air never stagnates. This particular air mass was so cold and widespread that there was little Mother Nature could do to prevent it once the situation established itself.

Other memorable cold snaps:

* Feb. 13, 1905, Oklahoma: Not far behind the 1899 cold snap, this one set the all-time cold temperature record in Oklahoma: -27F at Vinita.

* Dec. 1895, Texas: During a prolonged cold spell, Amarillo notched 261 consecutive hours below freezing.

* Jan. 1930, Texas/Oklahoma: The temperature got down to 13 F in Galveston, while farther north, Oklahoma's all time record (-27 F) was tied at Watts.

* Jan. 4, 1959, Texas: Spearman, in extreme northern Texas, had a HIGH temperature below 0F. The low was -22F.

* Dec. 1983, Oklahoma: The coldest December of the century for Oklahoma. Oklahoma City itself went from the 17th to the end of the year without the mercury reaching 32F.

* *late January, 1949, Texas: A cold wave brought below zero temperatures from Dallas to San Antonio. Two ice storms struck the Amarillo – San Antonio – Palestine triangle.*

* Jan. 9-12, 1962, Texas: The temperature dropped to -14F in the Panhandle and 10F in the Lower Rio Grande Valley. The Valley saw 65 consecutive hours below freezing.

* Jan.-Feb. 1951, Texas: Houston was below freezing for 132 consecutive hours.

Section 9: Snow

February seems to have more than its share of devastating snowstorms. The three basic ingredients for a snowstorm are low temperatures, ample moisture, and a developing storm system. All are available in February.

The moisture for a major snowstorm comes from the Gulf of Mexico and points south and east. The cold weather for a major snowstorm comes from Canada and points north.

For a developing storm system to put these ingredients together requires a special set of circumstances. It takes strong southeasterly or southerly winds to get the moisture into Texas and Oklahoma, but those same winds bring warm air. So the layer of cold air must be cold enough to allow snow, shallow enough to permit the warm, moist air to rise above it, and deep enough to prevent its retreat in the face of the moisture-bearing winds.

Fast-moving storm systems would not allow much time for the cold air to retreat, but they also would not allow much time for the moisture from the Gulf to arrive. Only a slowmoving system provides the necessary warm-air winds and enough time for the atmosphere's snow factory to get cranked up.

The Texas Panhandle and northwest Oklahoma are the area's snow belt, due to their lower wintertime temperatures. The most significant snowstorm to hit the area blasted parts of both states during Feb. 20-22, 1971. Ground zero was Buffalo, OK, which had 36" of snow on the ground by the 24th. Of course, the 30 to 60 mile per hour winds didn't allow that snow to lie flat. Drifts of up to 20 feet were reported. Loss of human life was small, but 13,000 head of cattle were lost in Texas and 11,000 in Oklahoma, despite military airdrops of hay.

Other exceptional snowstorms:

* Feb. 2-5, 1956, Texas: The all-time single-storm record was set for Texas when Hale received 33" of snow. Twenty persons lost their lives.

* Feb. 1-7, 1964, Texas: A Panhandle blizzard produced 25" of snow in Borger, with 30 mph winds and drifts to ten feet.

* Feb. 12-15, 1895, Texas: A rare Gulf Coast snowstorm brought up to 20" of snow from Houston to Orange.

* Dec. 1911, Oklahoma: Beaver, on its way to the state's seasonal snow record of 87", picked up almost three feet during the month.

* Jan. 12-13, 1985, Texas: The folks in San Antonio still talk about the 13.5" of snow from this storm. Available snowplows were inadequate.

Section 10: River Floods

Most of the major weather phenomena that have been discussed in previous sections have included some recent examples. Not so for floods which encompass an entire river basin. Through a combination of flood control and (mostly) awareness, people tend to no longer live in areas subject to major floods.

The Brazos River, the longest river that fits entirely within Texas, was the site of two of the most devastating river floods to strike Texas and Oklahoma. The second-worst was in early summer of 1899. Several days of heavy tropical rains led to the Brazos River overflowing its banks from Central Texas to the Gulf Coast. At one point, the river was 12 miles wide. The flood killed 35 people and caused an estimated \$9M of damage.

Why am I only describing the second-worst flood? Because the response along much of the river was for people to rebuild (on the fertile soil) and protect themselves against future floods by constructing levees along the river.

One problem, though: if the water rises to the top of a levee, you're in serious trouble.

The worst flood occurred fourteen years later, on December 1-5, 1913. The levees caused the water to rise higher before it overflowed its banks (catastrophically this time). The sudden rush of water made it much harder for people to flee to safety. Although damages were somewhat less, this flood killed 177 persons.

The response to this flood was more effective: move out. Below Waco, which has protection with reservoirs, very few people now live in the Brazos River floodplain, although Houston is expanding in that direction.

Other outstanding river floods:

* Sept. 15-18, 1936, Texas: Over two feet of rain in San Angelo led to massive flooding along the Concho River

* June 26-27, 1954, Texas: 27" of rain along the lower part of the Pecos River led to an estimated 2000-year return period flood along the Rio Grande.

* May 16-21,1957, Oklahoma: The drought of the 1950s ended much too suddenly when rains of a foot or more caused all major rivers in Oklahoma to flood. Agricultural damages alone totaled \$20M.

* Sept. 1932, Texas: Record floods along the Rio Grande from Del Rio to Brownsville killed 10.

* Oct. 13-16, 1923, Oklahoma: The overtopping of an upstream dam led to the evacuation of 15,000 in Oklahoma City. After this and earlier floods, suddenly the riverside was no longer the most desirable neighborhood in OKC.

Section 11: Dust Storms

Black Sunday: April 14, 1935. As far as I know, this is the only named day in Oklahoma/Texas weather history. It got its name not from hundreds of deaths or millions of dollars in losses, but from the sudden switch from day to night a few hours ahead of schedule. The cause was perhaps the most intense dust storm to ever hit Texas and Oklahoma.

Some dust storms spring up gradually, but this one came upon people suddenly, without warning. It was probably caused by a strong blue norther (in this case, a black norther), and visibility was reduced to 1 mile all the way down in South Texas.

This was back in the days without rural electric power. When the visibility went to zero in the Texas and Oklahoma plains, life ground to a halt and people caught outside sheltered themselves as best they could until sight (and travel) again became possible about an hour later.

Dust storms require a combination of very strong winds and dry weather. While the wintertime is windy and dry on the High Plains, evaporation is slow as well, and the soil usually retains some moisture. The most likely time of year for dust storms is the springtime, when fields are still bare, temperatures are rising and winds remain strong.

Black Sunday took place in the middle of the Dust Bowl drought, and there were several other major dust storms during February through April of 1935. While a long-term drought makes dust more likely, only a few months of dry weather are needed to loosen the topsoil.

A recent major dust storm, around Lubbock in December 2003, caused three traffic accidents and two deaths. July-December rainfall in Lubbock was about 17% of normal and only half of the previous record low rainfall.

Other memorable dust storms:

* *March 2-3, 1956, Texas: Widespread dust dropped visibility to zero in places and caused traffic accidents in which three were killed.*

* Feb. 19, 1954, Oklahoma: Winds of 60 to 85 miles per hour swept through the southwestern part of the state. In addition to the dust, there was extensive damage to trees, buildings, and power lines. One person was electrocuted.

* Jan. 25, 1965, Texas: Visibility was reduced to 100 feet in places. The official rain gauge in Lubbock measured three inches of dust accumulation.

* May 1939, Oklahoma: Three dust storms brought an end to the decade of dust, again with visibility as low as 100 feet.

Section 12: Tornadoes

Of all significant weather events, tornadoes are the ones that most stick in people's memory. They are beautiful, terrifying, deadly, and capricious, all at the same time.

Texas and Oklahoma combine to host some of the most devastating tornadoes on record. In the spirit of partnership, the most devastating tornado to hit the area ravaged both Texas and Oklahoma. This was the Woodward tornado of April 9, 1947.

This massive tornado (or, more likely, series of tornadoes) first touched down in the Texas panhandle near Amarillo, causing damage in White Deer, in Carson County. The tornado moved northeast, completely destroying the town of Glazier in Hemphill County. By the time it reached Higgins, the tornado was one mile wide. In Texas, the final tally was 68 dead and 201 injured, making it the fifth most deadly tornado ever to strike Texas.

But the devastating storm was just getting started. After crossing the border into Oklahoma, the tornado continued to stay close to the Acheson, Topeka, and Santa Fe railroad line. The biggest town along that line was Woodward, 30 miles from the border. The storm reached the town after sunset, at 8:43 PM, where it destroyed over 4,000 buildings and killed 107. The tornadic supercell made it all the way to Kansas before it dissipated. The final death toll in all three states was 181.

Other memorable tornadoes:

* May 11, 1953, Texas: A tornado struck Waco, killing 114, injuring 597, and destroying 1500 buildings. On the same day, a separate tornado killed 11 and injured 159 in San Angelo.

* May 18, 1902, Texas: The Goliad tornado sets the record for the deadliest Texas tornado at 114, later tied in Waco.

* May 3, 1999, Oklahoma: Seventy-five tornadoes killed 40 and injured over 700, causing \$1B in damage. One F5 swept through Moore, a suburb of Oklahoma City. Clearly, modern tornado tracking and warning systems prevented the death toll from reaching into the 100s.

* April 10, 1979, Texas: The Wichita Falls tornado leaves 20,000 homeless. Like the Moore tornado of 1999, the death toll would have been much higher without a modern warning system. As it was, the tornado left 42 dead and 1740 injured.

* Honorable Mention: Snyder, OK (1905), Rocksprings, TX (1927), Antlers, OK (1945), Peggs, OK (1920), Sherman, TX (1896), Saragosa, TX (1987), Pryor, OK (1942), Oklahoma City, OK (1942), Lubbock, TX (1970), and Jarrell, TX (1997).

Section 13: Observations and Forecasts

Not all bad weather is bad. Sometimes, severe weather presents an opportunity for understanding weather and improving our ability to predict it. Texas and Oklahoma were host to two significant milestones in our ability to observe and forecast hazardous weather.

On July 17, 1943 a hurricane was bearing down on the southeast Texas coast. This hurricane would strike the Bolivar Peninsula, dumping 17.8" of rain in 24 hours at Port Arthur and killing 19.

Its future destruction potential unknown, Col. Joseph B. Duckworth (pilot) and Lt. Ralph O'Hair (navigator) decided to fly from their air base near Bryan, Texas and experience the hurricane firsthand. They penetrated and explore the eye of the hurricane at an altitude of 7000 ft. More importantly, they managed to return to base and land safely.

The flight was akin to walking into a pitch-dark room without a flashlight. The first time you walk into the room it is scary, but once you've been through the place you know that the room is safe and there's no problem returning. A few more flights into hurricanes later that year confirmed the relative safety of penetrating tropical cyclones with aircraft. A formal reconnaissance program was established the following year, and aircraft have been measuring the locations and intensities of tropical storms and hurricanes ever since.

Less than five years later, on March 20, 1948, a tornado struck Tinker Air Force Base in Oklahoma, causing significant damage to aircraft on the ground. While no plans to do airborne reconnaissance into tornadoes was initiated, the base commander did direct the weather officers to develop a procedure for forecasting tornadoes.

Tornado forecasting had been attempted in the 19th century, and had been discredited due to a lack of success and scientific basis. The new policy was instituted at the same time that the Weather Bureau, by policy, refused to make tornado forecasts.

Major Ernest Fawbush, commander of the local weather detachment, and one of his forecasters, Captain Robert C. Miller, undertook some initial study of the weather patterns associated with the March 20 tornado. Five days later, a similar weather pattern arose. Nowadays, we know that a similar weather pattern could lead to no tornadoes, many tornadoes, or one tornado several hundred miles away. Back then, the situation seemed simple to the base commander: if the situation looks ripe for a tornado, warn for a tornado.

The forecast was issued, and, remarkably, it was correct! A second tornado struck the air base on March 25, five days after the first. Because of the advance "warning", aircraft were protected and damage was substantially reduced. This fortuitous tornado forecast initiated a new era in science-based severe weather forecasting and warning, with lifesaving benefits that we enjoy today.