FALL 2008

OKLAHOMA CLIMATE

OCTOBER SURPRISE: 1983

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Oklahoma Climate
Fall 2008

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MESSAGE FROM THE EDITOR

Gary McManus

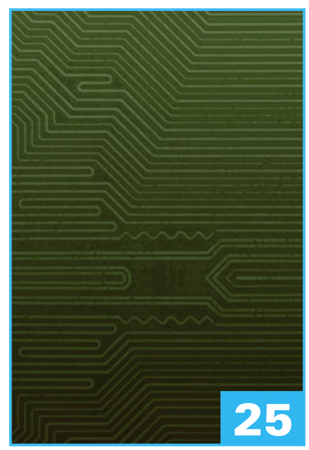
Oklahoma has had a few unfortunate run-ins with tropical systems in 2008. Gustav came first and rained on eastern Oklahoma's parade. Later Lowell moved over the west from the Pacific just as Ike moved over the east from the Atlantic. This is after last year's unwelcome visit from tropical storm Erin, which had the temerity to treat our state like the Gulf of Mexico and actually strengthen on its way through Oklahoma to the northeast. The last thing Oklahoma needs is a new hazard to worry about – aren't tornadoes and the like enough? Well, these types of visits are nothing new. We've had brushes with these tropical in-laws since before we became a state; the great Galveston storm of 1900 gave pre-statehood Oklahomans a miserably wet time. Our historical article "celebrates" one such storm on its 25th anniversary as we remember Hurricane Tico's flooding back in the fall of 1983. Tico represents what a declining tropical system can do when it interacts with one of our normal fall cold fronts. The results can be as devastating as they are soggy.

Oklahoma City residents will now know more about the weather across their fair city than ever before with the implementation of the Oklahoma City Micronet, featured in this issue. Meteorologists will also benefit from this new source of data as they study weather patterns over an area as small as a city; a keen insight into urban meteorology, courtesy of the fine folks at the Oklahoma Mesonet. Another feature article details a new measurement scale for the severity of ice storms. This ice storm-Fujita Scale, known as the Sperry-Piltz Utility Ice Damage Index uses a combination of ice accumulations and wind speeds to determine what effects can be expected from ice storms. The Oklahoma Mesonet is one of the world's most acclaimed weather observing networks, and the meteorologists that ensure the quality of that data every hour of every day deserve a good amount of the credit for that praise. Our third feature article details how this quality assurance system works, from the automated system of our computers down to where the human-element takes over.

Our classroom exercise helps students understand the difference between a frost and a freeze, just in time for winter. In addition, be sure to read our regular features, including: an interview with a distinguished Oklahoma scientist, an agricultural weather summary, the Urban Farmer, a weather safety article, and a climate summary of the summer months

I sincerely hope you enjoy this issue of "Oklahoma Climate." If you have any questions or comments, please feel free to contact me at gmcmanus@mesonet.org.

Gary McManus – Editor



OKLAHOMA CLIMATOLOGICAL SURVEY

OCTOBER SURPRISE: 1983

by Deke Arndt Associate State Climatologist

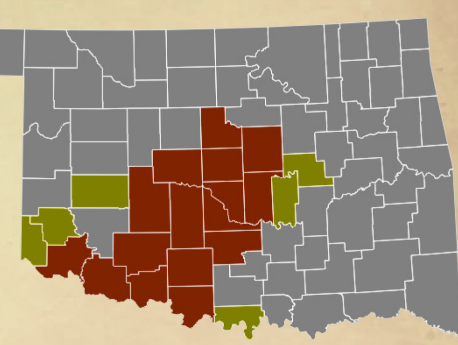
In early October 2008, Hurricane Norbert formed in the warm waters of the eastern Pacific, strengthened to Category 4 on the Saffir-Simpson Scale, meandered northward along the Mexican coast before making landfall near the tip of Baja California. And that was enough to cause Silver Anniversary jitters in much of Oklahoma. How so? Twenty-five years ago this fall, Hurricane Tico lived roughly the same life as Norbert up to and including landfall, but went on to produce colossal flooding throughout much of central Oklahoma.

The 1983 Pacific Hurricane season was extremely active, fueled by El-Nino-related warm waters in the eastern tropical Pacific Ocean. Tico was the nineteenth of 21 named storms to form in the Eastern Pacific that year, a record at the time. Twelve of these would grow to into hurricanes, with a jaw-dropping eight reaching "major hurricane" status (Category 3 or stronger). Even before causing havoc in Oklahoma, Tico was one of the strongest storms of the season, and certainly the most destructive and deadliest storm.

Tico's October 19th landfall on the western Mexican coast caused fatalities in the double-digits, but its destructive power did not vanish with its winds. The giant mass of moisture that it contained streamed northeastward into Texas, Oklahoma and Kansas, and encountered a stalled front. The combination of deep, tropical moisture with the focusing mechanism of a frontal boundary almost always spells disaster, and October 1983 was no exception to this rule: the resulting week of heavy rains across the south-central United States was inevitable. A swath of October rains stretched from Lubbock, Texas, across Oklahoma and far into the Ohio River Valley.

However, the most extreme rains were reserved for Oklahoma. A stripe of rainfall totals exceeding half a foot stretched from extreme northwest Texas to Tulsa, with a giant footprint of ten-plus-inch rains falling from Altus to Shawnee. Chickasha was Ground Zero for the event, collecting an eye-popping and gauge-filling 16.95 inches of rain in little more than two days. Oklahoma City's 24-hour rainfall total of 8.95" is still a record, a quarter-century later. As if to add a bizarre exclamation point to the whole episode, Tico threw in an F2 tornado near Elgin.

Predictably, creeks in the region could not handle the load, and quickly spilled out of their banks into neighboring communities. Flash-flooding was widespread and severe. As far as flash-floods go, Cottonwood Creek near Guthrie is one of the state's "usual suspects". Tico's rains provided its all-time high crest of 29.6 feet. This is 9.6 feet above flood stage. Much of low-lying Guthrie was inundated, resulting in one fatality, two million dollars in damages, and the evacuation of 1800 families. The Cache Creek system, another of Oklahoma's "repeat offenders", flooded parts of Apache, Cache, Lawton and Walters. Stories of harrowing threats and narrow escapes flowed throughout the state, including a woman in Washington who clung to her car's antenna for an entire night before an early morning rescue from an angry Walnut Creek.



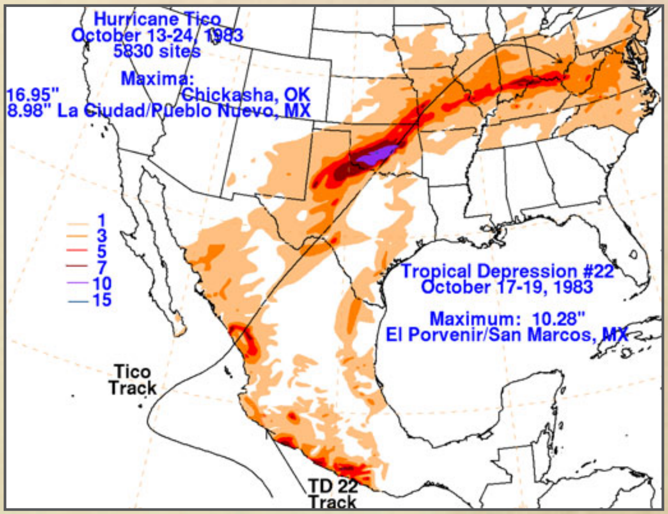
Highlighted are the counties that were affected by Hurricane Tico.

A half-mile of Santa Fe Railroad track was lost near Purcell. In Altus, it was even worse: a train derailed when the roadbed gave way, weakened by floodwaters of the Salt Fork of the Red River. Three cars were completely derailed, and dozens of others were buckled on the tracks. Cars were stranded in a foot of water on U.S. Highway 62, and a town official claimed that "the whole town is under water".

The event cased nearly $100 million in damages in Oklahoma. Most of this ($77M) was due to direct agricultural losses. Damage to private property added $6.5M to Tico's costs, and public damages totaled $10.2M. In the event's aftermath, President Reagan declared sixteen counties federal disaster areas.

As bad as the situation was, it could have been a lot worse. Notably, very little major river flooding was reported, despite record streamflow on the lower Washita. In the months leading up to Tico, most of the state became mired in drought conditions. This had effectively lowered lake and streamflow levels, which allowed room for the larger stream and reservoir systems to accommodate the October rainfall. This combination of natural dryness and human management help limit flooding to local eruptions of creeks and minor rivers.

Tico was one of a string of 1980s flooding events caused by Pacific tropical storms. Norma (1981) was responsible for higher rainfall totals in a much smaller footprint in south-central Oklahoma, while Paine (1986) left flooding in north-central parts of the state.



Location	Waterway	Notes
Altus	Salt Fork of Red	Flooding pervasive throughout Jackson County
Apache	East Cache Creek	Extremely flashy; 80 homes flooded
Cache	West Cache Creek	About a dozen families evacuated
Chandler	Bell Cow Creek	Problems reported on west site of Chandler
Chickasha	Line Creek	40 evacuated from the Chickasha Hotel
Dale	Deer Creek	Major flash flooding in town
Guthrie	Cottonwood Creek	29.6 feet stage was all-time record at location
Lawton	East Cache, Wolf Creeks	Roads closed throughout Comanche County
Lexington	Chouteau Creek	Widespread lowland flooding in Lexington area
Lindsay	Washita	60 blocks flooded by combined waters of Washita and Little Washita.
Midwest City	Crutcho, Soldier Creeks	Northern parts of city flooded
Ninnekah	Little Washita	Town “completely surrounded” by floodwaters
Norman	Brookhaven Creek	Residential west-side flooding
Purcell	Walnut Creek	Six large mobile homes washed away
Shawnee	North Canadian	Agricultural flooding
Walters	East Cache Creek	Two blocks flooded on northern side
Washington	Walnut Creek	At least two water rescues
Wellston	Deep Fork of Canadian	Low-lying Lincoln County areas inundated

Selected flooding impacts, by locality. Multiple sources, including the National Weather Service’s Storm Data, and newspaper accounts.

The Oklahoma City Micronet Project

by **Dr. Jeffrey B. Basara** Oklahoma Mesonet Director of Research

The Oklahoma City Micronet (OKCNET) is a dense network of automated weather stations designed to improve atmospheric monitoring across the Oklahoma City metropolitan area. The project included the deployment of three new Oklahoma Mesonet sites within Oklahoma City and the installation of sites mounted on traffic signals. As of 1 June 2008 all stations have been deployed and the network commissioning date is 1 November 2008.

Phase 1: Oklahoma City Mesonet Stations. As part of a joint effort between the OKCNET project and the Oklahoma Mesonet, three new Mesonet sites were installed within Oklahoma City in early 2007 (Fig. 1). The first site (OKCN) was installed in February 2007 on the campus of the Daily Oklahoman approximately 7 miles north of the central business district. In April 2007, two additional sites were deployed including one on the campus of Oklahoma State University in Oklahoma City approximately 4 miles west of the central business district (OKCW) and one approximately 4 miles east of the central business district (OKCE) on Oklahoma City municipal property.

More information regarding the specifics of the new Mesonet sites deployed in Oklahoma City can be found at:

http://www.mesonet.org/sites/

Phase 2: Traffic Signal Stations. The design, testing, and deployment of stations mounted on traffic signals would not be possible nor successful without the extensive assistance and collaboration provided by Oklahoma City officials. Oklahoma City boasts the world's largest wifi mesh network in the world, and with the assistance of Oklahoma City personnel, the traffic signal sites were designed to utilize the network of wireless access points across the metropolitan area. Each traffic light station consists of a Vaisala WXT510 sensor, a Campbell Scientific CR200 datalogger, an enclosure specifically designed for the traffic signals, and hardware to facilitate power and communications across the wifi network.

In December 2007, a working prototype station was completed and installed at the intersection of Main St. and Walker Dr. in the central business district of Oklahoma City. A series of tests were completed and all subsequent approvals were acquired from Oklahoma City officials by mid January 2008. Given final approval from Oklahoma City, all remaining components for the traffic signal stations were fabricated during the spring of 2008.

On May 8, 2008, installation of the remaining 35 traffic signal stations began in the central business district of Oklahoma City and, by May 30, all sites had been deployed across the metropolitan area (Fig. 1). The deployment of the traffic signal stations was accomplished via a truck rental agreement whereby a trained Oklahoma City technician operated the lift as a Micronet technician installed each station (Fig. 2a). During the installation procedure, a safety line was attached as the site was lifted into place. Next, each site was secured to the pole via stainless steel straps and the station linked to an Oklahoma City wireless access point via an ethernet cable (Fig. 2b). The link to the access point established both communications and the power needed to operate the station. Once secured and connected, the technician verified communications with Oklahoma Mesonet personnel and panoramic site photos were collected. The deployment of each station spanned approximately one hour, which allowed for multiple stations to be deployed in a single day.

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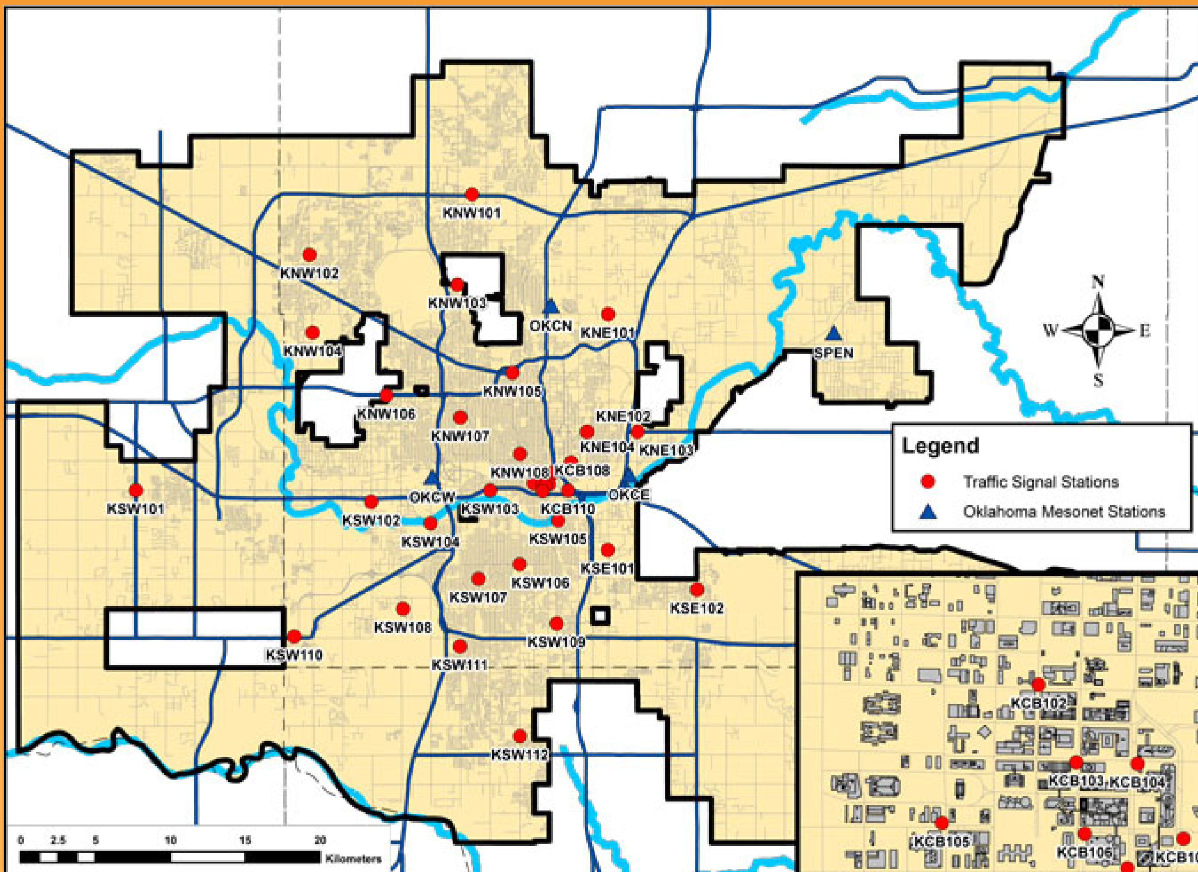
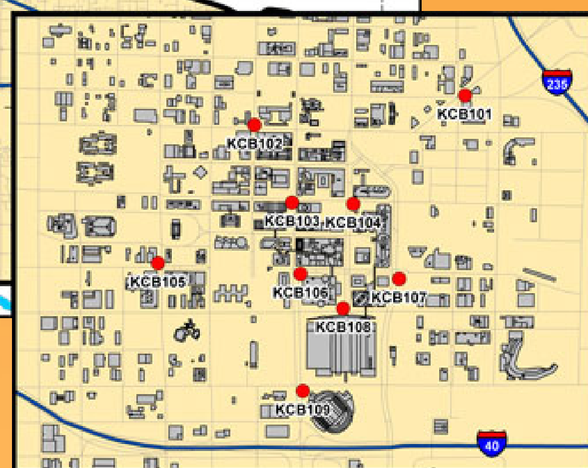




The Oklahoma City Micronet

Figure 1. Locations of Oklahoma City Micronet stations. The window in the lower right corner of the graphic shows the locations of traffic signal stations within the central business district of Oklahoma City with respect to the primary building structures and streets.

Figure 2a. A Micronet technician deploys the KCB104 traffic light station on 8 May 2008.

The spatial and temporal density of observations collected by the Oklahoma City Micronet has already shed new insights regarding atmospheric processes across the metropolitan area. For example, because the Micronet spans the gradient from quasi-rural to urban land use conditions, the Micronet has consistently detected an urban heat island with magnitudes as great as 11oF and associated gradient of air temperature due to the varying surface conditions. However, the air temperature gradient (and associated maximum/minimum values) is often impacted by the magnitude and direction of the near-surface wind conditions whereby locations downstream of the urban core were warmer than locations upstream of the central business district of Oklahoma City.

Figure 2b. An Oklahoma Micronet traffic signal station and a wifi node in Oklahoma City.

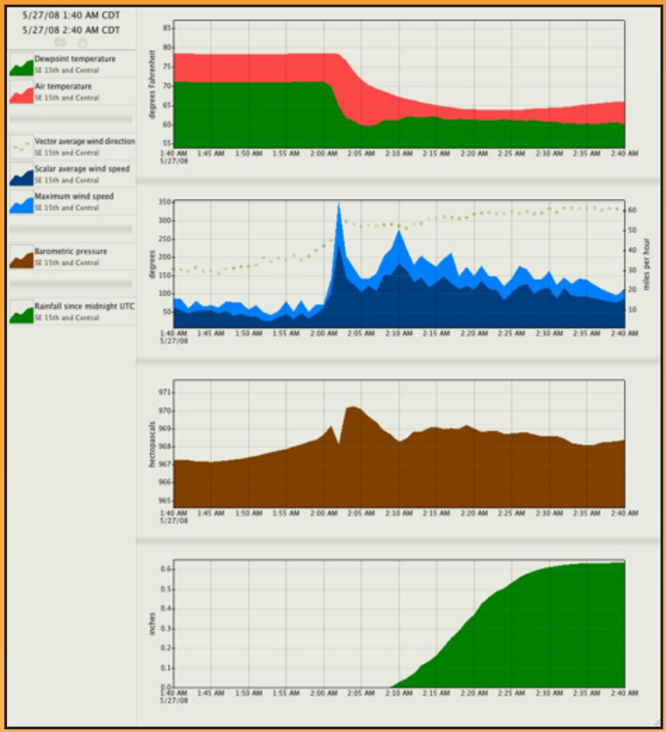


Figure 3. Time series observations from KSW105 at 2:02 am CDT on 31 May 2008. The KSW105 site is located approximately 1.2 miles southeast of the Oklahoma City central business district.

The network has also captured the impacts of severe weather across Oklahoma City. On 27 May 2008, a severe thunderstorm complex with a bow echo propagated through the metropolitan area during the early morning hours. Severe winds were observed along the leading edge of the gust front in advance of the heavy precipitation including a gust to 65 mph at the Micronet site located at SE 15th St. and Central Blvd. The time series data (Fig. 3) also confirm that the strongest winds were observed approximately six minutes prior to the onset of precipitation and approximately two minutes prior to the decrease in air temperature that occurred during the event. Further, there was a slight decrease in station pressure as the gust front passed followed by a rapid increase over the following two minutes.

With an average station spacing of about two miles, the Oklahoma City Micronet observes atmospheric conditions at a fine spatial resolution. Additionally, a key component of OKCNET is rapid data collection of research quality observations. At each traffic signal site, atmospheric conditions are measured and transmitted every minute to a central facility. Similarly, the observations at the Oklahoma City Mesonet stations are collected every five minutes and transmitted to a central facility. All observations receive real-time and archived quality assurance prior to distribution or display. As a result, approximately 640,000 research quality observations are collected each day across Oklahoma City. For more information and to view real-time observations in Oklahoma City, visit **http://okc.mesonet.org**.

Ron Elliot

Interview by Phil Browder,
Mesonet Electronics Technician

I had been waiting for just a tick past ten minutes, and in that short timeframe, no less than ten people had found their way into, and out of, the office of Dr. Ron Elliot, head of the Biosystems and Agricultural Engineering department on the campus of Oklahoma State University in Stillwater. These visitors ranged from wayward students to seasoned faculty, but all of them, including myself, had one thing in common: we all wanted a moment of Dr. Elliot's time. The difference between us was that I had an appointment, thank goodness.

His office was tucked away neatly in Room 111 at Agricultural Hall on the OSU campus, but for a brief moment, I thought I had wondered into Union Station, with all its comings and goings. Ignoring the hustle and bustle, I had just settled into a fine article on Cowboy football in the student paper when Dr. Elliot appeared, apologized profusely for running three minutes late, and led me into his private office. As I glanced around the room, I asked him if he had been busy. "A little," he replied, which was quite an understatement considering he had probably accomplished more that morning than I would the rest of the day. But, what else do you expect from the son of a farmer?

Long before he added a "Doctor" to the front of his name, Ron Elliot was born in Dekalb, Illinois, and shortly after, moved with his family to Sheffield, a small farming community about two hours west of Chicago. While growing up on the farm, Ron not only received a crash course in agriculture 101, but he also developed other interests as well. "I enjoyed the rural life and the agriculture", Ron says, "but I also enjoyed mathematics and science in school." Despite his love of the land, Ron decided in high school that the full-time farming life wasn't for him. "I didn't want to devote my whole life to production agriculture, as a farmer," Ron says, "but I wanted to keep and honor my roots in that [agriculture], so I put the two [science and agriculture] together, and thought that agricultural engineering would be a good field for me."

Ron graduated high school in 1969 and left the farm to enroll at the University of Illinois at Champaign-Urbana. He graduated from U of I with a Bachelor's Degree in Agricultural Engineering (A.E.) in 1973, and quickly followed it up with a Master's Degree in A.E. a year later. After spending three years working for the Illinois Environmental Protection Agency, Ron decided it was time to go back to school. He chose Colorado State University in Fort Collins because of

their emphasis on weather and water resource management, something he became interested in while working for the Illinois E.P.A. "Working in those areas leads you to the importance of weather and water management in irrigation scheduling," says Ron. "Certainly in research, weather is an important factor."

While at CSU, Ron rolled his interests in weather, water management and agriculture into one by pursuing research in the area of evapotranspiration, which is, as he put it, "a fancy word for plant/water use". Ron graduated from CSU with a Ph.D. in A.E. in the spring of 1981, and quickly sought university faculty positions that would allow him to continue his research. His first job interview brought him to Stillwater, where he was impressed with the "good people, resources and opportunities." So impressed, in fact, that while he visited three other universities, it was the position at OSU he chose. "Some time in October 1981 was my first day on the job. I thought I would stay a few years and see where I might go," Ron recalls. "That was twenty-seven years ago!"

Shortly after arriving at OSU, Ron's research in agriculture and water resource management ran into a glaring obstacle: a serious lack of timely statewide meteorological surface data. Says Ron, "I became interested in what weather data was available across Oklahoma—how good is it, how many places, what's the spatial and temporal resolution?" After doing some digging, what Ron uncovered didn't impress him. Not only were there very few sites (about twenty) around the state regularly collecting surface observations, but the speed at which the data became available was, to say it mildly, slow. "You'd wait a couple of months to get a daily value," Ron says. "It was pretty primitive." So, Ron joined a group of like-minded scientists from around the state and set about changing this lack of data. Once the University of Oklahoma officially came on board in 1987, Ron says the combination of the two universities was something the legislature couldn't ignore:

"We thought that OU and OSU coming together and asking for something that would benefit both was a huge selling point."

And so it was. With the combined power of the two largest state universities behind them, Ron and the rest of the group approached the Governor with a plan of action. By December of 1990, two million dollars of oil-overage funds available from a court settlement had been allocated to the cause. Add to that number $350,000 from both OU and OSU, and a "few ideas in the beginning" had transformed into the Oklahoma Mesonet—a statewide weather monitoring network with an operating budget of 2.7 million dollars. Over the next year, Ron joined others in locating station sites, deciding what weather conditions to monitor, and choosing the right instruments to monitor them. By late 1991, the first Mesonet towers were going up, and by fall of 1996, there were 114 spanning the state, over five times the amount that was present when Ron came to Oklahoma ten years prior. Today, that number is up to 120 sites, with an annual operating budget of around 3 million dollars. "It really has been the national leader, if not the world leader, in real time state weather data," Ron says.

Since January of 2001, Ron has been serving as head of the Biosystems and Agricultural Department at OSU, and he continues his involvement with the Mesonet by serving on its steering committee. When asked what the future holds for agriculture in Oklahoma, Ron says the importance of the Mesonet, along with cutting edge technology, will play an important roll in keeping the Sooner State globally competitive. "Farmers always want to know what's happening now, or what's happened in the past," says Ron, "but they especially want to know what's going to happen next hour, or tomorrow, or next week. The more good information we can get into their hands, they'll be able to make more informed decisions, allocate resources better, make more money, and again, get back to that global competition."

The Sperry-Piltz Utility ICE DAMAGE Index

BY: GARY MCMANUS, ASSISTANT STATE CLIMATOLOGIST

Warming of the surface and lower portions of the atmosphere has possibly led to an increased frequency of significant ice storms across Oklahoma over the last eight years. Six storms with ice depositions of more than one inch have occurred since the turn of the millennium. Those six storms caused catastrophic damage to electric utility infrastructure in every region of the state, with damage totals of more than one billion dollars. The warming at the surface is evident in a time-series of statewide average winter (December-February) temperature since 1896 (Figure 1). This warming is also indicated by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which noted an increase in winter temperatures at the surface and the lower and mid-troposphere across most of the United States and the northern hemisphere. While seemingly paradoxical, the hypothesis that a warming winter climate could lead to an increased frequency of ice storms is consistent with our current understanding of the atmospheric temperature profile required for freezing rain formation.

Nevertheless, the evidence of a link between a warming winter climate and an increase in ice storms is anecdotal at this time. However, the observed increase in frequency since 2000 suggests that significant ice storms will continue to affect Oklahoma for the foreseeable future. Should the climate continue to warm as projected by climate models, the possibility exists that freezing rain and ice storm events could eventually begin to decrease in Oklahoma. The annual average temperature in Oklahoma is projected to increase between 2-3 degrees F by the 2020s, and 4-6 degrees F by the 2090s.

The Oklahoma Association of Electric Cooperatives (OAEC) sought help for real-time assessment and forecasts of ice accumulation on their power lines. OAEC had partnered with the Oklahoma Climatological Survey (OCS) on development of a decision-support system that consolidated available information, but fell short of actual ice assessments and forecasts. OAEC worked with the National Weather Service (NWS) Forecast Office in Tulsa, Oklahoma, to address those needs. Using their experiences with previous ice storms, OAEC and NWS-Tulsa developed the Sperry-Piltz Utility Ice Damage Index. The index relies heavily on local NWS forecasters' experience with ice accumulations and real-time data from the Oklahoma Mesonet. The Utility Ice Damage Index

The Sperry-Piltz Utility Ice Damage Index (Table 1) categorizes damage potential in five levels through the use of radial ice thickness and wind speed. Utility systems may be able to handle moderate ice accumulations, but stressed lines under wind forces are more likely to break. Therefore, one inch of ice may be a Level 2 or Level 3 ice event, but if wind speed exceeds 25 mph, it becomes a Level 5 event. The algorithm was tested in several ice events during the winter of 2007-2008. Anecdotal evidence suggests that the algorithm performed exceptionally well, with observed damage consistent with the scale. In some cases, the algorithm out-performed local utility managers, either indicating more severe problems than they anticipated (prior to getting crews in the field) or areas of less damage within the overall storm pattern. Use of the algorithm has implications on deployment of repair crews during and after the event to restore power to customers as quickly as possible, and also has positive implications for use by the Oklahoma Department of Transportation to predict ice accumulation on streets, highways, and bridge surfaces.

Winter Temperature History with 5-year Tendancies [Oklahoma Statewide: 1896-2007]

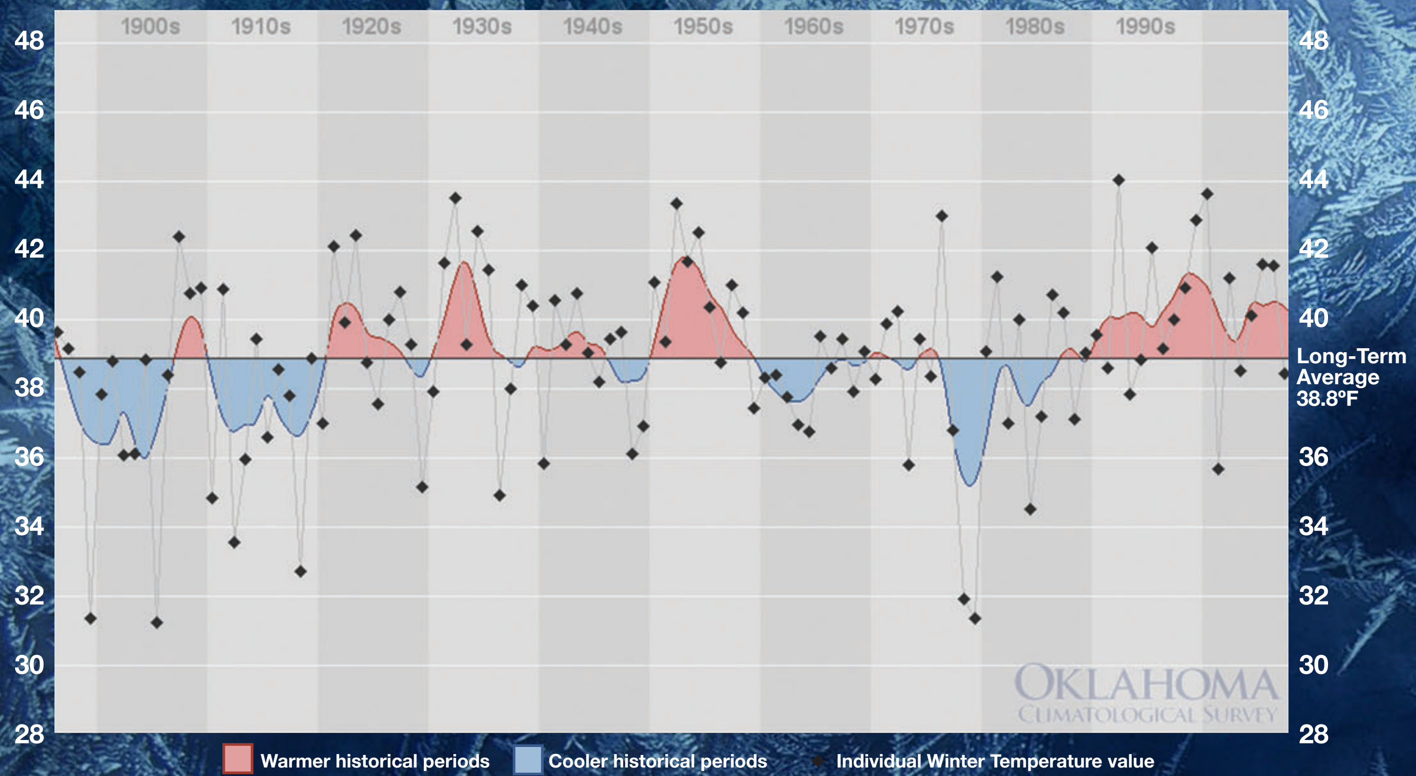


Table 1: The Sperry-Piltz Utility Ice Damage Index

Ice Index	Radial Ice Amount (inches)	Wind (mph)	Damage and Impact Descirptions
1	< 0.25	15-25	Some local utility interruptions possible. ..typically lasting a few hours.
	0.25-0.50	< 15	
2	< 0.25	>= 25	Scattered utility interruptions expected ...typically lasting a few hours.
	0.25-0.50	15-25	
	0.50-1.00	< 15	
3	0.25-0.50	>= 25	Numerous utility interruptions expected ...lasting up to 3 days. Damage to some main feederlines.
	0.50-0.75	15-25	
	0.75-1.00	< 15	
4	0.50-0.75	>= 25	Prolonged and widespread utility interruptions. Damage to many main feederlines expected. Utility outage expected to last more than 3 days.
	0.75-1.00	15-25	
	1.00-1.50	< 15	
5	0.75-1.00	>= 25	Catastrophic damage to exposed utility systems. Outage will last several weeks in some areas.
	1.00-1.50	15-25	
	> 1.50	< 15	

The Sperry-Piltz Utility Ice Damage Index combines ice accumulation and wind speeds to predict the type and amount of damage possible to utility systems.The categories are based upon combinations of precipitation totals, temperatures and wind speed. Utility systems may be able to handle moderate ice accumulations, but stressed lines under wind forces are more likely to break. Therefore, one inch of ice may be a Level 2 or Level 3 ice event, but if wind speed exceeds 25 mph, it becomes a Level 5 event.

Significant Oklahoma Ice Storms 2000-07

December 25-27, 2000 (Sperry-Piltz Level 4): Major snow and ice storms struck statewide, especially powerful in the southeast quarter. Power was lost to at least 120,000 homes and businesses, including 90% of the residents of McIntosh, Latimer, and Pittsburg counties. Extended power outages also led to disruptions of local water supplies in several areas. At least 27 fatalities were attributable to the extreme weather conditions, which extended well into January 2001. Total property damage in the state was approximately $170 million.

January 28-30, 2002 (Sperry-Piltz Level 5): This powerful winter storm wreaked havoc on the northwestern half of the state, and none suffered more than the state's power suppliers. The storm left over $100 million of damage in its wake, leaving some 255,000 residences and businesses without power. Enid, a city of 47,000, was entirely without electricity for days. The Oklahoma Association of Electric Cooperatives reported over 31,000 electrical poles destroyed due to the ice. With about 20 poles per mile on an average electrical supply line, that results in over 1,550 miles of destroyed power supply capabilities, enough to stretch from Oklahoma City to New York City. The most serious casualty in the wake of the ice storm, however, was the toll in human lives. Seven fatalities were directly attributable to the effects of the late-January storm. Four died in traffic accidents on the icy roadways, while two others died of asphyxiation while trying to get warm in enclosed spaces. Another resident died when a large tree branch crushed him as he tried to clear his residence of debris.

December 3, 2002 (Sperry-Piltz Level 4): The third significant ice storm in as many years, this icy blast left a damage footprint in a narrow band from west central to north central Oklahoma. Areas north of the icing region generally received 2-6 inches of snow, with some areas reporting more than eight inches. Moderate to heavy rainfall occurred to the south. The main impact of the ice storm was damage to electrical distribution systems. Because much of the area impacted by the storm is rural, the primary victims of the storms were members of rural electric cooperatives (RECs). About 30,000 REC customers were without power for some time during the storm. According to the Oklahoma Association of Electric Cooperatives, REC losses were about $4.5 million. Other power suppliers were impacted also. At the storm's peak, about 25,000 Oklahoma Gas & Electric (OG&E) customers lost power.

December 18-20, 2006, and December 28-29, 2006 (Sperry-Piltz Level 5): This event was actually a combination of two separate winter storms that struck the Oklahoma Panhandle over the year's final two weeks. These storms occurred in the state's most sparsely populated region, but the damage they did was still quite significant. The first storm struck on the 19th and 20th with moderate freezing rain across the western half of the Panhandle. Up to an inch of ice accumulation was noted in Guymon by the 20th with heavy tree damage and widespread power outages. Peak power outages topped out at about 10,000 customers. The Texas County towns of Guymon and Goodwell were hardest hit by the ice storm. Areas to the west received about one-half of an inch of ice, in general. Two-to-four inches of snow fell following the ice, complicating repair efforts. Those efforts were barely finished when a more powerful storm hit the area December 28-30. Heavy snow and high winds created blizzard conditions in the western Panhandle, where drifts were measured up to 20 feet high. Those winds, which gusted up to 55 mph, combined with ice thicknesses of 1.5 inches to produce widespread damage to power utility equipment once again in Texas County. Sustained winds were measured at 40 mph. About 700 power poles were lost in this second storm. More than 20,000 customers were without power at the storm's peak. In all, the two storms caused well over $2 million in damage to power utilities.

Table 2: A summary of significant ice events in Oklahoma since 2000.

Storm	Widespread Ice Accumulation	Maximum Ice Accumulation	Power Outages
December 2000	2.0 inches	3.0 inches	170,000
January 2002	2.0 inches	3.0 inches	255,000
December 2002	1.0 inches	1.5 inches	55,000
December 2006	1.0 inches	1.5 inches	7,000
January 2007	1.5 inches	2.5 inches	120,000
December 2007	1.0 inches	2.0 inches	640,000

Historical Oklahoma Ice Storms

January 12-15, 2007 (Sperry-Piltz Level 5): This storm caused catastrophic damage to the power systems in the eastern one-third Oklahoma, where ice accumulations were more than three inches in localized areas. Thirty-two deaths were linked to this storm: 19 perished in traffic accidents, eight succumbed to hypothermia, and three died due to accidental falls on the ice. Points northwest avoided widespread damage since most of the precipitation fell as snow and sleet. An arctic cold front moved into northeastern Oklahoma during the late evening hours of the 11th and had finally passed through the southeastern portion of the state by the evening of the 12th. A strong upper level low pressure system moved into the southern Rockies and several disturbances translated across the Southern Plains bringing periods of heavy sleet and freezing rain to the region. The initial precipitation began around daybreak on the 12th and the final round occurred on the 14th. A devastating swath of one to three inch ice amounts fell in an estimated 60 to 80 mile wide band from roughly Atoka to McAlester to Muskogee to Grove. An estimated 120,000 electric customers were without power due to downed power poles and power lines within this swath, some of which were without power for more than two weeks. A total of 15,000 customers from McAlester alone lost power.

December 8-11, 2007 (Sperry-Piltz Level 5): A devastating ice storm affected a large swath of Oklahoma beginning on the 9th and continuing through the 11th over parts of the area. The storm left behind a trail of severe damage to trees and power lines, which in turn led to the worst power outage in Oklahoma history (in terms of the number of people impacted). This was because the worst of the ice storm affected the urban corridor from near Lawton, to Oklahoma City, to Tulsa, and northeast into Missouri. By the time the storm had ended, over one inch of ice had accumulated over a good portion of Oklahoma. At least 27 deaths were reported statewide, mainly due to hundreds of automobile accidents, although some were due to prolonged cold air exposure or carbon monoxide poisoning. At the peak of the event, more than 641,000 electric customers were without power, amounting to over one million people. Even with a huge relief effort, more than 150,000 residents were still without power one week later. The local economy took a huge hit as the ice storm hit during a key weekend for holiday sales. The pecan crop loss alone was estimated at $25 million statewide. Shelters were opened across the state for people who did not have electricity, which many took advantage of. The storm cleanup was estimated to cost at least $200 million statewide. Cities were expected to remove over 750,000 cubic yards of debris. [– NCDC Storm Event Database]

January 1, 1993:
An upper-level storm system brought sleet and freezing rain to much of Oklahoma. Surface air temperatures were well below freezing so roads quickly became ice covered and dangerous. Roads remained ice covered until temperatures rose above freezing late in the morning on the 2nd. Numerous traffic accidents occurred and a few power outages were reported. In Oklahoma City, a 35-car pileup occurred around 2 a.m. on the 1st. The storm also caused problems for those flying as two 737s slid off icy runways at Will Rogers Airport. Many other flights were either delayed or canceled. – NCDC Storm Event Database

December 1987:
A large snow and ice storm caused more than $10 million in damages across the northwestern two-thirds of the state. About 114,000 customers were left without power and tree damage was severe. All flights to and from Will Rogers World Airport in Oklahoma City were cancelled, and several large broadcast antennas collapsed.

December 1937:
A significant ice storm struck southeastern and eastern Oklahoma, a mere 30 years after statehood in December of 1937. Considerable damage was done to trees, shrubs, and electric, telephone, and telegraph wires. Damages were totaled at a then-substantial $250,000 ($3.7 million in 2008 dollars). One elderly Muskogee resident claimed of the storm: "Seems like that one lasted a month."

SUMMER 2008 SUMMARY

by Gary McManus

The big stories of the summer revolved around water, or at least the lack or abundance thereof. Drought intensified to disastrous levels in the western Oklahoma Panhandle during June and July, garnering attention from around the world due to comparisons with the dryness of the Dust Bowl. Meanwhile, record rains were falling in other parts of the state, especially during June and August. The drought conditions eased in the Oklahoma Panhandle in late July. Averaged statewide, the summer precipitation total ranked as the 23rd highest on record with a surplus of nearly 3 inches. The northeast summer precipitation was fifth highest on record with a surplus of nearly 8 inches. The statewide average temperature was just a bit below normal and ranked as the 51st coolest on record. Severe weather tapered off after a very active June.

JUNE DAILY HIGHLIGHTS

June 1-4: June started off hot and steamy with temperatures rising close to 110 degrees at several locations during the first four days. The state's highest recorded temperature of 108 degrees occurred three separate times during this period. Maximum temperatures were not the only culprit as Oklahoma City set records for warmest minimum temperatures on three consecutive days. The heat fueled powerful thunderstorms as well. Severe storms struck northwestern Oklahoma on the first and the third, dropping hail to the size of softballs near Slapout in addition to many more scattered reports of large hail. Winds gusted to over 70 mph in several locations. Most of the heavy rains fell in the northeast, however, with 1-2 inches being reported in that region.

June 5-9: The fifth began with strong winds of over 50 mph in the northwest and ended with more severe storms in the north. These storms contained high winds as their main severe threat. Wind gusts of over 80 mph were reported at three locations with many more reports of over 70 mph. North central Oklahoma saw two days with heavy rains. The Oklahoma Mesonet site at Lahoma recorded over nine inches of rain during the period. Nearly half of that total fell during a heavy downpour on the fifth. Most of the state saw from 1-3 inches of rain during these five days, but a significant portion of the state saw between 3-6 inches. Flooding was reported across a large area of northeastern Oklahoma on the ninth due to heavy rains in that region.

June 10-12: This three-day period was totally free of rain, a welcome respite from the previous stormy conditions. Lows on the 10th were quite mild in the 50s and 60s. High Temperatures throughout the period were mostly in the 90s.

June 13-20: These eight days were marked once again by plenty of severe weather. Large hail and high winds took their toll once again, although flooding was the main severe culprit in the northeast. The largest hail reported by the public was 3.25 inches, about the size of a tea cup. The heaviest rains were once again in the northeast where 3-6 inches fell, hence the flooding reports. Storms occurred each day, but by the afternoon of the 20th the weather had begun to quiet down.

June 21-26: These six days were much more tranquil – and dry – with only a few showers scattered about. Highs ran in the 90s for the most part, although a few triple-digit temperatures did sneak in at a few places. A heavy storm managed to drop well over two inches of rainfall near Vinita.

June 27-30: More storms were on tap for the end of the month, although these were a bit tamer and struck primarily in southeastern Oklahoma. That area received between 2-3 inches, on average. Other than that, the period was seasonable with lows in the 60s and 70s and highs in the 80s and 90s.

JULY DAILY HIGHLIGHTS

July 7-10: Widespread rains finally fell across the state with the bulk of the heavy amounts found in the northern one-third. Between 1-4 inches fell across that area. Goodwell in the Oklahoma Panhandle garnered a whopping three inches. Another 1-3 inches fell across south central Oklahoma. Despite the rains, the period was devoid of any severe weather of note. The cold front that generated the rain cooled the state down with high temperatures on the ninth and tenth in the 80s and 90s.

July 11-13: The state's only real bout with severe weather occurred on the 12th with storms generated along a cold front, mostly strong winds and hail. A 70 mph wind gust was reported in Mayes County and 2.90 inches of rain fell in one hour according to the Breckenridge Mesonet site. Flash flooding was reported in Weatherford. The cold front cooled the state down from 90s and 100s to 70s and 80s, about 10 degrees below the seasonal normals.

July 14-18: This five-day period was mostly dry except for spotty showers once again across western Oklahoma. The rains were heavy in some places, but most areas across the state received next to nothing. Highs were in the 90s and 100s throughout the five days.

AUGUST DAILY HIGHLIGHTS

July 19-26: The heat ramped up to full force during these seven days under the influence of an upper-level ridge of high pressure. Low temperatures were mostly in the 70s with a few 80s and highs soared into the triple-digits. Just a few showers formed from time to time in the northeast.

July 27-31: The state's highest temperature of 109 degrees occurred at Grandfield on the 28th. Remnants of Tropical Storm Dolly brought a bit of moisture to a parched state. Amounts were generally less than an inch, but a few places along the Kansas border received between 2-4 inches. Highs were once again into the upper 90s and 100s.

August 1-6: The first six days of August were scorching hot with very little rainfall and plenty of sunny skies. High pressure dominated the region and kept the temperatures well into triple-digits across Oklahoma. The state's highest temperature of the summer – and year – occurred at Freedom on the fourth with a reading of 110 degrees. Cloudiness from tropical storm Edouard allowed for a relatively minor cool down on the sixth. High temperatures on that day remained in the 90s for the most part, a welcome respite from the 100s of the previous five days.

August 7-11: A stormy five day period brought heavy rains to eastern Oklahoma where more than seven inches fell in localized areas. Heavy rains were accompanied by large hail and strong winds in some instances. Most of the storms formed along a frontal boundary which had slipped into the state from the north. That boundary separated high temperatures in the 70s in the north and 90s in the south. Flash flooding was reported with the storms in central Oklahoma on the 11th.

August 12-13: Temperatures remained below normal in areas that had received plentiful rainfall the previous few days, and struggled to reach 80 degrees in the northeast. Highs reached the upper 90s in other areas, however. Low temperatures the next morning were 5-10 degrees below normal with some upper 50s reported. High temperatures returned to the 90s nearly statewide that afternoon.

August 14-17: Another rainy period, but the area receiving the most moisture was western Oklahoma this go around. The Oklahoma Mesonet site at Kenton recorded nearly four inches of rain during these four days. The storms began on the 14th with development noted along an outflow boundary from storms in southern Kansas. Southwestern Oklahoma garnered 1-2 inches as well. Temperatures were cool for mid-August, with 80s registered across the area for high three inches. Rain fell overnight on the 20th and the 21st. Temperatures began to warm up on the 20th and 21st as the rain lessened. Highs went from the 70s and 80s to the 80s and 90s by the end of the period.

August 22-28: Very little rain fell during these seven days. The most notable weather feature was the return of the summertime blues...and heat. The 90s and 100s resumed starting on the 22nd. A few storms popped up from time to time, but the most abundant natural resource during this period was sunshine. Drier and cooler air moved into the state from the north on the 25th but did not stick around long. That made for a wonderful autumn-like morning on the 26th with lows in the 50s and 60s. The heat once again returned by the 27th and 28th, however, with highs back into the upper 90s and 100s.

August 29-31: Heavy rains fell on the 29th as a cold front sagged into the state from the northwest. High winds and large hail accompanied the storms, which were slow-moving. Seiling had over three inches to lead the state. Those storms formed once again in the hot and humid air on the 30th. Central Oklahoma received a good soaking of about an inch, on average. The month's last day was very pleasant, with lows in the 60s and 70s and highs in the 80s.

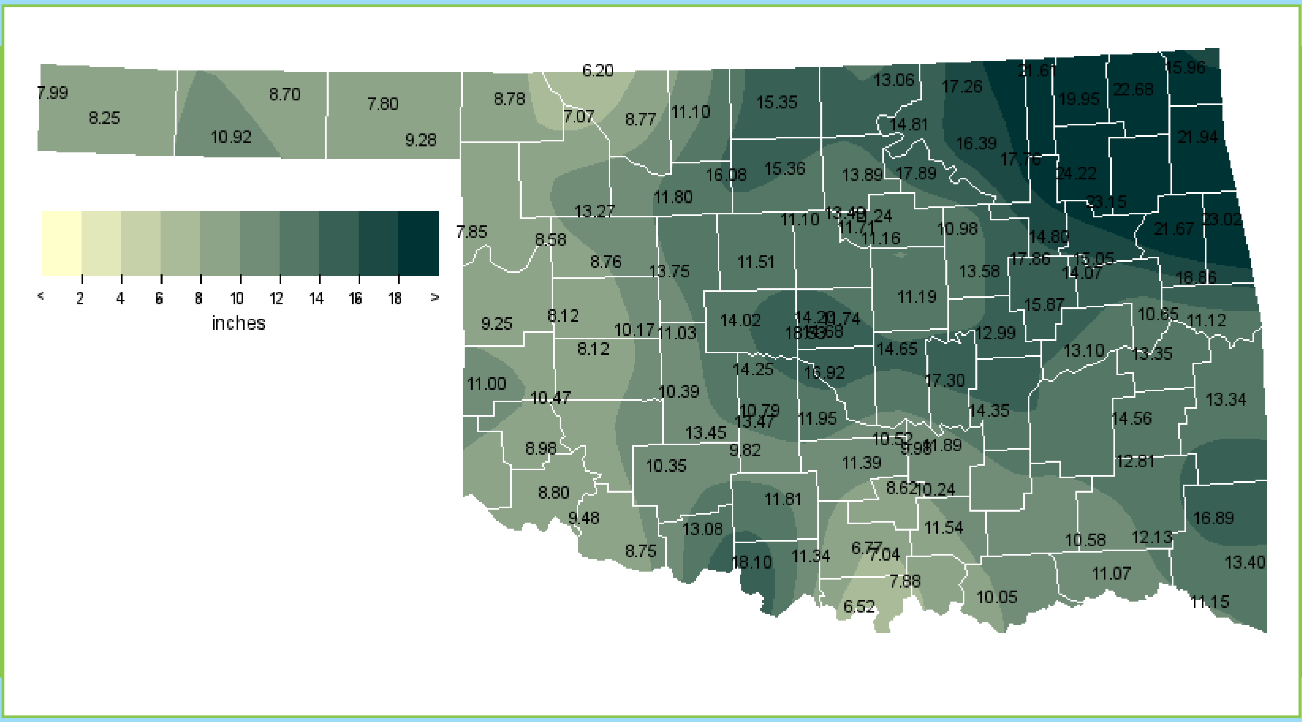
Summer 2008 Statewide Extremes

Description	Extreme	Station	Date
High Temperature	110°F	Freedom	August 4
Low Temperature	43°F	Boise City	June 6
High Precipitation	24.22 in.	Claremore	
Low Precipitation	6.20 in.	May Ranch	

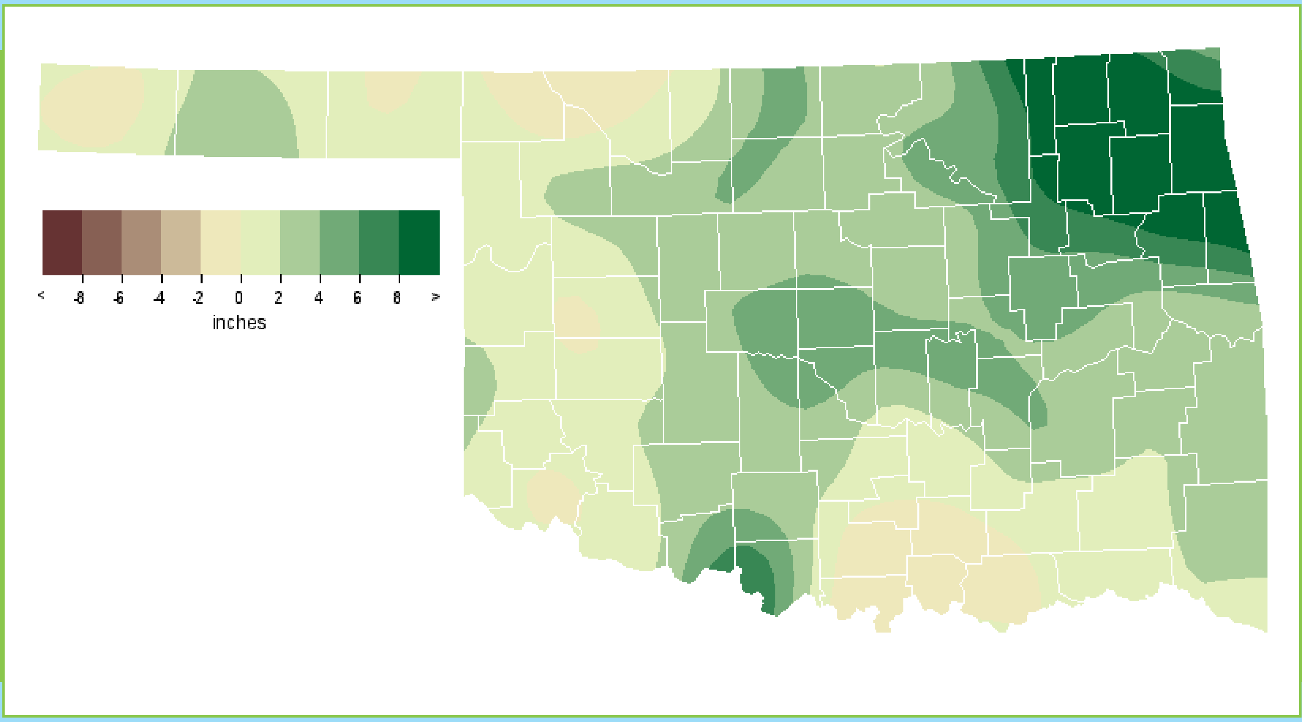
Summer 2008 Statewide Statistics

	Average	Depart.	Rank (1895-2008)
Temperature	79.4°F	-0.2°F	51st Coolest
	Total	**Depart.**	**Rank (1895-2008)**
Precipitation	12.53 in.	2.76 in.	23rd Wettest

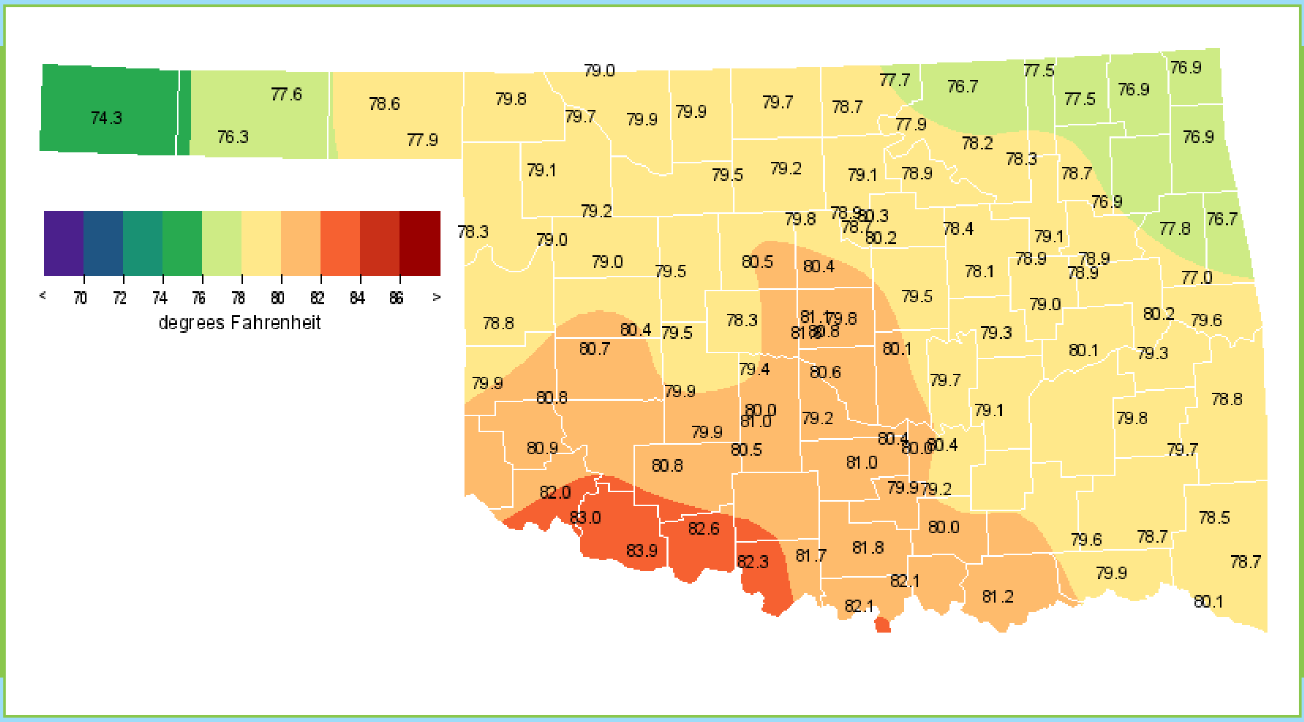
OBSERVED RAINFALL



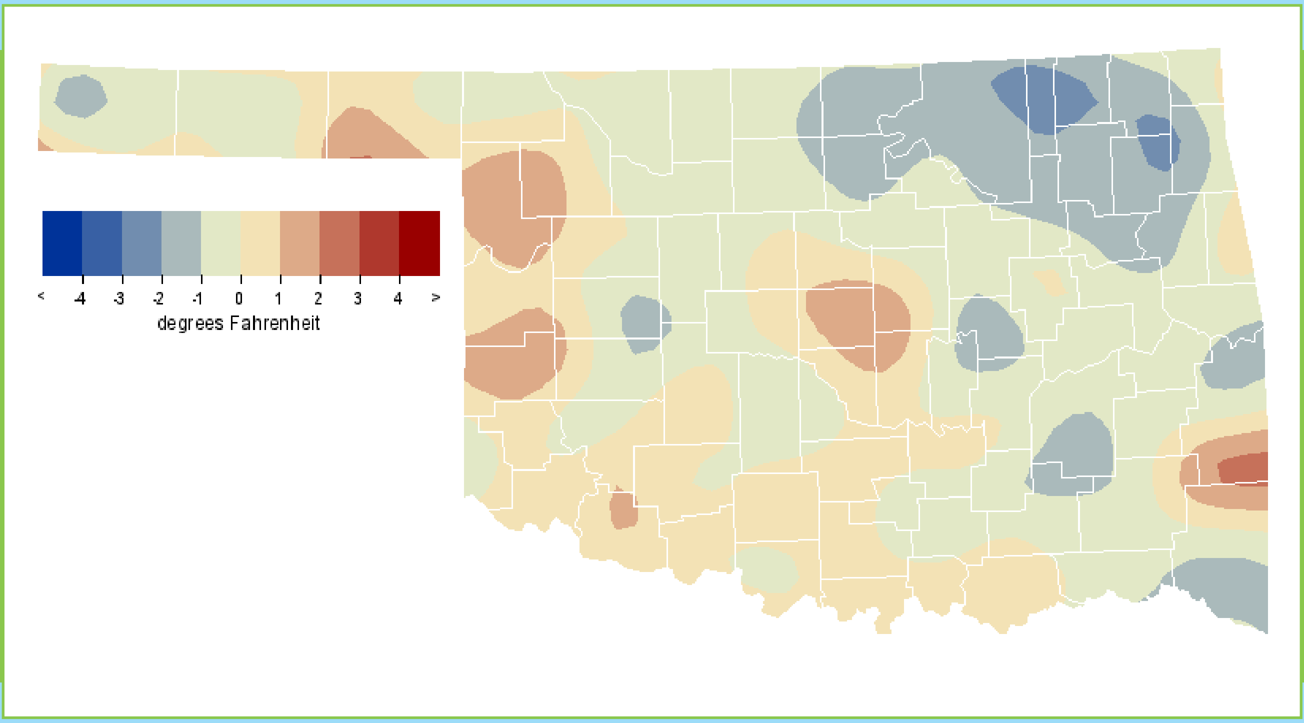
RAINFALL DEPARTURE FROM NORMAL



AVERAGE TEMPERATURE



TEMPERATURE DEPARTURE FROM NORMAL



SUMMER 2008 MESONET PRECIPITATION COMPARISON

Climate Division	Precipitation (inches)	Departure from Normal (inches)	Rank since 1895	Wettest on Record (Year)	Driest on Record (Year)	2007
Panhandle	8.70	0.74	47th Wettest	17.32 (1950)	2.66 (1936)	5.56
North Central	12.00	2.03	28th Wettest	17.45 (2005)	3.73 (1936)	14.97
Northeast	18.82	7.86	5th Wettest	23.78 (1948)	2.97 (1936)	16.75
West Central	9.80	1.09	41st Wettest	16.53 (1995)	2.79 (1980)	13.25
Central	13.10	3.33	28th Wettest	23.59 (2007)	1.97 (1936)	23.59
East Central	15.81	5.10	16th Wettest	20.53 (1958)	1.54 (1936)	17.01
Southwest	10.48	1.45	31st Wettest	17.11 (2007)	2.15 (1980)	17.11
South Central	10.25	0.53	43rd Wettest	19.72 (1950)	2.58 (1980)	17.53
Southeast	12.88	1.89	32nd Wettest	21.23 (1945)	3.50 (1934)	17.75
Statewide	12.53	2.76	23rd Wettest	17.26 (1950)	2.79 (1936)	16.21

SUMMER 2008 MESONET TEMPERATURE COMPARISON

Climate Division	Average Temp (F)	Departure from Normal (F)	Rank since 1895	Hottest on Record (Year)	Coldest on Record (Year)	2007
Panhandle	77.5	+0.3	51st Warmest	81.9 (1934)	71.5 (1915)	76.9
North Central	79.2	-0.7	37th Coolest	86.2 (1934)	74.3 (1915)	78.8
Northeast	77.8	-1.0	32nd Coolest	85.4 (1934)	73.8 (1915)	78.9
West Central	79.7	+0.3	57th Warmest	85.4 (1934)	74.6 (1915)	77.9
Central	79.9	-0.1	57th Warmest	85.6 (1934)	75.0 (1915)	79.2
East Central	78.8	-0.6	37th Coolest	85.4 (1934)	75.0 (1915)	79.1
Southwest	81.4	+0.2	55th Warmest	86.0 (1980)	77.1 (1915)	79.2
South Central	80.9	+0.2	53rd Warmest	86.2 (1934)	77.0 (1906)	79.4
Southeast	79.3	+0.1	50th Coolest	84.8 (1934)	75.3 (2004)	79.0
Statewide	79.4	-0.2	51st Coolest	85.2 (1934)	74.9 (1915)	78.7

SUMMER 2008 MESONET EXTREMES

Climate Division	High Temp	Day	Station	Low Temp	Day	Station	High Monthly Rainfall	Station	High Daily Rainfall	Day	Station
Panhandle	108	Jun 2nd	Beaver	43	Jun 6th	Boise City	10.92	Goodwell	4.16	Aug 18th	Hooker
North Central	110	Aug 4th	Freedom	54	Jul 14th	Alva	16.08	Lahoma	4.30	Jun 5th	Lahoma
Northeast	103	Aug 4th	Pawnee	56	Jun 10th	Pawnee	24.22	Claremore	3.66	Jun 9th	Nowata
West Central	107	Jun 3rd	Retrop	51	Jun 6th	Erick	13.75	Watonga	3.54	Jun 9th	Bessie
Central	106	Aug 3rd	Ninnekah	53	Jun 10th	Marshall	18.53	Oklahoma City	5.58	Aug 11th	Shawnee
East Central	105	Aug 3rd	Sallisaw	54	Jun 10th	Cookson	23.02	Westville	4.02	Jun 9th	Calvin
Southwest	109	Jul 28th	Grandfield	50	Jun 10th	Mangum	13.45	Apache	6.37	Aug 18th	Walters
South Central	108	Aug 4th	Ketchum Ranch	56	Jun 10th	Ada	18.1	Waurika	6.29	Aug 18th	Waurika
Southeast	107	Aug 3rd	Wister	57	Jun 30th	Wilburton	16.89	Mt Herman	5.16	Aug 11th	Wilburton
Statewide	110	Aug 4th	Freedom	43	Jun 6th	Boise City	24.22	Claremore	6.37	Aug 18th	Walters

AgWatch

by Albert Sutherland, CPA, CCA
Mesonet Assistant Extension Specialist
Oklahoma State University

In late September 2008, Oklahoma could have billed itself as "Oklahoma --- Your California Weather Destination." The mild Oklahoma weather at the end of September 2008 had southern California vacation written all over it. September finished out with mild temperatures, bright sunny skies and little wind. Mild, sunny September weather was just what Oklahoma farmers needed to move crops towards maturity after a cool August.

September provided some much needed heat units after a cooler than normal August. The map in Figure 1 shows how extensive the cooler August 2008 air temperatures were across Oklahoma. The bulk of the state experienced a 1-2 degree drop in air temperature averaged over the entire month. A couple of pockets to the east reached average temperatures 4 degrees below normal. There were only a few isolated Oklahoma Mesonet locations that had air temperatures slightly above normal.

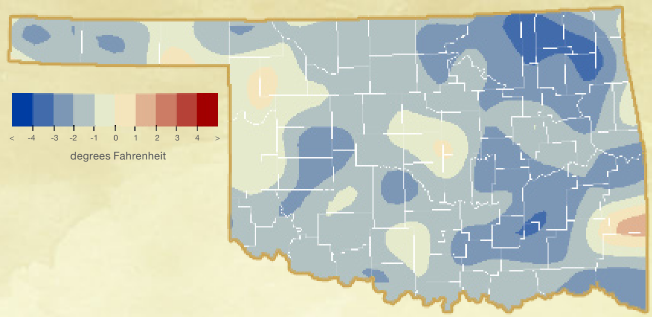


Figure 1: August 2008 Departure from Normal Air Temperature from the Oklahoma Climatological Survey.

Why was August 2008 cooler? Check out the map in Figure 2. August was one wet month. With large portions of Oklahoma inching close to 200% of normal rainfall, cloudy, rain-filled days led to cooler air temperatures. The big exception was an area in north central Oklahoma, where dumping rain gauges was a rarity. Grant and Kay counties received less than 20% of their normal rainfall for August.

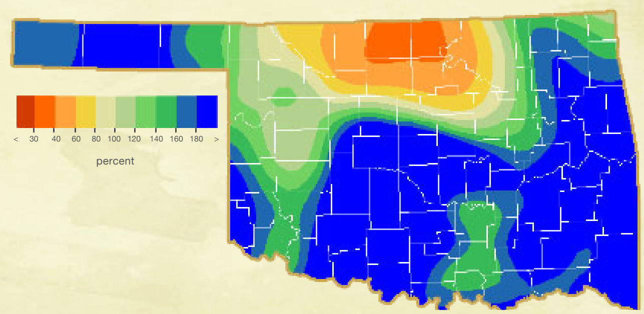


Figure 2: August 2008 Percent of Normal Precipitation from the Oklahoma Climatological Survey.

Cooler August 2008 temperatures delayed corn, sorghum, soybean and peanut maturity. Even after the warm September, cotton was the one row crop reported to be at its 5-year average maturity level for the week ending September 28, 2008, as reported in the September 29, 2008, issue of the Oklahoma Crop Weather report.

So after a cool August, the mild, sunny days of September were a relief. Adding to this relief for farmers was mid-September moisture that came out of the Pacific from the remnants of tropical storm Lowell. This moisture came at just the right time to help crops make the most of September's "California vacation weather."

While most of Oklahoma received beneficial rain amounts in mid-September, some locations in northwest Oklahoma found themselves with too much water. The Fairview Mesonet site recorded 12 inches of rain between September 3 and October 2, 2008. During this same period, Cherokee had 9.7 inches, Medford 11.2 inches, Red Rock 9.8 inches, Pawnee 7.9 inches and Putnam 8.0 inches. Low areas near Fairview flooded on September 12, a day when 9.13 inches was recorded at the Fairview Mesonet site.

As would be expected with beneficial rainfall and mild temperatures, most Oklahoma pasture and range lands were in good condition.

The emergence of wheat for grazing, while ahead of 2007, was still slightly behind the 5-year average at the end of September. A continuation of mild September weather into October should see wheat emergence jump. This should lead to good grazing conditions for cattle during the winter months of 2008-09.

So all in all as Oklahoma transitioned from summer to fall in 2008, the weather had growers knowing they were a little bit behind with delayed crop maturity, yet feeling glad overall for the mild September weather and hoping that the first freeze in 2008 doesn't arrive until November.

To access the products mentioned previously and connect to the latest agricultural weather information, go to Oklahoma AgWeather at **http://agweather.mesonet.org**. This web site is a joint project of the University of Oklahoma and Oklahoma State University. It uses the latest information from the Oklahoma Mesonet and the Oklahoma Climatological Survey. If you have any questions or comments about the Oklahoma AgWeather site, please, contact Albert Sutherland by phone at **405-224-2216** or by email at **albert.sutherland@okstate.edu**.

Urban Farmer

by Albert Sutherland, CPA, CCA
Mesonet Assistant Extension Specialist
Oklahoma State University

November

- Plant tulip bulbs 6 inches deep, once the 4-inch, 3-day average soil temperature under sod cools to 55°F.
- Fertilize tall fescue in early November. Use a quick release fertilizer at a rate of 1 pound of actual nitrogen per 1,000 square feet.
- Rake leaves, clean up flowerbeds, and build or add to your compost pile. A simple recipe for making a compost pile is to alternate 3 to 4-inch thick layers of green and dried plant material.
- Prune trees, after the majority of their leaves have turned color or dropped to the ground.
- Dig and transplant young trees or deciduous shrubs that need to be moved, after the majority of their leaves have turned color or dropped to the ground.

December

- Complete yard cleanup. It is important to remove leaves from tall fescue and bluegrass lawns, so the grass does not die from being smothered.
- Prune trees. A proper pruning cut leaves the branch collar intact. The branch collar is a raised doughnut shaped area that circles the base of the branch. Do not paint pruning cuts. Pruning paint actually slows callus growth that will cover cuts.
- Clip holly or evergreen plants for Holiday Season decorations. Insert cut stems into florist foam in decorative containers that can hold water.
- Roundup herbicide can be applied to dormant bermudagrass areas to control green winter weeds. For best results, apply on a day when the air temperature will be in the upper 40s or higher.

January

- Spray dormant oil to control insect pests on ornamentals and fruit trees. Apply when the daytime temperature is above 50°F and the nighttime temperatures are above freezing for 3-4 days. For spraying evergreen shrubs, use the lower summer rate.
- Roundup herbicide can be applied to dormant bermudagrass areas to control green winter weeds. For best results, apply on a day when the air temperature will be in the upper 40s or higher.
- Prune trees that are prone to excessive sap flow, during a cold period. These include pines, willows, elms, and maples. Do not apply pruning paint. It will not reduce sap flow and slows callus growth over branch cuts.
- Get ready for spring by checking out plant magazines, seed catalogs and Web sites. Colorful catalogs, magazines and Web sites will provide you many ideas for landscape projects and brighten a cold, drab winter day.
- Plan spring and summer landscape projects.
- Collect seed trays, media, and seeds to start transplants. Start seeds for hardy herbs (cilantro, dill, parsley) and hardy vegetables (broccoli, cabbage, onion) to be transplanted outdoors after mid-March.

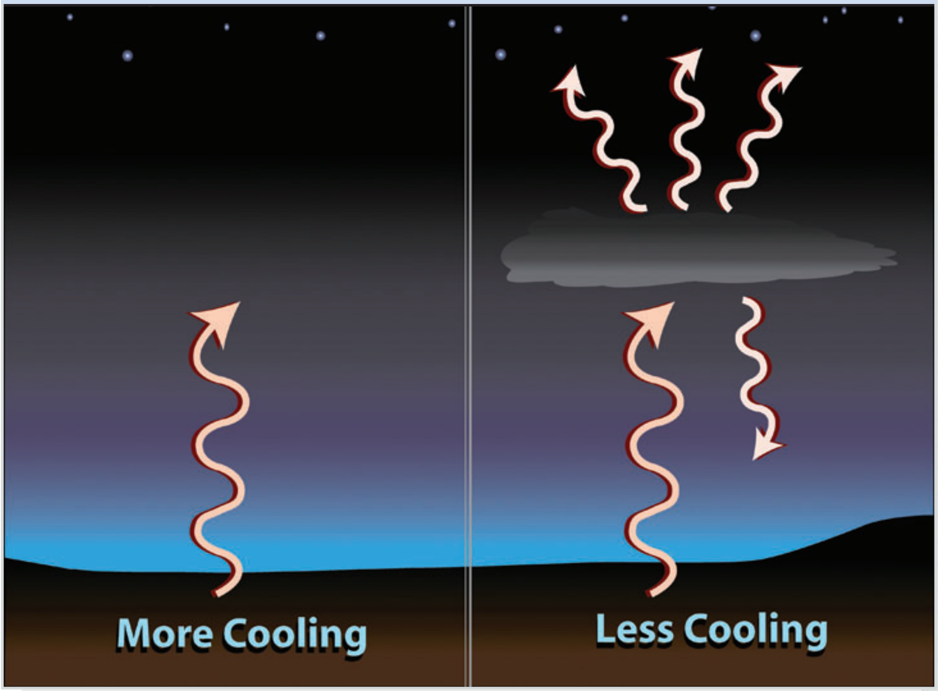
INTERPRETATION ARTICLE

Nicole Giuliano, Mesonet Outreach Program Manager

Frost *or* Freeze?

As fall transitions from warm nights to cool evenings, we sometimes see droplets (known as dew) on the grass. As it grows even colder, frost may form instead of dew, threatening tender plants. Sometimes on a really cold night, there is no frost, yet the fluid in plants freezes—this is known as a freeze. So, how can we determine if there will be dew or frost on the ground in the morning, or if instead a frostless freeze will convince us to wear a warm coat? One way that we can monitor conditions is by using a meteogram, a graph of weather conditions. First, however, we need to understand how these phenomena form.

Figure 1 - Radiational Cooling With and Without Clouds



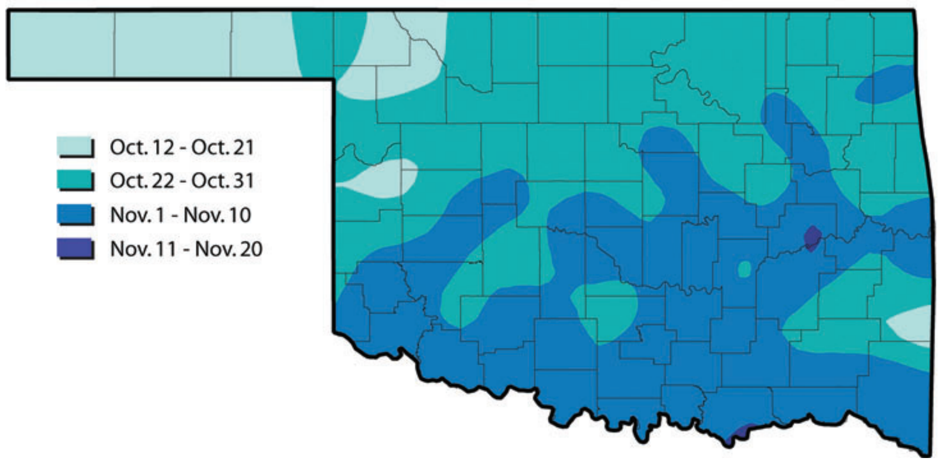
Even though dew, frost, and freezes form in different conditions, they all impact plant life. Dew forms when the air temperature cools to the dewpoint temperature, but both stay warmer than 32°F. The dewpoint temperature is the temperature to which air must cool for saturation to occur, meaning that the air has a relative humidity of 100%. When this occurs, the air is holding as much water vapor as it can, based on the current temperature and pressure. At this point, any further cooling will cause moisture to condense from the air in the form of dew. The necessary cooling may happen after the sun sets and no longer warms the ground, allowing energy to radiate away from the warm earth at night in a process called radiational cooling (see Figure 1). When there are no clouds, this radiated energy goes through the atmosphere and out into space, rapidly cooling the air just above the ground. However, when clouds are present, some of the outgoing energy is bounced back to the ground, keeping the surface warmer at night. Thus, the most favorable conditions for dew formation are calm or light winds, clear skies (more radiational cooling), and a temperature very close to the dewpoint temperature. Dew is usually a beneficial event—it provides water for thirsty plants. In fact, dew can help some plants—such as lichen—survive through long dry seasons.

Frozen dew starts out just like dew—the air temperature cools to the dewpoint temperature and dew forms. Later in the evening, however, the temperature cools to below freezing (cooler than 32°F) and these dew drops freeze into small beads of ice known as frozen dew. When temperatures exceed the melting or freezing point (32°F), the frozen dew melts back into a liquid form and provides the same benefits to plants as dew.

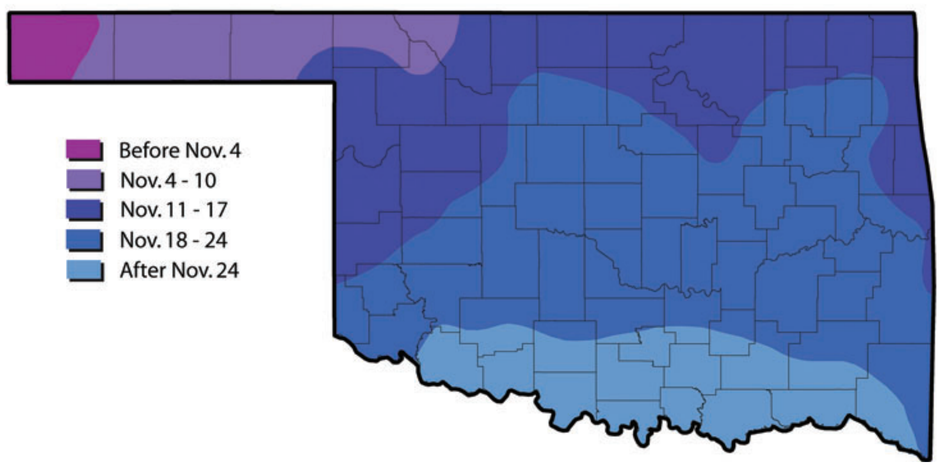
Continued >>

When the dewpoint temperature is at or below freezing, it is called the frost point. If the air temperature cools down to near the frost point (below freezing), water vapor may change directly from its gas phase to a solid (ice) in a process called deposition. Delicate, white ice crystals that form by deposition are called hoarfrost, white frost, or simply frost. When the sun hits these beautifully patterned crystals in subfreezing air, they may either melt or sublimate. In the process of sublimation, the solid ice changes directly into a gas (water vapor). Light frosts usually do not cause much damage, but heavy frosts often stunt or kill tender, young plants in the spring, or cause severe damage to mature plants in the fall.

■ **Figure 2 - Average Occurance of the First Freeze of Autumn**



■ **Figure 3 - Median Date of the First Hard Freeze (low temp. of 28°F) in Autumn**



For all of these events (dew, frozen dew, and frost), the most favorable environment for formation includes moisture (indicated by an air temperature near the dewpoint or frost point), clear skies, coldest temperatures near the ground, and light winds (usually below 5 mph). Conversely, a freeze usually involves slightly drier conditions, coldest temperatures higher in the atmosphere, and stronger winds (usually above 5 mph). A freeze is also called a black frost because a visible frost may not be seen in this event, but plants can freeze and then turn limp and black after thawing. The air temperature may drop below freezing, but still not reach the frost point, so no visible frost is formed. In a freeze, subfreezing air often blows into a region and sits there for a while. The longer this cold air mass sits over an area and the colder the air is, the more likely it is that plants will freeze and eventually die. A "hard freeze" or "killing freeze" occurs when plants are destroyed, the ground freezes, and heavy ice forms on puddles and containers of water. Based on the plant, temperatures that can cause a hard freeze vary, but a common threshold that is often used to forecast a hard freeze is a low temperature below 28ºF. In Oklahoma, the average first freeze of autumn is somewhere between mid-October and mid-November, as shown in Figure 2. The average date of the first hard freeze tends to be slightly later in the fall, somewhere between the beginning and the end of November, as seen in Figure 3.

Classroom >>

CLASSROOM ACTIVITY

Nicole Giuliano

Questions

One way that we can monitor weather conditions is by looking at a meteogram. A meteogram is a graph of atmospheric variables for a particular station or site[1]. To evaluate the likelihood of dew, frost, or a freeze, we want to look specifically at the air temperature, dewpoint temperature, and wind speed/direction. To make interpretation easier, we can also look at dewpoint depression—the difference between the air temperature and the dewpoint temperature (air temperature minus dewpoint temperature). The lower the dewpoint depression, the more moisture there is.

Table 1 lists the temperature, dewpoint, dewpoint depression, and wind speeds typically associated with dew, frozen dew, frost, and freezes (Note: these values are shown to give basic guidelines—they are not fixed, definitive rules). Unlike these four variables, the temperature profile with height cannot be seen in a meteogram. Instead, meteorologists use sounding data from a weather balloon to observe the temperature profile with height.

Table 1

Type of Event	Dewpoint Depression (°F)	Temperature (°F)	Dewpoint Temperature (°F)	Temperature Profile with Height	Winds
Dew	Less than 5 degrees	Warmer than 32 degrees	Warmer than 32 degrees	Coldest near the ground	Usually less than 5 mph (calm or light winds)
Frozen Dew	Less than 5 degrees	Warmer than 32 to form dew, then below freezing	Warmer than 32 initially, below 32 later	Coldest near the ground	Usually less than 5 mph (calm or light winds)
Frost	Less than 5 degrees	Cooler than 36 degrees	Cooler than 32 degrees	Coldest near the ground	Usually less than 5 mph (calm or light winds)
Freeze	Greater than 5 degrees	Cooler than 32 degrees	Cooler than 32 degrees	Colder air with increasing height (relatively warmer near the ground)	Usually greater than 5 mph

[1]For more information on meteograms and how to interpret all of the data found on a Mesonet meteogram, please see the Classroom Activity "Meteograms" in the Winter 2004-05 issue of Oklahoma Climate.

Classroom (Meteogram Directions & Questions) >>

You can easily make your own meteograms using WeatherScope, a program that can be downloaded for free at: **http://climate.ok.gov/software.**

How to Make the Meteogram Needed for this Activity:

Step 1: Open WeatherScope, Click on File -> New Graph
Step 2: Change the date and time:
1. Double-click on time in the upper left hand corner (in the Legend)
    a. Change Start date to 2/13/2004, Time to 5pm
    b. Change End date to 2/14/2004, Time to 5pm

Step 3: Change the Mesonet site:
1. Double-click on "Air Temperature at 1.5m" in the Legend
    a. Change the site to Cheyenne; Check the box next to Filled; Click on the box next to Color; Type in 224 for Red, 86 for Green, and 89 for Blue, Click OK, OK
2. Double-click on "Dewpoint Temperature" in the Legend
    a. Change the site to Cheyenne; Check the box next to Filled; Click on the box next to Color; Type in 0 for Red, 94 for Green, and 0 for Blue, Click OK, OK

Step 4: Click on the Air Temperature layer in the Legend. Hold down your left mouse button and drag this layer down below the Dewpoint Temperature layer. Now you can see your Dewpoint layer!
Step 5: Add a wind plot:
1. Click on Graph -> Split
2. Add Wind Gusts: Click on Product -> New Series
    a. Data Set: Oklahoma Mesonet Time Series; Site: Cheyenne; Variable: Maximum Wind Speed; Units: miles per hour; Options: Check Filled; Color: Red=128, Green=128, Blue=255, Click OK, OK
3. Add Wind Speed: Click on Product -> New Series
    a. Data Set: Oklahoma Mesonet Time Series; Site: Cheyenne; Variable: Wind Speed at 10m; Units: miles per hour; Options: Check Filled; Color: Red=50, Green=50, Blue=143, Click OK, OK
4. Add Wind Direction: Click on Product -> New Series
    a. Data Set: Oklahoma Mesonet Time Series; Site: Cheyenne; Variable: Wind Direction at 10m; Units: Degrees (degrees clockwise from North—which is 0 or 360°. This is the direction that the winds are coming from. 90° is from the east, 180° is from the south, and 270° is from the west); Options: Make sure both boxes are unchecked; Line: Uncheck box; Symbol: Check box and select the white circle with black outline; Size: Move slider to the middle of the bar; Color: Red=128, Green=128, Blue=64, Click OK, OK

Step 6: Add dewpoint depression:
1. Click on Graph -> Split
2. Click on Product -> New Series
    a. Data Set: Oklahoma Mesonet Time Series; Site: Cheyenne; Variable: Dewpoint Depression; Units: Fahrenheit degrees; Options: Check Filled; Color: Red=128, Green=128, Blue=64, Click OK, OK

Using your meteogram, as well as Table 1, answer the following questions:

1. On the evening of the 13th/early on the 14th at Cheyenne:
    a. Is there enough moisture for dew, frozen dew, or frost to form (HINT: is the dewpoint depression 5 degrees or less from 12am to 6am)?
    b. What is the range of wind speeds (lowest to highest) from 12am to 6am? (make sure you're looking at the wind speed at 10m, not the maximum or gust speeds)
    c. What is the highest temperature from 12am to 6am? It is above or below freezing?
    d. What type of event would you expect at Cheyenne?
    (HINT: more than one type of event can occur at the same time)

2. One chilly morning you walk outside to pick up the newspaper. On the way, you notice that your car has thick frost patterns on the windshield, but only a very thin layer of frost (tapering off to no frost) on the windows. The car was parked outside all night, under the stars. Why do you think the windshield has more frost than the other windows? (HINT: think about the direction of radiation from the windshield and the windows during radiative cooling overnight)

THE OKLAHOMA MESONET QUALITY ASSURANCE PROGRAM

By: Alexandria G. McCombs
Mesonet QA Meteorologist

Each day the Oklahoma Mesonet collects over 640,000 observations from 120 stations across the state. To ensure quality data from the Oklahoma Mesonet in real-time, a systematic, rigorous and continually maturing process is used to verify the quality of all measurements.

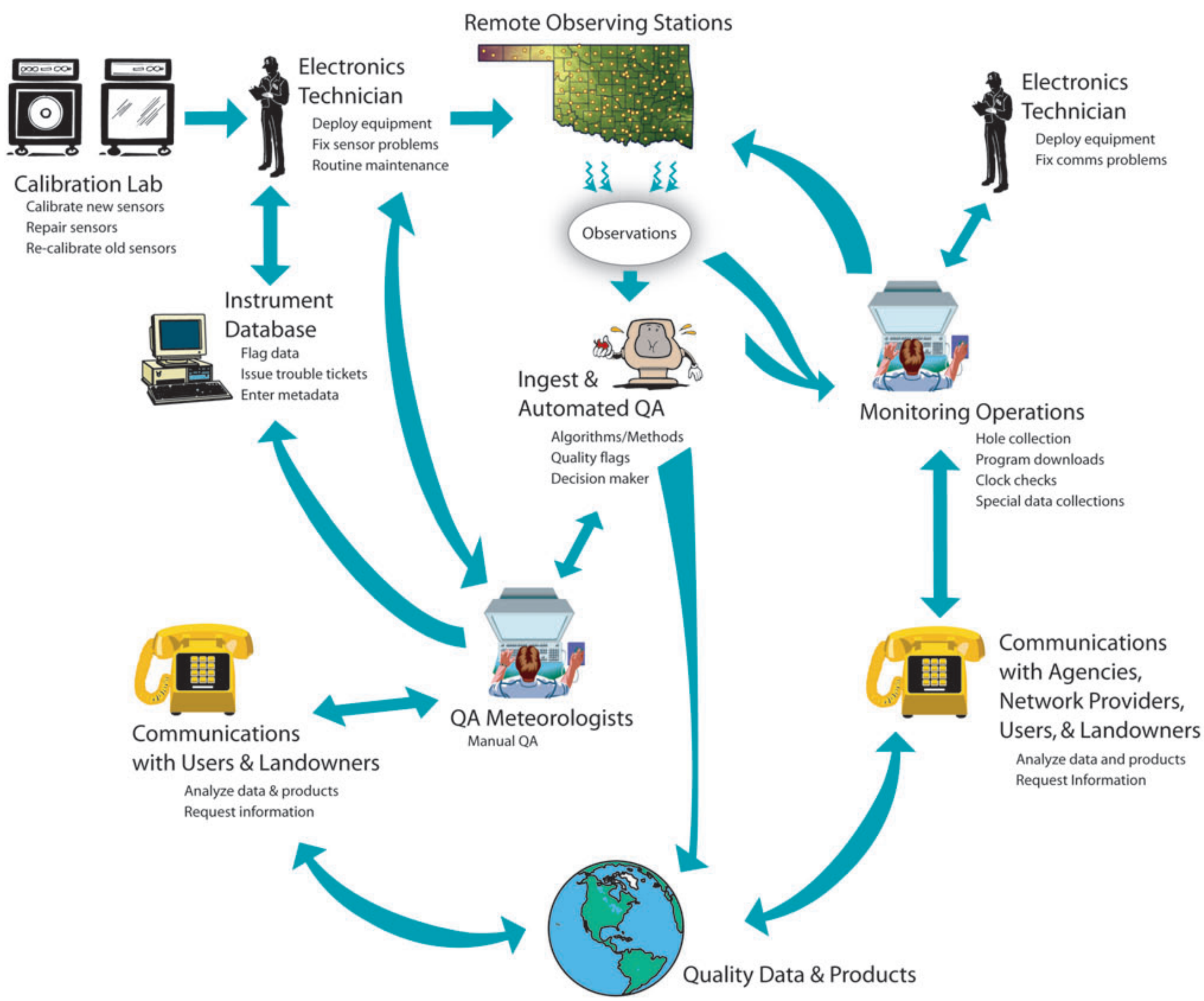
The quality assurance (QA) protocol used by the Oklahoma Mesonet begins with the receipt of a sensor from a vendor and ends with the distribution of real-time data and archived products. The four principle components of the Oklahoma Mesonet's QA system are:

1. **Laboratory Sensor Calibration**
2. **On-Site Inter-comparison of Sensors**
3. **Automated QA**
4. **Manual QA**

The QA system has been in operation at the Oklahoma Mesonet since the network was deployed in 1994. As computer processors became faster and Oklahoma Mesonet personnel gained a better understanding of mesoscale events, new QA methods were developed. The purpose of the QA system is to identify erroneous data and flag the data in the archive. Data is never altered, so the QA flag filters out erroneous data for the users. Figure 1 is an illustration of the Quality Assurance process at the Oklahoma Mesonet; the arrows show how data is transferred in this protocol.

Continued >>

Figure 1 - Schematic of the Oklahoma Mesonet QA. The arrows indicate the transfer of information or equipment. (McPherson et. al. 2007)



Automated and Manual QA

The automated QA software is a series of computer algorithms that are designed to detect significant errors in the real-time data stream. The automated QA system tests the data and then compiles the results and makes a decision on what flag the observation should receive; the data can be flagged as “good”,”suspect”,”warning” or “failure.”

Humans intervene at this point and may choose to override the decision made by the computer. Automated QA develops a report that lists all the stations and sensors that were found to have a problem. The QA Meteorologist looks over the report each day and may choose to override any automated QA flag. If there is a sensor problem, the QA Meteorologist may choose to issue a “trouble ticket” to have a Mesonet Technician go out into the field and fix the problem.
 Occasionally, automated QA will mark real events as bad. For example, when a strong cold front moves over the state, automated QA will frequently flag wind direction as suspect because as the cold front passes over a site, neighboring sites may have a northerly wind while the site has a southerly wind; this can be seen in figure 2. Since this was a real event, the QA Meteorologist was able to override the suspect flag and flag the data as good. The computer cannot decide between what is real and what is not, which is what makes the QA Meteorologist valuable.

Laboratory Sensor Calibration

Each time that a new sensor is received, Oklahoma Mesonet personnel test and calibrate it before deploying it in the field. When a sensor is removed from a site, the sensor is tested before it is cleaned or adjusted. This shows how well the sensor was performing in the field prior to its removal. If the sensor is not performing properly QA Meteorologists may choose to flag data as bad for a time period prior to when the sensor was replaced. If the sensor can be cleaned, adjusted and rotated back into the field, the sensor is tested and calibrated again before it is redeployed into the network.

Some types of sensors have preferred rotation periods; after a certain amount of months the sensor is replaced by a technician. This occurs even if there is not a problem with the sensor’s data.

On-Site Inter-Comparison of Sensors

Each summer, an Oklahoma Mesonet technician visits every station in the network to conduct an on-site inter-comparison of sensors. This test compares the output of the sensor at the Mesonet station to a set of sensors brought to the site by the technician. This is performed on the following sensors:

- **Relative Humidity (Vaisala HMP 45C)**
- **Air Temp. at 1.5m (Thermometrics Fast Air Temp.)**
- **Solar Radiation (Li-Cor Pyranometer)**
- **Atmospheric Pressure (Vaisala Barometer)**

The technician records the data from the reference sensors and the station sensors and then finds the difference in the observations. This information is then given to the QA Meteorologist to investigate. By comparing the sensors in the field, QA Meteorologists are able to see subtle biases that may not be identifiable by the automated QA or the QA Meteorologist. If a sensor is found to have a bias, the problem is traced and a trouble ticket is issued for a technician to replace the sensor.

Site Maintenance

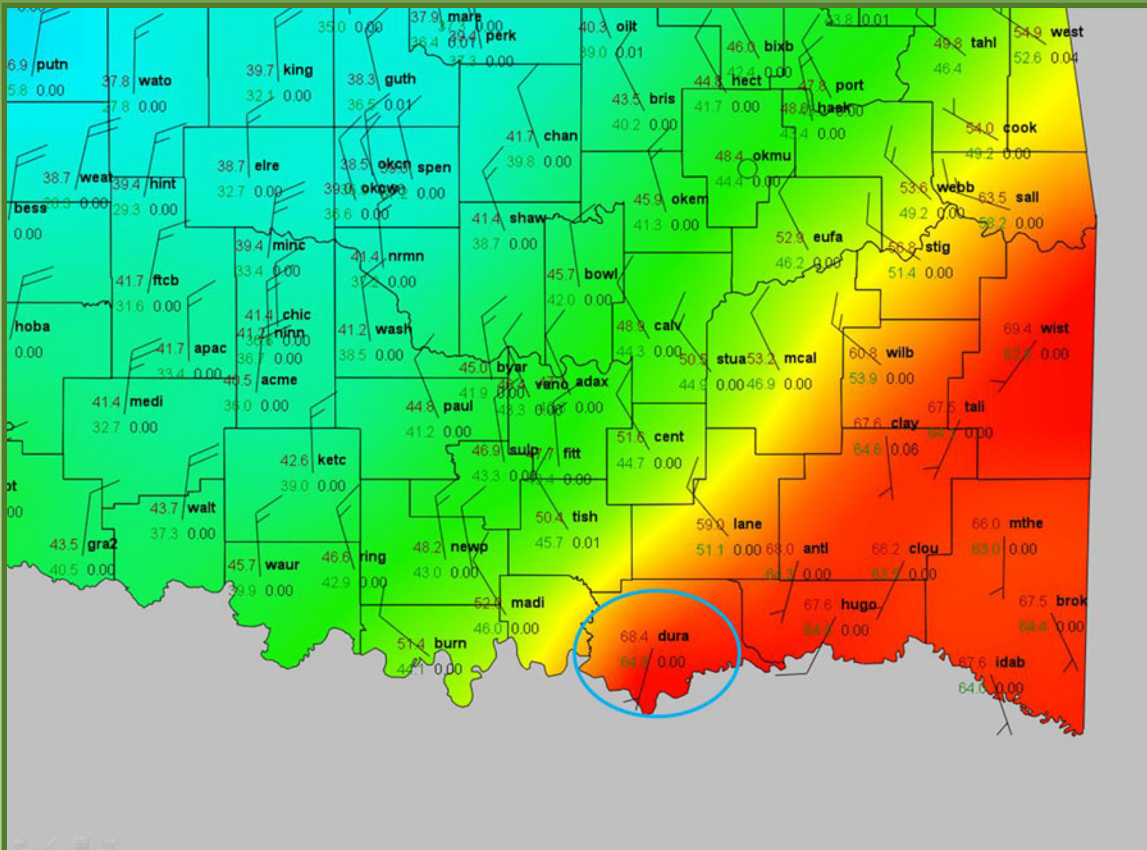
Every spring, summer and fall Oklahoma Mesonet technicians visit every station in the network to maintain vegetation and other elements of nature that may cause bad data. Often vegetation will grow over the bare soil temperature plot, which can insulate temperatures in the ground. An example can be shown in figure 3. This information is given to the QA Meteorologists so the appropriate data can be flagged. The findings of each site pass are posted online at:

http://www.mesonet.org/sitepass/

Summary

Without the Mesonet quality assurance system, the data released to users would not be research quality. Automated quality assurance tests cannot catch every bad observation without flagging good data, they are simply tools to help the quality assurance meteorologist and Oklahoma Mesonet personnel catch data problems.

Figure 2



Cold Front passage on 11/21/2007 13:50 UTC, Durant OK (DURA circled in blue) wind direction was flagged as suspect because neighboring sites had already shifted to have wind directions from the north. The color gradient is air temperature at 1.5m

Figure 3

Shawnee, OK Mesonet station bare soil plot on 20 May 2008 before (left) and after (right) spring 2008 site pass.

LAKE SAFETY TIPS

Visiting area lakes can be a fun for people of all ages. Here are a few tips to keep everyone safe during your next trip to the lake:

- » Don't consume alcohol - 50 percent of drowning deaths involve alcohol
- » Use properly fitted life jackets
- » Take a boating safety course
- » Monitor weather conditions – get off lake if storms nearby
- » Learn to swim
- » Never swim or boat alone
- » Don't dive into water before verifying the water depth
- » Avoid murky water which can hide underwater objects and unexpected drop-offs
- » Never swim under a raft or dock.
- » Verify equipment is in good shape.
- » Always turn the boat motor completely off near people in water
- » Don't ski at night or in restricted areas.

More information is available from these sites:

Oklahoma Boating Laws and Responsibilities:
http://www.boat-ed.com/ok/ok_specific_images/pdfs/OK_handbook_entire.pdf

American Red Cross Water Safety Tips:
http://www.redcross.org/services/hss/tips/healthtips/safetywater.html#general

National Weather Service Weather Radios:
http://www.srh.noaa.gov/oun/wxradio/

Lightning Safety:
http://www.lightningsafety.noaa.gov/overview.htm

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