



Moore, Oklahoma Tornadoes

Tornado Season

The most common area for tornado outbreaks occurs within a region known as 'Tornado Alley,' an L-Shaped area that includes parts of Texas, Oklahoma, Nebraska, eastern Colorado, and western Iowa, with the highest threat in Oklahoma. Forecasts for the 2013 summer season indicate the potential for violent weather resulting in strong and damaging storms including severe tornado outbreaks across the Midwest. May normally has the most tornado activity. The current season is proving to be deadly with multiple tornado outbreaks as evidenced by a devastating tornado that hit Moore, Oklahoma, a suburb south of Oklahoma City, on May 20, 2013.

Oklahoma F/EF 5 Tornadoes

Date	Location
May 31, 2013	El Reno
May 20, 2013	Newcastle/Moore
May 24, 2011	El Reno/Piedmont
May 3, 1999	Bridge Creek/Moore
April 2, 1982	Broken Bow
March 26, 1976	Spiro
May 5, 1960	Prague
May 25, 1955	Blackwell
Note: rated F5 (before 2007) or EF5 (equivalent, 2007 onward)	

<http://www.spc.noaa.gov/faq/tornado/f5torns.html>

Sixty (60) F/EF tornadoes have been documented within the conterminous United States between 1950 and May 31, 2013. Oklahoma has experienced eight (8) F/EF 5 tornadoes of which two (2) hit the Moore City area, one in May 1999 and the other in May 2013.

Tornado Intensity Classification

The National Weather Service uses the Enhanced Fujita (EF) Scale, a damage scale for winds, including tornadoes. The EF-scale classifies EF0-EF5 damage as calibrated by wind engineers and meteorologists across 28 different types of damage indicators, mainly various kinds of buildings, as well as other types of structures and trees. The scale is not rated according to wind speed, but wind speed is derived from the amount and type of damage. The National Weather Service categorized the Newcastle-Moore 2013 and the 1999 Bridge Creek-Moore tornado as EF5, the highest rating given to tornadoes.

The Tornado Classification table shows the original Fujita (F) Scale and the update to the Enhanced Fujita (EF) Scale. The EF scale was implemented in the United States on February 1, 2007. The EF-scale is a set of wind estimates not calibrated to actual wind speed measurements. As with the original F-scale, the enhanced version rates the tornado as a whole based on most intense damage within the path.

Tornado Classification

FUJITA SCALE			ENHANCED FUJITA SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Source: <http://www.spc.noaa.gov>

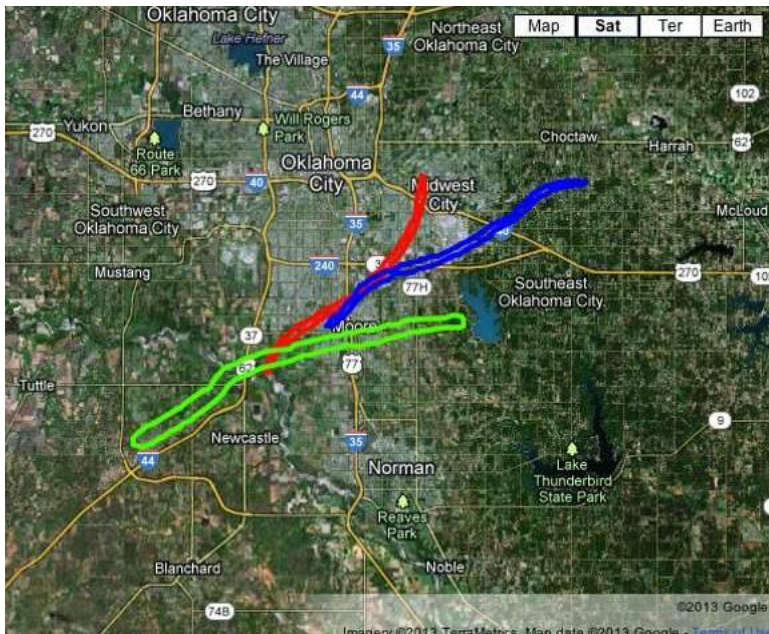
Moore, Oklahoma



The city of Moore is in Cleveland County, Oklahoma and is part of the Oklahoma City metropolitan area.

Moore encompasses an area of 21.9 sq. miles (56.72 km²). The 2011 population was 56,315, ranking Moore the seventh largest city in the state of Oklahoma.

Storm Track 2013, 2003, 1999



Red: May 3, 1999 Tornado Path
 Blue: May 8, 2003 Tornado Path
 Green: May 20, 2013 Tornado Path

The storm track show the paths of three tornadoes that struck Moore, Oklahoma in 1999, 2003, and 2013. The 2013 storm (green) overlaps the path of the 1999 storm (red).



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1999 Bridge Creek-Moore Tornado

The tornado that struck the Bridge Creek-Moore area May 3, 1999 was a result of multiple supercell thunderstorms that produced many large and damaging tornados known as the Great Plains Tornado Outbreak of May 3-4, 1999. Over 70 tornados were observed in the Oklahoma City region and this cluster is considered the largest tornado outbreak recorded in the state. And, up until the May 20, 2013 Newcastle-Moore Tornado, the 1999 Bridge Creek-Moore Tornado was the most expensive ever recorded with damage estimates of \$1 billion (1999USD), which currently is equivalent to \$1.4 billion. That tornado was the 100th tornado to strike Oklahoma City since 1890.

The Bridge Creek-Moore Tornado tracked for almost an hour and a half along a 38 mile (61.2km) path from Chickasha through south Oklahoma City and the suburbs of Bridge Creek, Newcastle, Moore, Midwest City, and Del City.

2003 Oklahoma City Area - Moore Tornado

On May 8, 2003 severe thunderstorms in southcentral Oklahoma resulted in two tornado supercells producing four tornados tracking across the city of Moore, southern Oklahoma City, Midwest City, and the city of Choctaw. Tornados were on the ground approximately 33 minutes and traveled 17.3 miles (27.7 km).

The storm responsible for the Moore Tornado developed during mid-afternoon and produced a weak tornado near Newcastle and west of Moore. Just after 5:00 PM, the new tornado touched down on the west side of Moore and moved east northeast across Moore. While there was extensive damage in the narrow 700 yard path, there were no fatalities but there were injuries. Damage across Moore was rated as EF3 with a maximum intensity of EF4. Structural damage included 300 homes destroyed, 300 homes with minor damage, 22 businesses with minor damages, and six businesses with major damages (McManus, 2004)

2013 Newcastle-Moore Tornado

On May 20, 2013 between 2:45 and 3:35 PM an EF-5 tornado struck Moore, Oklahoma. The intense tornado resulted in over \$2 billion in damages. Overall, the supercell that produced the Newcastle-Moore tornado affected 3,937 homes, business, and other buildings in Cleveland, Lincoln, McClain, Oklahoma, and Pottawatomie counties (*Claims Journal*, 2013). Especially hard-hit was the city of Moore with approximately 1,200 homes and Brairwood and Plaza Towers Elementary schools destroyed; and, the Moore Medical Center was heavily damaged (FEMA, 2013). Twenty-four people including nine children were killed and 377 people were injured. The swath of the tornado was calculated as 17 miles (27k) long, 1.3 miles (2.1k) wide with winds speeds in excess of 210 mph (340km). The tornado was on the ground for approximately 40 minutes. Debris was found up to one hundred miles northeast of the city of Moore.

The path of the May 20, 2013 tornado partially followed the path of the May 3, 1999 tornado, although the width of the May 20th tornado was wider than the May 3rd tornado.



Destroyed subdivision of Moore, Oklahoma

Heavily damaged Moore Medical Center



2013, 2003, and 1999 Tornado Facts

	2013 Newcastle-Moore	2003 Oklahoma City Area - Moore	1999 Bridge Creek - Moore
Date	May 20	May 8 (Moore), - 9, 2003	May 3
Time	2:45-3:35 pm	Moore: 4:49 - 5:22 pm	6:23-7:48 pm
Swath	17 miles (27km)	17.3 miles (27.7km)	38 miles (61.2km)
Width	1.3 miles (2.1km)	700 yards (.64km)	1320 yards (1.2km)
Rating	EF5	EF3- EF4	EF5
Damages	\$1.5 - 3 billion	Approx: \$1 billion (both days for all four tornados)	\$1 billion (1999 USD) \$1.4 Billion (USD)
Casualties	Moore: 24 fatalities; 377 injuries	Moore: No fatalities Total: 1 fatality; 145 injuries	Moore: 5 fatalities Bridge Creek: 12 fatalities Total: 41 fatalities; 583 injuries
Affected areas	Grady, McClain, and Cleveland Counties; the City of Moore	May 8: Moore, southern Oklahoma City, Midwest City, and Choctaw May 9: Bethany, Oklahoma City, Jones, Stroud	Oklahoma, Grady, McClain, and Cleveland Counties; the Cities of Bridge Creek and Moore

Interpretive Learning...

- 1) Using the maps of distribution of tornadoes across the United States found on the National Atlas (nationalatlas.gov) or ESRI (esri.com) websites listed in Education Resources describe the pattern of where tornadoes are or not prevalent. Why are they prevalent in some areas and not in others? Does the area referred to as 'Tornado Alley' stand out on the maps?
- 2) Explain the weather conditions that tend to induce tornadoes.
- 3) What is a Tornado Watch? A Tornado Warning? What should you do if there is a Tornado Warning in your area? What should you do if you hear the Emergency Sirens go off in a Tornado Warning?
- 4) Watch the movie "Twister." List any scientific terms used in the movie. What facts mentioned in the movie are accurate or not accurate and why.
- 5) What would engineers learn from tornados to improve structural designs, warning systems, and atmospheric measurements?
- 6) What are the social impacts of tornados?

Explore More...

Read about tornados:

Tornados in the Conterminous United States: 2000-2007, the front cover image and Inside the Cover Image feature explanation in the *Journal of Geography*, 2009, Vol.108, No. 2; Routledge, Taylor & Francis.

Leap Year Tornado Outbreak 2012, an IceEarth publication of CNL World. Available at: icearth.cnlworld.org

Discover spatial distributions of tornadoes:

ESRI: Tornado Related Images. Available at: <http://www.esri.com/services/disaster-response/severe-weather/moore-oklahoma-tornado-all-maps>

ESRI: Moore, Oklahoma, Tornado Public Information Map. Available at: <http://www.esri.com/services/disaster-response/severe-weather/moore-oklahoma-tornado-public-information-map>

The National Atlas: <http://nationalatlas.gov/mld/tornadx.html>

Investigating Tornadoes in USA Using ArcGIS Online, Part 1: <http://www.youtube.com/watch?v=TIQTxXMdZIU>

Research basic tornado concepts and understanding:

Scholastic: Severe Weather and Natural Disasters: <http://teacher.scholastic.com/activities/wwatch/tornadoes/>

FEMA Facts: <http://www.ready.gov/know-facts>

Weather Wiz Kids: Tornadoes: <http://www.weatherwizkids.com/weather-tornado.htm>

National Geographic: <http://video.nationalgeographic.com/video/kids/forces-of-nature-kids/tornadoes-101-kids/>
<http://environment.nationalgeographic.com/environment/natural-disasters/inside-tornadoes/>

View the slide presentation:

Highway Overpasses as Tornado Shelters: Fallout From the 3 May 1999 Oklahoma/Kansas Violent Tornado Outbreak. Available: <http://www.srh.noaa.gov/oun/?n=safety-overpass>

View active weather conditions:

NOAA National Weather Service: Active watch, warnings, advisories and short term forecasts in the lower 48 US states:

<http://www.nws.noaa.gov/view/largemap.php>

<http://www.spc.noaa.gov/climo/online/monthly/newm.html#2012>

NOAA National Weather Service: Enhanced Data Display site (EDD)

<http://preview.weather.gov/edd/>

Sources:

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- EarthSky Science News*. 2013. Moore Tornado. Available at: EarthSky.org
- McManus, Gary. 2004. *Oklahoma Climate Event summary: May 8-9, 2003 Central Oklahoma Tornadoes*. Oklahoma Climatological Survey, Norman, OK. Publication ES 2003-02. University of Oklahoma
- News Channel 5. Moore tornado takes a similar track to May 3, 1999 tornado in Oklahoma. Available at: http://www.newsnet5.com/dpp/weather/weather_news/Moore-tornado-takes-similar-track-to-May-3-1999-tornado-in-Oklahoma
- NWS Service Assessment Team, 2003: Record Tornado Outbreaks of May 4–10, 2003. National Weather Service, Silver Spring, MD.
- NWS Science Report, 2004: The May 2003 Tornado Outbreak: A Review. National Weather Service, Silver Spring, MD.
- Schneider, Russell S., Harold E. Brooks, and Joseph T. Schaefer. nd. *Tornado Outbreak Day Sequences; Historic Events and Climatology (1875-2003)*. Available at: <http://www.spc.noaa.gov/publications/schneider/otbrkseq.pdf>
- Tornado Rumor Control. 2013. Published by FEMA. Available at: <http://www.cityofmoore.com/tornado-rumor-control-published-fema>

Image Sources:

- Before (front cover): courtesy of DigitalGlobe, Inc. Permission to use image granted by DigitalGlobe, Longmont, Colorado.
- After (front cover): May 20, 2013. Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerodrid, IGN, IGP, swisstopo, and the GIS User Community | Bearing Tree Land Survey (<http://www.btls.us/>), Esri, State of Oklahoma
- Moore Oklahoma Tornado: Washington Post
- Ground Photographs: Google: Moore Tornado 2013

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