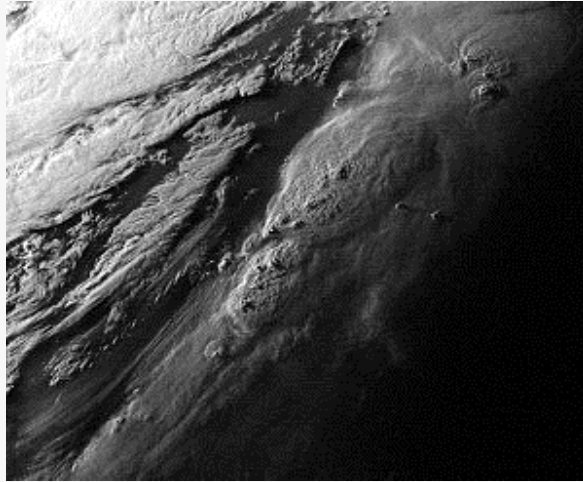


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May 2007 Tornado Outbreak



Satellite perspective of the tornadic storms on the evening of May 5, 2007

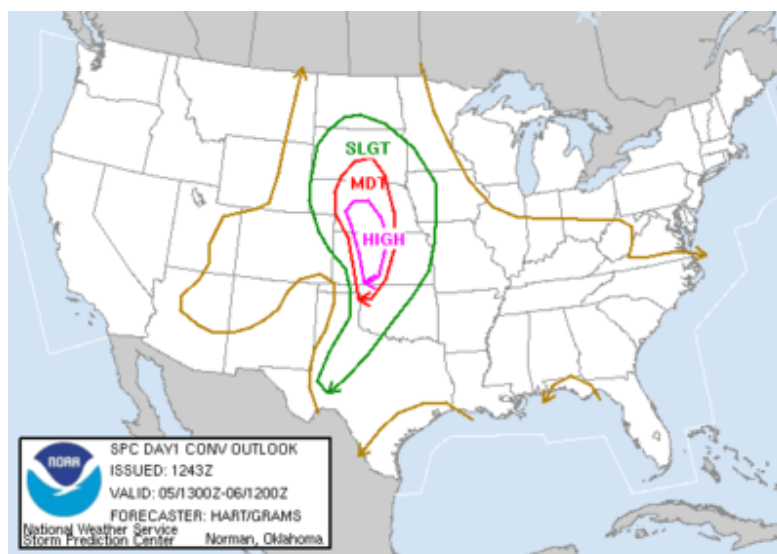
Date of tornado outbreak:	May 4–6, 2007
Duration¹:	56 hours, 9 minutes
Maximum rated tornado²:	EF5 tornado
Tornadoes caused:	123 confirmed
Highest winds:	
Largest hail:	
Damages:	\$268 million ^[1]
Fatalities:	14



The May 2007 Tornado Outbreak was an extended tornado outbreak that started on May 4, 2007, affecting portions of the Central United States. The most destructive tornado in the outbreak occurred on the evening of May 4 in western Kansas, where about 95% of the city of Greensburg in Kiowa County was destroyed by an EF5 tornado.^{[2][3]} The supercell killed at least 13 people including 11 in Greensburg and two from separate tornadoes.^{[4][5][6][7]} At least 60 people were injured in Greensburg alone. It was the strongest tornado of an outbreak which included several other tornadoes reported across Oklahoma, Colorado, Kansas and South Dakota that occurred on the same night.^[8] 25 tornadoes were confirmed that night.

The outbreak did not end there; a total of 84 tornadoes were confirmed reported on May 5 in the same area. Most were in open country but one fatality was reported in Ottawa County, Kansas near a county lake. Fourteen more tornadoes were confirmed on May 6 in the same general area before the activity subsided.

Meteorological synopsis



The 1300 UTC day one convective outlook, showing a high risk area in south-central Nebraska and western Kansas, surrounded by a large area of moderate and slight risk across the Great Plains.

This severe weather outbreak can be traced back to a powerful, slow-moving low pressure area with a warm front to the north over Nebraska and Missouri.^[9] On May 4, the low stalled over the High Plains and additional moisture coming from the Gulf of Mexico moved in behind the warm front and increased amounts of instability across much of the region, with CAPE values as high as 5,500 J/kg.^[10] In addition, the dry line, which marks a divided line between the dry and humid air mass, was positioned over the southern High Plains. This allowed for the initiation of scattered supercells on May 4. High wind shear also allowed for intense rotation in the atmosphere. All the ingredients were present for the developing of supercell thunderstorms producing damaging wind, large hail and tornadoes.^[11]

The Storm Prediction Center issued a moderate risk for severe weather across western Kansas and small portions of Oklahoma, Colorado and Nebraska for May 4, while temperatures were in the mid to high 80s°F (near 30°C). The atmosphere remained capped for much of the day, but storms began to develop in the late afternoon hours in western Oklahoma and the eastern Texas Panhandle.^[11] The most intense supercells developed in the early evening hours across northwestern Oklahoma and southwestern Kansas. They eventually produced 25 tornadoes, including the devastating Greensburg tornado and three other extremely large tornadoes which followed the Greensburg tornado late that evening.^[12] The supercells remained intact well into the overnight hours as the extremely unstable air mass precluded rapid dissipation expected with the loss of daytime heating which would normally be expected in the Plains. The last tornado of the night did not lift until shortly after 2:00 a.m. early on May 5.^[11]

On May 5, the SPC issued a high risk of severe weather for Central Kansas and central Nebraska, while moderate and slight risks for severe weather extended for areas far beyond.^[13] The low pressure system in place moved northward, but the extending front had barely moved.^[14] The storms were quick to develop. Severe weather reports were already coming in by late morning, and the first tornado reports came in during the early afternoon hours.^[15] The most intense activity took place during the late afternoon and evening hours as supercells developed along a long line from South Dakota to North Texas. Over 80 tornadoes were confirmed that day, along with hail as large as softballs and straight-line winds as strong as 90 mph (145 km/h).^[15] The activity weakened in the late evening, but not before the last tornadoes were reported in Iowa in the overnight hours.

The low gradually weakened and became less conducive for severe weather development on May 6. Nonetheless, the SPC issued a moderate risk for severe storms over parts of central Kansas and northern Oklahoma as the trough remained in place.^[16] The activity was far less than on the two previous days, however there were still several additional tornadoes across the Plains (all of them weak, mostly EF0).^[17] The system finally left the area on May 7 and did not produce any more significant severe weather.^[18]

Confirmed tornadoes

Main article: List of tornadoes in the May 2007 Tornado Outbreak

Confirmed Total	Confirmed EF0	Confirmed EF1	Confirmed EF2	Confirmed EF3	Confirmed EF4	Confirmed EF5
123	62	43	15	5	0	1

The Greensburg tornado family

Storm history and damage

Doppler radar wind velocities shortly before the tornado hits Greensburg. A second developing circulation, which later developed into another very large tornado, was also evident.

The storm that would affect Greensburg (located approximately 110 miles (177 km) west of Wichita) began forming after 5:00 pm CDT (2200 UTC) in the northeastern corner of the Texas Panhandle, and went through phases in the early evening across the Oklahoma Panhandle with a few isolated tornadoes.^[19] It slowly organized itself as it moved northeast through portions of Oklahoma, and then into Kansas.^[10] The first tornado warning with this cell was issued at 8:35 pm CDT (0135 UTC) for Clark County, Kansas,^[20] and the tornado first touched down at about 9:00 pm CDT (0200 UTC). Several storm chasers captured the formation of a tornado southwest of Greensburg around 9:20 pm CDT (0220 UTC).^[21]

The tornado apparently strengthened as it neared Greensburg, and at 9:38 pm CDT (0238 UTC), storm chasers reported that it had grown to over 1/2 mile in diameter.^[22] Several satellite tornadoes were observed as the very large wedge approached the city of Greensburg. At 9:41 pm CDT (0241 UTC) the National Weather Service office in Dodge City issued a rare Tornado emergency for Greensburg. A tornado emergency is an unofficial product used only for extremely life-threatening situations when a large and likely violent tornado is on the ground and approaching a populated area.^[23] The tornado plowed through Greensburg shortly after it was intercepted by storm chasers. It was an estimated 1.7 miles (2.7 km) in diameter and was later confirmed to have been an EF5 on the Enhanced Fujita Scale (the highest possible rating). Based on the damage produced, winds inside the tornado were estimated to have been in excess of 205 mph (330 km/h).^[24]



The center of Greensburg, Kansas, twelve days after being hit by the 2007 tornado.

The mayor of Greensburg stated that 95% of his community was destroyed.^[citation needed] Many houses were flattened or even blown away. Kiowa County Memorial Hospital sustained heavy damage, and as many as 30 people may have initially been trapped inside. A motel on the west edge of the city, two schools, a tractor

supply company, the Greensburg City Hall and other businesses fell victim to the violent winds and were destroyed or flattened. The downtown area was almost completely destroyed, trees were debarked, and vehicles were thrown hundreds of feet. Seven well built homes in Greensburg were cleanly swept away, warranting the EF5 rating.^[25] The city's water tower was completely toppled and smashed. The visitor's center at the Big Well (which is the world's largest hand-dug well) was completely destroyed. Train cars were also reported to be overturned and hazardous materials teams were called to inspect the wreckage. A tank car was carrying about 14,000 gallons (53,000 liters) of ammonia and the substance started to leak from the tank when workers were starting to lift back the tanker. The courthouse and the grain elevator were spared the worst of the tornado's effects. Meanwhile, the Greensburg meteorite, which was feared to have been blown away, was found and recovered a few days afterwards.^[26] The tornado continued north before dissipating, and by several accounts continued to grow as it left the city. The total path length was 22 miles (35 km), and the width of the funnel reached 1.7 miles (2.7 km).^[27]



The destroyed Greensburg High School after the tornado.

After extensive surveys in the area, the National Weather Service office in Dodge City revealed that a second large tornado later developed just a few miles east of the Greensburg wedge. The new tornado rapidly grew to about 2 miles (3.2 km) in diameter as it moved northeast. In Pratt County the tornado destroyed more homes, including one that was swept off its foundation. The tornado also affected several other communities, including Trousdale in Edwards County and Macksville in Stafford County. The same supercell spawned additional tornadoes that caused significant damage across Barton County where it affected the cities of Ellinwood and Claflin about two hours after the Greensburg tornado. Another tornado later hit the Holyrood area causing additional damage.^{[28][29]} The tornado destroyed 961 homes, caused major damage to 216 others and minor damage to 307 other houses.^[30]


After additional surveys, NWS Dodge City had confirmed 12 tornado tracks by the Greensburg supercell in Kansas alone on May 4 including the two satellite tornadoes and an additional brief tornado east of Greensburg at 9:55 p.m. CDT at the same time the main tornado was weakening and dissipating a few minutes

after at 10:05 PM CDT.^[28] The new Enhanced Fujita Scale was implemented on February 1, 2007, and the Greensburg tornado was the first tornado rated EF5 on it. Including tornadoes from the older Fujita Scale, the most recent F5 to hit the United States had been on May 3, 1999 during the 1999 Oklahoma tornado outbreak, when a tornado destroyed Bridge Creek.^[28]

This tornado event surpassed the number of fatalities registered on May 4, 2003 during the May 2003 tornado outbreak sequence when eight people were killed by three separate tornadoes that affected areas around Kansas City and points south and west of the city; the last major deadly outbreak registered in Kansas prior to the Greensburg event.^[31] It was also the deadliest day and single tornado to hit the state of Kansas since an F5 tornado (which was also the last F5 in that state before this event), hit Wichita and Andover in Sedgwick and Butler counties, killing 17 during the Andover, Kansas Tornado Outbreak on April 26, 1991.^{[32][33]} The Greensburg event was also the deadliest single tornado in the United States since a tornado hit Volusia County in central Florida on February 2, 2007 where 13 were killed in an EF3 tornado. It was also the deadliest day for tornadoes since 20 people were killed in six communities on March 1, 2007.

Aftermath



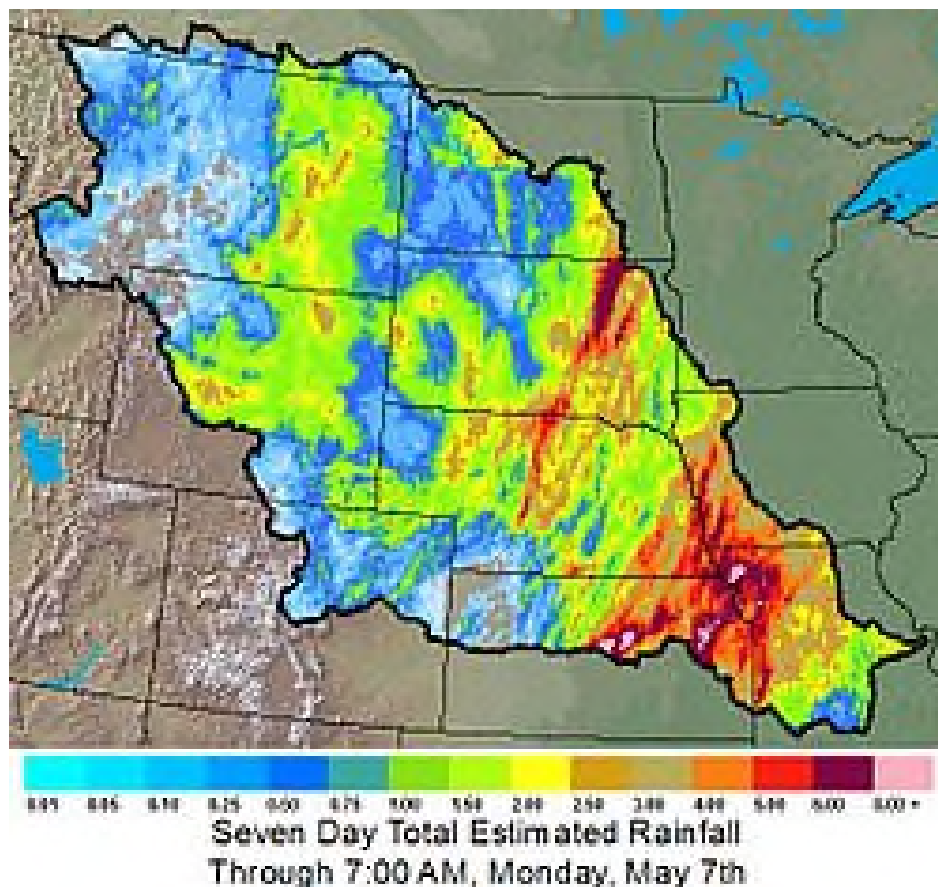
 Marine One, carrying George W. Bush, flies over the devastated community of Greensburg, Kansas Wednesday, May 9, 2007.

Hours after the tornado hit, Greensburg was judged unsafe and was fully evacuated. Some of the injured were transferred to hospitals in Dodge City and Wichita. The Kansas National Guard was called in to assist in the security measures. Over 100 Red Cross officials were called in while some worked with the Federal Emergency Management Agency for the recovery efforts. Shelters were established at the Haviland High School and Barclay College in nearby Haviland, Kansas and the Oddfellow Lodge in Macksville, Kansas.^[34] After the tornado, looting was reported in the community and at least seven suspects, including four soldiers that were not part of the relief effort and went to Greensburg on their own, were arrested and faced charges of burglary and theft.^{[35][36]} A dusk-to-dawn curfew was put in place in the community after the tornado hit.^[37]

The American Red Cross maintained a list of "Safe and Well" families at their website disastersafe.redcross.org.^[38] Meanwhile, officials also set a shelter for lost and injured animals as they reported to have found 163 animals alive in Greensburg after the tornado.^[39] Kansas Governor Kathleen Sebelius and President George W. Bush both declared Kiowa County a disaster area.^[40]

Total damage from the outbreak was estimated at about \$268 million,^[1] and insured damage from the Greensburg tornado alone was estimated at \$153 million.^[41]

Non-tornadic events



Rain amounts during the first week of May in the Missouri River Basin

In addition to the tornadoes, widespread flooding occurred across central North America as a result of the same system producing continuous thunderstorms. There were two major reasons for the flooding: The storm system itself moved very slowly, having produced significant tornado outbreaks in almost the same places for three days. In addition, the storms moved along each other's paths, so

one storm dropped heavy rains on the same place that the storm before it did (this is also known as "training").



Flooding on the 102 River at Maryville, Missouri. The river is normally about the size of a creek and is on the extreme right of the photo

Across portions of eastern Nebraska and western Iowa, rainfall amounts exceeded locally 6 inches (152 mm).^[42] In northeastern and central Kansas, rainfall amounts approached 5 – 6 inches locally (125 – 150 mm).^{[43][44]} In North Dakota,^[45] southern Manitoba and southern Saskatchewan, heavy rainfalls of 1 – 3 inches (25 – 75 mm) fell from this system from May 4 to May 7.^[46] Similar amounts were reported in Alberta on May 3 and May 4.^[47]

Some of the worst flooding affected Topeka, Kansas, where several rescues had to be made, and the Kansas City Metro Area, where several roads were closed. In neighboring Missouri, levees broke along the Missouri River which caused extensive flooding to hundreds of homes and the northwest and central part of the state. The National Guard were assisting on filling sandbags to protect homes, schools and plants across the state which experienced some of the worst flooding since the Great Flood of 1993 which affected most of the Mississippi River Valley. Torrential rains on May 10 had also caused flooding in parts of southern Missouri as well as in eastern Kansas.^{[48][49]} The heavy rains also affected activities surrounding the Riverfest (Wichita River Festival) which postponed some events until May 14.^[50] The Arkansas River reached record levels near Haven when it crested at 13.08 feet on May 8. Some flooding into low lying areas was also observed in the Wichita Metropolitan Area. Rainfall amounts in southern and southeastern Kansas also exceeded 6 inches (152 mm) over a two-day period on May 6 and May 7. There were several reports of farmers who lost several cattle who have been tossed by the high water levels.^[51]

In Aberdeen, South Dakota, 7.75 inches (197 mm) of rain fell the evening of May 5 into the early morning hours of May 6, causing significant flooding in some areas around the city. It was also the city's new 24-hour record rainfall, breaking the old mark of 5.20 inches (132 mm) set in June 1978.^[52] The highest unofficial rainfall total was reported in Epiphany, South Dakota where as much as 10 inches (254 mm) fell during the weekend.^[53] The highest official report of rain, 8.73

inches (222 mm) at Columbia, South Dakota, set a new official 24-hour May rainfall record for the entire state of South Dakota.^[54]

In southern Oklahoma City and surrounding communities, strong straightline winds caused damage to several buildings and downed trees and power lines in the early morning hours of May 7, with cleanup efforts being complicated due to flooding rains accompanying the storm. About 11,000 homes were without power during the event.^[55] There were also reports of floods across many other areas in Oklahoma. Oklahoma Governor Brad Henry had declared a state of emergency for all 77 counties across the state due to all the severe weather including the tornadoes, the flash floods and hail.^[56]

Snow was also reported across higher elevations in Colorado, Wyoming, Nebraska and Utah with local amounts of up to one foot (30 cm) across central Colorado.^[57]

See also

- [List of F5 and EF5 tornadoes](#)
- [List of North American tornadoes and tornado outbreaks](#)
- [Tornadoes of 2007](#)
- [Tornado Emergency](#)

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External links

- [High resolution Photograph of Greensburg, KS Wedge Tornado Under The Parent Supercell At The Time It Was Damaging Greensburg.](#)
- [Videos and discussions of recent Midwest Tornado](#)
- [Preliminary synopsis of tornadoes in Barton and Rice County \(from the same supercell that formed the Greensburg tornado\) \(courtesy of NWS Wichita, Kansas\)](#)

- [Aerial photos of Greensburg, KS after the tornado](#)
- [Additional Tornado damage and storm event photos \(courtesy of KAKE-TV, Wichita\)](#)
- [NWS Dodge City, Kansas Greensburg Tornado Page](#)
- [TORNADOES, HEAVY RAIN HAMMER CENTRAL PLAINS, MORE STORMS EXPECTED](#)
- [Greensburg area tornadoes summary \(courtesy of NWS Dodge City, Kansas - last update: May 22, 2007\)](#)
- [Weather Synopsis of May 5, 2007 Outbreak in Oklahoma \(NWS Norman, Oklahoma\)](#)