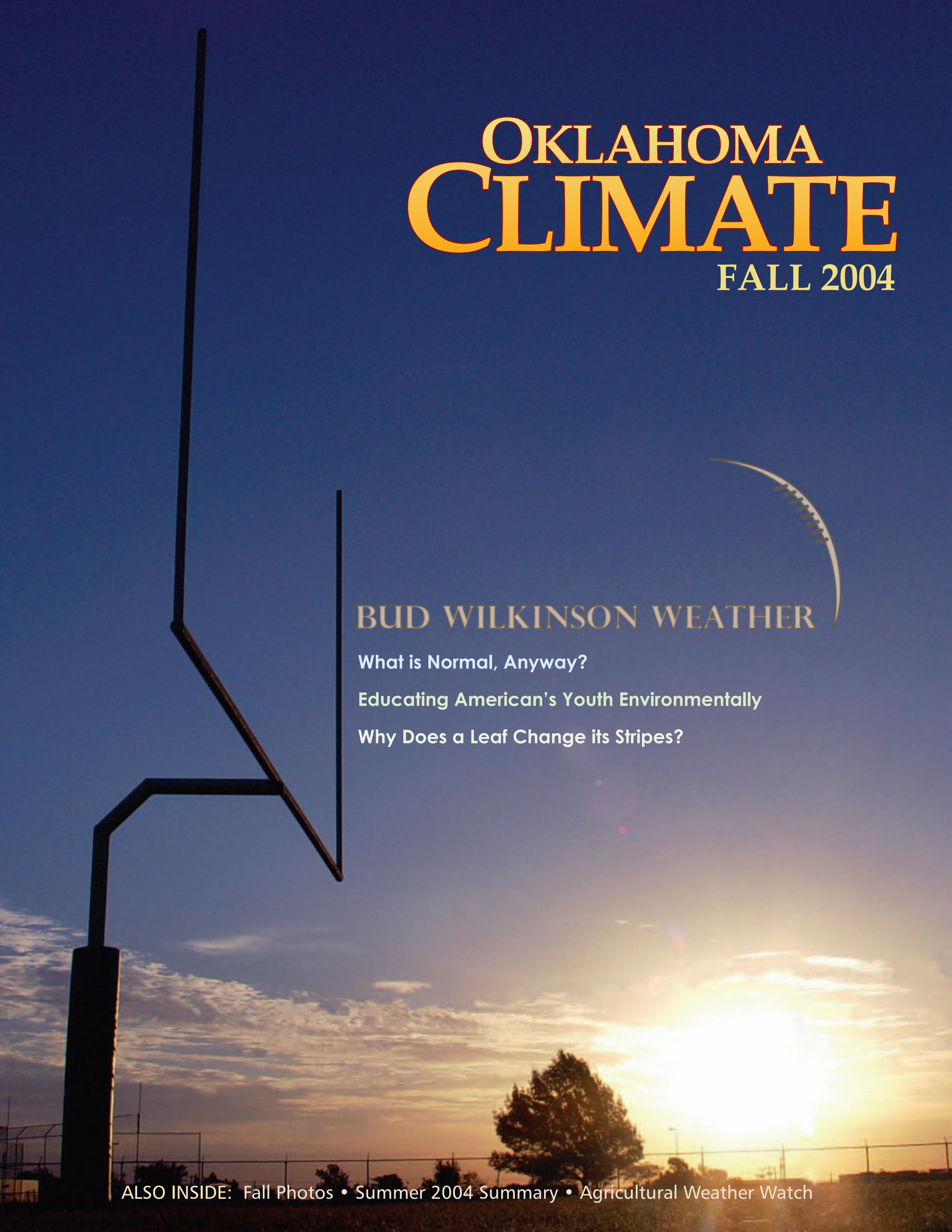
OKLAHOMA CLIMATE

FALL 2004



BUD WILKINSON WEATHER

What is Normal, Anyway?

Educating American's Youth Environmentally

Why Does a Leaf Change its Stripes?

ALSO INSIDE: Fall Photos • Summer 2004 Summary • Agricultural Weather Watch

MESSAGE FROM THE EDITOR

Autumn in Oklahoma is looked upon with much anticipation due to three momentous events: the beginning of football season, the end of the stifling summer heat, and the beginning of football season. Okay, I may have overstated one of those, but there is no denying that Oklahoma is a football state, as much a part of our identity as red dirt, Native Americans, and tornadoes. Still, most of us relish that day in which the first strong cold front of the season appears on the weather maps, signifying an end to the seemingly endless blast furnace known as summer in Oklahoma. That thirst for relief was undoubtedly less strident than in years past, however, due to the deliciously cool 2004 summer weather. Another fall phenomenon that is looked upon with both dread and delight is the beginning of the new school year. Parents circle that day with red ink on the calendar, while youngsters count each passing day as one step closer to the end of summer fun. With these thoughts in mind, we greet the new season with this, the 5th edition of Oklahoma Climate.

We begin with a wonderful piece of Oklahoma football history, chronicling the legend of Bud Wilkinson's rain-free career at the University of Oklahoma. Many Sooner fans probably think Coach Wilkinson received a bit of divine intervention, but Oklahoma's acting State Climatologist, Derek Arndt, searches for some atmospheric clues to solve the mystery. "Normal" is an oft-used term by climatologists (some would consider that something of an oxymoron), but what exactly is meant by the expression, climatologically speaking? Derek takes a stab at an explanation in his article "What is Normal?" And what fall tome would be complete without a bit of autumnal color splashed across its pages? Check out our photos of the beautiful and breathtaking fall colors from the forests of Oklahoma! Our resident arboreal expert and Mesonet Assistant Extension Specialist Al Sutherland offers up an explanation of exactly why those leaves change colors, and how differing weather conditions govern those changes. Keeping with that theme, our Classroom Activity gives students the chance to interpret the effect of solar radiation on those colors. What is the state of environmental education in today's schools? Get the opinions of our K-12 Educational Outreach team in an important piece entitled "Educating American's Youth Environmentally." And finally, as you are out watching those fall sports, be aware that September and October are considered Oklahoma's secondary severe weather season. As a reminder, we have included some tips on lightning safety.

We certainly hope you enjoy this issue, and remember, please feel free to contact us with any questions or comments you might have. Just drop me a line at gmcmanus@mesonet.org.

Gary McManus – Editor

Oklahoma Climate Fall 2004

Cover Photo: Norman, OK on September 26, 2004. Photo by Ryan Davis. 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

BUD WILKINSON WEATHER

By Derek Arndt - Acting State Climatologist | Cerry Leffler - Administrative Manager

Bud Wilkinson's Sooners are known for amazing streaks that still dwell in collegiate record books – and one that inhabits the climatological record books.

It doesn't take long for a visitor to Oklahoma to learn that football is important here. It often dominates conversations, decisions, and even life in the Sooner State. It is sometimes cursed, often praised, and folks who live here embrace its finest hours and accept its ugliest moments.

Likewise, it doesn't take long for a visitor to learn that weather is important to Oklahoma. It, too, can dominate conversation, decisions and life. Like football, weather draws curses and praise, depending on the season's performance. And, without a doubt, folks who live here embrace its finest hours and accept its ugliest moments.

Each domain has its share of prominent people, but one man seems to have transcended the two. Charles Burnham "Bud" Wilkinson is known nationally for excellence on the playing field, but his apparent mastery of Oklahoma's autumn weather actually worked its way into the local vernacular. Its use has waned a bit in recent years, but a careful listener at a college or high school football game might hear thanks – or longing – for "Bud Wilkinson Weather."

What is Bud Wilkinson Weather?

Bud Wilkinson's Sooners were known for streaks. It is difficult to identify which is most impressive: 47 straight victories in 1953-57, or 13 consecutive conference titles, including every Big Seven crown ever issued. Wilkinson was definitely no ordinary football coach. He held a degree in English, wore a tie on the sidelines, and accepted his first head coaching job (at Oklahoma in 1947) at the age of 31. His televised coach's show was truly ground breaking – the Gentleman Coach was telegenic fifty years before "telegenic" became a word. But was he also a master of the weather?

By the end of Wilkinson's tenure, football fans in Oklahoma had noticed another streak – it had never rained on Wilkinson's Sooners during a home game. In fact, many Sooner home games during the era were so idyllic that folks began to refer those special Oklahoma autumn afternoons – crisp, sunny, and placid – as "Bud Wilkinson Weather."

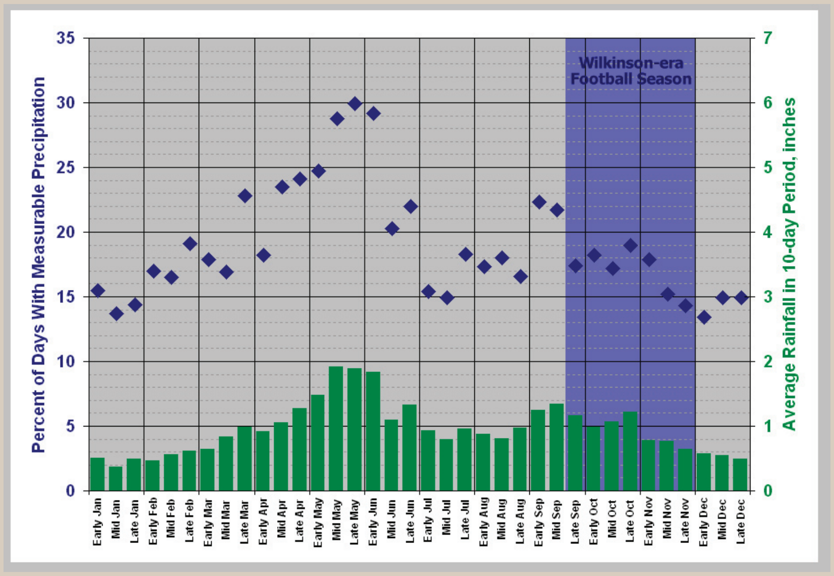


Figure A: Average precipitation tendencies at Norman from 1905-2003. Each month is divided into three units: early (1st-10th), middle (11th-20th), and late (21st-end of month). Blue diamonds represent the percent of days, on average, with measurable precipitation during each of these periods. Green bars indicate average ten-day rainfall totals during these periods. The frequency of rainy days in Norman during the Wilkinson-era football season is approximately 17%, or about one out of six.

Is The Legend True?

With the exception of a blowing mist during the Sooners' 55-14 drubbing of Colorado in late October 1951, no precipitation was observed during Wilkinson's home career. And even on that day, no measurable amount of rainfall fell until several hours after the final gun, so the climate record supports the Legend of Bud Wilkinson Weather.

Wilkinson's Sooners played 81 home games, all in the last ten days of September through the last week of November. Norman's long-term climate record indicates that measurable precipitation falls on about 17% of the days in this period (FIG A). If 81 of these "football season" days were randomly drawn from Norman's history, the odds of choosing zero rainy days are exceedingly small. In fact, they are very similar to the chances of rolling a die 81 times without showing a "6" – about 2.5 million to one!

But the Sooners had a few factors on their side to reduce these odds. Foremost of these is the fact that a Wilkinson-era football game only lasted about two hours. Rain fell on several of the days that the Sooners hosted games, but never during the actual contests. Sometimes this "Wilkinson Effect" took on eerie proportions. For example, in October of 1959, ten straight days of heavy rains caused severe flooding across much of the state. In Norman, the downpour stopped just ten minutes before kickoff.

Coach Wilkinson's Secret Weather Weapon: The Pacific Ocean

Another factor that helped Wilkinson's Sooners escape the rains was the general dryness (relatively speaking) of autumns during the era. Wilkinson's teams played almost all of their home games within a ten-week stretch from late September through November. During the Wilkinson years of 1947-63, the number of rainy days in Norman during these weeks was significantly lower than the historical average dating to 1905 (FIG B). During the Wilkinson Era, the average number of rainy days during this ten-week "football season" was 10.1. In non-Wilkinson years, Norman has seen 12.8 rainy days per "football season."

Bud Wilkinson's football recruits mostly weighed 150-200 pounds and came from cities and towns across the southern plains. But his best weather weapon weighed in at billions and billions of tons

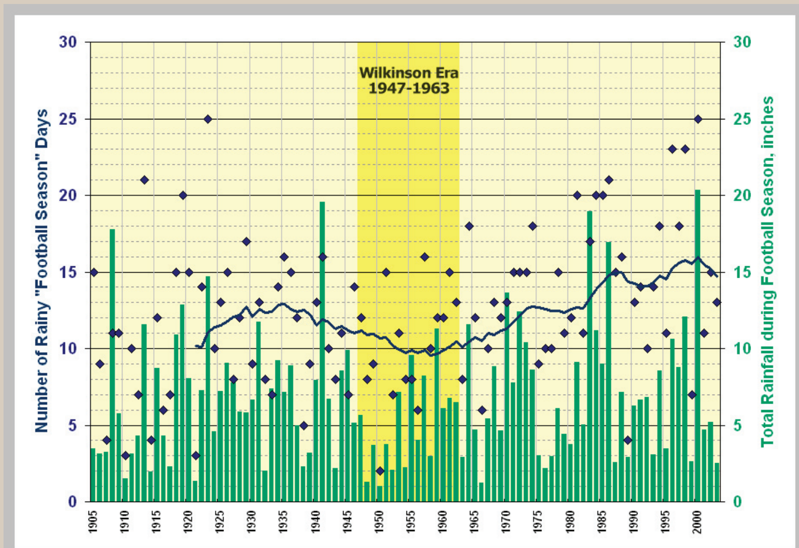


Figure B: The number of rainy days (blue diamonds) and total rainfall (green bars) for each of Norman's "football seasons" (Sep 20 - Nov 30) since 1905. The blue line represents the 17-year running average of rainy days (Wilkinson coached 17 years at Oklahoma). This long-term average reached its lowest point near the end of the Wilkinson Era.

and hailed from as far away as Indonesia and the Bering Sea. The distribution of surface and near-surface temperatures in the Pacific Ocean is a significant influence on the climate of the southern plains. These features are measured in several ways, one of which is the Pacific Decadal Oscillation, or PDO.

In Oklahoma, there seems to be a connection between the PDO and seasonal precipitation patterns. During the Bud Wilkinson Era, the PDO was predominantly in its negative phase, which is associated with drier autumns in the southern plains (FIG C). This configuration was likely a factor in the generally dry autumns that marked the 1950s and early 60s in Oklahoma.

An Incredible Streak

Regardless of the explanation: chance, natural, or supernatural influences, the 81-game rainless streak is truly extraordinary. It is one of several Wilkinson-era records that may stand for generations, unless football or Oklahoma's climate changes dramatically. If either of those changes occurs, or even if they don't, Oklahomans will gather to discuss it. If they're lucky, they'll discuss it on a crisp, clear autumn day, which they might call "Bud Wilkinson Weather".

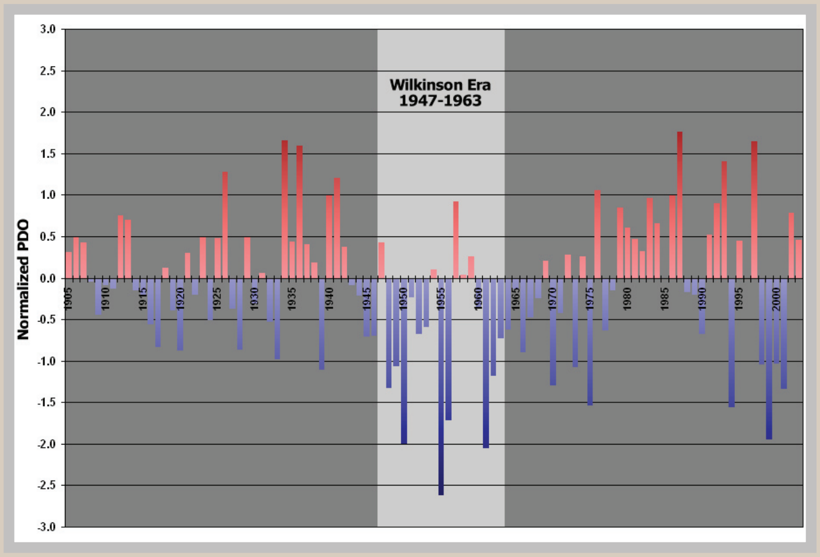
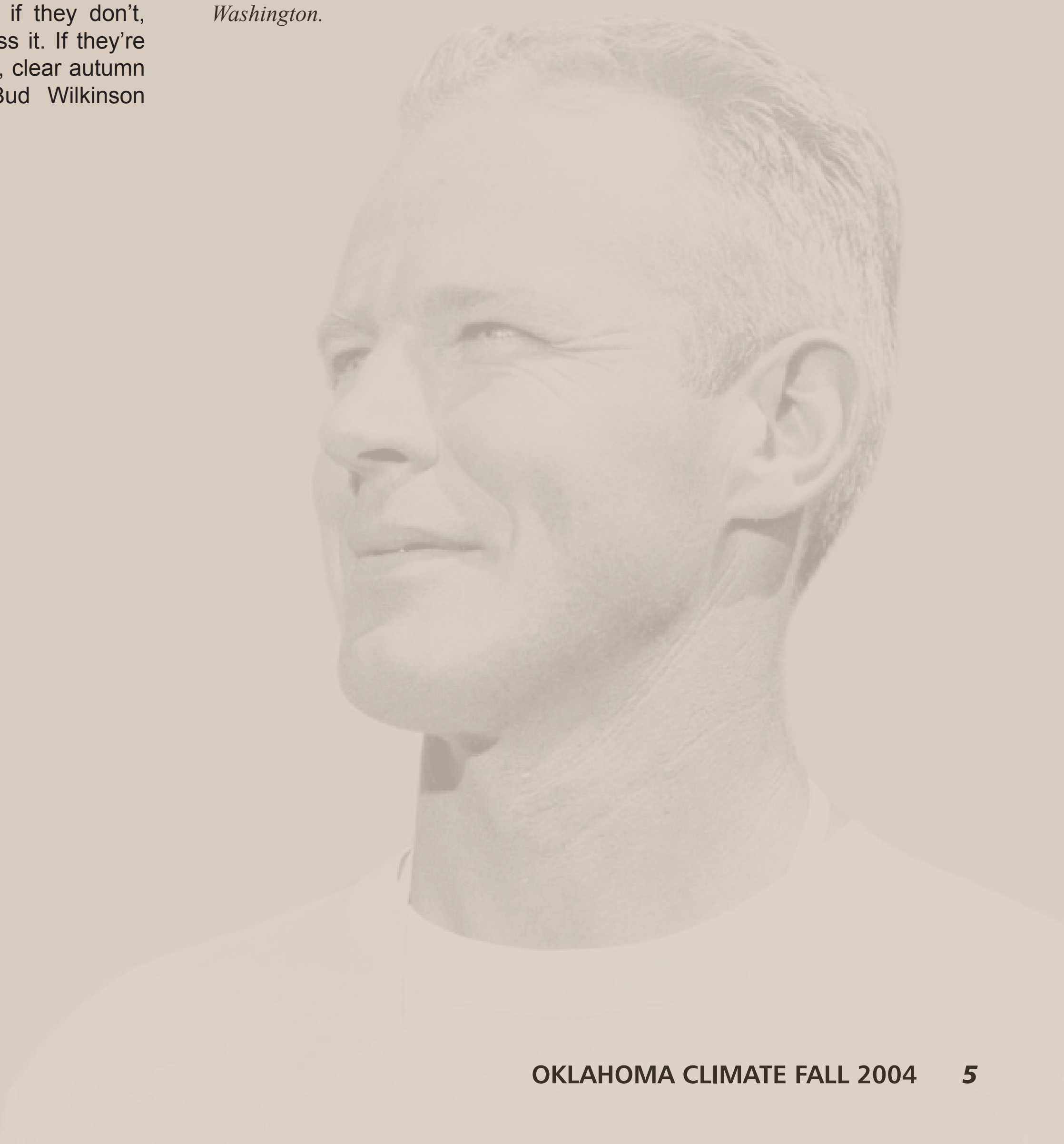


Figure C: A normalized Pacific Decadal Oscillation (PDO) index for the autumn months since 1905. Negative phases of the PDO (blue bars on this graphic) are somewhat associated with drier autumns in the southern United States. Positive phases (red bars) tend to correlate slightly with wetter autumns. Data courtesy of the Joint Institute for the Study of the Atmosphere and Ocean at the University of Washington.



WHAT IS **NORMAL**, ANYWAY?

By Derek Arndt - Acting State Climatologist

We see or hear the term almost every day: today's "normal" high, or this month's "normal" rainfall. Just what exactly do meteorologists mean – or think they mean – by "normal"?

When describing Oklahoma's weather, "normal" is not the first adjective that springs to mind. Tempestuous? Sure. Unpredictable? At times. Capricious? Of course. With the availability of so many rich descriptors, it seems absurd to color Oklahoma's weather with such a gray term as "normal". But the word shows up often in morning papers, evening telecasts, and afternoon statements by the National Weather Service or the Oklahoma Climatological Survey. It is the basis for countless comparisons, ranging from the immediate ("today's high was seven degrees below normal") to the long-term ("the normal growing season at Walters is 225 days") to forecasts ("above-normal precipitation is predicted for this summer").

So, what exactly is this ubiquitous term? Why is it the basis for so many comparisons? How is it best used? Does it ever change?

What It Is

At its essence, a "normal" is not much more than a 30-year average. In fact, in most situations, that's exactly what a normal is: a 30-year average. To be specific, today's normals are based on the 30 years of 1971-2000. For example, the normal October temperature at Tulsa is 62.6 degrees Fahrenheit. It is the average value of the thirty Octobers from 1971-2000 (Table 1). Even though these Octobers ranged from 56.1 in 1993 to 66.3 in 1979, it's the average that is used as the normal.

These values are updated every ten years with the latest data. For example, the latest switch moved us from the 1961-1990 normals to the current 1971-2000 normals. When this happened, the 1960s (1961-1970) were replaced by the 1990s (1991-2000). Because the 1960s happened to be fairly dry, and the 1990s happened to be very wet, the normal rainfall increased for most of the state, and dramatically in places. When this happened the ongoing drought seemed much worse overnight (Fig. 1).

An unfortunate turn of events slapped the word "normal" on top of these 30-year averages. But the climatological use of the word has its origins in statistics, where "normal" has a very specific meaning that has to do with data distributions, bell curves, and so on. Like an unwanted nickname, the term stuck, which led to many of the misinterpretations seen today.

What It Isn't

It is only natural for people to hear the word "normal" and think it means "typical" or "usually" or even "supposed to". But these connotations are far from the truth, especially in Oklahoma, and especially during the spring and fall. These transitional seasons feature the cyclic struggle for dominance between summer-like conditions and winter-like conditions. Anybody who lives in the southern plains can tell you that these competing air masses rarely reach a compromise during the transition months. Instead, this battle often occurs as a see-saw, with cold air invasions and interceding warmth. In this type of scenario, most days will be significantly above or below normal! For example, the normal high temperature at Enid on October 15th is 74 degrees. In 94 years of observations at Enid, October 15th has featured a high of 74 degrees exactly once (Fig. 2). Moreover, on more than half of those dates, the high temperature hasn't even fallen in the 70s! Such is the case with daily normals: Mother Nature rarely obeys them, especially on the shorter term.

Rainfall normals are especially troublesome on the short term. In Oklahoma, rain often comes in large doses, even on a month-by-month time scale. This has significant ramifications for monthly rainfall normals. In a thirty-year data set, it is common to see a handful of whopper rainfall amounts amidst a population of more modest totals. This is especially true during autumn in Oklahoma, when monthly rainfall totals are highly variable. A few very large values can pull the group's average up above most of the rest of the population. The normal October rainfall at Ada gives a great example of this process. In 1972, 1981, 1985 and 2000, more than nine inches of October rainfall drenched Ada. These large events helped skew the overall normal upward to 3.89" (Fig. 3). This "normal" rainfall is greater than eighteen of the thirty months in the data set! This highlights the dirty secret of rainfall normals: most individual months will have below-normal rainfall.

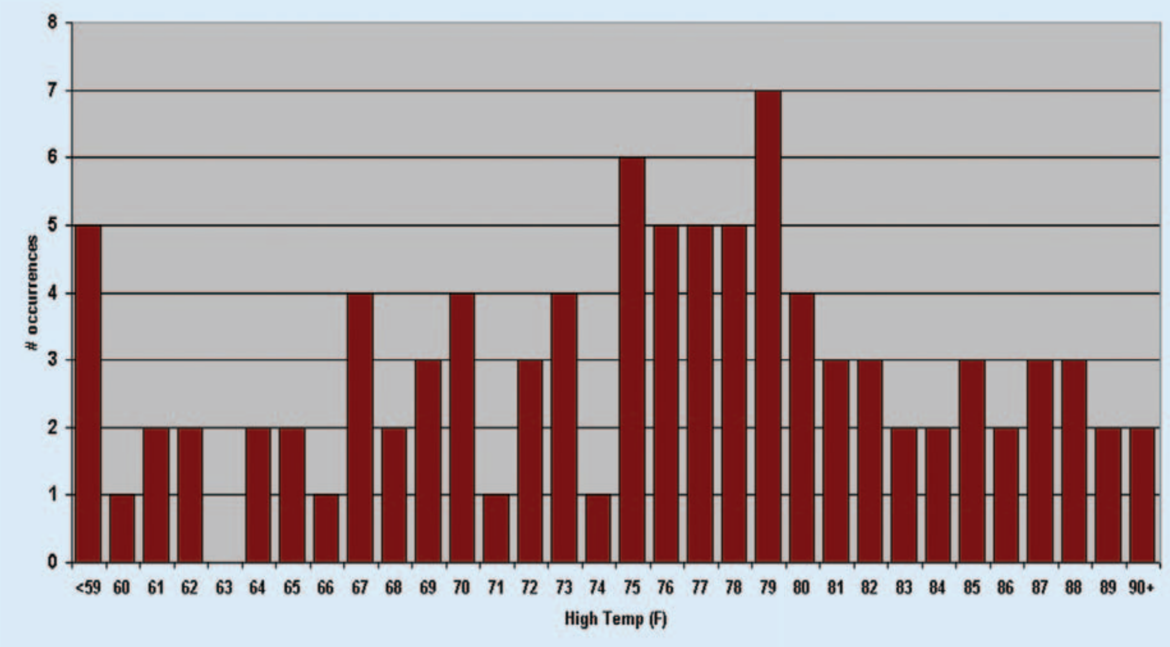
These issues help underscore the danger in thinking about normals in terms of "should be" or "usually" or "supposed to be". In short, individual events are governed by the status and the physics of the atmosphere, and not by 30-year averages.

So, Why Use It?

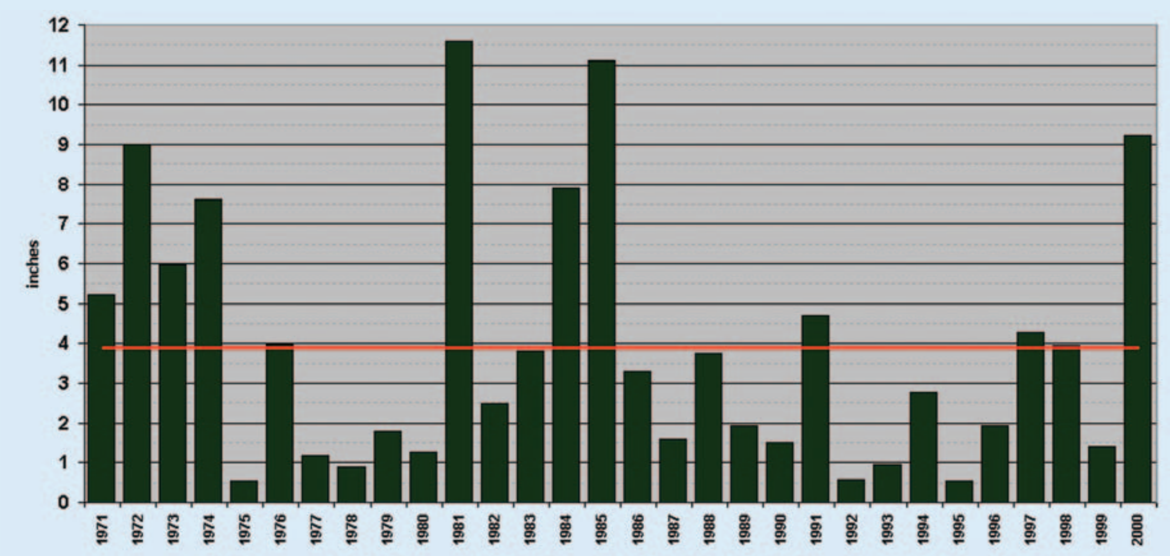
In many ways, normals are still the best planning tool for many applications. With proper knowledge of their limitations, normals can provide very useful information for a variety of agricultural, water resources and energy industry functions.

In the longer term, as weeks turn into months and months into years, normals become more significant. Put another way: a 50% rainfall deficit over twelve months means much, much more than a 50% rainfall deficit over twelve days.
And, in many ways, normals help provide some perspective on current events by providing a tentative baseline to define current weather and climate events.

High Temperatures at Enid



October Rainfall at Ada: 1971-2000



Year	Temp
1971	65.5
1972	61.4
1973	65.5
1974	63.6
1975	63.7
1976	56.2
1977	62.2
1978	63.6
1979	66.3
1980	61.5
1981	61.2
1982	63.8
1983	64.8
1984	64.1
1985	63.4
1986	61.4
1987	59.6
1988	58.9
1989	64.0
1990	61.2
1991	64.3
1992	62.5
1993	56.1
1994	63.4
1995	62.9
1996	61.4
1997	62.0
1998	63.0
1999	62.3
2000	66.2
Normal	62.6

Table 1: Tulsa's normal October temperature is an average of these 30 observed values.

Photo By: Lou Anella


Photo By: Jennifer Barnes


Photo By: Lou Anella


Photo By: Lou Anella

Educating American's Youth Environmentally

By: Andrea Melvin - Program Manager for K-12 Outreach

The basic tenet of the American educational system for the past half-century has been the use of an instructional model where a knowledgeable teacher asks only the questions she can answer. Students memorize information long enough to complete an exam. Often these students enter the workforce with little or no ability to recognize problems and to be able to offer solutions. American businesses are looking to foreign soil to produce a workforce that demands lower salaries and has a higher technological skill set than American graduates. American schools must meet the needs of American businesses or this trend will continue.

In a 1999 report from the National Business Education Association, businesses described the ideal employee as someone who can work in a group, create analytical reports, interpret data, make decisions, be a critical thinker, be flexible, is a skilled communicator, is ethical, and is self-motivated to find solutions. Our current model of education does not seem ideal at producing this type of employee. Students may never get a chance to think for themselves; therefore, they can never become highly skilled, self-motivated employees.

Another stumbling block to creating self-motivated employees is the division of educational material into distinct subject areas. Science is taught separately from mathematics. English is taught separately from history. Students complete assignments in each area sometimes borrowing skills from other subject areas. However, students feel these skills are disconnected. They struggle to uncover the relevance of writing skills in physics class or the historical significance of a scientific discovery.

Recent success stories are coming to light all across the country. Teachers are moving away from textbook-based lectures to hands-on, inquiry-based instruction. Students formulate their own questions, make predictions, design experiments, test their predictions, collect data, and draw conclusions. The goal is no longer to "find" the answer. Instead, students are encouraged to ask additional questions and repeat the process.

One of the easiest ways to introduce inquiry-based instruction is by creating a framework for questions to develop naturally. How can the public expect students to ask new questions when students look at the same four classroom walls all day, every day? Teachers are discovering that by moving students outside into their local environment the question floodgates open wide. Enthusiasm and the desire to learn take over. The deepest learning occurs when students understand how educational content relates or is connected to their daily lives. Mathematics is no longer a 50-problem assignment on fractions and percents. Instead students calculate the percentage of phosphates in a local stream or the fraction of seeds that germinate.

Environmental Education provides the answer to, "Why do I have to know this?" When students feel a part of their local environment, they are more likely to take action if an event negatively impacts the environment. The goal of environmental education is to produce an environmentally literate citizenry. One definition of environmental literacy is "a fundamental understanding of the systems of the natural world, the relationships and interactions between the living and the non-living environment, and the ability to deal sensibly with problems that involve scientific evidence, uncertainty, and economic, aesthetic, and ethical considerations." (OKCEL, 2004) Good environmental education programs do not advocate a specific opinion or solution. These programs provide the information so that individuals have the opportunity to weigh the issues and make their own decisions.

The National Environmental Education and Training Foundation conducted surveys on environmental behaviors and beliefs. The Foundation discovered that 2 out of 3 Americans could not pass a simple environmental quiz. In contrast, 95% of adult Americans support environmental education in K-12 classrooms. Eighty percent of those surveyed wanted private companies to provide employees with training in how to solve environmental problems. These statistics show that Americans lack adequate knowledge of environmental issues but they support increased environmental education for both themselves and their children.

In fact, schools are seeing this same trend. Schools with outdoor classrooms, gardens, and nature trails have seen an increase in parental support and volunteerism. Environmental education programs appear to be the answer to many school problems. Motivated students complete assignments, develop better social skills, and are less likely to be disruptive. Teachers of motivated students spend less time on discipline issues and more time facilitating learning experiences. Parents become partners in the learning process, not just fund-raisers.

In Oklahoma, schools benefit from national and state environmental education programs. National programs like Project Wet, Project Wild, Project Learning Tree, and many others provide professional development workshops for teachers along with curriculum guides. These programs have developed materials on water conservation, recycling, and methods for protecting wildlife habitats. Oklahoma's environmental education groups are working together to develop partnerships. The Oklahoma Consortium for Environmental Literacy (OKCEL) is the driving force behind this movement (http://www.okcel.org/). The result of these partnerships will be a cohesive effort to improve the environmental education standards for Oklahoma students and to build a network of educators armed with the resources and knowledge to teach within the environmental education framework.

EarthStorm, an educational outreach program of the Oklahoma Climatological Survey (OCS) and a member of OKCEL, ties real-time weather data from the Oklahoma Mesonet (Oklahoma's statewide environmental observing network – http://www.mesonet.org – and environmental curriculum together into a cohesive learning experience. Many environmental issues are driven by weather events. For example, too much rain or too little rain destroys habitats. EarthStorm participants, from more than 200 Oklahoma schools, receive training and mentorship from scientists at the University of Oklahoma and Oklahoma State University. These classrooms monitor weather data daily.

Access to the Oklahoma Mesonet's real-time data facilitates a "real-world" laboratory, where students (parents and teachers) can make measurements, calculations, and graphs to better understand the weather. EarthStorm classrooms have integrated the data into their math and science curriculum, and have found it useful in building self-esteem, computer skills, and a sense of FUN in the classroom. JoAnn Ball from Comanche Public Schools, and a long time EarthStorm participant, says, "We now work in a laboratory without walls. Rural areas are at a disadvantage no longer."

To learn more about OCS's K-12 Outreach program, check out: **http://k12.ocs.ou.edu/**

The Dept. of Energy's Atmospheric Radiation Measurement Program and the Oklahoma Mesonet sponsor EarthStorm.

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SUMMER 2004 SUMMARY | By: Gary McManus

Oklahoma is famous for its chaotic weather. From tornadoes to blizzards, heat bursts to ice storms, sudden atmospheric changes have become a state staple. In defiance of Mother Nature's fickleness, however, one truth has remained constant: summers are hot in Oklahoma. Following the driest May in Oklahoma history, the state looked primed for yet another scorching summer season. It was with much delight, therefore, that Oklahomans were treated with the 4th coolest and 14th wettest summer since 1895. The uncharacteristically pleasant June-August period was the result of predominant northwesterly flow of upper-level air which ushered in numerous fronts and prolonged periods of showers and thunderstorms. Consequently, the increased thunderstorm activity resulted in an increase in severe weather. Fortunately, no tornadoes were reported during the summer months, with the primary severe weather threats being confined to large hail, high winds, and flooding rainfall.

Precipitation

Nearly the entire state finished with above normal rainfall, mainly due to significant precipitation surpluses in far western, central, and extreme eastern Oklahoma. Some of these areas were more than eight inches above normal for the June-August period. Averaged over an area, the south central portion of the state fared best at over five inches above normal, the 8th wettest summer on record for that region. West central, central, and east central sections were all well over four inches above normal for the same period. The Panhandle, in addition to north central and southwestern Oklahoma, only exceeded the established normals by between two and three inches, but those totals still ranked their summer precipitation amounts in the top one-quarter on record. The Oklahoma Mesonet site at Cookson topped the state's precipitation totals with over 22 inches of rainfall recorded for the three-month period.

Temperature

The true star of the summer season was the pleasantly cool weather which took root in Oklahoma throughout much of the season. Leading the way was south central Oklahoma at nearly four degrees below normal, the coolest summer on record for that region. All sections of the state averaged at least 2.5 degrees below normal, combining for a statewide-averaged temperature more than three degrees below normal. Every area of the state finished with an average summer temperature in the top-eight coolest on record. Triple-digit temperatures, while relatively scarce compared to a normal Oklahoma summer, still reared their ugly heads on occasion. The highest temperature of the summer, 105 degrees, occurred on August 3rd at Cherokee and again on June 14th at Hooker. The coolest temperature of 44 degrees was recorded by the Oklahoma Mesonet site at Kenton on June 11th.

Summer Daily Highlights

June 1-4: A weak cold front greeted the state on the 1st, and the accompanying dryline provided the month's first bout with severe weather along the Red River. More widespread severe weather came on the 2nd as unstable air advanced towards a stationary front in the north. The storms that formed and rolled south produced wind gusts of at least 80 mph in Beggs, Cushing, Glencoe, and Morrison. Wind gusts at 15 other locations reached 70 mph, and hail reports of at least two inches in size occurred in Garfield, LeFlore, and Texas counties. Rainfall amounts of close to three inches were reported in southern Oklahoma. The 3rd and 4th proved more calm, with lows in the 50s and 60s, partly cloudy skies, and highs in the 70s and 80s.

June 5-10: Another period of heavy rains and frequent severe weather. This tumultuous six day period was punctuated by a 4.17-inch rainfall total on the 7th at Pauls Valley as slow-moving thunderstorms dissipated and regenerated over the beleaguered town. Flash flooding was reported throughout that area. The rest of the period was similar, with storms forming over various frontal boundaries in other states before crossing into Oklahoma. The highs during this period were above normal for much of the state as warm, humid air from the south moved north.

June 11-14: Another period of relative calm, this period was marked by fewer organized areas of precipitation. High temperatures were above normal, with the state's highest recorded temperature for the month, 105 degrees, occurring on the 14th at Hooker. The 14th also was notable for being one of two days during June without measurable rain being recorded within the state, according to the Oklahoma Mesonet.

June 15-22: An extended period of soggy weather barraged the state during these eight days. Severe storms struck the Panhandle on the 15th, accompanied by severe winds and large hail. The severe weather on the 21st produced severe wind gusts of 80 mph in Mooreland, and a wind gust of 74 mph was recorded by the Mesonet site in Shawnee. The 22nd saw the active weather of this period diminish, but not before dumping more than two inches of rain across eastern Oklahoma.

June 23-26: The 23rd was the second and final day in which the state received no measurable rainfall within its borders. A cold front which entered the state before stalling generated showers and storms intermittently over the next three days. The moisture which fell aided fog formation on the 24th and 25th. Visibilities were reported as less than one-quarter of a mile in Ada and Durant on the 25th.

June 27-30: An upper-level disturbance set off additional slow-moving showers and thunderstorms, adding to the already burgeoning rainfall totals. Altus recorded the most rainfall during this period at over three inches, most of which fell on the 28th. Watonga also reported more than three inches of rainfall to bring the month to a close. The month's final day was fittingly wet, as scattered showers and thunderstorms covered almost the entire state. Some areas in and around Jefferson County reported over three inches of rain, with more general reports of two inches in the southern half of Oklahoma.

July 1-10: A flash flood watch covered much of central Oklahoma on the month's first day, as the ground remained saturated from rainfall during the previous month's final days. Amounts of well over one inch were reported across the southwest that day. Hail and high winds were the main severe weather threat in central and western Oklahoma through this period, with widespread flooding occurring in eastern portions of the state on the 2nd and 3rd. Bixby and Glenpool both reported numerous road closures due to flash flooding following heavy rain. Ten other locations in eastern Oklahoma reported flooding during those two days. Several reports of hail to the size of tennis balls were reported on the 5th in Garfield, Grant, and McClain Counties. The worst instance of severe weather occurred early in the morning in Kingfisher County. A squall line generated winds estimated up to 100 mph, overturning an oil derrick 13 miles west of Kingfisher. The collapse of the 120-foot derrick killed a 22-year old Ringwood man. Winds of over 80 mph were recorded by the Buffalo and May Ranch Mesonet sites in northwestern from that same complex of storms earlier in the night.

July 11-15: Conditions more typical of July returned on the 11th. Hot and muggy afternoons were accompanied by warm nights as a dome of high pressure moved over the state. Heat indices soared above 105 degrees as temperatures hovered near the triple-digit mark. Skies remained mostly clear through this five-day period.

July 16-18: A cool front approached from the north on the 16th, triggering a few light showers near the Kansas-Oklahoma border. The front pushed through the state during the day. Temperatures ahead of the front soared past the century mark, whereas behind the front temperatures were much more pleasant, remaining in the 80s. Thunderstorms formed each night in the southeastern Colorado and moved southeast into the Oklahoma Panhandle. Temperatures were generally in the 80s and low 90s across the state during this period. Bartlesville, McAlester, Muskogee, and Tulsa either tied or set records for low temperatures on the morning of the 18th.

July 19-21: Another tranquil interlude from the storminess, clear skies dominated this three-day interval. Highs in the upper-90s and low-100s were common, as another dome of high pressure settled over the state. A few storms formed near Kenton on the 21st, but rainfall amounts were light.

July 22-24: A cool front generated storms in the extreme northwest on the 22nd, before finally pushing through the state over the next two days. Severe storms were widespread in the north on the 23rd, with numerous reports of hail and high winds. Wind gusts of up to 75 mph were reported near Blackwell and Enid. High temperatures remained in the mid-70s behind the front, but rose above 100 degrees ahead of its passage. The storms reached central and southern Oklahoma early on the 24th as the front traveled slowly southward. The heaviest precipitation was reported in Payne County, where the Perkins Mesonet site recorded over an inch of rain. The storms later produced wind gusts above 60 mph near Lake Texoma.

July 25-31: The month finished as it began, with an extended period of cool weather. Fifteen records were set at National Weather Service observing stations for cooler-than-normal weather from the 25th-30th. Lows routinely dropped into the 50s in the north, and daytime highs at times failed to reach 70 degrees. Very pleasant conditions were in store for the state on the 30th. Lows were in the 50s and 60s, and highs were generally in the 80s under clear skies. A return to summer-like conditions ended the month as highs returned to the 90s, with heat indices again exceeding 100 degrees.

August 1-3: High pressure at the surface began the month with false portents of another hot August. Mostly sunny skies and southerly winds raised temperatures into triple-digits for this three-day stretch over much of the state. Heat indices jumped up close to 110 degrees, with low temperatures in the more-seasonable mid-70s.

August 4-8: The month's first cold air intrusion entered the state on the 4th, generating showers and thunderstorms. Northern areas received nearly an inch of rain, with lighter amounts elsewhere. Partly cloudy skies and temperatures up to 10 degrees cooler than the previous day greeted the state on the 5th. Boise City's high temperature was a fall-like 78 degrees on that day. The unseasonably cool weather continued for the next several days, as did the occasional bouts with showers and storms. The northern third of the state struggled to reach 80 degrees throughout this period, and lows were commonly in the 50s in this area.

August 9-11: This period was characterized by the most turbulent weather of the month. Showers and storms associated with a stalled front occurred each day, bringing strong winds, large hail, and flooding rainfall. Winds between 60-80 mph accompanied storms in northern Oklahoma on the 9th, and again across central Oklahoma on the 10th. The cold front made a final push through the state on the 11th, and the main severe weather threat shifted to flooding rainfall. Portions of central Oklahoma saw general amounts of three to five inches of rainfall, and flash flood warnings were issued for Midwest City, Oklahoma City, and Shawnee. The Oklahoma Mesonet site at Shawnee recorded nearly five inches of rainfall on the 11th for the state's heaviest rainfall event of the month.

August 12-18: The weather following the cold front passage could best be described as downright cold for August. Low temperatures dipped into the upper-40s in northern Oklahoma on the 12th and 13th, with highs struggling to reach 70 degrees. McAlester tied its record low temperature of 58 degrees on the 12th, as did Oklahoma City on the 14th, falling to 60 degrees. High temperatures in the 70s and 80s were common across the rest of the state throughout the entire seven-day period. The tranquil weather was interrupted on the 15th as showers and thunderstorms brought torrential rainfall to western sections of the state. Clinton received nearly four inches of rainfall, with other areas measuring from two to three inches. Oklahoma City broke its record for coolest high temperature on the 15th with 72 degrees, shattering the old mark of 77 degrees set in 1942.

August 19-22: The 19th and 20th were wet and cool as another cold front moved through the state. Nearly three inches fell at Durant on 19th, with one to three inches common in northern Oklahoma. Temperatures once again dipped into the 70s and 80s behind the front. Highs in the Panhandle on the 19th failed to reach 70 degrees. Skies were partly to mostly cloudy throughout this period and temperatures remained unseasonably cool.

August 23-27: Warm moist flow from the south returned, and temperatures once again flirted with summer-like conditions. Buffalo reached 99 degrees in northwestern Oklahoma on the 23rd, while winds were from the south at 10-20 mph, with gusts of over 30 mph. The clear skies during this period allowed temperatures to once again soar above 100 degrees. Heat indices in turn exceeded the 110-degree mark. Another approaching cold front on the 27th generated showers and storms across northwestern Oklahoma. Hail to the size of quarters with localized wind gusts of 60 mph were reported with the storms.

August 28-31: August's final days reflected the weather of the majority of the month: unseasonably cool and wet. Overcast skies on the 28th kept highs in the 70s and 80s. Storms generated by the cold front's passage dumped nearly two and a half inches of rainfall in Stephens County, while much of central Oklahoma had from a quarter to a half of an inch of rain. The 29th was nearly a perfect day. Fair skies, light winds, and highs in the lower 80s, nearly 10 degrees below normal, were common across the entire state. An upper-level disturbance on the 30th once again triggered showers and storms in the west. Close to four inches fell near Buffalo and Erick, and flash flood warnings were issued for those areas. The month ended under fair skies, light winds, and temperatures in the 80s and 90s.

Summer 2004 Statewide Extremes

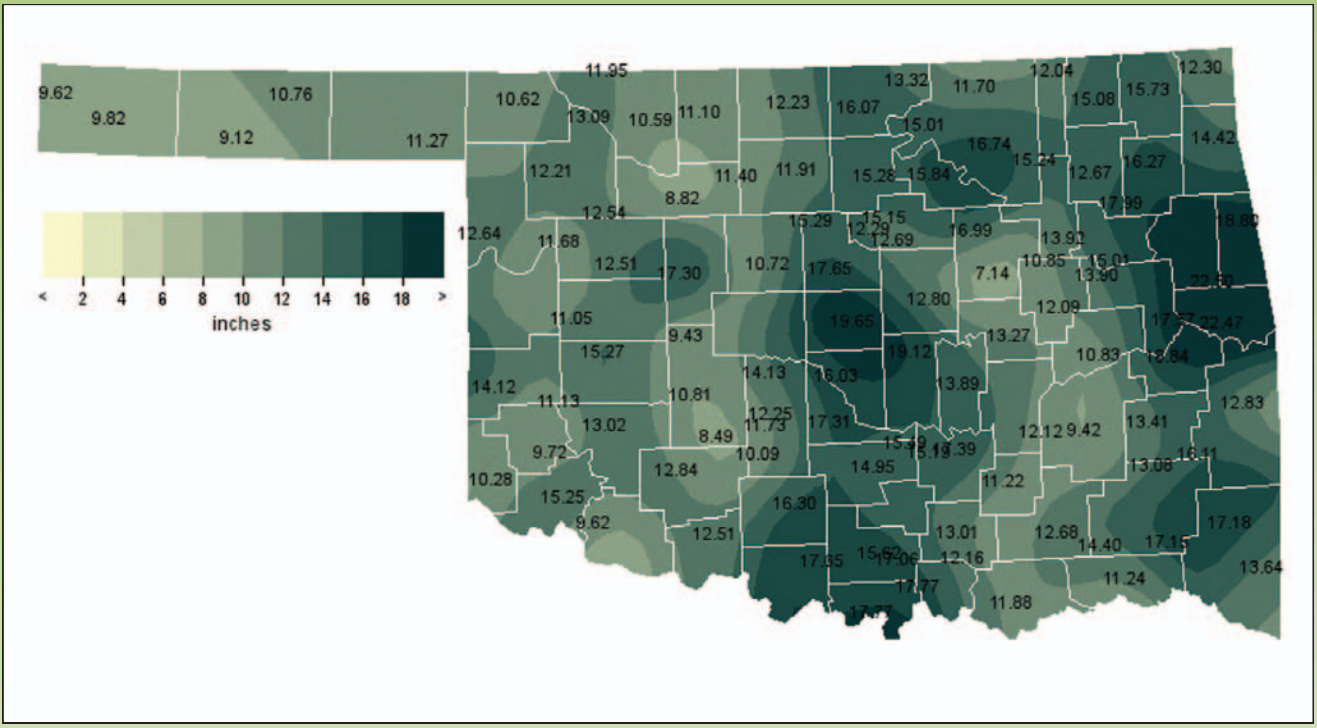
Description	Extreme	Station	Date
High Temperature	105ºF	Cherokee	August 3rd
Low Temperature	44ºF	Kenton	June 11th
High Precipitation	22.50 in.	Cookson	
Low Precipitation	7.14 in.	Bristow	

Summer 2004 Statewide Statistics

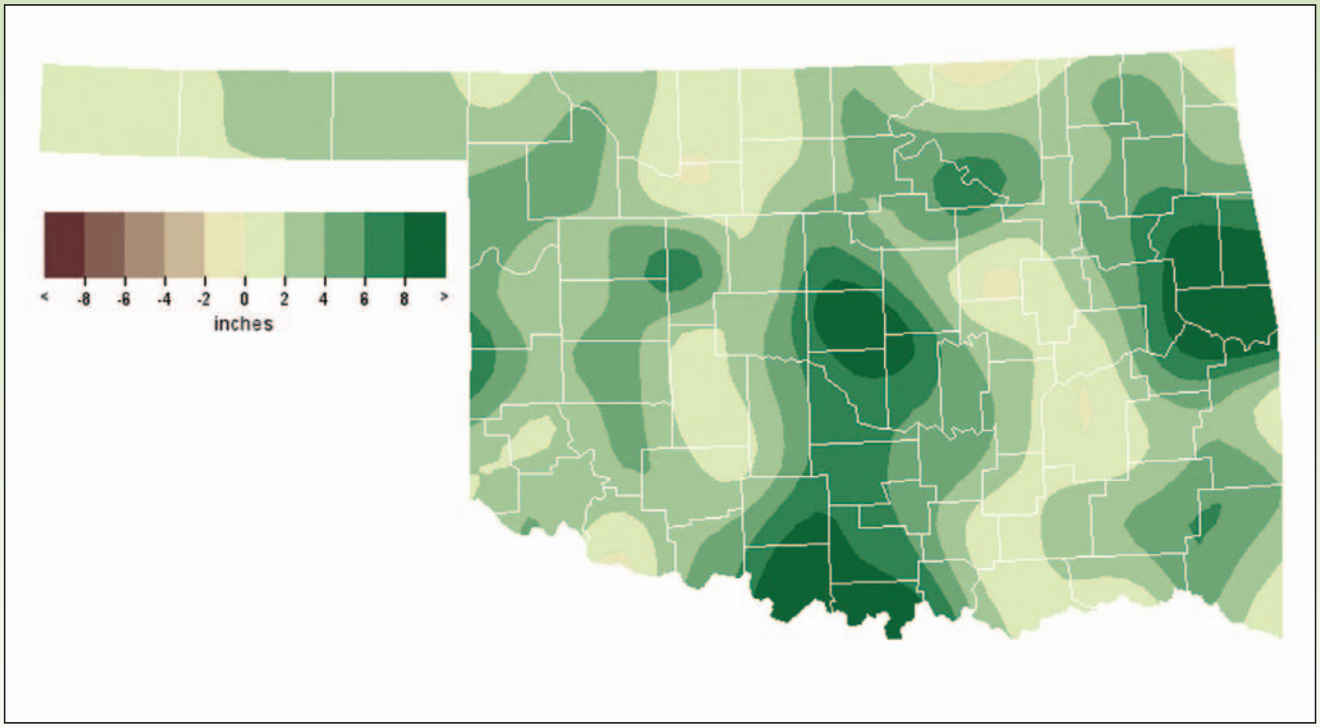
	Average	Depart.	Rank (1892-2004)
Temperature	76.2ºF	-3.4ºF	4th Coolest
	Total	**Depart.**	**Rank (1892-2004)**
Precipitation	13.47 in.	3.70 in.	14th Wettest

SUMMER 2004 SUMMARY

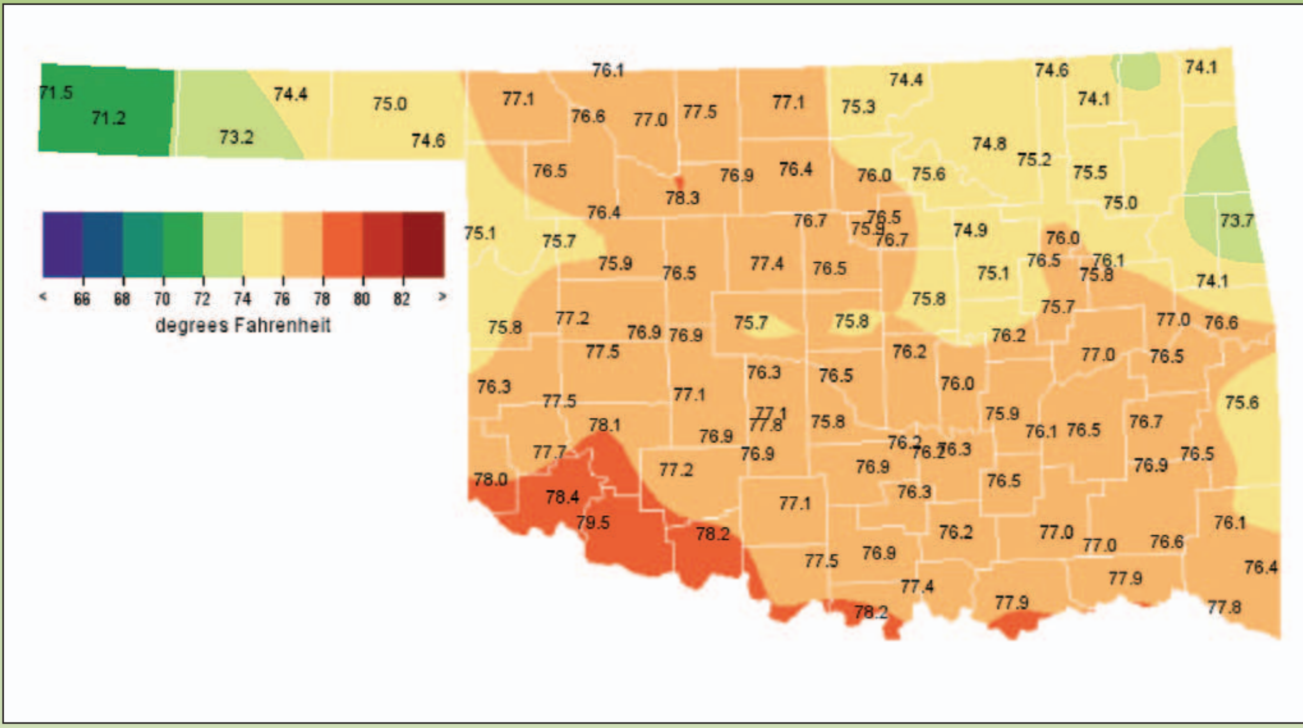
Observed Rainfall



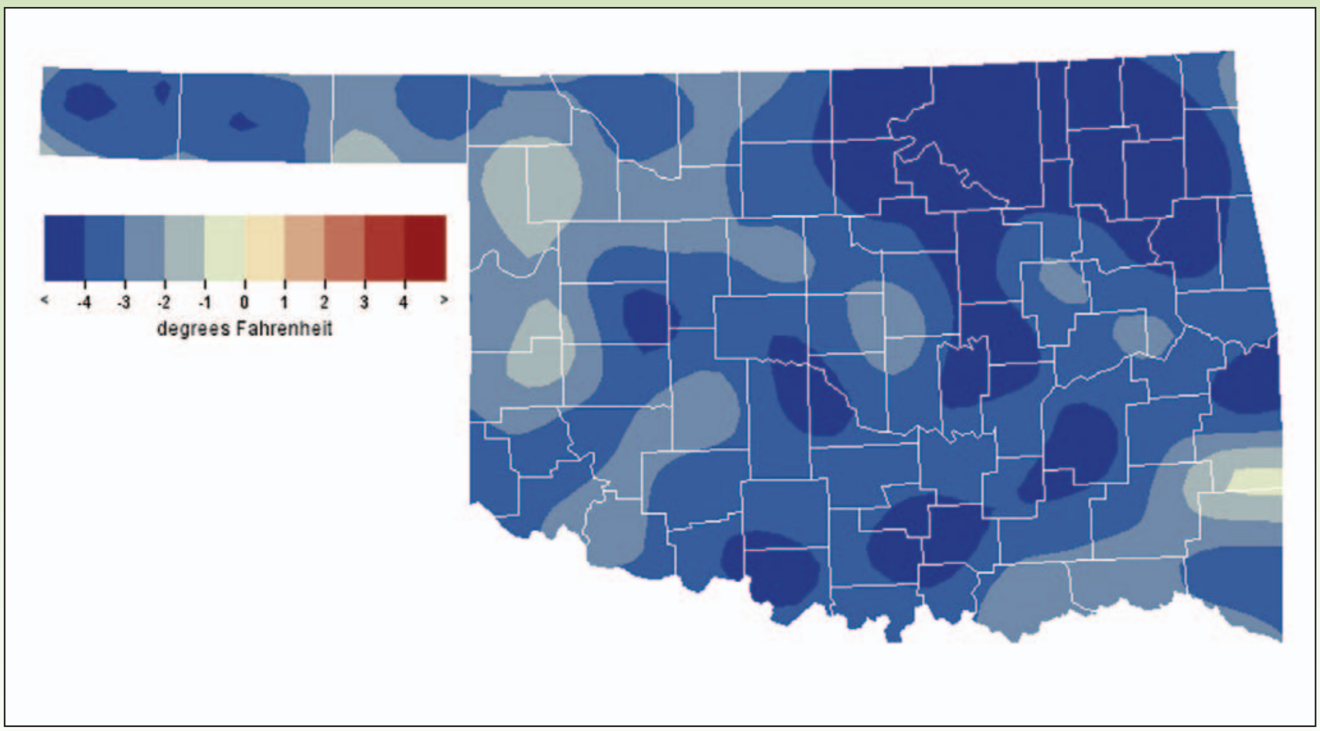
Rainfall Departure from Normal



Average Temperature



Temperature Departure from Normal



Summer 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	10.55	2.59	20th Wettest	17.32 (1950)	2.66 (1936)	11.43
North Central	12.35	2.38	23rd Wettest	16.95 (1995)	3.73 (1936)	8.96
Northeast	14.66	3.70	18th Wettest	23.78 (1948)	2.97 (1936)	14.07
West Central	13.29	4.58	10th Wettest	16.53 (1995)	2.79 (1980)	8.58
Central	14.12	4.35	16th Wettest	17.61 (1992)	1.97 (1936)	9.84
East Central	15.40	4.69	17th Wettest	20.53 (1958)	1.54 (1936)	10.46
Southwest	11.20	2.17	24th Wettest	16.22 (1996)	2.15 (1980)	11.17
South Central	15.08	5.36	8th Wettest	19.72 (1950)	2.58 (1980)	8.85
Southeast	14.34	3.35	25th Wettest	21.23 (1945)	3.50 (1934)	11.39
Statewide	13.47	3.70	14th Wettest	17.26 (1950)	2.79 (1936)	10.54

Summer 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	74.0	-3.3	7th Coolest	81.9 (1934)	71.5 (1915)	78.2
North Central	76.5	-3.4	6th Coolest	86.2 (1934)	74.3 (1915)	80.4
Northeast	75.1	-3.7	5th Coolest	85.4 (1934)	73.8 (1915)	79.2
West Central	76.6	-2.9	8th Coolest	85.4 (1934)	74.6 (1915)	80.0
Central	76.3	-3.7	5th Coolest	85.6 (1934)	75.0 (1915)	80.4
East Central	76.0	-3.4	4th Coolest	85.4 (1934)	75.0 (1915)	79.9
Southwest	77.8	-3.4	4th Coolest	86.0 (1980)	77.1 (1915)	81.2
South Central	76.9	-3.9	1st Coolest	86.2 (1934)	77.0 (1906)	80.7
Southeast	76.8	-2.5	7th Coolest	84.8 (1934)	75.9 (1992)	78.5
Statewide	76.2	-3.4	4th Coolest	85.2 (1934)	74.9 (1915)	79.9

Summer 2004 Mesonet Extremes

Climate Division	High Temp	Day	Station	Low Temp	Day	Station	High Monthly Rainfall	Station	High Daily Rainfall	Day	Station
Panhandle	105	Jun 14th	Hooker	44	Jun 11th	Kenton	12.64	Arnett	3.11	Jun 20th	Buffalo
North Central	105	Aug 3rd	Cherokee	51	Jul 26th	Seiling	16.07	Blackwell	3.81	Jun 20th	Freedom
Northeast	97	Jul 20th	Pawnee	48	Aug 13th	Miami	17.99	Inola	3.83	Jul 2nd	Bixby
West Central	104	Aug 4th	Retrop	50	Jul 26th	Camargo	17.30	Watonga	3.86	Aug 15th	Cheyenne
Central	102	Jul 15th	Chickasha	51	Aug 21st	El Reno	19.65	Spencer	4.59	Aug 11th	Shawnee
East Central	99	Aug 26th	Hectorville	49	Aug 13th	Cookson	22.50	Cookson	6.03	Jul 2nd	Webbers Falls
Southwest	103	Jul 16th	Altus	53	Aug 21st	Mangum	15.25	Altus	3.35	Jun 28th	Altus
South Central	100	Jul 16th	Waurika	53	Aug 12th	Centrahoma	17.77	Burneyville	4.17	Jun 7th	Pauls Valley
Southeast	98	Jul 14th	Wilburton	49	Aug 13th	Wister	17.18	Mt Herman	2.95	Jun 16th	Mt Herman
Statewide	105	Aug 3rd	Cherokee	44	Jun 11th	Kenton	22.50	Cookson	6.03	Jul 2nd	Webbers Falls

Agriculture Weather Watch

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

This year has generally been a good year for agriculture in Oklahoma. Most producers experienced mild weather, good prices, and above average production. With this triple "hat trick" in 2004, what will be the likelihood of a repeat next year?

If the Oklahoma past is any indication, the most likely scenario is a time of less ideal weather, lower prices, and less production in 2005. That makes 2004 a year to set aside some plenty for leaner times. That may be a portion of a crop sold later, more money moved to investments, or a little more money tucked away in the bank.

An indication of leaner times can already be seen in the soil moisture maps on the AgWeather website (www.agweather.mesonet.org). On September 15, the state map of 2-inch Fractional Water Indexes showed only two small slightly green areas and lots of dark brown locations. The dark brown indicates areas with a fractional water index of less than 0.2. The 10-inch fractional water index was only slightly better with the majority of Oklahoma locations reporting less than 0.4. Even the deeper soil moisture levels are on the dry side for most of central, western, and far northeast Oklahoma.

The fractional water index scale is a 0.0 to 1.0 scale. With 1.0 indicating a saturated soil and 0.0 a powder-dry soil. Below is a fractional index chart and generalized plant responses, when soils remain at this level for long periods of time.

1.0 = saturated soil
0.8-1.0 = Optimum water for plant growth
0.5-0.8 = Limited plant growth
0.3-0.5 = Plant wilting
0.1-0.3 = Plant death
<0.1 = Barren

Dry soils mean we need some rain soon in Oklahoma. August and early September have been times with little rain for most Mesonet tower locations. While the summer was mild with lots of rain in June and July, growing crops have taken up most of the early season accumulated soil moisture within the top three feet of the soil surface.

Wheat sown in early September has jumped out of the ground in many fields. While this may lead to early pasture, the emerged wheat will require moisture soon to meet early grazing expectations. It also runs a higher risk of insect attack this fall and winter, then root rot next spring.

From times of plenty to times of want, that is the life of Oklahoma crop and livestock producers. At least in Oklahoma, agricultural producers don't have to add hurricanes to their list of concerns.

Urban Farmer

September

- Apply a fall lawn pre emergent for winter annual weed control. Popular products include Princep, Barricade, Balan, Surflan or Team.
- 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.
- Plant pansies. Plants will generate new blooms during the fall and winter, whenever temperatures go above 40ºF.
- Divide spring-flowering perennials.
- In the garden, plant garlic, radish, rutabaga, spinach, Swiss chard, radish, and turnip.
- Plant Austrian winter peas, vetch, wheat or rye for a winter cover crop in garden beds.
- Seed tall fescue for new shady lawn areas or to thicken existing stands.

October

- Plant deciduous trees and shrubs.
- Plant most bulbs, except tulips.
- Determine the nutrients in your soil with a soil test. Contact your local OSU Cooperative Extension Service Office for sample bags, pricing and office hours.

November

- Plant tulips after 4-inch average soil temperatures drop below 55ºF.
- Fertilize tall fescue in early November. Use a quick release fertilizer at a rate of 1 pound of nitrogen per 1,000 square feet.
- Rake leaves, clean up flower beds, and build a compost pile.
- Prune trees after the majority of a trees leaves have turned color or dropped to the ground. This is also a good time to dig and transplant yard trees that need to be moved.

Why Does A Leaf Change Its Stripes?

By Albert Sutherland

It is easy to think of forests as timeless, constant environments of greenery. Yet annually each fall, deciduous trees remind us that they are part of a great cycle. They drop their summer greenery and take on exquisite hues of red, orange, yellow, purple, and brown. How does all of this color suddenly appear from leaves that have been green all summer? Why are there years of intense color and years when the color show is so drab?

Throughout the summer, tree leaves are green from the high levels of chlorophyll. This critical plant pigment captures sunlight to begin the process of plant energy production. The light captured by the chlorophyll is used to change water and carbon dioxide into carbohydrates. These sugars are used by the tree as energy for plant growth. Although individual chlorophyll molecules are short lived, trees make lots of replacement chlorophyll molecules from April through September. All this chlorophyll keeps the leaves green throughout the growing season.

As October arrives with shorter days and longer nights, production of replacement chlorophyll drops off. As the chlorophyll production declines, anthocyanin pigment kicks into gear.

Anthocyanin pigments can be red or purple in color. In leaves with a more acidic pH (low pH), the anthocyanin is red. When the leaves are more alkaline (high pH), the anthocyanins are purple to blue in color. By mid to late October, the chlorophyll is gone and other pigments color each leaf.

Along with anthocyanin, there are two other pigment groups that play a vital part in leaf color: the carotenoids and tannins. Carotenoid and tannin pigments are in the leaf all growing season, but are not evident due to the high levels of green chlorophyll present through the summer. In the fall, we finally get to see these overshadowed pigments. Carotenoid pigments create the yellow and orange colors we see in leaves. Tannins are responsible for the brown hues.

Through varying concentrations of anthocyanins, carotenoids and tannins leaves take on various shades of red, red-orange, orange, yellow, gold, bronze and brown. Most tree species are known by a typical fall color. Shumard oak leaves are typically bright red from high anthocyanin, while blackjack oaks turn brown from high tannin levels. Maples are best known for their brilliant scarlet, red hues, and orange-red, due to high anthocyanin. Gingko, sycamore, cottonwood, aspen, and birch provide bursts of yellow due to high carotenoid and almost no anthocyanin.

Not only are there species differences, but trees within a species vary in the quantities of color pigments. Some landscape trees, like Chinese Pistache, can range in fall color from bright yellow to red-orange or red-purple. This makes it a little more challenging to pick out a landscape tree with the “perfect fall color.” One way around this dilemma is to select and plant your deciduous landscape trees in the fall. While the intensity of color can vary from year to year, the leaf color is consistent for each tree. So you can select a tree in the fall and know you’ll have that same fall color each year in your landscape. Fall is also one of the best times to plant deciduous trees.

Another way to get consistent fall color is to select a named variety tree. These trees are propagated by grafting, so that each tree is genetically identical. ‘Autumn Flame’ and ‘Red Sunset’ are two red maples widely known for consistent bright red color.

Trees that color primarily from carotenoids or tannins have more consistent color from year to year. This is because the pigments are already present in the leaf.

Leaf color from anthocyanin varies in intensity with changes in the weather. Bright sunny days followed by cool, but not freezing nights are ideal for anthocyanin production. Nights with air temperatures below 45°F and above 33°F are best. Cool nights prevent sugar transport out of the leaves, thus increasing leaf anthocyanin production. On warm nights, sugar transport out of the leaves is high, so little sugar is available that can be made into anthocyanins. A prolonged fall warm spell inhibits anthocyanin production and greatly reduces color intensity. Cloudy or rainy weather in October will also lead to poor color.

One of the weather myths is that frosty weather makes fall color better. Frosts actually reduce leaf coloring and an early freeze will eliminate fall color. Once leaf tissue freezes, it quickly dries up and falls from the tree.

Soil moisture also plays a role in leaf coloring. Dryer soils in the fall increases anthocyanin production, leading to brighter fall color. So dryer soils are better for fall color, but not severely dry soils. When a severe drought sets in, trees may respond by prematurely dropping their leaves.

The most intense fall color comes from a combination of a warm wet spring, mild summer, and warm sunny fall days, followed by cool nights.

Traveling along the Talimena Drive in the Ouachita National Forest is one of the best ways to view fall's colorful forest spectacle. Talimena Drive is Highway 1 that goes east out of Talihina, Oklahoma. Leaves along this route typically start turning color around the middle of October with a color peak in the last week of October and the first week of November.

Some fall foliage locations in south central Oklahoma include the Chickasaw National Recreation area, near Sulphur, and Highway 77 around Lake Murray, just southeast of Ardmore. Both of these locations are at their peak viewing in mid to late October.

One of the earliest fall displays occurs at Red Rock Canyon State Park, near Hinton, Oklahoma. The peak color typically occurs in mid October. The canyons in this area are home to the 'Caddo' sugar maple with brilliant red fall color.

If you want to go on a longer excursion, State Highway 10 from Miami to Tahlequah and State Highway 82 to Gore offer 133 miles of scenic beauty. The peak fall foliage occurs between late October and mid November. Five different state parks along the way provide plenty of wonderful places to enjoy a picnic or camp overnight.

INTERPRETATION ARTICLE

The previous article entitled "How Does a Tree Change Its Stripes?" explained how leaves change their color. Weather conditions play a vital role in the range of autumn colors displayed. Too much wind causes the leaves to fall off early. Too much rain produces diseases which attack the leaves. Once trees are left with a large number of healthy leaves, the two determining factors in the color are temperature and sunlight.

Temperature Impacts

For bright red leaves, temperatures should be warm during the day and cool at night. Freezing temperatures are bad news for leaf-watchers. Trees will drop their leaves quickly once they experience freezing temperatures.

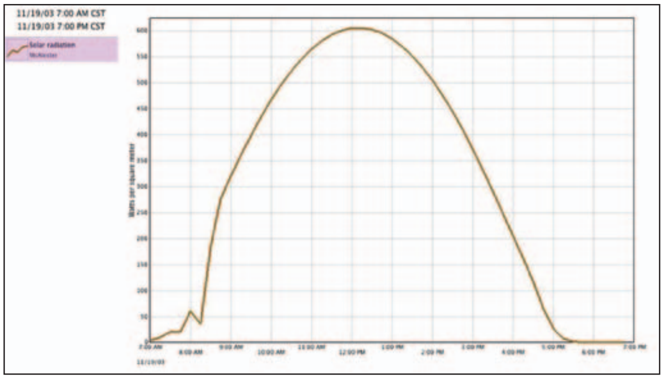
Sun Impacts

Clear skies are extremely important for colorful autumn leaves. Clear daytime skies allow the sun to heat the earth's surface, which increases the air temperature. Clear nighttime skies allow the earth's surface to cool rapidly. Several days or weeks with these conditions produce red, purple, and crimson colors that join the normal yellows, golds, and oranges.

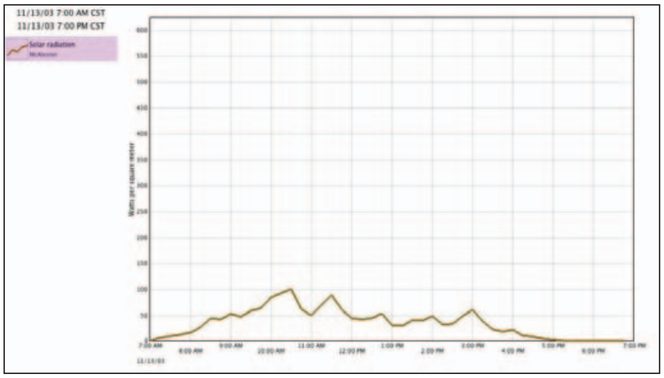
Solar Radiation (SRAD)

The Oklahoma Mesonet is a useful tool to help you anticipate when the leaves will begin turning colors and when to expect the leaves to begin falling. Solar radiation is a measurement of the amount of sun energy absorbed by the earth's surface. For a given time of the year, clear skies will produce relatively high solar radiation values as compared to cloudy skies. Comparing typical autumn solar radiation values with visible satellite images can help you determine which solar radiation values are produced when clouds are present in the atmosphere.

A graph of solar radiation is a quick way to determine cloud cover. The smooth curve of Graph 1 depicts a clear day. The jagged line of Graph 2 shows how much less solar radiation is collected when clouds move over the instrument.



Graph 1



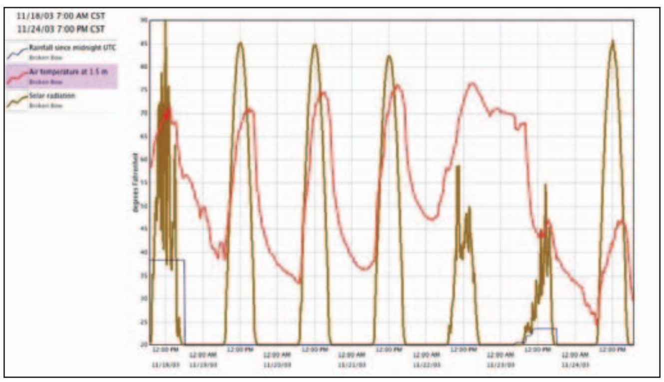
Graph 2

Classroom Activity

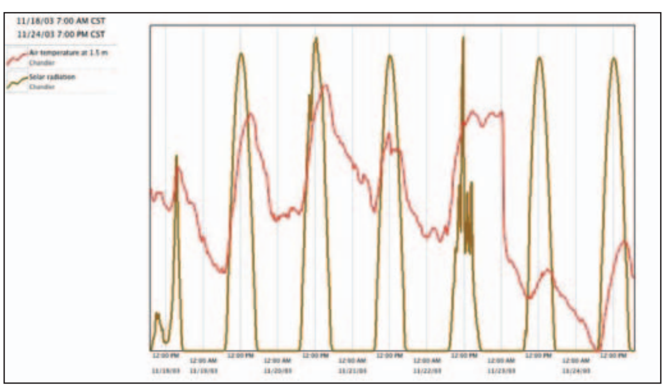
Oklahoma is often referred to as a transition zone. The wide range of temperature and precipitation values result in a diverse range of plant species. Eastern Oklahoma is much like the eastern U.S. with a large variety of trees and other plants requiring a modest amount of rainfall. As you travel to western Oklahoma, you encounter fewer trees and more grasses.

In this activity, we will look back on the autumn of 2003 at two Mesonet sites: Broken Bow and Chandler. Broken Bow is located in far southeast Oklahoma in a highly forested area. Chandler is in east central Oklahoma on the edge of the Cross-Timbers region, where the trees begin to thin.

On the graphs below, the brown line is solar radiation and the red line is temperature. The graphs begin on November 18th at 7 am and end on November 24th at 7 pm. Graph A is from Broken Bow and Graph B is Chandler.



Graph A *– Solar radiation, rainfall, and temperature from Broken Bow*



Graph B *– Solar radiation and Temperature from Chandler*

1. How many clear days did Broken Bow have? Chandler?

2. What percent of clear days did Broken Bow have? Chandler?

3. What percent of cloudy days did Broken Bow have? Chandler?

4. What was the temperature range at Broken Bow for the period of the graph? For Chandler?

5. Which site received the most total solar radiation for the week? Explain why you chose this site.

6. Which site do you believe had the widest range of autumn leaf colors? Explain why you chose this site.

7. Did anything happen during the week that might have interfered with the leaf colors? What happened? Did this occur at both sites?

8. Which impacts leaf color the most: the number of clear autumn days, the range of daily temperatures, or reaching a specific temperature over night? Test your theory by collecting data this fall.

FALL 2004 in ___________________________ (your home town)

Pick a tree in your backyard or on the school playground and record your observations below:

a) Date leaves begin to turn
b) Date of first freeze
c) Date leaves begin to fall
d) Date last leaf falls

Submit your data to andrea@mesonet.org . Results will be posted at http://k12.ocs.ou.edu/

Lightning Safety...

In the United States, an average of 67 people are killed each year by lightning. Over the last 30 years, lighting has been more deadly than tornadoes or hurricanes. Oklahoma ranks 14th in the nation in lightning deaths from 1959-2003. The majority of deaths in the state are a result of victims not taking cover during a thunderstorm.

Lightning Safety Tips:

Keep a watchful eye on the sky. Look for darkening skies; don't wait for rain or thunder to begin to take action. Lightning can occur many miles ahead of a thunderstorm core.

Postpone activities promptly. Do not wait for rain, thunder or lightning. Move quickly into an enclosed building, not an open structure like a carport or a patio. Take cover in a hard-topped vehicle if a building is not nearby.

If no shelter is available, DO NOT take shelter near trees. It is safer to crouch down in the open, away from trees.

Get out of the water. Water is a very good conductor of electricity. Stay out of small boats and stay off the beach. If caught in a boat, crouch down in the middle and stay away from metal objects. Remember, lightning tends to strike the tallest object. If one is out on the water in a boat, they are the tallest objects!

Organizers and Coaches are encouraged to listen to NOAA weather radio for a tone-alert feature during events or games.

The 30/30 Rule:

The 30/30 rule is a guide that coaches and outdoor event organizers should employ to keep safe in a thunderstorm.

The first "30" refers to 30 seconds. If the time between a flash of lightning and it's corresponding clap of thunder is less than 30 seconds, then lightning could potentially strike the area.

The second "30" refers to 30 minutes. After the last lightning flash, wait 30 minutes before leaving shelter and resuming outdoor a activities.

Photo courtesy of Mark Shafer.

National Weather Service:
www.lightningsafety.noaa.gov
http://www.lightningsafety.noaa.gov/resources/LightningFactsSheet.pdf

Federal Emergency Management Association (FEMA)
http://www.fema.gov/hazards/thunderstorms/thunderf.shtm

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