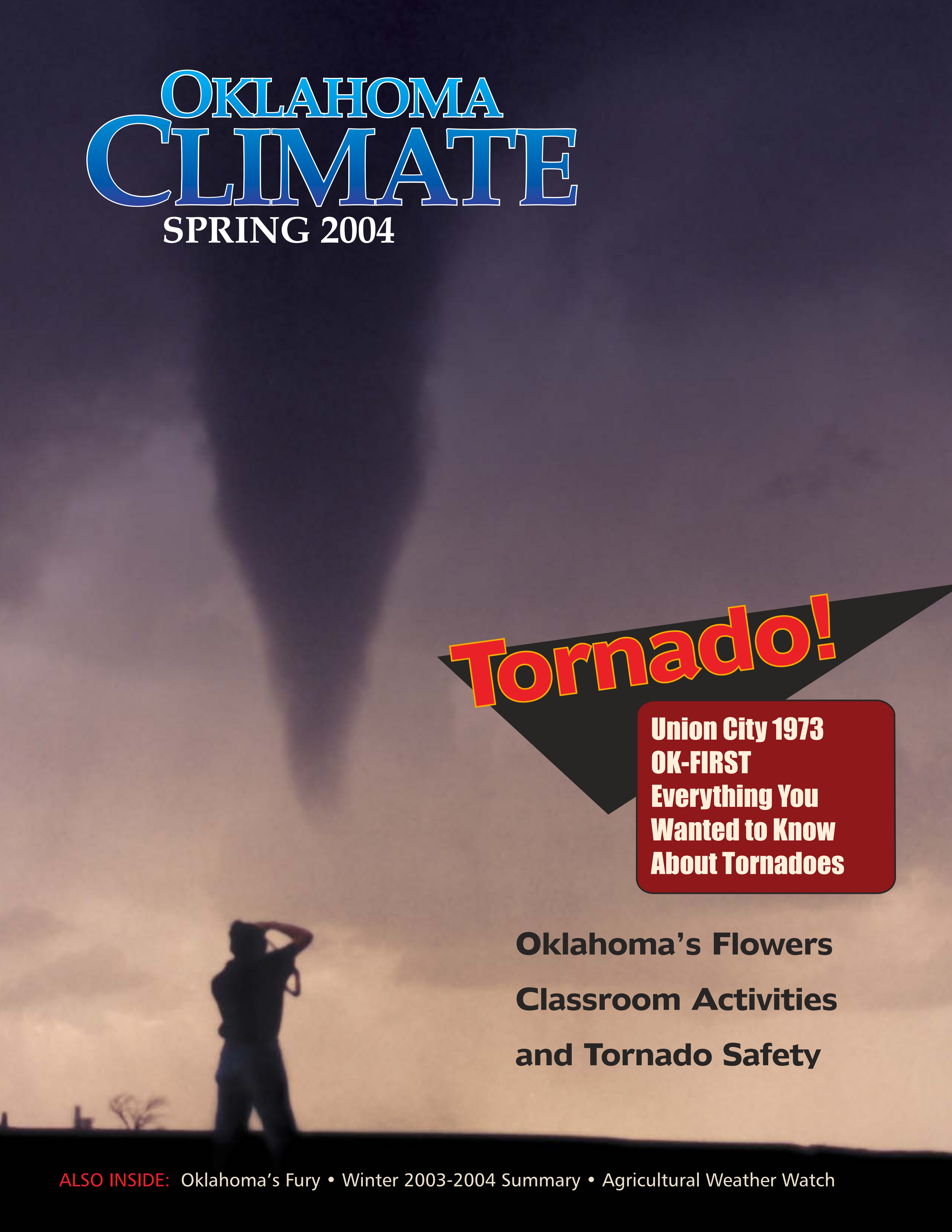
OKLAHOMA CLIMATE

SPRING 2004



Tornado!

Union City 1973
OK-FIRST
Everything You Wanted to Know About Tornadoes

Oklahoma's Flowers

Classroom Activities

and Tornado Safety

ALSO INSIDE: Oklahoma's Fury • Winter 2003-2004 Summary • Agricultural Weather Watch

MESSAGE FROM THE EDITOR

Welcome to the spring 2004 edition of the Oklahoma Climatological Survey's seasonal Climate series, "Oklahoma Climate." The theme of this third edition, "Tornado!" may seem a bit cliché, but with more than 2900 tornadoes, 271 fatalities and over 4000 injuries since 1950, Oklahoma's reputation as the epicenter of Tornado Alley is well earned. Solidifying that infamous distinction, our state experiences more significant tornadoes per square mile than anywhere else on the planet.

Our knowledge of tornadoes has come a long way since the somber voice on the television during tornado warnings urged us to run through the house opening windows (did it really seem like a good idea to get closer to windows during a tornado?). And of course, I was assured by many well-meaning adults growing up in Buffalo that we were safe from tornadoes since our fair city lay within a valley. Even today you will hear the oft-repeated myth that rivers somehow deter twisters. We now know, however, that tornadoes can strike virtually anywhere, any time of the year, and any time of the day.

Current research involving these violently rotating columns of air received a significant jump-start with the Union City tornado of May 24, 1973. As Assistant State Climatologist Derek Arndt writes in this issue's historical perspective of that event: "…the storm (at the time) was the most heavily and thoroughly sampled tornadic supercell in history. The body of knowledge eventually built around this event reaches far and deep into several disciplines of meteorology."

Also in this issue, we delve a bit deeper into Oklahoma's tornado lore with an article from National Weather Service forecaster Doug Speheger, who is quickly becoming recognized as the state's pre-eminent tornado statistician. The Climate Survey's efforts to arm Oklahoma emergency managers with the most up-to-date weather information possible are detailed in a review of the OK-FIRST program by the program's director, Dale Morris. Oklahoma educators can get their students involved with a classroom exercise covering Oklahoma's county tornado totals since 1950. For the green thumbs out there, the spring lawn and garden checklist is loaded with timely information (it's time to plant that Swiss chard and kohlrabi!). And what tornado tome would be complete without a bevy of twister pictures? See our attempt in the pictorial presentation "Oklahoma's Fury." For a nice change of pace, Dr. Renee McPherson advises us how to add a bit of color to our lives (and gardens) by planting native Oklahoma wildflowers. And last – but not least – a recap of the winter weather is included.

I sincerely hope you enjoy this, our third chronicle of Oklahoma's exciting and varied seasons. If you have any questions or comments, please feel free to contact me at gmcmanus@ou.edu.

Gary McManus – Editor

Oklahoma Climate Spring 2004

Cover Photo: Dover, OK Tornado on Oct 4, 1998. Photo by Keith Brown. If you have a photo that you would like to be considered for the cover of Oklahoma Climate, please contact Gary McManus at gmcmanus@ou.edu.

Table of Contents

The Oklahoma Climatological Survey is the State Climate Office for Oklahoma

Dr. Kenneth C. Crawford, Director and State Climatologist

Editor
Gary McManus, Climatologist

Contributors
Derek Arndt
Dr. Kevin Kloesel
Gary McManus
Dr. Renee A. McPherson
Dale Morris
Doug Speheger
Albert Sutherland

Design
Stdrovia Blackburn, Visual Communications Specialist

Oklahoma Climatological Survey

Union City 1973

By Derek Arndt
Assistant State Climatologist
Oklahoma Climatological Survey

Few things can bring immediate impact like an F4 tornado, but one event in Canadian County helped steer the course of science.

The Union City tornado. Photo courtesy NOAA Photo Library, NSSL collection.

People on the plains live with the small but persistent threat of large and violent tornadoes. Oklahoma's history – and inevitably, its future – is peppered with the awe and tragedy borne by these terrible winds. Some of these tornadoes claim lives. Some take dreams – others haunt them. But all bring an immediate and life-changing impact to somebody.

May is the state's most prolific tornado-producing month. As such, it holds a formidable record of high-impact tornadoes. Its legacy includes the 1882 destruction in the Indian Territory mining town of McAlester and the 1905 catastrophe in and around Snyder, where 97 people died. More recently, the month delivered the May 3rd, 1999 statewide outbreak and 2003's back-to-back OKC tornadoes.

May 24th, 1973 produced an F4 tornado that scoured the landscape in and around the farming community of Union City, in southern Canadian County. The impact was as described above: immediate and life-changing. Many homes were destroyed and two people were killed. But this storm differs from many of its May cousins thanks to several scientific advancements made in its wake. These advancements ultimately led – and in some cases, directly led – to a better understanding and forecasting of these storms.

The tornado spun up around 4:45 pm a few miles northwest of the town and intensified rapidly as it progressed eastward. Several farms sustained major damage to trees and outbuildings, and one farmhouse was completely destroyed. The storm then curved to the right, as tornadic storms often do, and struck the town directly. Dozens of homes were destroyed or heavily damaged, along with the town's grain elevator and several churches.

The lasting significance of the storm came through the many different eyes that were cast upon it, both in person and remotely via Doppler radar. At the time, and for several years afterward, the storm was the most heavily and thoroughly sampled tornadic supercell in history. The body of knowledge eventually built around this event reaches far and deep into several disciplines of meteorology.

The early 1970s were the formative years for the art, science and tactics of modern storm chasing. The National Severe Storms Laboratory (NSSL) in Norman began coordinating a chase program with the University of Oklahoma in 1972. Obviously, wireless phones and real-time laptop displays were not available to these pioneer chasers. Instead, scientists and students relied on occasional calls from a convenient phone booth, less-than-perfectly-reliable FM radio, and their developing "field sense" to intercept storms.

On the day of the Union City event, an isolated cell developed ahead of an advancing squall line. These cells were known to be preferred candidates for tornadic activity, and soon NSSL personnel directed their chase teams south and east of the maturing supercell. Several OU chase teams recognized the developing cell as significant and engaged it from the north. Together, both sets of crews gathered a huge volume of visual data. High-dollar 16-mm cameras on loan from NASA provided movies of the event. Volumes of still photos, snapped by the chasers or borrowed from the public, provided more data for photogrammetic analyses of debris. By studying these visual media in the months and years following the event, scientists got a thorough picture of the storm's flow field at many points along its path.

Mangled cars, broken trees and shattered homes testify to the destructive power of an F4 tornado in Union City. Photo courtesy NOAA Photo Library, NSSL collection.

Radar meteorology is another discipline that benefited from the event. In 1970, NSSL brought into service a state-of-the-art Doppler weather radar. At that time, the "Norman Doppler" didn't offer the operate-from-your-desk convenience of today's radar terminals. One or more technicians worked the radar from the bowels of the outbuilding that housed it. It was crowded, stuffy, and often hot work. Until 1973, the person operating the Norman Doppler didn't even have the luxury of seeing the radar echoes. Instead, he had to aim the radar blindly, based on coordinates provided via telephone by the operator of NSSL's conventional WSR-57 radar, which had a real-time display.

By May 1973, however, the Norman Doppler had a black-and-white real-time display in its chambers, and NSSL scientist Rodger Brown used it to track the developing Union City supercell. Meanwhile, his colleague Don Burgess followed the storm with the WSR-57. By the time the tornado struck Union City, Burgess could actually see the tornado from the observation platform near his post.

Because they had collected Doppler radar data for practically the entire life cycle of the storm, Brown and Burgess knew that the team had an excellent data set to work with. "We hadn't looked at any of the radar data yet, so we didn't know the eventual magnitude of the case study," Burgess recalled. "But we knew we'd done well that afternoon." In fact, confidence was high enough that scientists hopped in a plane and did a preliminary aerial survey late that afternoon, shortly before sunset.

By the time the chase teams returned that night, compared notes and shared

The Union City tornado. Photo courtesy NOAA Photo Library, NSSL collection.

experiences, it was apparent that this case study would pay scientific dividends. The following day, comprehensive damage surveys began in Union City and surrounding areas. Town residents were interviewed, and their eyewitness accounts provided valuable input to the process. In the weeks that followed, Union Cityans cleaned and rebuilt their town while accommodating and assisting tornado researchers. “We were almost like residents ourselves,” Burgess said. “We ate in the town café almost every day for weeks. I don’t think I ever heard a negative word from any of them.”

The radar data, stored on seven-track reel-to-reel tape, was processed and scientists pored over the results. Brown, Burgess, and colleague Les Lemon noticed a peculiar signal in the radar’s velocity field, at the exact location where the tornado was observed by the chase teams. The signal repeated itself on following frames, each time exactly where the tornado was reported. “At first, it honestly looked like bad data,” Brown said. “But when it occurred over and over right on top of the tornado, we knew we were onto something.” They had found what is now known as the Tornadic Vortex Signature. Today, the TVS is widely used as one radar indicator of a potential tornado.

The publications that arose from the event were numerous. NSSL scientists dissected the storm from many perspectives and launched a tour de force that culminated by filling much of January 1978 issue of *Monthly Weather Review*, a leading meteorological journal. The articles featured unprecedented detail about the tornado’s anatomy and life cycle, photogrammetric procedures, damage surveys and, of course, Doppler radar data. The OU chase teams published their observations and subsequent research in several meteorological journals. The storm chasers were even featured in an issue of *Popular Science*, which had a reporter and photographer ride along during the Union City event. That article introduced many Americans to storm chasing.

The direct scientific results weren’t the only dividends of the Union City efforts. The comprehensive sampling set a standard that today’s tornado scientists still respect. Professor Howard Bluestein of the University of Oklahoma arrived in Norman not long after the Union City event, and has spent many years at the forefront of scientific chase efforts. While much has changed in the past 30 years, including the advent of truck-mounted radars and GPS positioning, Bluestein asserts that “Union City is still the prototype for the well-sampled storm. That level of coordination and the completeness of catching the storm’s entire life cycle … in many ways, that’s what we shoot for when we do a case study.”

Even the tactics of storm chasing improved due to experiences during that Thursday afternoon. Chuck Doswell, who went on to a prodigious career as a researcher and storm chaser, chased the storm as an OU graduate student. The Union City dataset was so robust partly due to data gathered by OU chasers from north of the storm. Because they approached from a different location to the storm’s north, they had to punch through the storm’s core of torrential precipitation, strong winds and very large hail. One car didn’t make it and rode out the storm from the road’s shoulder. Doswell’s car emerged, however, and he observed the storm from the heavily-damaged townsite.

NSSL’s Norman Doppler radar in June 1973, just a few weeks after the Union City tornado. The radar was operated from within the blue building housing the unit. Photo courtesy NOAA Photo Library, NSSL collection.

“We were still learning so much with every chase,” Doswell pointed out. “After some reflection that night, we realized that we could have very easily driven out of the core and right into the tornado. On that day, I made it a policy to avoid core-punching,” he grinned.

The impact of the storm was not lost on the residents of Union City. To commemorate the town’s recovery from the devastating storm, a tornado was added to the Union City seal in 1985. Twelve years later, Union City officials unfurled a new town flag that featured a tornado. It flies on holidays outside the Union City Town Hall.

The scientific strides surrounding the Union City tornado were not a random occurrence. They were made possible by hard work, preparation and practice in the months and years leading to the event. These favorable conditions, and a bit of good fortune, enabled the coordinated and comprehensive sampling that made the Union City tornado a significant scientific success.

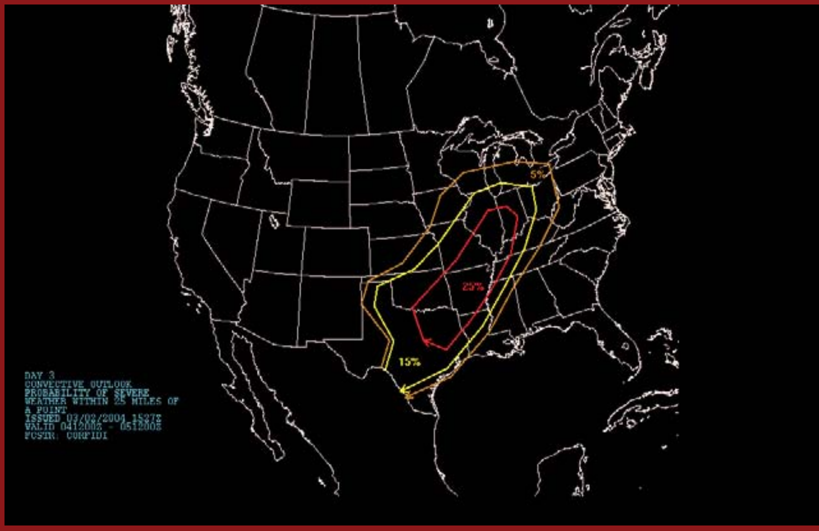
Never before had so many different scientific perspectives converged on a single tornadic event. The massive research effort that followed crystallized many concepts: most have proven right; some were later corrected by subsequent research. But the lasting impact of the storm on the understanding of tornadoes is unquestionable. As Doswell put it: “Reverberations from the event, and the research that followed, are still felt today. We are still benefiting from derivatives of what we learned from Union City.” ■

Special thanks to NSSL’s Dr. Rodger Brown and Don Burgess, Dr. Chuck Doswell of the Cooperative Institute for Mesoscale Meteorological Studies, Dr. Howard Bluestein of the OU School of Meteorology, and Charlie Liles of the NWS Albuquerque forecast office.

OK-FIRST

By Dale Morris
Program Manager for Public Safety Outreach
Oklahoma Climatological Survey

As part of its mission to provide weather information cost-effectively to the state's decision-makers, the Oklahoma Climate Survey launched the OK-FIRST program in 1996 to serve the state's public safety community. Since its inception, OK-FIRST has provided emergency management, fire service, and law enforcement agencies with a decision-support system based upon timely and accurate weather information. OK-FIRST combines the information resources generated by the Oklahoma Mesonet with modern Doppler radar data from the network of NEXRAD radars, plus forecasts, warnings, and advisories from local National Weather Service offices and national centers. OK-FIRST also trains personnel from every participating agency on the use and application of this information for their operations. As a result, public-safety officials across Oklahoma routinely access updated and localized information on demand to better protect local citizens and to keep other officials out of harm's way when responding during hazardous weather conditions. OK-FIRST empowers these officials to make proactive decisions beneficial to the protection of life and property during these weather-impacted situations.



Guidance product issued by the Storm Prediction Center in Norman. The Storm Prediction Center is a national center of the weather service and issues forecasts and watches for severe thunderstorms and tornadoes for the entire continental United States. This product provides a forecast of the probability of severe thunderstorms. OK-FIRST participants routinely use SPC guidance products to prepare for the possibility of severe weather.

The data provided by OK-FIRST allows users to discriminate among different types of thunderstorms. By pinpointing circulations and locating hail cores within these storms, emergency managers more efficiently and safely coordinate storm spotters. These spotters are required to visually confirm tornadoes as the tornadoes touch down because radars usually cannot detect actual tornadoes located beyond just a few miles away from the radar. Coordinators then reposition spotters to better see developing funnel clouds and tornadoes. Finally, emergency managers assist the National Weather Service in the warning process by forwarding spotter reports as well as implementing warnings locally by activating the community's local notification systems, such as outdoor warning sirens and local cable TV override.

OK-FIRST is an all-hazard decision-support system designed for all types of hazardous weather experienced in Oklahoma. During storms, OK-FIRST provides local officials with information about hail, flooding rainfall, and potentially damaging winds. Communities are better prepared for winter weather events and allocation of resources during wildfire conditions. With help from the U.S. Forest Service, Oklahoma Mesonet personnel at OSU and OU jointly developed the most detailed fire danger rating system in the world. OK-FIRST then distributes data from the Oklahoma Fire Danger Model to provide local fire departments with information concerning: how fast a wildfire will spread, the probability a wildfire will ignite, how hot a wildfire will burn, and how tall the flames will be. Firefighters are also alerted to impending wind shifts which are detected both by the Oklahoma Mesonet and the NEXRAD radar units.

Public safety officials often use OK-FIRST information in a variety of ways. OK-FIRST has been used to protect people at outdoor events such as local athletic events, concerts, and parades. Several successful criminal prosecutions were based, in part, upon OK-FIRST data used forensically by detectives to better pinpoint time of death during homicide investigations to invalidate a suspect's alibi.

Among the comments shared by OK-FIRST users:

- "I can look at OK-FIRST and figure out where I need to send spotters rather than just scattering them out across the county and hoping that they are in the right places."
- "The number of times storm spotters are activated has been drastically reduced, and when they are activated, it is for a shorter duration. Also, fewer spotters are needed."
- "The more your work with it, the more it factors into all your decisions. OK-FIRST information, being timely and accurate, has kept disasters from happening. Absolutely critical decisions become routine because good timely information kept you on top of the situation." ■

Laboratory session of an OK-FIRST training workshop. Assistant State Climatologist Derek Arndt explains an image from the Oklahoma Fire Danger Model, while K-12 Outreach Coordinator Andrea Melvin (standing) helps a participant.

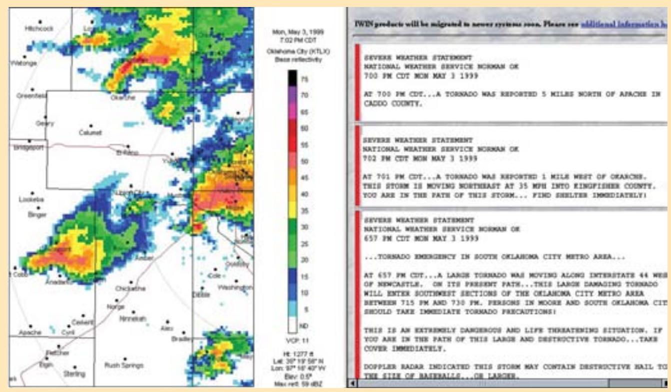
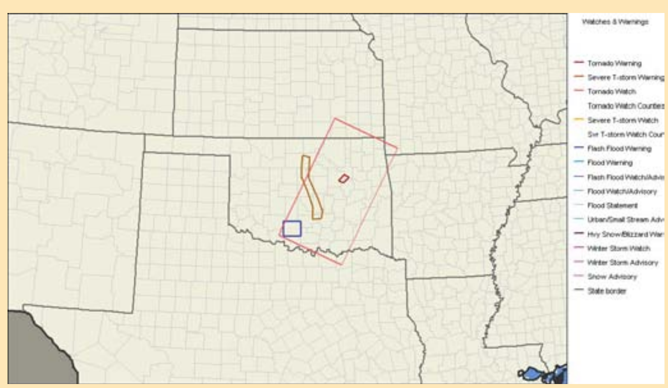
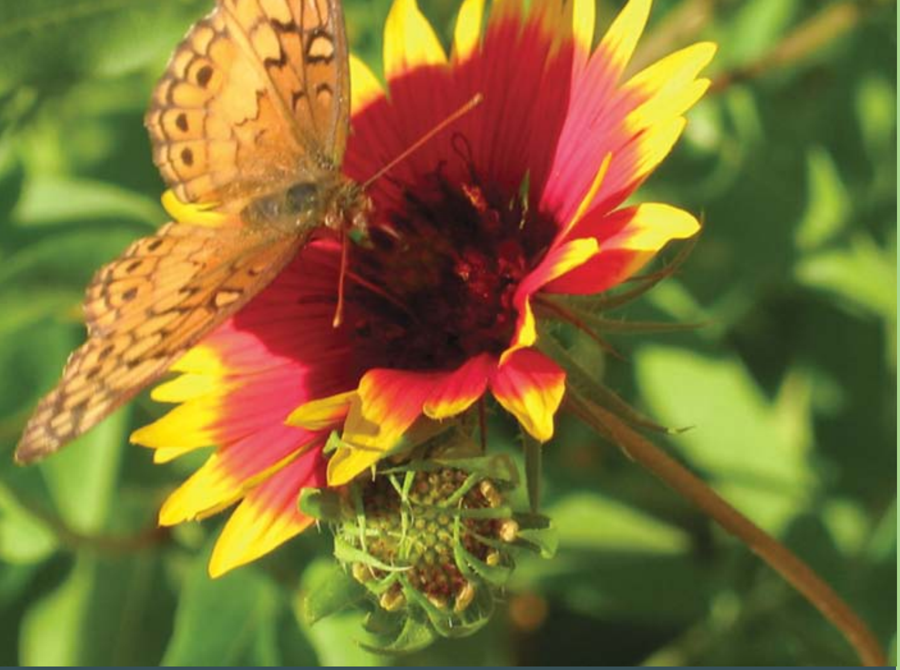


Illustration of what an OK-FIRST user's computer screen may have looked like at 7:02 p.m. on May 3, 1999. The left side of the screen shows the radar image from the Oklahoma City radar and indicates three separate tornadic supercell thunderstorms with "hook-echo" signatures (southwest of Moore, near Okarche, and near Anadarko). The right side of the screen contains three severe weather statements issued by the National Weather Service Forecast Office in Norman. Each statement provides details about the tornadic storms observed by the radar.



Map of current watches and warnings issued by the National Weather Service. In this case, the map illustrates a tornado watch over eastern Oklahoma, with a tornado warning just southwest of Tulsa, a severe thunderstorm warning in north central Oklahoma, and a flash flood warning in south central Oklahoma.



A Bounty of Beauty

By Dr. Renee A. McPherson
Associate Director
Oklahoma Climatological Survey

What is today's best-kept gardening secret? It is that many beautiful, resilient flowers are native to Oklahoma's climate, including its climate extremes. Hummingbirds, eastern bluebirds, goldfinches, butterflies, and other wildlife know this secret, and they seek locations where gardeners have planted Oklahoma native flowers.

Benefits of Planting Native Species

Oklahoma's native flowering plants provide a wealth of shapes, sizes, colors, and seasons to make almost any gardener happy. Many of these plants serve as hosts to larval caterpillars, feasts for butterflies and hummingbirds, and sanctuaries for small birds that don't want to be eaten by vigilant hawks. You may not see the wide variety of Oklahoma's native butterfly and bird species until you start planting native flowers.

Do you have "challenging spots" in your garden, where you can't seem to get anything to grow? There's likely an Oklahoma native wildflower that will thrive in that location. Do you have red clay mixed with red clay? There are native flowers that will bloom faithfully in this gardening nightmare. Are you tired of dragging your watering hose around weekly, spraying for this disease and that, and continually adding fertilizer to the soil year in and year out? These jobs don't completely disappear with native plants, but they can be reduced to a level whereby you can spend more time enjoying your garden than attending to it. The key is to attentively care for the plants until they become established.

There are many wildflowers to choose from for Oklahoma gardens. Try to stay away from non-native species that commonly are advertised as wildflowers (such as those included in Table 1). Table 2 provides a list of plants, the wildlife they attract, growing requirements, bloom color, and bloom time. There is a wildflower that will fit almost every need and garden area.

How Do I Start?

A good garden begins with good research. The most important environmental aspects are light levels (e.g., full sun, partial shade), soil type (e.g., clay, loam, sand), and soil moisture (e.g., dry, bog-like). Use these attributes to begin to decide what plants will thrive in your local environment. Table 2 provides many plants for consideration. If you just want to make a simple start, plant Indian Blanket (Gaillardia pulchella) in full sun and dry-to-average moisture. It's Oklahoma's State Wildflower and the butterflies love it!

Three online wildflower resources that I've used are the USDA's web site (http://plants.usda.gov/), the Wildseed Farms website (http://www.wildseedfarms.com; a Texas wildflower seed producer and supplier), and Easyliving Native Perennial Wildflowers (http://www.easywildflower.com; a Missouri wildflower seed supplier). The USDA site contains detailed information and pictures of native Oklahoma plants. The Wildseed Farms and Easyliving Native Perennial web sites provide a wealth of botanical information, growing tips, and pictures for many native Oklahoma wildflowers. Check with your favorite nursery or garden store to see what wildflowers they recommend. Because the same common name can be used for two or more different species of plants, be sure you compare the scientific names.

Growing native flowers should begin in a manner similar to any other gardening project — with careful planning, soil preparation, and weeding until the flowers become established.

One frustration for first-time wildflower gardeners (and I speak from experience here) is that many native seeds only germinate after they experience Oklahoma's winter. That is, they require several weeks of cold and moist weather before germination. Plant them in the spring, as I tried once, and you'll spend your time weeding a bed of stubborn seeds for the entire summer. Native seeds that require "cold, moist stratification" can be planted in the late fall or early winter, or they can be placed inside a moist plastic bag in the refrigerator for 4-6 weeks. If you purchase seeds from a reputable source, the directions will explain what to do. Just don't ignore them like I did!

Table 1: Non-Native Flowers in Oklahoma

Common Name	Scientific Name	A/P/B	Native
African Daisy	Dimorphotheca aurantiaca	A	S. Africa
Baby's Breath	Gypsophila muralis	A	Europe
Basil	Ocimum basilicum	A	Africa, Mideast
Chicory	Cichorium intybus	P/B	Europe
Cornflower	Centaurea cyanus	A	Europe
Cosmos	Cosmos bipinnatus	A	Mexico
Evening Primrose	Oenothera lamarckiana	A	unknown
Forget-me-not	Myosotis sylvatica	A/P	Eurasia
Foxglove	Digitalis purpurea	B	Europe
Gloriousa Daisy	Rudbeckia gloriosa	P	cultivar
Lantana	Lantana camera	P	S. America
Moss Verbena	Verbena tenuisecta	P	South America
Ox-Eyed Daisy	Chrysanthemum leucanthemum	P	Europe
Queen Anne's Lace	Ammi majus	A	N. Africa/Eurasia
Rose Mallow	Lavatera trimestris	A	Europe
Scarlet Flax	Linum rubrum	A	Africa/Europe
Shasta Daisy	Chrysanthemum maximum	P	Europe
Spurge	Euphorbia myrsiniites	P	Europe
Sweet Alyssum	Lobularia maritima	A	Europe
Sweet William	Dianthus barbatus	P	Europe
Swiss Chard	Beta vulgaris	P	Eurasia, Africa
Thyme	Thymus praecox	P	Europe
Wallflower	Cheiranthus allionii	P/B	Canary Islands
White Yarrow	Achillea millefolium	P	Europe
Yellow Cosmos	Cosmos sulphureus	A	Mexico

Wildflower's "Bad Rap"

Many people equate "native wildflowers" with "weeds". This unfortunate perception can come from planting poorly selected wildflower seed mixes designed for mass merchandising. The plants often provide a beautiful burst of color the first year, as the selection of seeds in these mixes is designed to produce swift results. Unfortunately, in the second year, the plants do not live up to the first year's floral display and take on a weedy appearance.

A point of confusion for many people is when "naturalized" plants are marketed as native wildflowers. Oklahoma's native plants grew here before the Land Rush. Naturalized plants were introduced from some other place, usually Europe, and flourished in the environment because of the lack of natural competition. Over time, some of these "naturalized" species have become "invasive" species, replacing the native plants on which Oklahoma's wildlife depends.

Made for Oklahoma's Climate

Native plants may act as annuals in one plant hardiness zone and perennials in another zone, or they may grow as perennials across the entire state. Either way, these natives already are "tuned" to Oklahoma's climate — not only its average temperature, but its extremes in temperature and precipitation. The good result for gardeners is that these well-adapted flowers are easy to care for. Once established, they rarely need pampering. Many natives even thrive in Oklahoma's red clay! ■

Table 2: Native Flowers of Oklahoma

Common Name	Scientific Name	A/P/B	Native	Wildlife	Sun	Soil Type	Soil Moisture	Height	Bloom	Color	Comments
Alamo Fire	Lupinus texensis	A	U.S./TX		Full	clay, loam, sand	Dry to moist	1-2 ft	Mar-May	red	cannot tolerate poorly drained, clay based soils
American Basketflower	Centaurea americana	A	OK		Full	clay, loam, sand	Average to moist	1-5 ft	May-Aug	purple	specimen or clumps in border
Aromatic Aster	Aster oblongifolius	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	18-30 in	Oct-Nov	blue/yellow	tolerates clay
Ashy Sunflower	Helianthus mollis	P	OK	birds, butterflies	Full	sand	Dry to average	4-6 ft	Aug-Sep	yellow	thrives in poor, dry soils
Black-Eyed Susan	Rudbeckia hirta	A/B	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	2-3 ft	Jun-Aug	yellow/black	deadhead to encourage additional blooms
Blanketflower	Gaillardia aristata	P	U.S./West	birds, butterflies	Full	loam	Dry to average	12-18 in	May-Sep	red/yellow	drought tolerant
Blazing Star	Liatris spicata	P	U.S./East	birds, butterflies	Full	clay, loam, sand	Average	2-6 ft	Jun-Sep	deep rose-purple	takes 2-3 yrs to become established
Blue Flax	Linum perenne lewisii	P	OK		Full	clay, loam, sand	Average	1-2 ft	May-Sep	light blue	prefers light sandy soil
Blue Sage	Salvia azurea	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	2-5 ft	Jul-Oct	blue	pinch back twice each season to keep shorter & bushier
Blue Wild Indigo	Baptista australis	P	OK		Full	clay, loam, sand	Dry to average	1-4 ft	Mar-Jun	blue	tolerates clay soils and drought
Butterfly Weed	Asclepias tuberosa	P	OK	butterflies	Full	clay, loam, sand	Dry to average	1-2 ft	Jun-Sep	bright orange	takes 2 yrs to become established
Cardinal Flower	Lobelia cardinalis	P	OK	birds, butterflies	Shade	clay, loam, sand	Moist	2-4 ft	Jul-Oct	red, pink, or white	divide in spring as needed
Columbine	Aquilegia canadensis	P	OK	birds, butterflies	Part. Shade	loam, sand	Average to moist	2 ft	Mar-May	red/yellow	cut back brown leaves after flowering, do not flower first season
Compass Plant	Silphium laciniatum	P	OK	birds, butterflies	Full	clay, loam, sand	Average	4-8 ft	Jul-Sep	yellow	tolerates poor soil & drought
Crossvine	Bignonia capreolata	P	OK	birds	Part. Shade-Full	clay, loam, sand	Moist	30 ft	Apr-Jun	orange-red	vine, semi-evergreen
Culver's Root	Veronicastrum virginicum	P	OK	butterflies	Full	clay, loam, sand	Average to moist	3-4 ft	Jun-Aug	white	dramatic when massed
Dakota Vervain	Verbena bipinnatifida	P	OK	butterflies	Part. Shade-Full	clay, loam, sand	Dry to average	6-12 in	May-Jul	white, pink	rocky slopes
Drummond Phlox	Phlox drummondii	A	OK		Full	sand	Average	8-24 in	Apr-Jun	deep red	prefers light or sandy soils
Fire Pinks	Silene virginica	P	OK	butterflies	Lt. Shade-Full	clay, loam, sand	Dry to average	1-2 ft	Apr-Jun	red	a must for wild shade garden
Fremont's Leather Flower	Clematis fremontii	P	U.S./KS		Part. shade-Full	loam, sand	Average	12-18 in	May-Jun	purple	non-climbing clematis
Gayfeather	Liatris pycnostachya	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to moist	2-4 ft	Aug-Dec	purple-lilac	prefers gravelly or sandy soil, requires 2-3 yrs to become established
Golden Alexander	Zizia aptera	P	OK	butterflies	Shade	loam, sand	Dry to average	12-20 in	May-Jun	yellow	plant near front of garden path
Gray Goldenrod	Solidago nemoralis	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	2-3 ft	Jun-Nov	yellow	tolerates poor soil & drought
Great Blue Lobelia	Lobelia siphilitica	P	OK	birds, butterflies	Lt. Shade-Full	clay, loam, sand	Average to moist	2-3 ft	Jul-Oct	blue	does not tolerate drought
Indian Blanket	Gaillardia pulchella	A	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	1-3 ft	May-Sep	red/yellow	state wildflower of Oklahoma, drought tolerant
Indian Grass	Sorghastrum nutans	P	OK	birds	Lt. Shade-Full	clay, loam, sand	Dry to average	3-8 ft	Sep-Nov	golden brown	state grass of Oklahoma, specimen or background border
Indian Paintbrush	Castilleja indivisa	A/P/B	OK	birds, butterflies	Lt. Shade-Full	clay, loam, sand	Dry to moist	8-24 in	Apr-Jun	red-orange	requires time to establish
Indian Pink	Spigelia marilandica	P	OK	birds	Part. Shade	loam	Average	1-2 ft	Jul-Sep	scarlet	woodland garden
Joe Pye Weed	Eupatorium purpureum	P	OK	butterflies	Lt. Shade-Full	clay, loam, sand	Average	4-7 ft	Aug-Sep	rose	pinch back in early summer to make bushier plant
Lanceleaf Coreopsis	Coreopsis lanceolata	P	OK	birds	Lt. ShadeÐFull	clay, loam, sand	Dry to average	2-3 ft	May-Jul	bright yellow	2 years to become established
Lead plant	Amorpha canescens	P	OK	butterflies	Full	loam, sand	Dry to average	1-3 ft	May-Aug	purple/orange	silvery foliage, takes 2-3 yrs to mature
Lemon Mint	Monarda citriodora	A/P	OK	birds, butterflies	Lt. Shade-Full	clay, loam, sand	Dry to average	1-3 ft	May-Aug	deep purple	grows almost anywhere
Lupine	Lupinus perennis	P	U.S./ East&North		Full	sand	Dry	1-2 ft	Apr-Jun	blue-purple	sandy or gravelly soil, cannot be transplanted
Marsh Milkweed	Asclepias incarnata	P	OK	butterflies	Full	clay, loam, sand	Moist	3-4 ft	Aug-Sep	pink	cannot be transplanted
Meadow Phlox	Phlox maculata	P	U.S./East	birds, butterflies	Full	loam	Average	2-3 ft	Aug-Oct	pink	intolerant of drought, slowly spreads
Mealy Blue Sage	Salvia farinacea	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	1-2 ft	Mar-Nov	violet-blue	prefers sandy or gravelly soil, does not transplant well

Table 2: Native Flowers of Oklahoma

Common Name	Scientific Name	A/P/B	Native	Wildlife	Sun	Soil Type	Soil Moisture	Height	Bloom	Color	Comments
Mexican Hat	Ratibida columnaris	A/P	OK	birds	Full	clay, loam, sand	Dry to average	2-3 ft	Jun-Sep	fire-red/yellow	drought tolerant
Missouri Primrose	Oenothera missouriensis	P	OK	butterflies	Lt. Shade-Full	sand	Dry to average	6-14 in	May-Sep	lemon-yellow	nice border plant or ground cover, transplants well
New England Aster	Aster novae-angliae	P	U.S./East	birds, butterflies	Lt. Shade-Full	clay, loam, sand	Average to moist	2-6 ft	Aug-Oct	rose, purple	divide every 2-3 years in late fall
Passion Flower	Passiflora incarnata	P	OK	birds, butterflies	Lt. Shade-Full	loam, sand	Average	to 25 ft	May-Jul	purple, pink, white	tough vine, needs trellis for climbing, ground cover
Plains Coreopsis	Coreopsis tinctoria	A	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	1-3 ft	May-Aug	yellow/maroon	tolerates areas with poor drainage
Prairie Aster	Machaeranthera tanacetifolia	A	OK		Full	clay, loam, sand	Dry to average	12-18 in	May-Sep	lavender/ yellow	sandy or gravelly soil
Prairie Beard Tongue	Penstemon tubaeflorus	P	OK		Full	clay, loam, sand	Dry to average	2-3 ft	Apr-Jul	white	makes nice moonlight display
Prairie Phlox	Phlox pilosa	P	OK	birds, butterflies	Full	loam, sand	Average	12-18 in	May-Jun	pink	open woods
Prairie Senna	Cassia fasciculata	A	OK	birds, butterflies	Part. Shade-Full	clay, loam, sand	Average	3 ft	May-Aug	yellow	open woods
Purple Coneflower	Echinacea purpurea	P	OK	birds, butterflies	Full	clay, loam, sand	Average to moist	2-3 ft	Jun-Oct	purple/red-orange	drought tolerant
Purple Prairie Clover	Petalostemum purpureum	P	OK		Full	clay, loam, sand	Dry to average	1-3 ft	May-Sep	lavender-purple	difficult to transplant, drought tolerant
Queen of the Prairie	Filipendula rubra	P	U.S./North-east		Part. Shade-Full	clay, loam, sand	Average to moist	3-7 ft	Jun-Aug	pink, rose	foliage may scorch in full sun if dries out
Rose Vervain	Verbena canaden-sis	P	OK		Part. Shade-Full	clay, loam, sand	Dry to average	1-2 ft	May-Jun	pink	ground cover, containers
Royal Catchfly	Silene regia	P	OK	birds, butterflies	Full	loam	Average	2-3 ft	Jul-Aug	red	will grow in sandy or gravely soil
Sand Penstemon	Penstemon am-biguus	P	OK		Part. Shade-Full	clay, loam, sand	Dry	2 ft	May-Aug	white, pink	extremely drought tolerant, best grown in sand
Scarlet Sage	Salvia coccinea	A/P	U.S./South	birds, butterflies	Full	clay, loam, sand	Dry to average	1-3 ft	Apr-Frost	fluorescent red	
Shining Blue Star	Amsonia illustris	P	OK	butterflies	Full	loam, sand	Part. Shade-Full	2-3 ft	May	blue	tolerant of many conditions
Shooting Star	Dodecathean meadia	P	OK		Part. Shade-Full	clay, loam, sand	Dry to moist	8-24 in	Apr-Jun	pink	take 3 yrs to bloom, wood-land environments
Showy Goldenrod	Solidago speciosa	P	OK	birds, butterflies	Full	loam, sand	Dry to average	1-3 ft	Jul-Oct	yellow	provide good air circu-lation, does not cause allergies
Showy Primrose	Oenothera spe-ciosa	P	OK	birds	Full	clay, loam, sand	Dry to moist	8-16 in	Mar-Jul	soft pink	can be very invasive, nice ground cover
Sky Blue Aster	Aster oolentangi-ensis	P	OK	butterflies	Lt. Shade-Full	clay, loam, sand	Dry to average	2-3 ft	Aug-Oct	blue/yellow	tolerates dry soil
Spiderwort	Tradescantia ohiensis	P	OK		Part. Shade-Full	loam, sand	Dry to average	1-3 ft	May-Jul	blue, rose-blue	cut to 12” in Jul to encour-age fall color, can become invasive in ideal conditions
Standing Cypress	Ipomopsis rubra	B	OK	birds, butterflies	Part. Shade-Full	clay, loam, sand	Dry to average	2-5 ft	Jun-Aug	bright red	blooms in second year, self seeds
Tall Gayfeather	Liatris aspera	P	OK	birds, butterflies	Lt. Shade-Full	loam, sand	Dry to average	2-3 ft	Aug-Sep	purple	
Tall Larkspur	Delphinium exal-tatum	P	U.S./East	butterflies	Full	loam, sand	Average to moist	3-4 ft	Jul-Aug	purple-blue	needs protection from strong winds, poisonous
Texas Bluebonnet	Lupinus texensis	A	OK		Full	clay, loam, sand	Dry to moist	1-2 ft	Mar-May	blue	easy to grow
Virginia Bluebells	Mertensia virginica	P	U.S./East		Shade-Part. Shade	clay, loam, sand	Average to moist	1-2 ft	Mar-Apr	blue	go dormant in summer
White False Indigo	Baptisia alba	P	OK		Full	clay, loam, sand	Dry to moist	2-5 ft	May-Ful	white	tolerates drought & poor soil
White Prairie Clover	Dalea candida	P	OK	butterflies	Lt. Shade-Full	loam, sand	Average	2-4 ft	Jun-Sep	white	tolerates drought
Willow-leaved Sunflower	Helianthus salici-folius	P	OK	birds, butterflies	Full	clay, loam, sand	Average	4-8 ft	Sep-Oct	yellow	spreads over time to form dense colonies
Wine Cup	Callirhoe involu-crata	P	OK		Lt. Shade-Full	clay, loam, sand	Dry to average	6-18 in	Feb-Jul	wine, dark red	gravely or sandy soil preferred, containers, ground cover
Wood Phlox	Phlox divaricata	P	OK	birds, butterflies	Part. Shade	loam	Average	6-20 in	Apr-May	blue	soil rich in organic matter
Yellow Coneflower	Echinacea para-doxa	P	OK	birds, butterflies	Full	clay, loam, sand	Dry to average	2-3 ft	Jun	yellow	divide clumps when become overcrowded
Yellow Wild Indigo	Baptisia sphaero-carpa	P	OK		Full	clay, loam, sand	Dry to average	2-3 ft	Apr-May	yellow	loamy or sandy soils, small shrub

OKLAHOMA'S FURY

Thunderstorm downburst over Norman, OK. Photo courtesy of Billy McPherson.

The Cordell tornado of May 22, 1981. Photo courtesy NOAA Photo Library, NSSL collection.

Chickasha on May 3rd, 1999. Photo courtesy David Demko.

A tornado in Dover, OK, October 4, 1998. Top photo courtesy Brad Illston. Middle photos courtesy of Todd Lindley.

A tornado southwest of Anadarko on May 3, 1999. Photo courtesy of Danny Cheresnick.

WINTER 2003-2004 SUMMARY

After a significantly dry beginning in December, Oklahoma's winter of 2003-04 experienced a lessening of the drastically dry conditions of the previous 12 months. In fact, the two consecutive months of above normal statewide-averaged precipitation during January and February marks the state's first such occurrence since July-August of 2002. The two wet months still were not enough to boost the winter's precipitation total above normal, although it did come close, ranking as the 48th wettest since 1895. A drought of another kind was welcomed with open arms by the state's residents. January 20 marked the 249th consecutive day, beginning on May 17, 2003, in which no tornadoes were reported within the state's borders. That eclipsed the previous record of 248 days, from July 16, 1990, through March 20, 1991, in which the state went without a confirmed tornado. At season's end, the record had increased to 289 days. Finally, after two straight months with above normal temperatures, more winter-like temperatures made an appearance during February. Despite the cool finale, the statewide-averaged winter temperature ranked as the 31st warmest since record-keeping began in 1892.

Precipitation

Considering the desperate situation a significant part of the state found itself in during most of 2003, Oklahoma's close-to-normal winter precipitation total was a welcome respite. Although much of the south and east were below normal, as well as the Panhandle, a swath of the state from southwestern through west central and north central Oklahoma had a precipitation surplus for the season. A portion of this surplus was undoubtedly due to snowmelt, as much of the surplus area had greater than 6 inches of snowfall over the three-month period. North central Oklahoma was particularly wet, with close to 5 inches of precipitation on average, the 19th wettest winter on record. The far western Panhandle, already experiencing extreme drought conditions, received less than a half of an inch of precipitation

Temperature

While there were patches of the state that were actually cooler than normal during winter, most of the state was at least a degree above normal. West central sections were 3-4 degrees above normal in small areas, but 2 degrees above normal on average, the 25th warmest winter since 1895. Not surprisingly, given the amount of snow that fell in that area, north central Oklahoma had temperatures nearest to normal at less than 1 degree above that mark.

Winter Daily Highlights

December 1-4: The year's final month began on a pleasant note, with sunny skies and seasonable temperatures. The winds kicked up from the south, however, a feature which would become commonplace throughout the month. An upper-level disturbance on the 3rd brought showers to the northeastern region of the state. Amounts were generally two-thirds of an inch or less.

December 5-8: A strong cold front entered the state on the fifth, accompanied by strong northerly winds and frigid temperatures. Kenton reached a bone-chilling 14 degrees that night. Temperatures never rose past the 40s on the fifth and sixth before strong southerly winds returned, along with unseasonably warm temperatures. High temperatures soared into the 60s and 70s on the seventh, 15-20 degrees above normal. The eighth saw the southern half of the state experiencing record high temperatures, while their northern neighbors were preparing for the state's first significant winter storm of the season. Oklahoma City set a record high of 72 degrees, and similar temperatures were commonplace throughout southern Oklahoma.

December 9-12: A second but more powerful front moved through the state on the ninth, bringing the state's first real bout of winter weather. While accumulations in northwestern and north central Oklahoma generally ranged from 1 to 3 inches, winds with gusts of up to 50 mph drifted the snow 2 to 3 feet high. Accumulations in the northeast were much more significant. Tulsa received up to 8.5 inches in localized areas, with nearly 10 inches in Osage County. Thunderstorms rumbled through central Oklahoma ahead of the front with heavy rainfall and pea-sized hail. Four days after the first winter storm, another powerful system moved in from the west on the 12th. North central sections bore the brunt of this storm, with 8-12 inches of snow falling in Grant, Kay, Garfield, and Noble Counties.

December 12-21: The next nine days were rather anti-climactic following the twin winter storms of the previous four days. Lows remained 10-15 degrees colder over the snow pack in the north before melting. Strong southwesterly winds, gusting to nearly 60 mph on the 15th, created a dust storm reminiscent of the Dust Bowl era. Reports of reddish-brown film of dust on cars came from as far away as Chicago.

December 22-31: The remainder of the month was much like the previous nine days, with warm days and cold nights being interspersed with brief bouts of cooler air. Showers and thunderstorms associated with the frontal passages occurred on the 22nd, 27th, and 28th, mainly in eastern sections. Nearly an inch fell in localized areas on the 22nd, and a little over an inch fell on the 27th and the early morning hours of the 28th. Far from a winter wonderland, Christmas Day saw temperatures in the upper 50s and 60s, and southerly winds of 15-25 mph, with gusts to 35 mph. The month's final day was very pleasant, with warm, moist air being borne northward on moderate southerly winds.

January 1-3: The first few days of the New Year saw temperatures across the state soar up to 25 degrees above normal. Record high temperatures were set at Tulsa and McAlester on the 2nd, and once again at Tulsa on the 3rd.

January 4-10: The widespread warmth of the month's first three days came to an abrupt halt on the 4th with the arrival of arctic air, which had been lurking just to the north. Beaver experienced the lowest temperature of the month, -4 degrees, on the 6th. The weather was fairly mild for the remainder of this period through the 10th.

January 11-17: The first rainfall of this period occurred on the 12th as a trough moved across northern Oklahoma. The rain was generally less than a third of an inch, but it set the stage for heavier rainfall later. The temperatures throughout this period were once again above normal, capped by a high mark of 72 degrees at Tipton on the 14th. Significant, widespread rainfall moved into the area on the 16th and 17th, thanks to another upper-level storm approaching from the west. Much of west central and southwestern Oklahoma garnered more than an inch of precipitation on the 16th, with Altus leading the pack at 2.43 inches.

January 18-23: Colder air settled over the state on the 19th. Lows dropped into the teens, and wind-chills remained in the single-digits. Another storm system approaching from the west kicked up southerly winds once again on the 20th, this time around providing very little in the way of precipitation.

January 24-25: Another cold front entered the state from the north, although temperatures behind the front merely dropped back down to more seasonable levels for a day. The front stalled in the northwest, creating widely varying high temperatures on the 25th, and providing more rain over the state. Precipitation amounts in northwestern Oklahoma were generally around one-tenth of an inch, but over one-half of an inch in the southeast. Temperatures were in the 40s in northern areas behind the front, but above 70 degrees in southern sections.

January 26-31: The month's final 6 days resembled a roller coaster temperature-wise. Arctic air moved in on the 26th and 27th, and with it wind chills down below zero in the north, along with a nice blanketing of snow. Snowfall amounts were generally between 1-3 inches, although some localized amounts exceeded 4 inches in Woods County. Three fatalities were associated with the wintry weather due to traffic accidents. Temperatures warmed into the 50s and 60s on the 28th, although they remained in the 30s in the north, where the arctic air still hovered. The cold air oozed southward, reaching central Oklahoma on the 29th.

February 1-3: The month started on a damp and frigid note due to a cold front pushing into the state from the west. Precipitation started in the northwest as freezing rain and snow behind the front, remaining liquid east of the boundary. Rainfall totals were generally less than one-half of an inch, with Chandler leading the pack at 0.78 inches. Snowfall amounts were from a trace at many locations to 4 inches at both Lahoma and Goltry. Skies cleared overnight on the 2nd as a surface high dropped in over the state behind the cold front. Wind chill readings were in the single digits in the morning, and the snow cover kept highs below freezing in north central sections. Those conditions remained in place on the 3rd in advance of another approaching storm system.

February 4-7: Rain, sleet, and snow made another appearance on the 4th in association with an upper-level low from the west. Snowfall amounts were generally between 2-4 inches. Medford and Enid had 6.5 inches of snowfall at the storm's end. The system moved out overnight on the 5th, leaving scattered light drizzle in its wake. Temperatures never rose above freezing in the areas with snow cover, but managed to climb into the 40s in southern sections. The weather remained chilly through the 7th. Lows fell to near zero each day, with highs in the 30s and 40s.

February 8-10: The weather finally warmed on the 8th. High temperatures rose 10-15 degrees higher than the previous day into the 60s. Mangum reached 62 degrees as strong southerly winds gusted to over 25 mph. A weak cold front on the 9th ushered out the spring-like weather of the 8th. Light rain and snow occurred briefly with the front before clearing out later in the day. High pressure settled in, which kept temperatures below normal for the next two days.

February 11-15: Another storm system moved in from the west on the 11th. Light rain and snow flurries fell in the northwest as a cold front entered the panhandle. Cold weather remained in place for another upper-level disturbance's entrance on the 14th. Snowfall amounts of 6 to 8 inches were common across the south near the Red River. Quanah received over 7 inches to lead the state, while Madill and Atoka had close to 6 inches.

February 16-19: Fair skies and light winds greeted the state the morning of the 16th as high pressure settled in behind the cold front. The weather proceeded to get warmer and windier through the 19th. Highs progressed from 50s and 60s on the 17th to 60s and 70s on the 18th, finally culminating with 70s and 80s on the 19th. Altus and Mangum recorded the state's highest temperature of the month with 81 degrees on the 19th. Unfortunately, as the temperatures rose, so did the winds. The state faced extreme fire danger on the 18th and 19th, as winds gusting to 50 mph accompanied the warm, dry conditions. Thunderstorms formed around sunset on the 19th in the northwest, producing severe wind gusts and nickel-sized hail

February 20-25: The warmth of the past several days was replaced with cooler, more seasonable weather. High temperatures on the 20th ranged from the upper-40s to the mid-60s. The weather became a bit more pleasant on the 21st and 22nd, culminating with highs in the upper-60s and low-70s. Showers and storms formed that night in southeastern Oklahoma as a cold front entered the panhandle. Tipton received an inch of rain, although most totals across the area were less than one-half of an inch. The cold front moved through the state on the 23rd, triggering more showers in central and south central sections. Rain continued overnight through the 24th and 25th. After the rain finally ended on the 25th, southern sections of the state had received a much-needed soaking, generally greater than an inch.

February 26-29: Unseasonably cold weather was left in the wake of the previous storm system. Lows ranged from the upper-teens to the lower-30s, with Gage reaching a bone-chilling 7 degrees. The state warmed up quite nicely, however, with highs in the mid-50s to low-60s. After a warmer morning on the 27th, temperatures jumped up to the 60s and 70s. Yet another upper-level disturbance approached the state on the 28th, increasing winds from the south to over 40 mph. The associated cloudiness kept temperatures cooler than the previous day, however, staying mostly in the 50s.

Winter 2003-2004 Statewide Extremes

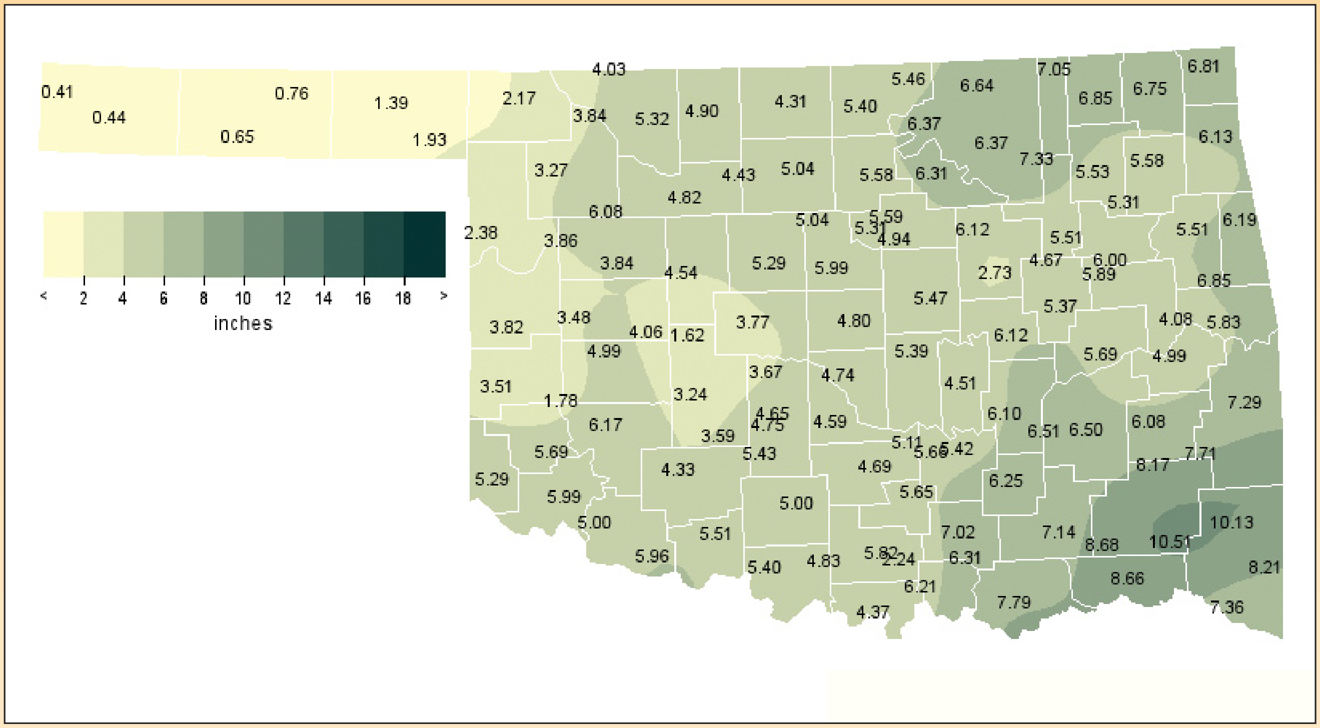
Description	Extreme	Station	Date
High Temperature	81ºF	Altus	February 19th
Low Temperature	-4ºF	Beaver	January 6th
High Precipitation	10.51 in.	Cloudy	
Low Precipitation	0.41 in.	Kenton	

Winter 2003-2004 Statewide Statistic

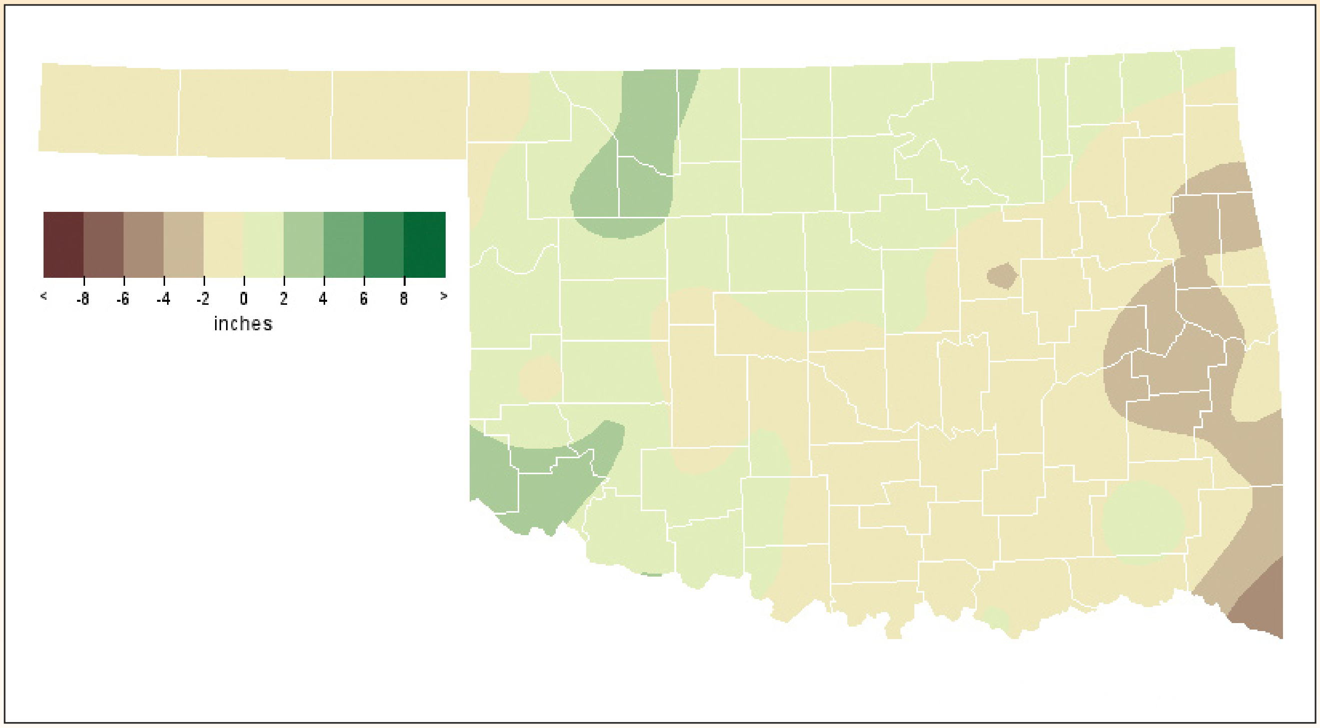
	Average	Depart.	Rank (1892-2004)
Temperature	40.2ºF	1.4ºF	31st Warmest
	Total	**Depart.**	**Rank (1892-2004)**
Precipitation	5.01 in.	0.22 in.	48th Wettest

WINTER 2003-2004 SUMMARY

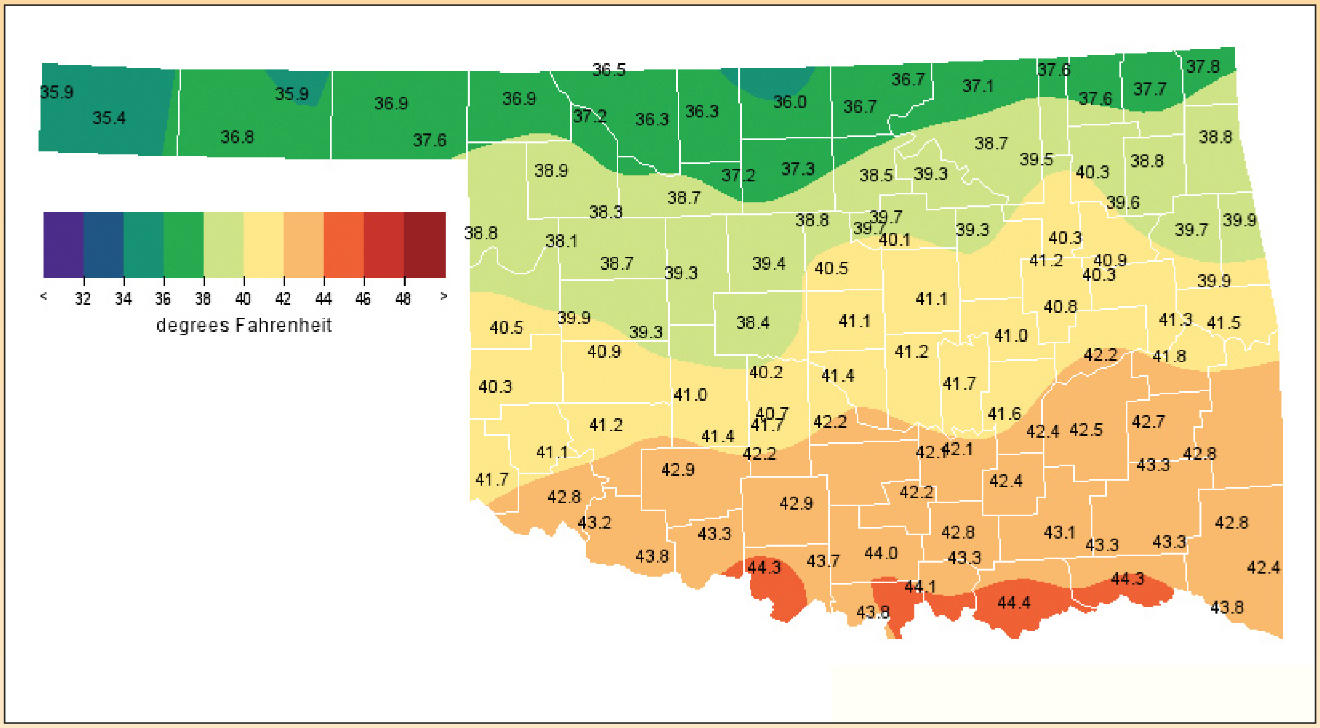
Observed Rainfall



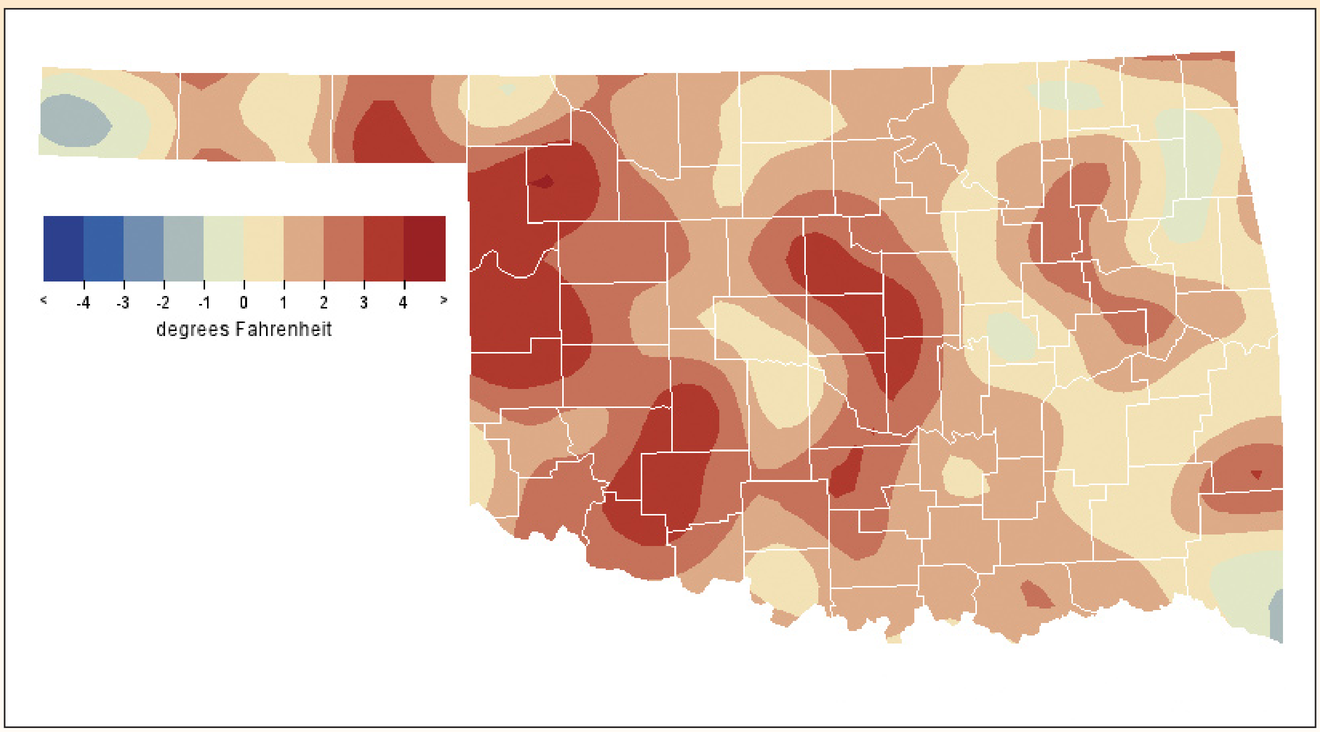
Rainfall Departure from Normal



Average Temperature



Temperature Departure from Normal



Winter 2003-2004 Mesonet Precipitation Comparison

Climate Division	Precipitation (inches)	Departure from Normal (inches)	Rank since 1895	Wettest on Record (Year)	Driest on Record (Year)	2003
Panhandle	1.27	-0.59	41st Driest	5.13 (1960)	0.10 (1904)	1.62
North Central	4.81	1.36	19th Wettest	7.78 (1985)	0.55 (1909)	3.04
Northeast	6.30	0.47	37th Wettest	15.24 (1985)	1.94 (1918)	5.96
West Central	3.76	0.60	27th Wettest	7.83 (1960)	0.21 (1909)	2.71
Central	4.94	-0.3	38th Wettest	13.80 (1985)	0.38 (1909)	4.16
East Central	5.71	-1.83	36th Driest	14.59 (1938)	1.97 (1918)	8.19
Southwest	4.76	0.99	28th Wettest	9.05 (1985)	0.14 (1909)	3.49
South Central	5.58	-1.06	53rd Driest	13.36 (1998)	0.53 (1909)	6.43
Southeast	8.28	-1.74	39th Driest	20.47 (1932)	3.13 (1963)	9.88
Statewide	5.01	-0.22	48th Wettest	10.37 (1985)	1.24 (1909)	4.98

Winter 2003-2004 Mesonet Temperature Comparison

Climate Division	Average Temp (F)	Departure from Normal (F)	Rank since 1895	Hottest on Record (Year)	Coldest on Record (Year)	2003
Panhandle	36.8	1.4	26th Warmest	40.1 (2000)	27.1 (1899)	35.9
North Central	37.3	0.9	42nd Warmest	43.0 (1992)	27.5 (1979)	36.3
Northeast	38.8	1.2	34th Warmest	43.9 (1932)	29.4 (1979)	37.4
West Central	39.6	2.0	25th Warmest	43.4 (1992)	29.5 (1979)	37.4
Central	40.6	1.5	26th Warmest	44.7 (1992)	30.8 (1905)	38.9
East Central	41.2	1.0	41st Warmest	45.6 (1932)	32.7 (1978)	40.0
Southwest	42.2	2.2	23rd Warmest	44.9 (1952)	32.4 (1899)	40.0
South Central	43.2	1.3	34th Warmest	47.6 (1952)	34.7 (1905)	41.0
Southeast	43.2	1.0	44th Warmest	48.4 (1932)	35.3 (1978)	40.7
Statewide	40.2	1.4	31st Warmest	44.0 (1992)	31.2 (1905)	38.6

Winter 2003-2004 Mesonet Extremes

Climate Division	High Temp (F)	Day	Station	Low Temp (F)	Day	Station	High Seasonal Rainfall	Station	Low Seasonal Rainfall	Station
Panhandle	80	Feb 18th	Kenton	-4	Jan 6th	Beaver	2.38	Arnett	0.41	Kenton
North Central	77	Jan 2nd	Fairview	-1	Jan 6th	Freedom	6.08	Seiling	3.27	Woodward
Northeast	76	Jan 3rd	Porter	2	Jan 6th	Foraker	7.33	Skiatook	5.31	Inola
West Central	79	Feb 19th	Erick	0	Jan 6th	Butler	5.07	Retrop	3.48	Butler
Central	77	Jan 2nd	Guthrie	1	Jan 6th	El Reno	6.12	Oilton	3.52	Washington
East Central	76	Jan 2nd	Hectorville	6	Jan 6th	Westville	6.85	Hobart	3.24	Fort Cobb
Southwest	81	Feb 19th	Altus	2	Jan 6th	Mangum	7.79	Durant	4.37	Burneyville
South Central	80	Jan 2nd	Burneyville	7	Jan 6th	Ketchum Ranch	10.51	Cloudy	6.08	Wilburton
Southeast	75	Jan 3rd	Idabel	11	Jan 6th	Wilburton	4.51	Cloudy	1.91	Antlers
Statewide	81	Feb 19th	Altus	-4	Jan 6th	Beaver	10.51	Cloudy	0.41	Kenton

Agriculture Weather Watch

By Albert Sutherland, CPH, CCA
Mesonet Assistant Extension Specialist
Oklahoma State University

A check of Oklahoma's over-wintering wheat crop in early March, made it easy to see that wheat growth follows the weather, not the calendar. The 2004 Red River snowfall in late February chilled the wheat in southwest Oklahoma and really slowed its growth. While in the rest of the state, Mark Hodges, executive director of the Oklahoma Wheat Commission, noted that mild temperatures, lots of sunlight and good soil moisture provided the perfect environment for rapid wheat growth, during this same time period.

One of the new methods for determining wheat maturity is identifying when first hollow stem occurs. Early March reports of first hollow stem indicated that central Oklahoma wheat field maturity was only a few days behind those in southwestern Oklahoma. Normally there would be a 2-3 week difference in growth stage.

First hollow stem is the growth stage when a hollow area forms in the wheat stem portion above the root system and below the developing head. Once wheat reaches the first hollow stem stage, continued grazing will quickly reduce the grain yield potential. In research conducted by OSU Emeritus Professor Gene Krenzer and OSU animal science Professor Gerald Horn, the net return for a wheat grain-stocker cattle enterprise can fall from $57 per acre to only $2 per acre, if cattle graze wheat two weeks past first hollow stem.

In southwest Oklahoma, low soil moisture and cold temperatures have created three crop maturity groupings. About 25% of the wheat fields are close to normal maturity. These fields have the potential to produce an average grain yield and quality. In the next maturity group, are fields with 1-2 tillers per plant. Fields in this group will likely have yields 20-30% below normal. In the last maturity group are fields with very young plants that may only produce half of a normal yield. A number of producers have plowed up young wheat fields with poor stands to plant oats.

In northwestern and central Oklahoma, mid-winter rains provided adequate moisture for wheat growth. Producers are anticipating yields and quality near to slightly above normal.

Eastern Oklahoma is known for large areas of grass pasture. This year they have received enough rainfall to produce excellent grass forage and avoided the downpours that turn pastures into mud bogs. For eastern Oklahoma livestock producers, it has been a great winter.

While eastern Oklahoma areas saw a return to good soil moisture in early winter, western Oklahomans watched the storms move across the southwest USA states, only to miss them. Then in late February, the storm pattern changed and enough rain fell in southwest Oklahoma to make it the 14th wettest February on record.

At the end of February, the soil moisture at 10 inches showed good moisture levels over all of Oklahoma, with the exception of Cimarron and Texas panhandle counties. Looking deeper in the soil, it was apparent that more moisture was needed to recharge deep soil moisture in much of western Oklahoma. The early March rains were a tremendous gift, in an area suffering from two years of below average rainfall. To view soil moisture charts on the Oklahoma AgWeather (http://agweather.mesonet.org) website, click on SOIL, and select Soil Moisture from the menu. The soil moisture is easiest to monitor by using the Fractional Water Index products. The Fractional Water Index is a 0-1 scale, with 0 being dry and 1 being saturated.

AGRICULTURE

Lawn and Garden

March

- This is a great month for planting trees and deciduous shrubs. You can tame your planting bug, without planting frost sensitive plants too early.
- Fill in shady lawn areas by seeding with a blend of tall fescue and Kentucky bluegrass.
- Divide and replant summer-flowering perennials. Mow on high setting or cut liriope (monkey grass).
- Control weeds in flower beds. This is also a good time to spread compost or aged manure.
- Plant frost tolerant vegetables, such as beet, broccoli, cabbage, carrot, Swiss chard, kohlrabi, lettuce, onion, green peas, potato, radish, spinach, and turnip.

April

- After mid-April, there is little danger of frost for most of Oklahoma.
- This is the perfect month for planting evergreen shrubs. Planting in April allows you to miss those common March frosts that can damage young foliage.
- Apply a labeled fungicide to pine trees to control the devastating foliage disease, Diplodia Tip Blight. Make the first application when pine tip candles expand to half their full size. In severe cases, three applications are needed at 10-14 day intervals.
- In the garden, set out tomato, pepper, and eggplant transplants. Plant sweet corn near April 1st or the last week of March. Planting of lima bean, green bean, cucumber, squash can wait for warmer temperatures that are typically after April 10.
- In the later part of April, fertilize bermudagrass turf areas with one pound of actual nitrogen per 1,000 square feet of lawn area. For zoysiagrass, cut this rate in half.

May

- Early May is a super time to plant all of those heat loving perennials and annuals. These plants like warmer soil temperatures and the warmer May weather. While you're picking out flowering plants at your favorite nursery or garden center, remember to purchase some foliage plants, too. You'll love the wide selection of the new sun and shade coleus varieties.
- Vegetables that do best planted in May, when soil temperatures are close to 70ºF, include okra, southern pea, sweet potato, cantaloupe, and watermelon.
- Bermudagrass will be ready for its first or second fertilizer application. Consider using a slow release material that will provide more uniform growth and color, while reducing the risk of nutrient runoff.
- After mid-May, soils typically warm up enough to seed bermudagrass or buffalograss.
- After warm-season lawns have "greened-up" and "filled-in," control broadleaf and grassy weeds with the appropriate weed control material.
- Clean out the water garden. Divide and repot water garden plants.

TORNADO ALLEY!

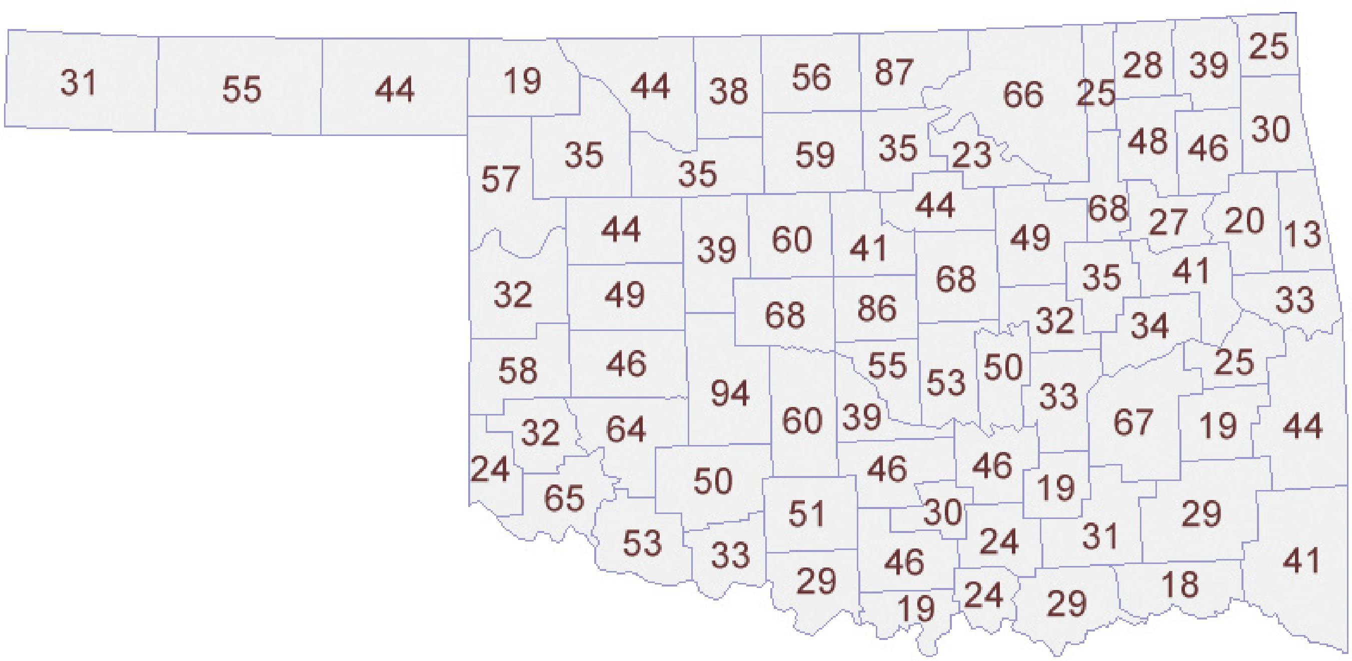
The diagram below shows the number of reported tornadoes by county in the 54-year period from 1950-2003.

Analysis:

1. Shade in red each county that reported 54 or more tornadoes in the 54-year period. These counties experience on average, at least one tornado per year. Using a map of Oklahoma, list these counties.
2. Based on the shaded areas in Question 1, have more tornadoes been observed in the Panhandle, in Western Oklahoma, in Central Oklahoma, or in Eastern Oklahoma?
3. What other factors can you think of that might influence tornado reports? [Teachers Note: Consider factors such as population and county size]
4. Which county has the most reported tornadoes since 1950?
5. How many tornadoes does this county average per year? (Take the total number of tornadoes and divide by 54 years. The answer should be expressed in tornadoes per year.)
6. Which county has reported the least number of tornadoes?
7. Using the data, which city has likely experienced the most tornadoes, Tulsa or Oklahoma City?

Number of Tornadoes by County: 1950-2003

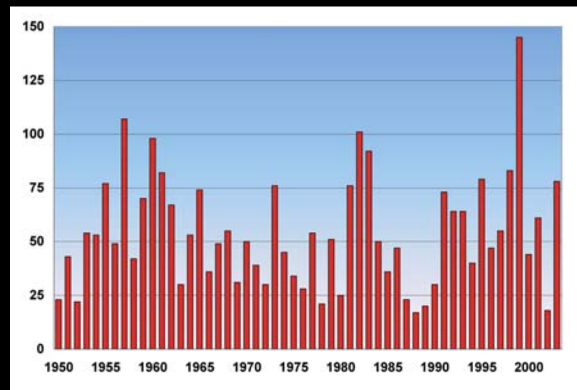
Based on 1950-2003 tornado occurrences compiled by NWS OUN's Doug Speheger



Everything You Wanted To Know About Tornadoes

(But Were Afraid To Ask)

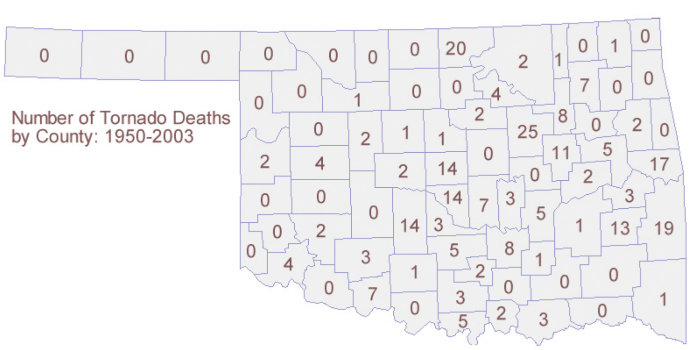
Doug Speheger
Meteorologist
National Weather Service



Annual Number of Oklahoma Tornadoes 1950-2003

The warm temperatures of spring are finally returning to Oklahoma. As spring returns, thunderstorms bring needed rainfall to the state. But sometimes those thunderstorms also bring severe weather and tornadoes. It had been a long time since Oklahomans had to worry about tornadoes. There were no tornadoes reported in the state for over 9 months beginning in the middle of May 2003 until a tornado touched down on March 4, 2004 just north of Sallisaw. This 292-day stretch was the longest that Oklahoma had not had a tornado since tornado records began being kept in 1950. But spring is here again, and it is time to be alert for the chance of tornadoes. Over three out of every four tornadoes recorded in Oklahoma occur in the three and a half months from mid-March through June, so now is the time to be prepared.

Since 1950, there have been over 2,900 tornadoes documented in Oklahoma. Fortunately, most tornadoes are weak. More than 70% are classified as F0 or F1 on the Fujita intensity scale meaning that the winds are estimated at 112 mph and these account for only 2% of tornado deaths within the state. But even weak tornadoes can cause damage to homes and buildings and you should always protect yourself when tornadoes or severe weather are occurring nearby. Violent tornadoes, those rated as F4 or F5 on the Fujita scale with winds over 207 mph, are much rarer. There have been 54 violent tornadoes over the past 54 years, or about 2% of Oklahoma tornadoes. The most recent violent tornadoes have been the May 8, 2003 tornado in Moore and south Oklahoma City and three that occurred on May 3, 1999 – near Dover (Kingfisher County); near Mulhall (Logan County); and the tornado that moved from Bridge Creek (Grady County) into south Oklahoma City and Moore. But



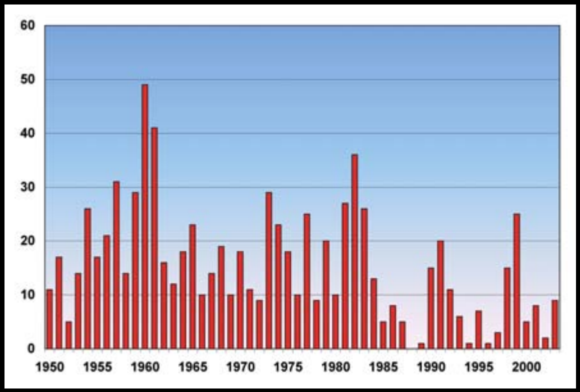
Tornado Classifications:

F0-F1	Weak
F2-F5	Significant
F2-F3	Strong
F4-F5	Violent

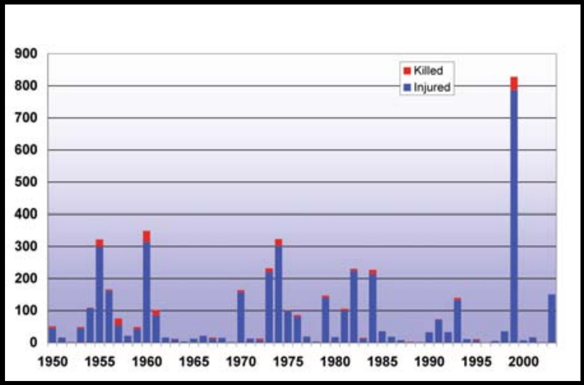
despite the rarity, these violent tornadoes have accounted for 71% of tornado deaths.

Oklahoma has a long history with tornadoes. The state's most deadly tornado moved through Woodward on April 9, 1947. One hundred and sixteen Oklahomans were among 181 people killed as this tornado (or a family of tornadoes) moved from the Texas panhandle, across northwest Oklahoma and into southern Kansas. Woodward was hit especially hard with 101 people killed in that town. Even before Oklahoma became a state, 97 people were killed by a tornado in Oklahoma Territory in May 1905, most in the town of Snyder. In 1920, a tornado destroyed the town of Peggs in Cherokee County, killing 71 of the town's 250 residents.

But Oklahoma's place in the middle of "tornado alley" has also brought a history of forecasting these killers. On the evening March 20, 1948, a tornado moved through southern portions of Oklahoma City and struck Tinker Air Force Base causing destroying aircraft and causing millions of dollars in damage on the base. Captain Robert Miller and Major Ernest Fawbush studied the weather conditions from that day, and just five days later noted that similar weather conditions were developing in Oklahoma. On March 25, 1948, Captain Miller and Major Fawbush issued the first tornado forecast before another tornado struck Tinker Air Force Base that evening. In more recent times, development and research in the 1980s by the National Severe Storms Laboratory in Norman showed that Doppler radar could be used to detect developing circulations within thunderstorms that often precede tornadoes. Now Doppler radars have been placed nationwide and are an important part of the



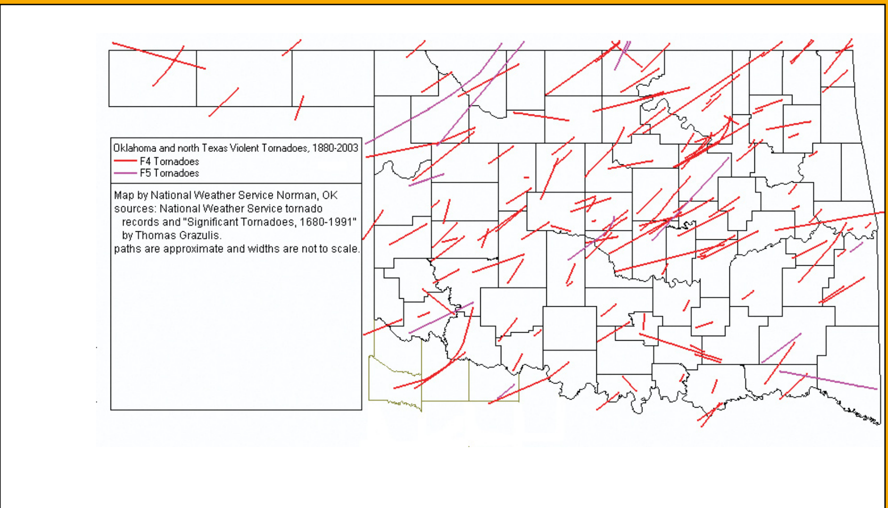
Annual Number of Oklahoma Significant Tornadoes 1950-2003



Tornado Related Casualties in Oklahoma by Year 1950-2003

severe weather warning process. To this day, Oklahoma remains an important center for researching tornadoes.

Meteorologists from the National Weather Service and the Oklahoma Climatological Survey work closely with emergency managers across the state to try to warn you when tornadoes and severe weather are likely. Because of the improvements in detecting tornadoes and warning citizens, the large casualties from tornadoes as were seen with tornadoes in the first half of the 20th century are rare. But tornadoes are still violent phenomena and can still cause significant damage and deaths even when warnings are issued and heeded. The Bridge Creek-Oklahoma City-Moore tornado on May 3, 1999 killed 36 people despite the excellent warnings. Other tornadoes can develop suddenly. It is a good idea to have a plan ready to protect you and your family if dangerous weather threatens. Following a few simple safety rules will decrease the chances of getting hurt during severe weather. Many of the tornado safety rules can be grouped into three categories: Get In, Get Down and Cover Up. The best protection is a safe room or an underground storm cellar. If these options are not available, then get in to the interior of a well-constructed building, and get down into the basement or the lowest floor. Interior bathrooms or closets are good options. Stay away from rooms with windows or areas with wide-span roofs like gymnasiums or warehouses. Cars and mobile homes do not offer good protection, so leave yourself enough time to go to a substantial structure. Then cover up with whatever is available like a mattress, blankets or even a bicycle helmet. This will help to protect your head and body from flying debris. Be prepared ahead of time, and know where the best place to find shelter is before the storms approach.



Most tornadoes in Oklahoma occur in the afternoon and evening hours with almost 80% of tornadoes developing between 3 P.M. and midnight. But tornadoes can develop at any time of the day. Last May, strong tornadoes struck areas near Ringling, Lake Murray and Madill between 1-3 a.m. If you were threatened by a tornado in the middle of the night while you were sleeping, how would you be alerted to the potential danger? One good item to have in your house is a Weather Radio that can give you warnings directly from the National Weather Service. On many models, an alert can be sounded for you when a watch or a warning is issued for your area. Many newer models have "S.A.M.E." technology, which stands for Specific Area Message Encoder. With these models, you can program the radio to alert you only when watches and warnings are issued for certain counties that you want to be alerted for.

Tornadoes will occur in Oklahoma. But plan ahead and know what to do so you will be in much better position to stay safe. ■

The 10 deadliest tornadic events in Oklahoma, ranked by fatalities.
(courtesy of the Norman NWS office)

Rank	City	Date	Killed
1	Woodward	April 9, 1947	116
2	Snyder	May 10, 1905	97
3	Peggs	May 2, 1920	71
4	Antlers	April 12, 1945	69
5	Pryor	April 27, 1942	52
6	Oklahoma City	May 3, 1999	40
7	Oklahoma City	June 12, 1942	35
8	Moore	April 25, 1893	31
9	Bethany	November 19, 1930	23
10	McAlester	May 8, 1882	21

TORNADO SAFETY...

GET IN! GET DOWN! COVER UP!

Tornadoes are the most violent atmospheric phenomenon on the planet. Winds of 200-300 mph can occur with the most violent tornadoes. The following are instructions on what to do when a tornado warning has been issued for your area or whenever a tornado threatens:

IN HOMES OR SMALL BUILDINGS:

Go to the basement (if available) or to an interior room on the lowest floor, such as a closet or bathroom. Wrap yourself in overcoats or blankets to protect yourself from flying debris. Put on a football helmet or bicycle helmet.

IN SCHOOLS, HOSPITALS, FACTORIES, OR SHOPPING CENTERS:

Go to interior rooms and halls on the lowest floor. Stay away from glass enclosed places or areas with wide-span roofs such as auditoriums and warehouses. Crouch down and cover your head

IN HIGH-RISE BUILDINGS:

Go to interior small rooms or halls. Stay away from exterior walls or glassy areas.

IN CARS OR MOBILE HOMES:

ABANDON THEM IMMEDIATELY!! Most deaths occur in cars and mobile homes. If you are in either of those locations, leave them and go to a substantial structure or designated tornado shelter. DO NOT SEEK SHELTER UNDER AN OVERPASS!

IF NO SUITABLE STRUCTURE IS NEARBY:

Lie flat in the nearest ditch or depression and use your hands to cover your head.

Chickasha on May 3rd, 1999. Photo courtesy of David Demko.

National Weather Service -- Norman:
http://www.srh.noaa.gov/oun/severewx/

NOAA -- Storm Prediction Center:
http://spc.noaa.gov/faq/tornado/#Safety

National Severe Storms Laboratory:
http://www.nssl.noaa.gov/NWSTornado/

Oklahoma Climatological Survey
100 East Boyd, Suite 1210
Norman, OK 73019-1012
phone 405.325.2541 fax 405.325.2550
http://www.ocs.ou.edu
email ocs@ou.edu