OKLAHOMA CLIMATE

FALL 2003

OKLAHOMA CLIMATE FALL 2003 SUMMARY

Fall 2003
Volume 1 Issue 1

Oklahoma Climatological Survey

MESSAGE FROM THE STATE CLIMATOLOGIST

The Oklahoma Climatological Survey (OCS) has, as part of its legislative mandate: "To prepare, publish and disseminate periodic regular climate summaries for those individuals, agencies and organizations whose activities are related to the welfare of the state and are affected by climate and weather." We believe OCS to be the nation's unequivocal leader in the fulfillment of this task: the provision of climate services to its state's citizens and decision-makers. Our ground breaking Monthly Climate Summaries, powered by real-time data from the Oklahoma Mesonet, offer a depth and timeliness that no other climate publication in the world can surpass. Despite our success thus far, however, we continue to strive for improvement.

As a culmination of those efforts, I am proud to introduce the inaugural Seasonal Climate Summary of Oklahoma. A companion to the monthly summary, the seasonal summary will delve deeper into Oklahoma's climate. Each quarterly publication will be thematic, with informative articles and vibrant color maps and graphics. Weather-related classroom activities and lessons also will be included for use by educators. Meant to be both a planning and informational tool, the summaries will contain horticulture tips from the state's leading agronomists at Oklahoma State University, along with weather safety guidelines from Oklahoma's emergency preparedness experts.

The theme of the first edition of the Oklahoma seasonal summary is "Water Management." In addition to an overview of the summer's weather, you will find several fascinating articles about Oklahoma's water resources. "The Taming of the Washita" is an historical perspective chronicling the effort to end the periodically devastating and deadly floods along the Washita River in western Oklahoma. Other articles will detail the usefulness of the Oklahoma Mesonet's world-renowned soil moisture network, and describe OCS's attempts to aid the nation's defenses against chemical and biological weapon attacks. Oklahoma's science students young and old will enjoy an exercise detailing how to read a weather map, and how to make their own as well. Gardeners also will find plenty of information on what to plant and exactly when to plant it.

We hope you will enjoy reading this new chronicle of Oklahoma's varied and amazing climate as much as we did creating it. As always, we appreciate questions and comments concerning OCS and its publications. For more detailed accounts of Oklahoma's weather, be sure to check out the Oklahoma Monthly Climate Summary, published during the first week of each month.

Dr. Kenneth C. Crawford
Director and Regents Professor of Meteorology

Oklahoma Climate Fall 2003
Volume 1, Issue 1

Cover Photo: Photo by Stdrovia Blackburn. 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.

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Oklahoma Climatological Survey

Taming the Washita

How Western Oklahoma Became a Center of Innovative Flood Control Practice

By Derek Arndt
Assistant State Climatologist
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The Washita River trickles into Oklahoma not far from its origin in the Texas panhandle. It ultimately empties into Lake Texoma, where it increases the Red River's flow by half. On its 250-mile journey to the Red, the Washita drains an often-picturesque watershed that is narrow and offers slightly steeper slopes than other western Oklahoma basins. These characteristics allow runoff from its tributaries to reach the main stem quickly – sometimes too quickly. Heavy rainfall and unrestrained flow can be a recipe for tragedy on the Washita, which early settlers tasted far too often.

Major floods on the Washita were a nearly annual event during the first half of the 20th Century. Lives, property and dreams were torn from the Washita Valley by a river acutely sensitive to the region's characteristic heavy rains. The region's most fertile topsoil – that of the Valley's bottomlands – was repeatedly stripped by the racing waters, only to be abandoned downstream in useless, debris-filled heaps.

A section of railroad destroyed in a 1949 flood on the Washita reveals water's destructive potential. The first construction of flood control measures on the river began just a few months earlier. (Carl Albert Congressional Archives, University of Oklahoma)

Twice ravaged by long-term drought during the 1910s and 1930s, and consistently menaced by an angry Washita, many of the Valley's agricultural community of 250,000 persons became avid participants in the movement of the time: soil conservation. Measures such as terracing, crop rotation and revegetation brought some success, but the recurring floods often defeated even these careful practices. Something needed to be done to tame the Washita. Citizens implored the Governor to take action to, among other things, "stop Texas floods and silt from invading our state."

The final blow came on April 3-4, 1934, when a "Norther" dumped more than a foot of rain on the Washita's upper reaches. Just two inches fell near Hammon, but the surge from upstream swept violently through the town after midnight and took entire families – with their homes – to their deaths. Seventeen people were killed, including all six children of the A.M. Adams home. Some victims were recovered in neighboring Custer County, while others were never found.

After the Hammon tragedy, several events occurred in concert to change the Valley's flood fortunes. Congress passed the Flood Control Act of 1936, the first national policy that married flood control and soil conservation measures. The Act made the U.S. Dept. of Agriculture a prominent player in flood management.

During the '30s, Don McBride, chief engineer at what is now the Oklahoma Water Resources Board, constructed a novel plan to tame the Washita. His ideas brewed a decade earlier while working as the water engineer for the Washita River town of Carnegie. His approach called for regulating the river not by one large dam, but by 25 medium-sized structures on its tributaries. This method of upstream flood control had not been tried in North America, and would eventually get swept up in the growing "upstream-downstream" debate on how to best implement the controls demanded by the 1936 Act. Upstream proponents advocated using rapidly-improving earthen dam technology to bottleneck floodwaters near their source, while downstream proponents favored construction of larger and fewer dams on the main stems.

For years, the upstream-downstream debate, legal wrangling and inter-agency disputes held up progress on construction. World War II slowed the process further. But McBride continued to champion his plans for the Valley. In December 1944, Congress authorized the USDA to provide post-war flood control and conservation measures in 11 watersheds. Thanks to McBride's tireless work, and support from his newfound ally, Oklahoma Governor Robert S. Kerr, the Washita Valley was the first of these to witness construction.

However, on the road to implementation, the USDA scrapped the details of McBride's plan and replaced his 25 medium-sized reservoirs with 650 planned "Flood Retarding Structures". These were small earthen dams designed to control basins of generally less than 10 square miles.

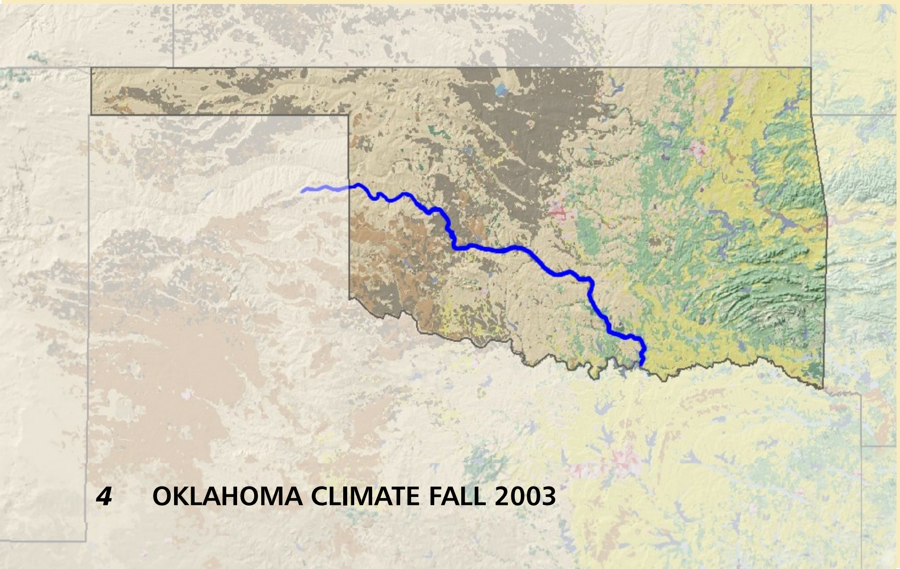
Work started in 1946, and on July 8th, 1948, thousands gathered to commemorate Cloud Creek Site One near Cordell as the continent's first upstream flood control dam. More than a thousand small dams followed, almost twice the number originally planned. More than half of the Washita's tributaries were – and still are – regulated by small upstream dams.

In what could easily be mistaken for a drought photo from the era, corn stands ruined in a blanket of sand left by a 1930's flood on the Washita near Strong City. (Carl Albert Center Congressional Archives, University of Oklahoma)

The program was a resounding success. Major flooding events on the Washita all but disappeared in the last half of the Century. The Valley's precious topsoil stayed in the smaller watersheds and was no longer lost in large amounts to the main stem. This further reduced the flood hazard by keeping the main channel clear. Many unforeseen wildlife, recreational, irrigation, drainage and water supply benefits were also realized. The rate of silt deposited into Lake Texoma was reduced dramatically, extending the estimated useful life of the lake. The Washita Valley became a role model for the nearly 1,400 watershed plans and more than 10,000 dams that followed nationwide.

And, while Don McBride's original plans weren't followed as he wrote them up, his reputation flourished on a national level. He was often consulted on projects throughout the nation. Longtime ally Kerr referred to McBride as "the third Senator from Oklahoma".

The Washita River



Today, many of the structures built in the 1940s and 1950s have exceeded their original life expectancy. Ironically, these dams could represent a flood hazard in the event of a failure.

Oklahoma has once again assumed a leadership role in upstream flood prevention. In July 1998, almost 50 years to the day after the completion of Cloud Creek Site One, the USDA announced a pilot dam rehabilitation project. Two dams in the Sergeant Major Creek watershed near Cheyenne received a new lease on life: a 100-year lease, to be exact.

Oklahoma Rep. Frank Lucas shepherded the "Small Watershed Rehabilitation Amendments Act" to passage in 2000. The bill authorized $90 million toward rehabilitation of the nation's upstream flood control dams. "Congress began the job of addressing this problem 50 years ago," Lucas wrote upon the bill's passage. "Now we can pick up the flag and renew our dedication to protecting lives and property through conservation." ■

The Oklahoma Mesonet's Soil Moisture Network

Brad Illston
Research Associate
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Calculating the amount of water in the soil is critical to many people. Farmers can use soil moisture data to aid in scheduling of crop watering. Firemen use soil moisture data to pinpoint possible areas of danger for wildfires. Soil moisture data also can be included in computer models to improve weather forecasts. Oklahoma has put itself in the forefront of public use and research of soil moisture with the Oklahoma Mesonet's Soil Moisture Network.

In 1996, soil moisture sensors were installed at 60 Mesonet sites at depths of 5, 25, 60 and 75 cm. Based upon the initial success in using data from this original deployment, soil moisture sensors were installed at 43 additional Mesonet sites during 1998 and 1999 (Figure 1). A key aspect of the network of soil moisture sensors is that estimates of both soil-water potential and water content are collected every 30 minutes.

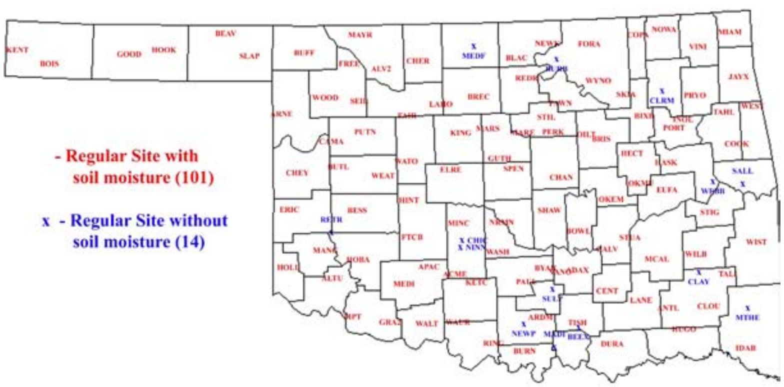


Figure 1. Map of Mesonet station locations and soil moisture sensor distinction.

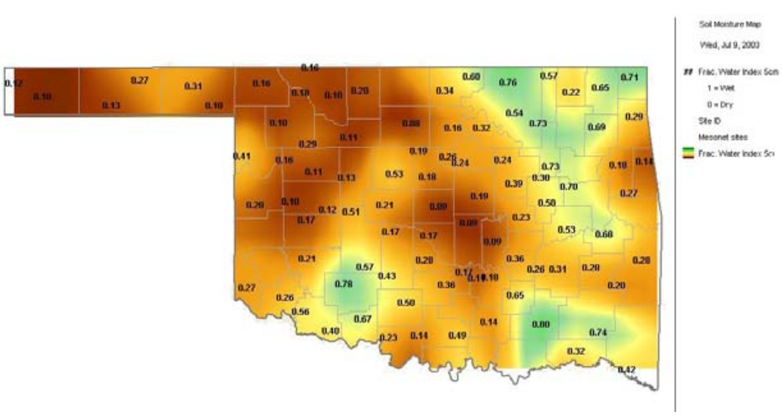


Figure 2. Sample Map of Fractional Water Index as seen on the website.

The sensors measure soil moisture by taking the temperature of a wire, heating the wire, pausing for a few seconds, and then taking the temperature a second time. Heat dissipates within water, so the more water contained in the soil, the greater the change in temperature measured by the sensor. This temperature difference allows hydrological variables such as soil water content, soil matric potential, and Fractional Water Index (FWI) to be calculated.

Soil water content is the physical amount of water per volume of soil. Different soil types (i.e. sand, clay, etc.) have different sizes of particles, which results in varying amounts of space available for water to fill. Soil matric potential is the force, like pressure, needed to move water vertically. When there is less water in the soil, a larger force is required to move the water. Soil matric potential is useful in agricultural situations, when it is important to know how effective certain plants are at removing water from the soil. However, soil matric potential is an exponential function, which makes it more difficult to implement in real time. Thus, the Oklahoma Mesonet put soil matric potential values into four categories. This allowed statewide plots to be easier to understand.

Since soil water content depends heavily upon soil texture, and soil matric potential is exponentially related to soil wetness, FWI was developed for an easy to use and understandable index. FWI tells us how far between the dry and wet extremes of the sensor a particular sensor reading resides. This unitless value ranges from very dry soil having a value of zero, to saturated soils having a value of one.

Figure 2 shows a typical image of soil moisture at a depth of 5 cm – about the length of your thumb – during the early part of the summer. The darker brown areas show drier soils, while the green areas indicate more moist soils. Maps like these, as well as maps of categorized matric potential, for all four soil depths are updated daily on a website for public viewing. Custom maps showing a particular day in the past also can be generated on the website.

In addition to statewide maps of soil moisture, the website allows the user to view a particular

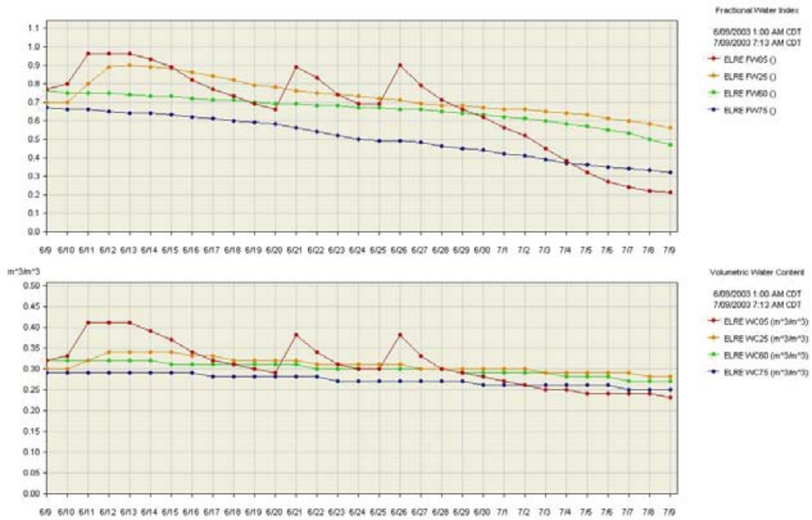


Figure 3. Sample Meteogram of Fractional Water Index and Water Content as seen on the website.

site in more detail. Figure 3 shows a 30-day time series of soil moisture at the El Reno Mesonet site. The top plot shows FWI and the bottom plot shows soil water content. Each colored line represents a particular depth within the soil. Here the public can see how the soil moistures values have decreased over the past 30 days. Similar to the statewide plots, custom maps of different time periods can be generated on the website.

This vast network of soil moisture sensors has led to many research opportunities, many of which would not have been possible without the Oklahoma Mesonet. The Oklahoma Climatological Survey has produced a detailed climatology of Oklahoma soil moisture. This climatology allows state water and agriculture officials to better understand what typical values of soil moisture should be, and when they are reaching extreme values for a particular time period. Other studies have focused on the droughts of 1998 and 2000, which seriously impacted the state's economy. A better understanding of how droughts occur and discovering signals to warn of impending droughts will aid the advanced preparations for those who rely on soil moisture.

Further drought studies indicate fall and winter rainfall may help alleviate near-surface soil moisture problems during severe droughts, but deeper depths may continue to be impacted by the dry conditions. Figure 4 shows the FWI values for the Mesonet station in Hollis during 1998. The drought can clearly be seen during the middle part of the year (summer), but during the fall and winter, when rain has fallen, only the top two depths (red and yellow lines) recover from the drought conditions. This research demonstrated how a drought can impact a location longer than originally thought.

There is still much to learn about soil moisture, and the Oklahoma Mesonet will continue to be an integral part of this process. More products will be made available in order to provide even more detailed soil moisture information to the public. Additional data sets will be produced for researchers to analyze. The discoveries which result will greatly benefit not only Oklahomans, but communities across the globe as well. Just as other portions of the Oklahoma Mesonet have pioneered how weather data is used, the soil moisture network will surely follow in its footsteps. ■

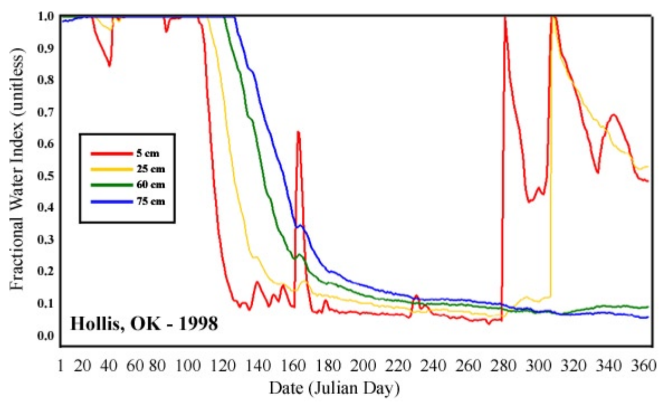


Figure 4. Meteogram of Fractional Water Index at Hollis, OK during 1998.

To view soil moisture charts over the Internet, go to Oklahoma AgWeather (http://agweather.mesonet.org), then 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. Data can be viewed as statewide maps for each depth or on time series charts for a single site.

Techs On the Trail

The Oklahoma Mesonet technicians are the backbone of the network. They travel to every nook and cranny in the state, literally each county, maintaining the Mesonet's instruments, and ensuring that only the highest quality data are collected and made available to the public. During their travels, they are fortunate enough to see what many of us tend to overlook: the wondrous and rugged beauty of the Oklahoma landscape. Below are just a few of the amazing sites they have seen in their travels – captured with the snap of a camera lens.

"The Mesonet Tower near Norman overlooks a field of wildflowers"
Photo courtesy of Gavin Essenberg, Norman Mesonet site

"An abandoned farmhouse keeps a lonely vigil on the flat plains north of Fletcher."
Photo courtesy of Ken Meyers, Senior Electronics Technician

(background photo)
"The Wichita Mountains near Medicine Park"
Photo courtesy of J. Colin Caldwell & Stephen G. Bodrar

"The Sun sets over the Redrock Mesonet Site"
Photo courtesy of J. Colin Caldwell & Stephen G. Bodrar

SUMMER 2003 SUMMARY

Oklahoma's summer was an exhibit of extremes during 2003. A cool, moist June was followed immediately by dreadfully hot and arid weather during July. August saw a mixture of both extremes, putting a hot, humid exclamation point on the season. The sum total of those climatic extremes, however, is a summer that finished a bit warmer and wetter than normal. According to data from the Oklahoma Mesonet, the summer ended as the 52nd warmest and 38th wettest since record-keeping began in 1895.

While the state's severe weather season normally becomes less active during the blistering months of summer, the absolute dearth of any violent weather during June-August of 2003 was yet another unusual extreme. For the first time since accurate tornado statistics began in 1950, no tornadoes were reported anywhere in Oklahoma throughout the summer. That continues a three-year streak of minimal summer tornadic activity; the summers of 2000, 2001 and 2002 experienced two, one and three tornadoes, respectively. On average, the June-August period sees 12 tornadoes touch down within Oklahoma's borders.

Precipitation

The summer's precipitation was feast or famine across the state, owing to its tendency to arrive via thunderstorm activity. The areas that feasted the most, a swath from the northeast down through central and southwestern regions of the state, as well as parts of the panhandle, were well above normal. Claremore, in northeastern Oklahoma, received nearly 20 inches of rainfall. Unfortunately, the famine aspect of that comparison came to fruition as well. Areas in south central, northwestern, and west central Oklahoma remained bone dry throughout the summer. Madill, along the Red River in south central Oklahoma, only received a little over 2 inches of rainfall over the three month period. Most of the precipitation that did fall came during June and August; 2003's July was one of the driest since record-keeping began in 1892.

Temperature

After the 8th coolest June on record, the summer heat normally experienced during Oklahoma summers was salvaged by July and August, which were both warmer than normal. Generally, the eastern half of the state was cooler than normal for the season, while the western half of the state was above normal. Pockets of cooler temperatures accompanied many of the same areas that received excessive rainfall, while many of the areas with below-normal precipitation were warmer.

June Daily Highlights

June 1-5: The precipitation began quickly during June as the first of several upper-level disturbances generated a large complex of showers and thunderstorms on the High Plains of Kansas and Nebraska. Caught in the predominant northwesterly flow, this thunderstorm complex moved across Oklahoma, bringing beneficial rainfall. The same scenario played out for the next four days, as thunderstorms formed northwest of the state and roared in during the nighttime hours. The cold fronts associated with the disturbances helped to tame temperatures and keep the state unseasonably cool.

June 6-9: The rain trickled to a temporary halt as a surface high pressure system built into the state from the northwest. Northerly winds dominated this period, and were reinforced by another strong cold front on the 8th. Rain did fall in southern Oklahoma, but amounts were generally less than an inch.

June 10-14: Another stormy pattern developed over the state as a front stalled over Oklahoma, and several upper-level disturbances passed over from the west. Severe weather occurred each day, with flash flooding prevalent in central and southwestern Oklahoma. Widespread heat erupted over the state on the 11th on the south side of the stalled front.

June 15-17: Fair weather dominated this period, although the sunny weather heated the ground enough to generate a few isolated thunderstorms. In the weak upper-level environment, these slow-moving storms dropped excessive amounts of rain before dissipating. Most of the state, however, experienced fair skies and temperatures in the 80s – a welcome respite from the soggy conditions of the first half of the month.

June 18-21: A weak surface front lingered in the area and combined with several disturbances from the west to once again bring showers and thunderstorms to the state. The heat began to show up in southern sections, although the areas that received rain remained cool. Most of the heavy rainfall amounts were on the 21st, with Newport receiving over two inches.

June 22-24: The rain fled once again and the state welcomed another brief glimpse of summer, all courtesy of an upper-level ridge of high pressure over the western U.S. Strong southerly winds of up to 30 mph elevated the temperatures into the upper-90s across the state, with Cherokee reaching 100 degrees on the 23rd.

June 25-26: An unusually strong cold front entered the state early on the 25th, triggering widespread showers and thunderstorms. Winds swung around to the north at 10-20 mph behind the front in the rain-cooled air. Both days saw generous rainfall amounts, with Perkins, Newkirk, Antlers, Marena, and Durant all totaling over 3 inches for the period. Lows dropped from the 70s before the frontal passage to the mid-50s afterwards. Highs behind the front were in the 70s and 80s, below normal for this period.

June 27-30: Oklahoma experienced one last day of tranquil weather on the 27th under the influence of a surface high pressure system before northwesterly flow dominated once again. Just as with the month's first week, the northwesterly flow carried thunderstorm complexes from the lee of the central Rockies into the state. Northeast Oklahoma endured more heavy rainfall amounts and rivers overflowing their banks on the 29th and 30th.

July Daily Highlights

July 1: A weak surface front stretched across Oklahoma on the month's first day, generating a few showers and thunderstorms. Despite the frontal boundary, temperatures across the state reached into the upper 90s.

July 2-8: Oklahoma's weather for the next seven days was dominated by an upper-level ridge of high pressure, which effectively suppressed any precipitation chances through that period. Temperatures soared into the upper 90s and low 100s, and combined with moisture flowing northward from the Gulf of Mexico to push heat indices well over 105 degrees.

July 9-13: The high pressure dome moved westward as a frontal boundary slipped into northern Oklahoma, where it stalled. Upper-level disturbances which moved over the state produced occasional thunderstorms. The strong southerly winds ahead of the frontal boundary pushed temperatures even higher, as heat indices reached 110 degrees in some areas.

July 14-18: Lahoma reached 109 degrees again on the 14th. Not to be outdone, Cherokee and Medford topped the month's high temperature charts with a sweltering 110 degrees on the same day. The extreme heat and humidity continued, and along with the lack of rainfall made for miserable weather in Oklahoma.

July 19-22: A weak frontal boundary approached from the north, and the large dome of high pressure shifted farther to the west, allowing a few upper-level disturbances to pass over the state. The showers and thunderstorms generated by these disturbances did little to alleviate the sweltering conditions.

July 23: The passage of the cold front from the previous day gave the state a brief respite from the heat, with highs across the state reaching only into the mid-90s.

July 24-27: The heat returned almost immediately as a dome of high pressure once again became the dominant force controlling Oklahoma's weather. Temperatures were nearly 10 degrees above normal through this period, with very little relief in the way of clouds.

July 28-30: A cold front lumbered into northwestern portions of the state, triggering a few showers and thunderstorms. Norman was hit particularly hard on the 30th by a microburst that produced a wind gust of 79 mph. The winds flipped planes moored at the Norman airport, and flipped tractor-trailer rigs on the interstate in that area. Over 20,000 residences and business lost power due to downed power lines, and a swath of large hail accompanied the storms.

August Daily Highlights

August 1-3: The month started on a stormy note with strong to severe storms forming in western and east-central Oklahoma along an outflow boundary. The storms were accompanied by 80 mph winds near Glenpool on the 1st and rainfall amounts greater than 2 inches were common in the northeastern one-third of the state. Temperatures were not diminished with the precipitation, however, as temperatures soared into the mid-100s.

August 4-8: A cold front in northern Oklahoma created pleasant weather behind the front on the 4th with highs in the lower 80s. Otherwise, the scorching temperatures remained throughout this period. As the front stalled, it became a focal-point for additional showers and thunderstorms.

August 9-11: This was yet another period of hot, steamy weather interspersed with thunderstorms. Storms early on the 9th in western Oklahoma brought strong winds and dangerous lightning. Rainfall totals of over 1 inch were common over western regions.

August 12-14: High pressure aloft over Colorado and an upper-level low over Louisiana sandwiched Oklahoma on the 12th, giving the state its most pleasant stretch of weather for the month. Highs remained in the upper 80s for the most part, only warming up into the low 90s for the next two days. More showers and thunderstorms formed as the upper-level low over Louisiana moved west across Texas. Severe storms with strong winds struck central Oklahoma on the 13th, with rainfall amounts exceeding 1 inch in that area.

August 15-21: High pressure aloft dominated the region throughout this period. Temperatures once again soared into the mid- to upper-100s, and precipitation was virtually non-existent.

August 22-25: A dome of high pressure over the middle- and high-plains combined with a surface low over Oklahoma to pump abundant moisture northward into the state. Daytime heating and the surface boundary generated severe thunderstorms over the northeastern two-thirds of the state.

August 26-28: Heavy rainfall returned to the state with over 1 inch of rain recorded at the Mesonet site in Buffalo on both the 26th and the 28th. The weather remained hot and muggy despite the rainfall, however. In areas not affected by the rain-cooled air, temperatures and heat indices rose once again into the mid- to upper-100s.

August 29-31: Oklahoma experienced one of the wettest three-day periods since October 2002 in the month's final stanza. Showers and thunderstorms formed early on the 29th along an outflow boundary. The storms, primarily in northeastern parts of the state, dumped from 2 to 4 inches of rainfall on the area. An unusually strong cold front for late August approached the state from the north on the 30th, once again triggering showers and thunderstorms. Medford received nearly 8 inches of rainfall in a 24-hour period, and the Mesonet site northwest of Alva recorded nearly 6 inches. Flooding occurred on the 30th, mostly in northeastern Oklahoma and near Medford in the north.

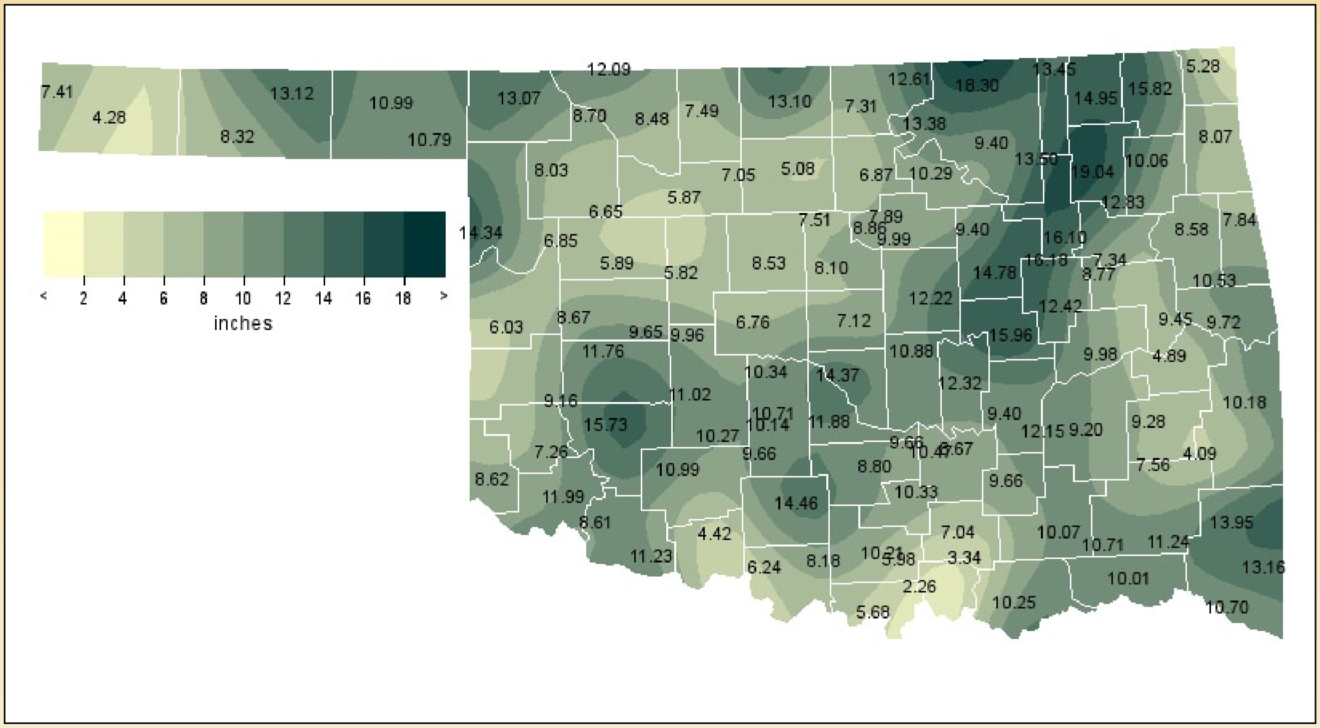
Summer 2003 Statewide Extremes

Description	Extreme	Station	Date
High Temperature	111ºF	Mangum	August 7th
Low Temperature	44ºF	Boise City	June 6th
High Precipitation	19.04 in.	Claremore	
Low Precipitation	4.28 in.	Boise City	

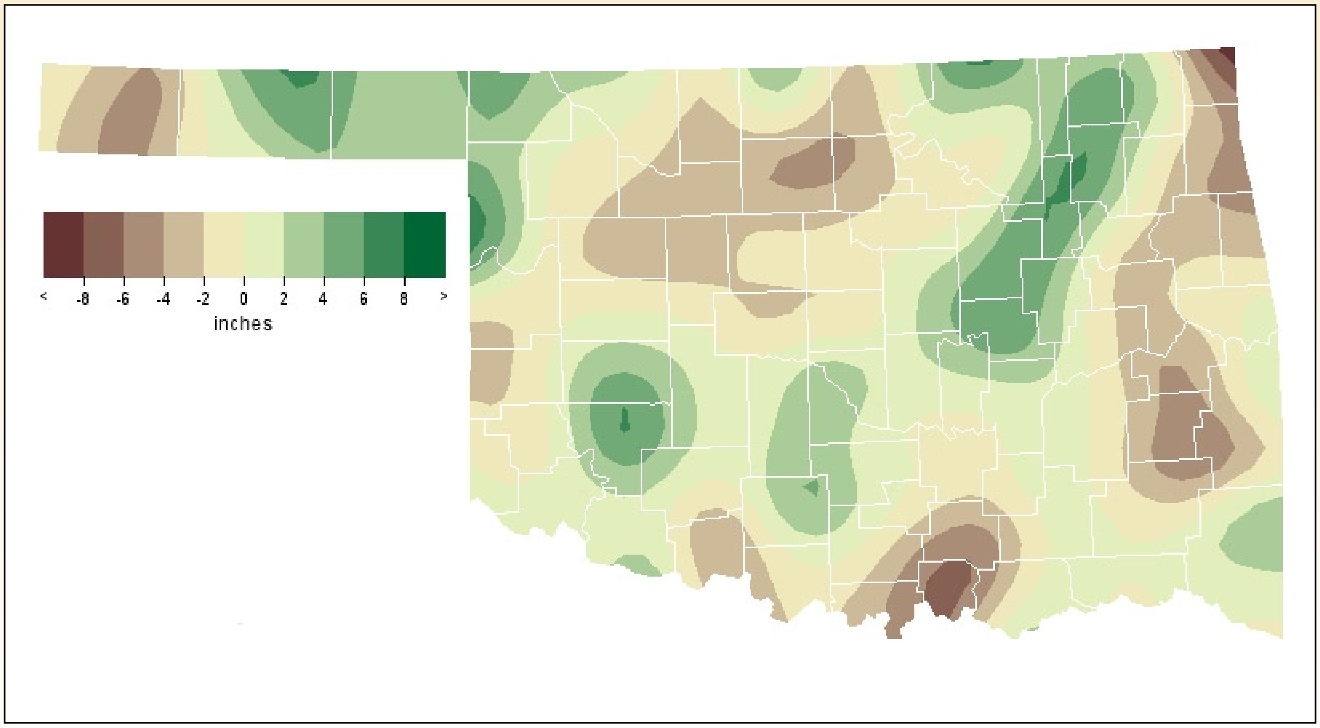
Summer 2003 Statewide Statistic

	Average	Depart.	Rank (1892-2003)
Temperature	80.6ºF	1.1ºF	52nd Warmest
	Total	Depart.	Rank (1892-2003)
Precipitation	10.51 in.	0.74 in.	38th Wettest

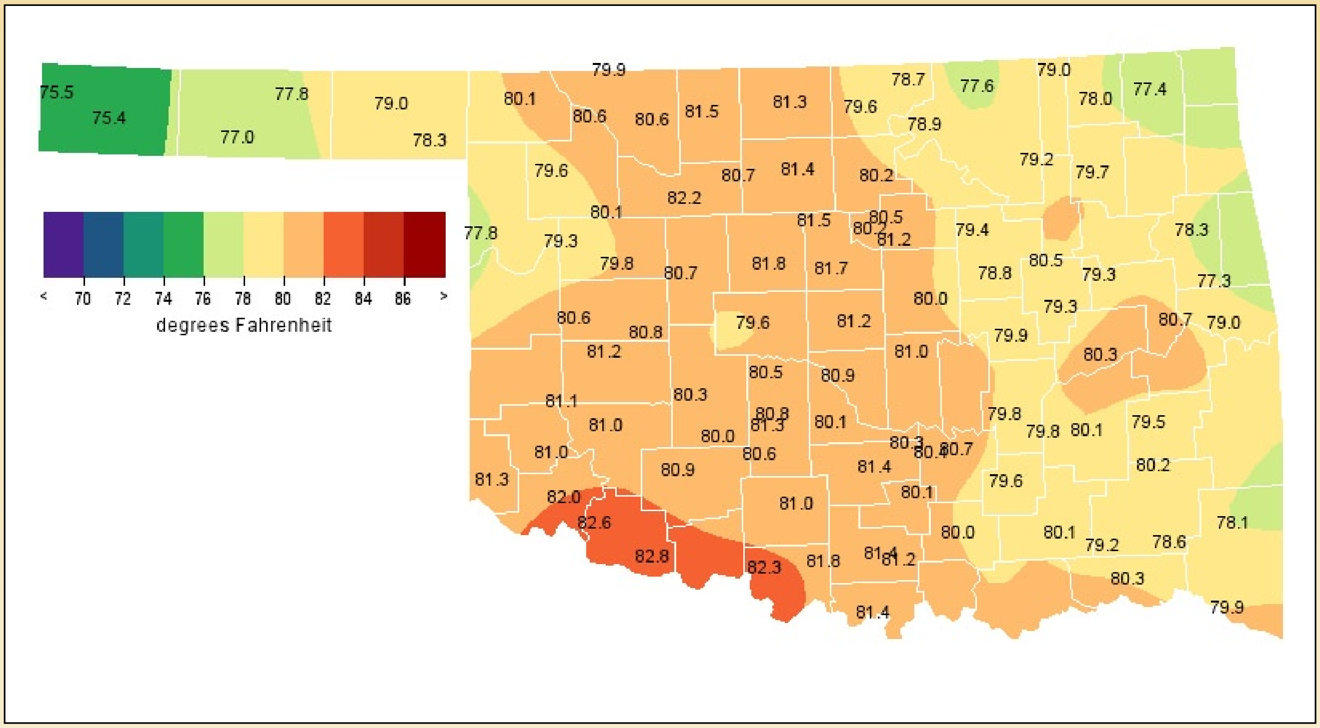
Observed Rainfall



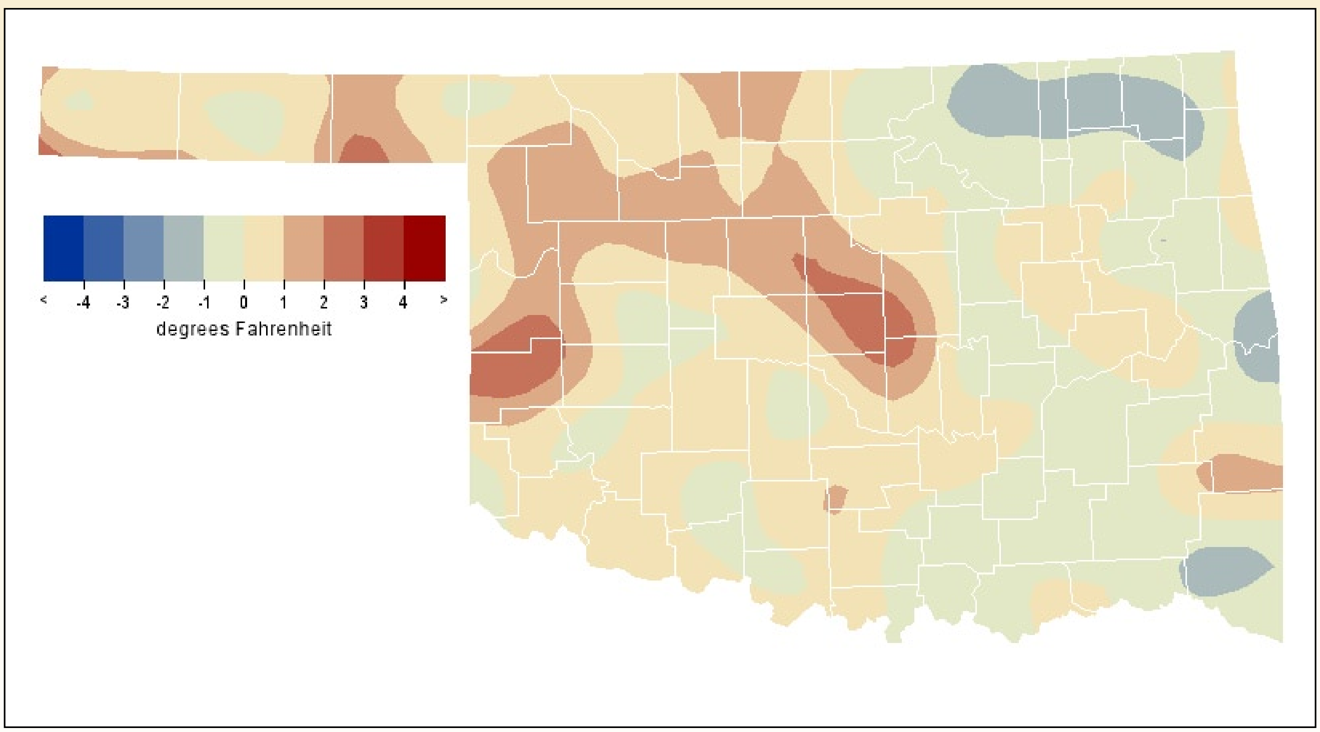
Rainfall Departure from Normal



Average Temperature



Temperature Departure from Normal



Summer 2003 Mesonet Precipitation Comparison

Climate Division	Precipitation (inches)	Departure from Normal (inches)	Rank since 1895	Wettest on Record (Year)	Driest on Record (Year)	2002
Panhandle	10.29	2.33	21st Wettest	17.32 (1950)	2.66 (1936)	9.64
North Central	8.41	-1.56	42nd Driest	16.95 (1995)	3.73 (1936)	12.88
Northeast	12.52	1.56	40th Wettest	23.78 (1948)	2.97 (1936)	11.44
West Central	7.98	-0.73	54th Wettest	16.53 (1995)	2.79 (1980)	8.04
Central	10.37	0.60	45th Wettest	17.61 (1992)	1.97 (1936)	11.06
East Central	9.93	-0.78	45th Driest	20.53 (1958)	1.54 (1936)	10.41
Southwest	10.01	0.98	31st Wettest	16.22 (1996)	2.15 (1980)	7.57
South Central	8.31	-1.41	46th Driest	19.72 (1950)	2.58 (1980)	11.73
Southeast	10.09	-0.90	45th Driest	21.23 (1945)	3.50 (1934)	10.37
Statewide	9.83	0.06	54th Wettest	17.26 (1950)	2.79 (1936)	10.50

Summer 2003 Mesonet Temperature Comparison

Climate Division	Average Temp (F)	Departure from Normal (F)	Rank since 1895	Hottest on Record (Year)	Coldest on Record (Year)	2002
Panhandle	77.6	0.3	46th Warmest	81.9 (1934)	71.5 (1915)	78.8
North Central	80.5	0.6	44th Warmest	86.2 (1934)	74.3 (1915)	79.9
Northeast	78.5	-0.3	46th Coolest	85.4 (1934)	73.8 (1915)	79.2
West Central	80.5	1.0	37th Warmest	85.4 (1934)	74.6 (1915)	79.6
Central	80.6	0.6	37th Warmest	85.6 (1934)	75.0 (1915)	79.4
East Central	79.5	0.2	52nd Coolest	85.4 (1934)	75.0 (1915)	79.6
Southwest	81.3	0.2	55th Coolest	86.0 (1980)	77.1 (1915)	80.8
South Central	80.8	0.1	55th Coolest	86.2 (1934)	77.0 (1906)	79.8
Southeast	79.4	0.2	46th Coolest	84.8 (1934)	75.9 (1992)	79.0
Statewide	79.9	0.3	51st Warmest	85.2 (1934)	74.9 (1915)	79.6

Summer 2003 Mesonet Extremes

Climate Division	High Temp	Day	Station	Low Temp	Day	Station	High Seasonal Rainfall	Station	High Daily Rainfall	Day	Station
Panhandle	108	Aug 7th	Beaver	44	Jun 6th	Boise City	14.34	Arnett	4.06	Aug 30th	Slapout
North Central	110	Jul 14th	Medford	47	Jun 8th	May Ranch	13.10	Medford	7.93	Aug 30th	Medford
Northeast	104	Jul 28th	Burbank	49	Jun 8th	Vinita	19.04	Claremore	5.06	Aug 29th	Vinita
West Central	109	Aug 7th	Retrop	47	Jun 8th	Camargo	11.76	Bessie	2.52	Aug 30th	Retrop
Central	109	Jul 20th	Marshall	48	Jun 7th	El Reno	15.96	Okemah	4.77	Aug 30th	Bowlegs
East Central	105	Jul 28th	Hectorville	50	Jun 27th	Cookson	16.18	Hectorville	4.29	Aug 30th	Hectorville
Southwest	111	Aug 7th	Mangum	52	Jun 27th	Hinton	15.33	Hobart	3.24	Aug 29th	Altus
South Central	108	Aug 7th	Waurika	53	Jun 7th	Burneyville	14.46	Ketchum Ranch	3.17	Aug 31st	Ringling
Southeast	104	Jul 18th	Clayton	52	Jun 7th	Antlers	13.95	Mt Herman	3.26	Jun 26th	Antlers
Statewide	111	Aug 7th	Mangum	44	Jun 6th	Boise City	19.04	Claremore	7.93	Aug 30th	Medford

Agriculture Weather Watch

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This year has confirmed what drives agriculture in Oklahoma: the quantity and timing of rainfall. Rain is key to a healthy Oklahoma agricultural industry, since our major crops are raised without irrigation. This leaves producers at the mercy of the rain that falls to determine yield and crop quality. Even Oklahoma's livestock industry is dependent on rainfall. The vast majority of beef, Oklahoma's highest value agricultural commodity, gain their weight on non-irrigated wheat or grass pasture.

The Oklahoma Mesonet now has soil moisture data available. You can review soil moisture for up to 90-day periods for 2-inch, 10-inch, 24-inch and 30-inch depths going back to October 1, 2002 for the vast majority of Oklahoma Mesonet tower locations. This new data set provides a valuable measure of surface and deep soil moisture.

This year, deeper soil moisture was sufficient in early summer to buffer the effects of below normal rainfall for the majority of the state. The rains that fell came at times when crops could make maximum use of the water. This allowed for a better than average wheat harvest and adequate winter grazing pasture for beef producers, in spite of below normal rainfall for spring and early summer.

In July, summer heat and minimal rainfall combined to highly stress non-irrigated plants. Adequate soil moisture fell off, even down to the 24-inch and 30-inch depth sensors.

As fall approaches, agricultural producers will need higher than average rainfall to maintain deeper soil moisture and provide proper soil moisture in the upper soil depths for wheat seed germination.

Some negative weather events included the extended rain during wheat harvest, isolated hail events, and a late spring freeze. The extended rainy period during wheat harvest lowered wheat quality, which led to lower test weights. Hail storms that swept the state just prior to wheat harvest were locally devastating. The late freeze killed off the primary pecan flower buds, greatly reducing the pecan crop. Other fruit crops were not severely affected.

Lawn and Garden

September

- Last bermuda fertilization, use a quick release fertilizer at a rate of 1 pound of nitrogen per 1,000 square feet.
- Fall lawn preemergent for winter annual weed control, popular products include Princep, Barricade, Balan, Surflan or Team.
- Fall pansy planting. Plants will generate new blooms during the fall and winter, whenever temperatures go above 40°F.
- Divide spring-flowering perennials.
- In the garden, plant garlic, radish, rutabaga, spinach, Swiss chard, radish, and turnip.
- For fallow winter garden beds, plant a cover crop of Austrian winter peas, vetch, wheat or rye.
- Seed tall fescue for new shady lawn areas or to thicken existing stands.
- Fertilize tall fescue in late Sept. to stimulate growth as air temperatures cool, use a quick release fertilizer at a rate of 1 pound of nitrogen per 1,000 square feet.

October

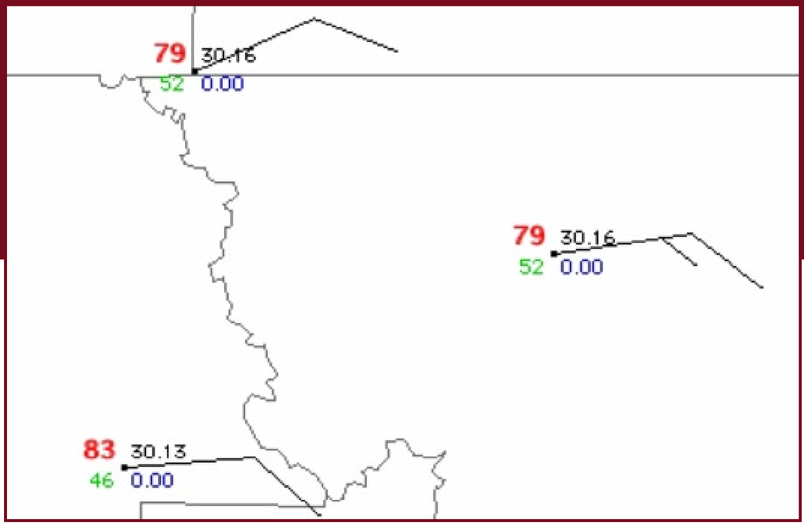
- Plant deciduous trees and shrubs.
- Plant most bulbs, except tulips.
- Analyze soil with a soil test. Contact your local OSU Cooperative Extension Service Office for sample bags, pricing and drop off times.

November

- Fertilize tall fescue in early Nov., use a quick release fertilizer at a rate of 1 pound of nitrogen per 1,000 square feet.
- Plant tulips, after 4-inch average soil temperatures drop below 55°F.
- Rake leaves and make compost pile.
- Prune trees after the majority of a trees leaves have turned color or dropped to the ground.

The Station Model

When meteorologists plot surface weather conditions on a weather map, a standard plotting convention is used. This type of map is called a “station model plot”. An example of an Oklahoma Mesonet station model plot is shown in the figure below. The Oklahoma Mesonet station model depicts current temperature (upper left in red), dew point temperature (lower left in green), wind speed and wind direction (the black “wind barb”), altimeter setting (upper right in black), and total precipitation since midnight (lower right in blue).



The black dot is centered on the latitude and longitude of the Mesonet site where the weather observations are made. In the U.S., surface temperature and dew point temperature are expressed in degrees Fahrenheit, the altimeter setting is plotted in inches of mercury, and the precipitation is recorded in inches.

Wind direction is represented on the station model plot by the position of the “wind barb”. The barb enters the dot at the location that the wind is coming from. In the example above, Hobart (the easternmost station) is experiencing winds from the east. Retrop (the northernmost station) is recording northeast winds (winds from the northeast) and Mangum is reporting winds from the east. Imagine driving along the line that enters the station dot. You will be traveling with the wind.

The wind speed is coded on the tail of the wind barb. Long tails are worth 10 miles per hour each, while short tails denote 5 miles per hour. At Hobart, the combination of a long tail and a short tail indicates a wind of 15 miles per hour. Retrop and Mangum are both experiencing winds of 10 miles per hour.

ACTIVITY: ANALYZING OBSERVATIONS

After plotting observations on a map, meteorologists analyze their field of choice (e.g., temperature, dewpoint, pressure). The analysis is accomplished by drawing lines of constant value, known as **isopleths** ("iso" means equal and "pleth" means value). The isopleths *connect* points of equal value and *separate* larger values of a field from smaller values.

Isopleths can be drawn for any scalar field. Particular types of isopleths are indicated below:

Temperature ⟶ Isotherms
Dew Point ⟶ Isodrosotherm
Pressure ⟶ Isobar
Rainfall ⟶ Isohyet

Contour Intervals

The process of contouring a weather map aids in the visual interpretation because the process reveals the spatial pattern. For example, a contoured field of air temperature depicts locations of features such as cold fronts and dry lines. However, to create the best possible contour analysis, it should be performed carefully, with a consistent set of contour intervals.

The exact contour interval for a specific analysis depends upon the field to be analyzed and the spatial scale of the analysis. For example, an analysis of temperature might be performed using a 5 °F contour interval. Contour values should be evenly divisible by the interval. For example, a series of contour values for a 5°F temperature analysis would be 35 °F, 40 °F, 45 °F, 50 °F, etc., rather than 32 °F, 37 °F, 42 °F, 47 °F, 52 °F. Typical contour intervals are shown below:

Field	Contour Interval	Suggested Contour Values
Sea-Level Pressure	4 mb	992, 996, 1000, 1004, 1008, 1012
Temperature	5 °F	50, 55, 60, 65, 70, 75, 80
Dew Point Temperature	5 °F	40, 45, 50, 55, 60, 65, 70

Performing the Analysys

It is often advisable to begin an analysis in the center of the map, rather than at the edge. Be careful to interpolate between observation points in the placement of a contour line to produce a smooth representation of the pattern. Isopleths also should not extend outside the field of data. For example, an analysis of the data from the Oklahoma Mesonet should not extend into neighboring states because no Mesonet observing sites are located there. Closed contours should identify maximum and minimum values. On pressure charts, the maximum value should be labeled with an uppercase "H" and the minimum value with an uppercase "L". Maxima and minima in temperature fields are sometimes marked with "W" and "C" (warm vs. cold), and moisture plots might be labeled with "M" and "D" (moist vs. dry).

Guide to Isoplething

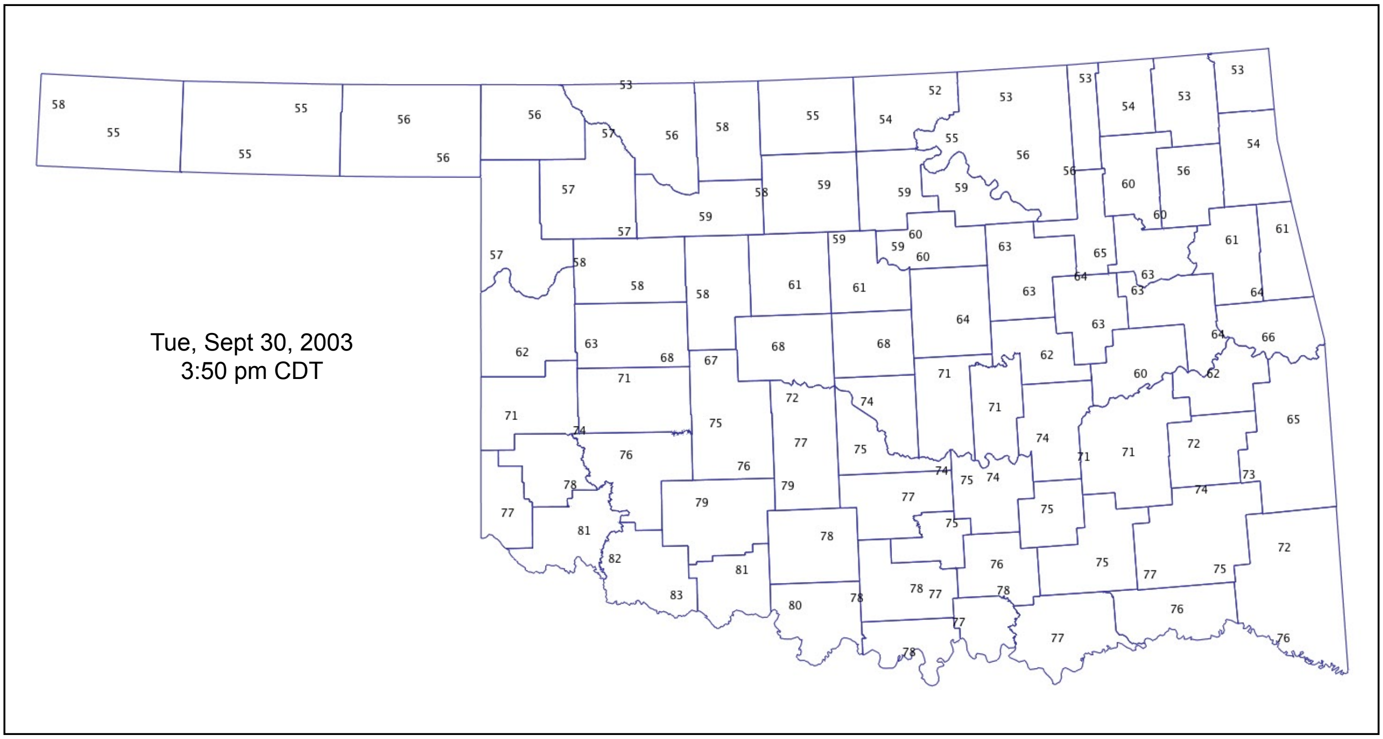
- Isopleths NEVER branch or cross. They should either be closed lines or end at the edge of the data field.
- Isopleths should be drawn smoothly and labeled clearly. Each contour line should be labeled at the beginning and end of the line. Long contour lines may also be labeled at a small number of places along the line.
- Lightly sketch isopleths at first and then go back and darken them after you are sure they are correct.
- Isopleths should be drawn at equal intervals. Typically, isobars (lines of constant pressure) are drawn at intervals of 4 mb and isotherms (lines of constant temperature) are drawn every 5°F.

Exercise

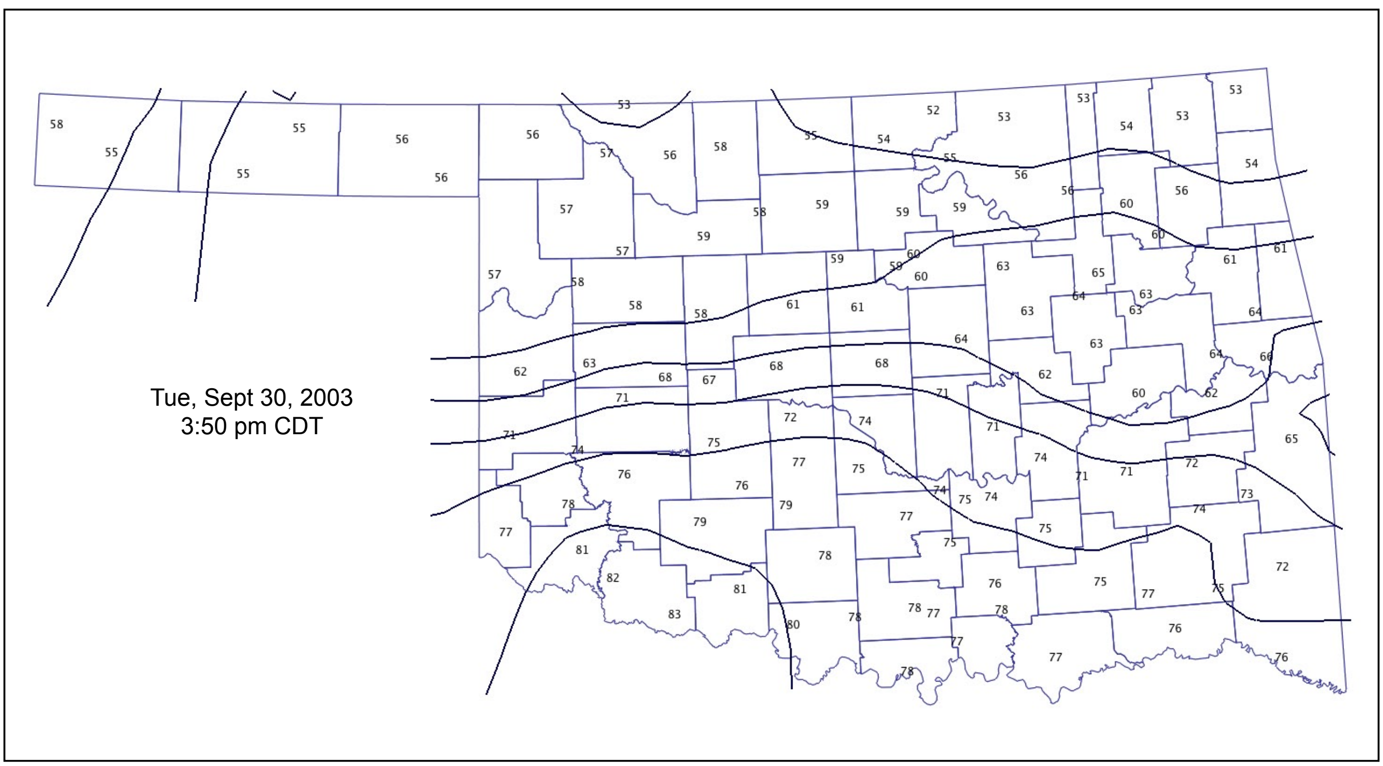
1. Draw isotherms at intervals of 5 °F on the enclosed map.

2. Where is the strongest temperature gradient located (the rapid change from low temperature to high temperature?

Oklahoma Mesonet Air Temperature



Oklahoma Mesonet Air Temperature Key



The Joint Urban 2003 Field Experiment

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Figure 1. A weather station mounted on a traffic pole during Joint Urban 2003 (Peter Hall from OCS is pictured).

During June and July 2003, the largest urban dispersion field experiment of its kind was conducted in Oklahoma City. Scientists from across the United States and around the world traveled to Oklahoma with the intention of understanding how air flows within urban environments in the event that harmful contaminants are released within an urban setting (e.g., pollution, an industrial accident, or a chemical or biological attack).

To accomplish the goals of the experiment, extensive preparations were made over a period spanning nearly three years, well in advance of September 11, 2001. Oklahoma City was chosen for a myriad of reasons which included a consolidated and well defined central business district of tall buildings, relatively flat terrain without large bodies of water bordering the city, predictable wind conditions for the study period, the gridded nature of the city streets, and the support of city officials for the project. Another main consideration for the selection of Oklahoma City was the extensive weather observing infrastructure in place in central Oklahoma that included the Oklahoma Mesonet.

Between the dates of June 28 to July 31, 2003, a vast array of instrument systems installed specifically for JU2003 collected high-resolution observations of meteorological variables in and around Oklahoma City. The instruments continuously gathered data from surface-based and tower-based measurements at ground level, on traffic poles (Figure 1), the sides of buildings, and on rooftops (Figures 2 and 3). Additional instruments were installed on the perimeter of the city to gather information on the vertical profile of wind speed, wind direction, and temperature.

However, to gather detailed information of how air moves through the urban canyon structures and into buildings, a special tracer was released when atmospheric conditions were suitable. The tracer, sulfur hexafluoride, is a colorless, odorless, tasteless gas commonly found in household products such as athletic shoes and tennis balls. During the course of the experiment, 10 tracer release studies that lasted approximately 8 hours were conducted and specialized instruments were deployed throughout the city to measure the concentration of the sulfur hexafluoride. The tracer experiments were very critical to the success of JU2003 because each release simulated how a contaminant would move through the city given certain atmospheric conditions. Initial results from the tracer experiments demonstrated that, even though the tracer was five times heavier than air, it was transported quickly to the rooftops and into the buildings where people lived and worked.

Figure 2. A roof top mounted weather station mounted during Joint Urban 2003.

Figure 3. A roof top mounted weather station mounted during Joint Urban 2003.

The Oklahoma Climatological Survey played a critical role in the planning and completion of the experiment. OCS staff helped install and maintain instruments used to gather background information on the atmosphere within Oklahoma City. In addition, OCS staff met with city leaders, property owners and managers, as well as the media to explain and educate citizens about JU2003. Finally, once the JU2003 was underway, OCS personnel used their local expertise to help forecast when conditions were favorable for the tracer release studies. The challenge to the forecasters was to identify the proper wind conditions 24-36 hours in advance of the tracer release. Then, while the tracer experiments were ongoing, OCS staff monitored weather conditions to ensure successful experiments as well as provide advanced warning in the event of inclement weather.

Because the success of each tracer release hinged on wind speed and direction, it was critical for the operational staff to have real-time data. Thus, the Oklahoma Mesonet was used extensively throughout the experiment to provide critical, up-to-date weather information in central Oklahoma. In fact, during the tracer release studies, data from the Oklahoma Mesonet represented approximately 90% of the information used by operational forecasters for the experiment.

The results of JU2003 will have a significant impact on emergency preparedness in Oklahoma City, cites across the United States, and cities around the world in the event that harmful contaminants are released into the atmosphere. In addition, the wealth of information gathered during the experiment will aid in the increased understanding of urban meteorology. It is expected that while initial results will be available in the next few months, scientists and students will investigate the data collected during JU2003 for the next decade or so. ■

FLOOD SAFETY TIPS

Severe flooding episodes occur in Oklahoma virtually every year, most frequently during the spring and fall. Implementation of sound floodplain management and building strategies, particularly through the National Flood Insurance Program, is the most effective way for communities to avert potential flood damages. Communities should go above and beyond minimum NFIP standards, consistent with the National Association of State Floodplain Manager's 'No Adverse Impact' initiative. Unfortunately, only 12 percent of homes in Oklahoma's designated floodplains are covered by flood insurance.

On an individual basis, Oklahomans should be aware of the dangers of driving into floodwaters. Almost one-half of all flood-related fatalities occur in vehicles, primarily when people drive into flooded highway dips or low drainage areas at night. *As little as six inches of water can cause drivers to lose control of their vehicles*. Flood waters one foot deep can displace 1500 pounds. Two feet of water will sweep most vehicles off the road, even those equipped with four wheel drive!

Three simple tasks will help save your life. **Know your area's flood risk ahead of time**. If you are unsure, contact your local emergency manager or the local chapter of the Red Cross. **Prepare a family disaster plan** in the event that you need to evacuate. You may wish to wrap valuable documents and insurance policies in sealable plastic bags. **Be alert to signs of flooding and monitor** local National Weather Service flood watches and warnings.

Remember, a Watch means flooding is possible; a Warning means flooding is occurring.

Here are some additional resources:

National Flood Insurance Program:
http://www.fema.gov/nfip/

Association of State Floodplain Managers:
http://www.floods.org

Oklahoma Floodplain Managers Association:
http://www.okflood.org/

Oklahoma Water Resources Board:
http://www.owrb.state.ok.us/hazard/

The American Red Cross:
http://www.prepare.org/

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