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A Closer Look at Weather Forecast and Weather Parameters from a Public Health Perspective

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Background

Extreme heat poses a huge threat to public health throughout the six SCIPP states. For example, according to the statistics provided by the National Weather Service, Texas had the highest number of heat-related deaths than other states in 2011. Extreme heat has also been reported to be associated with an elevated risk of a variety of disease outcomes besides deaths, e.g., heat stroke, heat exhaustion, cardiovascular and respiratory diseases. Extreme heat affects some populations more than others, and those people include elderly, outdoor labors, children, athletes, poor and those with pre-existing diseases (e.g., cardiovascular diseases, diabetes, and renal diseases). Residents in SCIPP states are expected to experience a more difficult situation in the future because heat waves were projected to happen more often and be more intense as a result of a warming climate.

Although many heat-related health studies have been conducted in the U.S. and around the world, scientists have not reached a consensus on the 'best' heat wave warning triggers to activate heat-wave and health warning systems (HHWSs) and the 'best' metrics characterizing heat exposures. This article will summarize two recent studies related to these two questions from a public health perspective.

Performance of Forecast Products in Identifying Heat Waves and Estimating Heat Wave Effects on Mortality

Weather forecasting is an art and a science. Figure 1 demonstrates how weather forecasts are made. Basically, forecasters in local National Weather Service offices receive weather observations through satellites, radar, weather balloons and weather stations, and forecasted weather conditions from a few numerical forecast models and model output statistics (MOS) products. The MOS products are calibrated forecast outputs to link the original outputs of numerical forecast models at grid cells to the observations at weather stations.

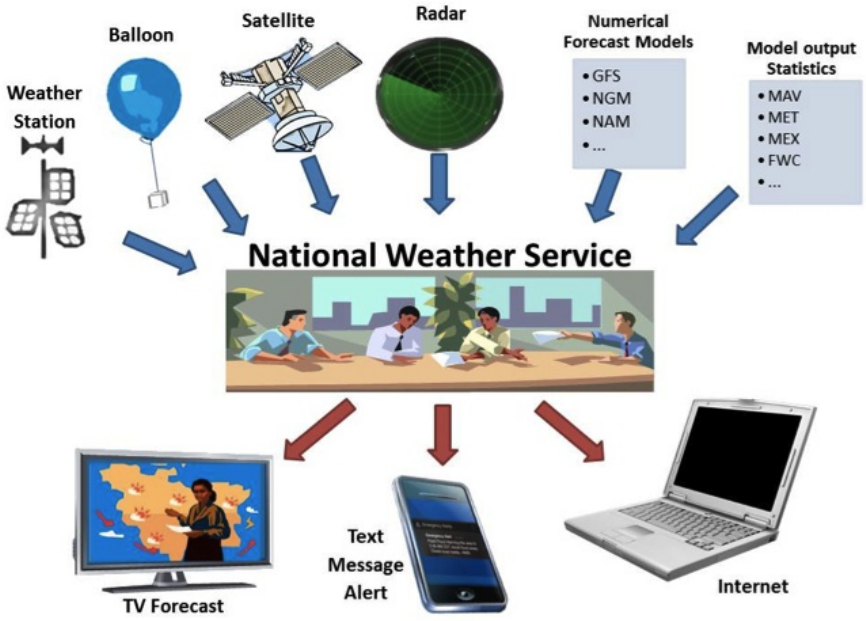

Figure 1. Simplified weather forecasting process

Forecasters make decisions on weather forecasts and heat warnings based on HHWSs and their judgment. A few metrics have been used to activate HHWSs: absolute or relative temperature

threshold, heat index (HI), physiologically-based discomfort classifications, the temperature–mortality relationship derived from epidemiologic analysis, and spatial synoptic classification (SSC). Unfortunately, these metrics have been shown that they differed in identifying heat-wave days. Moreover, all current HHWSs rely on weather forecasts; however, they have not taken weather forecast's uncertainties into their systems.

We obtained mortality data and historical weather observation and forecast data in Detroit from 2002 to 2006. We mainly looked at three MOS products (FWC, MAV, MET) and one operational product made by local forecasters (Revised Digital Forecast, RDF). We compared forecast products' performance in predicting heat-wave days. We also fit statistical regression models between mortality and temperatures derived from observations and each forecast product separately. We estimated heat effects (the independent effect on mortality due to daily temperature) and heat-wave effect associated with heat waves.

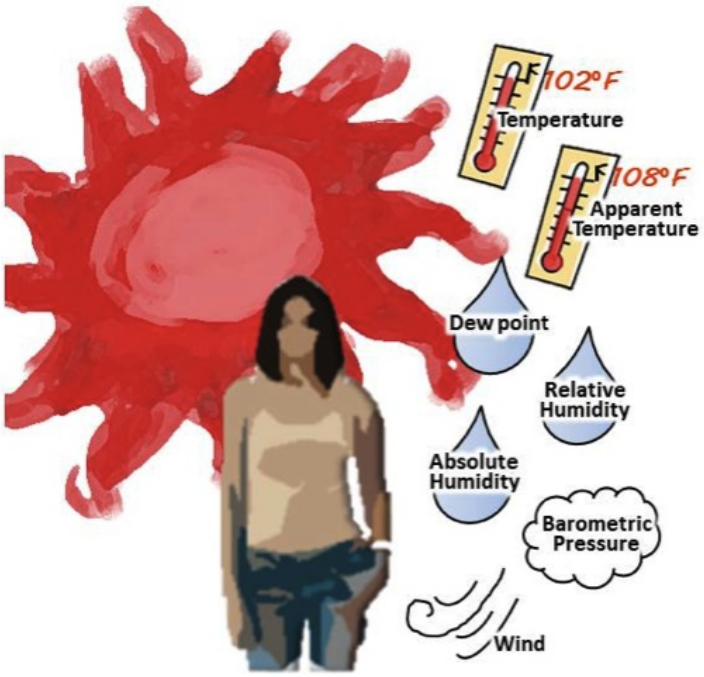

Figure 2. Heat and weather

The forecast quality in identifying heat-wave days varied with forecast product and timing of issuance. One-day-ahead RDF forecast had about half the number of false positives than all other forecasts. Forecasts generally tended to overestimate heat effects and to underestimate heat-wave effects.

This study highlights the challenges in issuing heat alerts based on weather forecasts because forecast models are not designed for predicting weather extremes and forecast quality varies with products and issuing time. False heat alerts can cause a substantial cost of public health actions and lose people's trust. This research also suggests local knowledge in both weather and population health is critical to issue heat warnings. A more accurate heat-wave and health warning system requires that climate/meteorology and public health researchers should work together.

What weather variables are important in predicting heat-related mortality?

How hot is too hot? Conceptually, our feeling varies by person and depends on many weather parameters shown by Figure 2, e.g., temperature, humidity, wind and pressure. Previous studies have used different variables to characterize heat exposures, e.g., daily mean/minimum/maximum temperature, relative humidity, apparent temperature/ heat index (a function of temperature and humidity), and air mass. However, these weather metrics may not well characterize heat exposures, which are affected by many factors. This study aimed to rank weather variables in predicting heat-related mortality.

Statistical methods used in the literature cannot deal with too many weather variables at the same time because they are highly correlated.

This study used a recent breakthrough statistical method called 'random forests'. We applied this method to merged weather-mortality datasets in four U.S. cities (Chicago, IL; Detroit, MI; Philadelphia, PA; and Phoenix, AZ) from 1998 to 2006. Nearly forty weather variables were included in models, including daily minimum, mean and maximum temperature, dew point, apparent temperature, barometric pressure and absolute humidity on the same day as, one day before, and two days before the deaths occurred. Absolute humidity refers to the actual moisture in the air, while relative humidity is defined as the ratio of the actual moisture against the maximum amount of moisture that the air can hold at a given temperature.

Although the ranks of weather variables varied with city and causes of death, apparent temperature was the most important predictor for total mortality. This study is the first to show absolute humidity as one of the most important variables predicting heat-related mortality, suggesting that absolute humidity may be a more important metric reflecting physiologically stressful heat exposure than relative humidity. Absolute humidity has been ignored in previous heat-related studies. These results also imply that apparent temperature is a reasonable variable for activating heat alerts and warnings because it is better than other metrics in predicting total mortality. This study also implies that we should consider absolute humidity in future heat-health studies to investigate possible physiological mechanisms between heat and a variety of diseases.

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Drought Update

Luigi Romolo
Southern Regional Climate Center

Drought conditions in the Southern Region improved over much of Oklahoma and Texas, with some areas seeing a one category improvement. Rainfall in eastern Tennessee resulted in the removal of drought conditions there, however, some counties in the northeast are still abnormally dry. In total, the region improved by approximately three percent in areal coverage in terms of moderate drought conditions or worse. There was also a four percent reduction in the amount of extreme and exceptional drought in Texas and Oklahoma combined. These improvements were the direct consequence of above normal precipitation for the month of July.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	44.85	55.15	38.73	24.34	9.13	1.79
Last Week 7/29/2014	43.30	56.70	39.88	24.65	10.33	2.08
3 Months Ago 5/6/2014	25.93	74.07	54.44	41.67	29.82	14.72
Start of Calendar Year 12/31/2013	55.85	44.15	27.23	13.21	3.58	0.72
Start of Water Year 10/1/2013	26.20	73.80	50.11	17.90	3.16	0.25
One Year Ago 8/6/2013	25.56	74.44	56.46	38.82	15.95	3.75

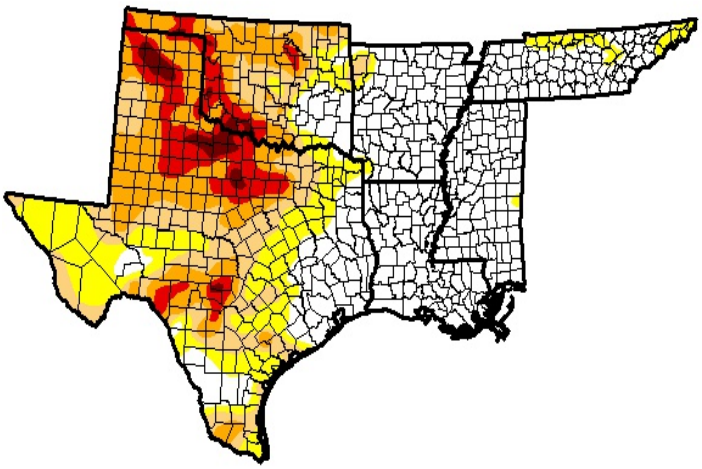
Intensity:

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompany text summary for forecast statements. **http://droughtmonitor.unl.edu**

Multiple wind reports were recorded on July 23, throughout much of eastern Oklahoma and Arkansas. Most of the damage was restricted to trees and power lines. There were some reports of damaged homes in Sebastian County, Arkansas. In Caddo Parish, Louisiana, a 64 year old woman was killed by a falling tree.

In Texas, on July 15, two EF-0 tornadoes in the Panhandle and heavy rains across central Texas, knocked out power out to 7,000 in San Antonio and another 2,000 in the Metroplex. Storms in the East at the end of the month did the same, leaving 3,400 without power in Houston and causing local flash floods (Information provided by the Texas Office of State Climatology).



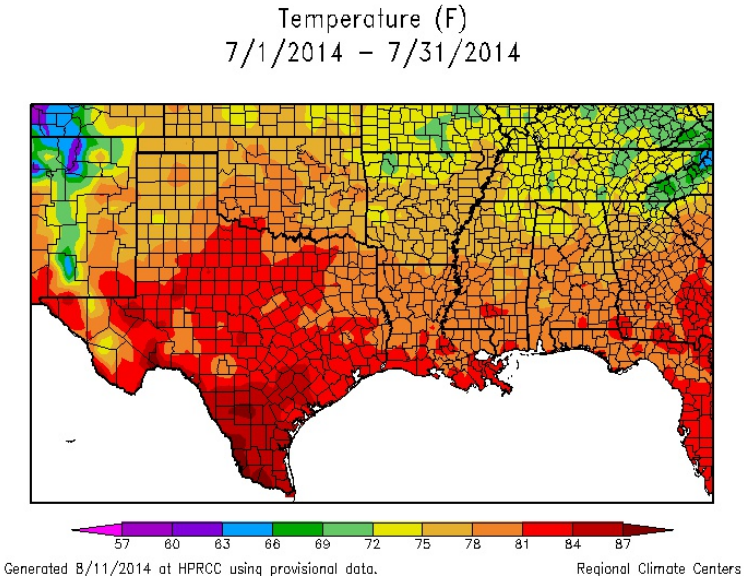
Released Thursday, August 7, 2014.
Brad Rippey National U.S. Department of Agriculture

Above: Drought August 5, 2014. Image is courtesy of National Drought Mitigation Center.

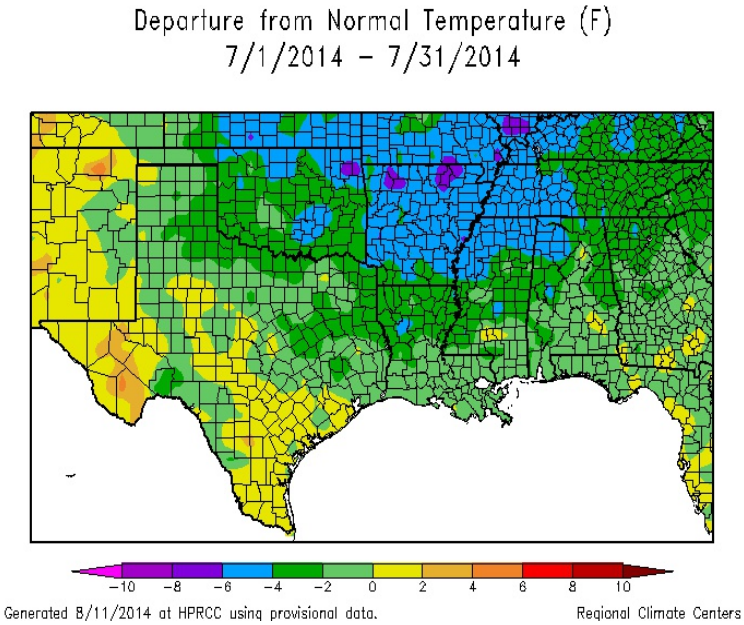
Temperature Summary

Luigi Romolo
Southern Regional Climate Center

The month of July was a cooler than normal month across the board for the Southern Region. For the most part, temperatures averages 2 to 4 degrees F (1.11 to 2.22 degrees C) below normal. The coolest areas of the region occurred in Arkansas and in the surrounding counties of Oklahoma, Mississippi and Tennessee. Only two small portions of the Southern Region averaged slightly above normal. This included the western panhandle of Texas and the southern counties of Texas. All six states reported average temperatures for the month that were below normal, and for the region as a whole, it was the thirteenth coldest July on record (1895-2014) with a region-wide average temperature of 79.54 degrees F (26.41 degrees C). The state wide average temperatures for the month are as follows: Arkansas reported 75.70 degrees F (24.28 degrees C), Louisiana reported 80.20 degrees F (26.78 degrees C), Mississippi reported 77.70 degrees F (25.39 degrees C), Oklahoma reported 78.20 degrees F (25.67 degrees C), Tennessee reported 73.60 degrees F (23.11 degrees C), and Texas reported 81.80 degrees F (27.67 degrees C). For the state of Arkansas, it was the coldest July on record (1895-2014) and the first time the state reported an average July temperature that was lower than 76.00 degrees F (24.44 degrees C). It was also the second coldest July on record (1895-2014) for the state of Mississippi, and only the second time Mississippi reported an average July temperature lower than 78.00 degrees F (25.56 degrees C). For Tennessee it was their third coldest July on record (1895-2014), while Oklahoma and Louisiana recorded their seventh and ninth coldest July on record (1895-2014), respectively. For Texas, it was only their forty-fifth coldest July (1895.2014).



Average July 2014 Temperature across the South.

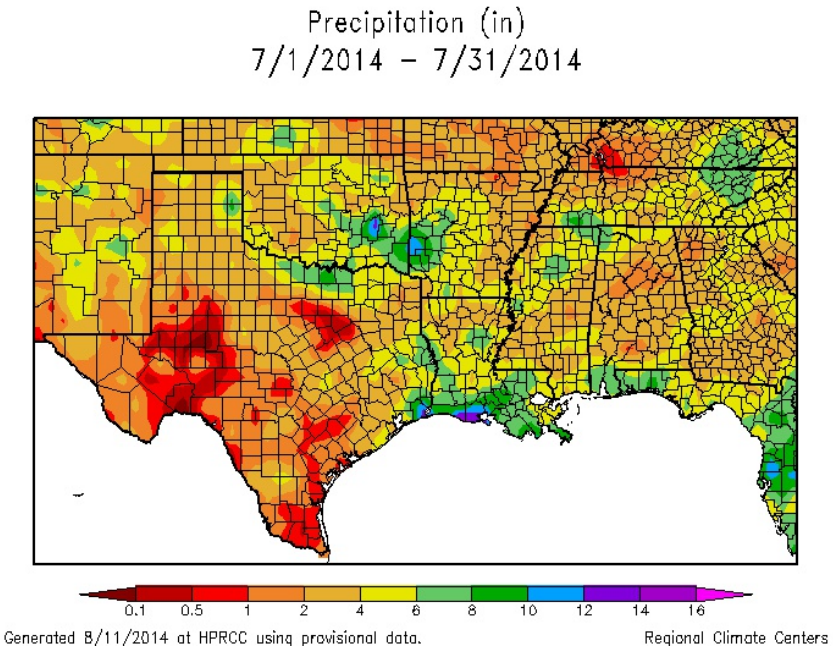


Average Temperature Departures from 1971-2000 for July 2014 across the South.

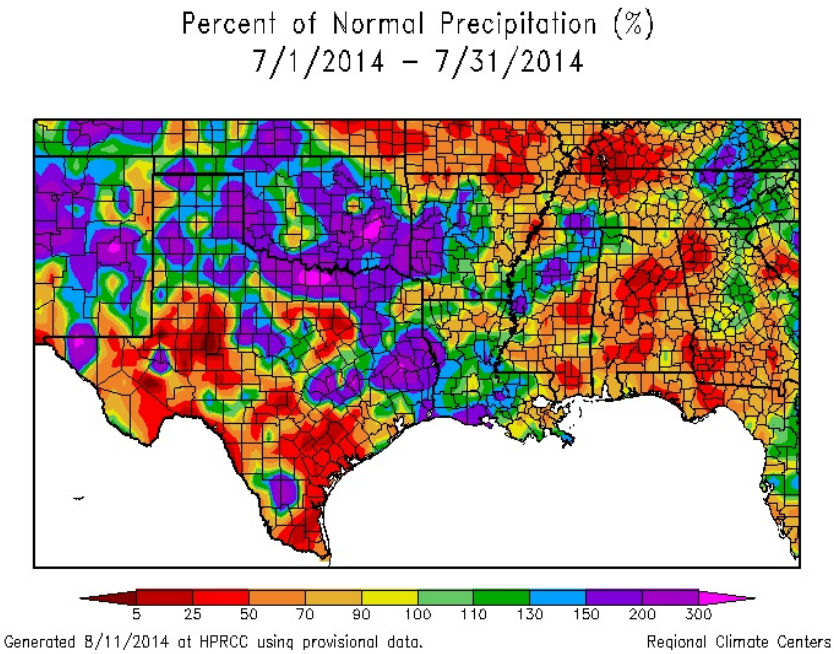
Precipitation Summary

Luigi Romolo
Southern Regional Climate Center

July precipitation varied spatially over the Southern Region. The state of Oklahoma, along with northern Texas, enjoyed a wetter than normal month, which helped alleviate drought conditions, however, other portions of the region saw precipitation totals that were only 50 to 70 percent of normal. Drier than normal areas included southern Texas, northern Arkansas, southern Mississippi, and much of central and western Tennessee. In Oklahoma and northern Texas, precipitation totals varied from 150 to over 200 percent of normal. The state wide averaged precipitation totals for the month are as follows: Arkansas averaged 4.20 inches (106.68 mm), Louisiana averaged 5.80 (147.32 mm), Mississippi averaged 3.99 inches (101.35 mm), Oklahoma average 4.44 inches (112.78 mm), Tennessee average 4.10 inches (101.85 mm), and Texas averaged 2.48 inches (62.99 mm). For Oklahoma, it was the twenty-first wettest July on record (1895-2014). All other state rankings fell within the two middle quartiles.

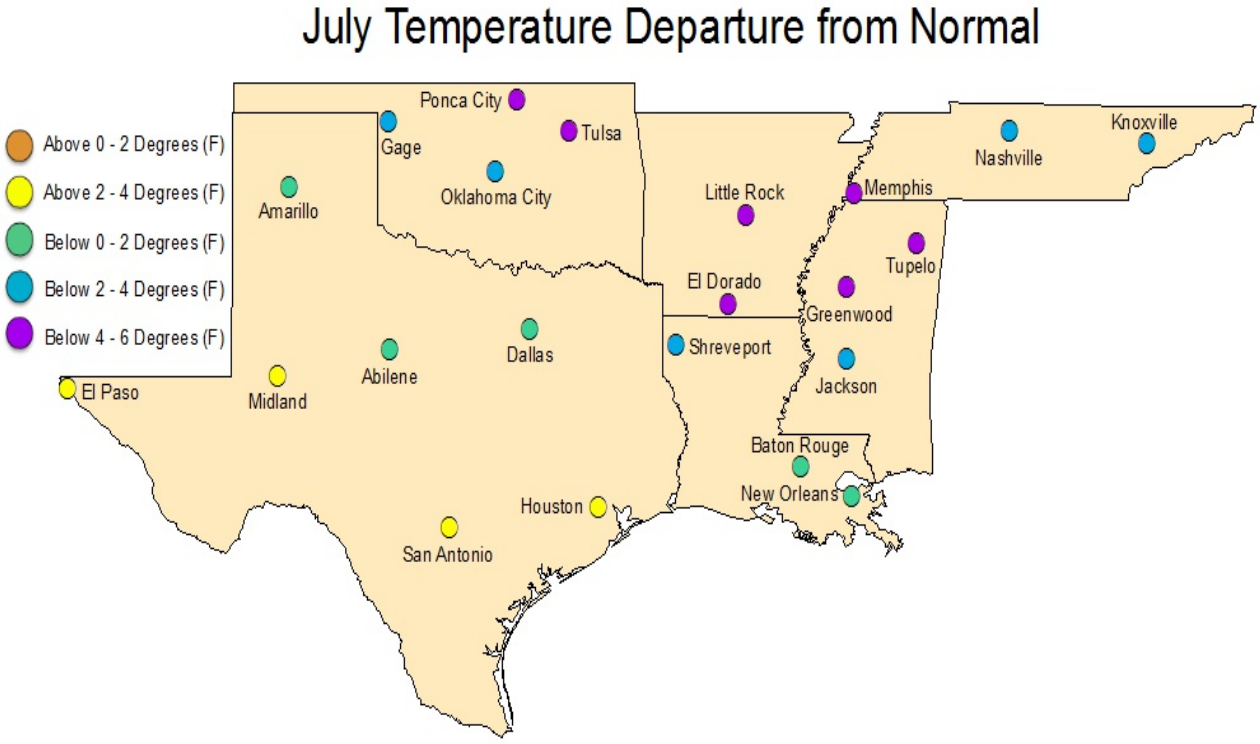


July 2014 Total Precipitation across the South.

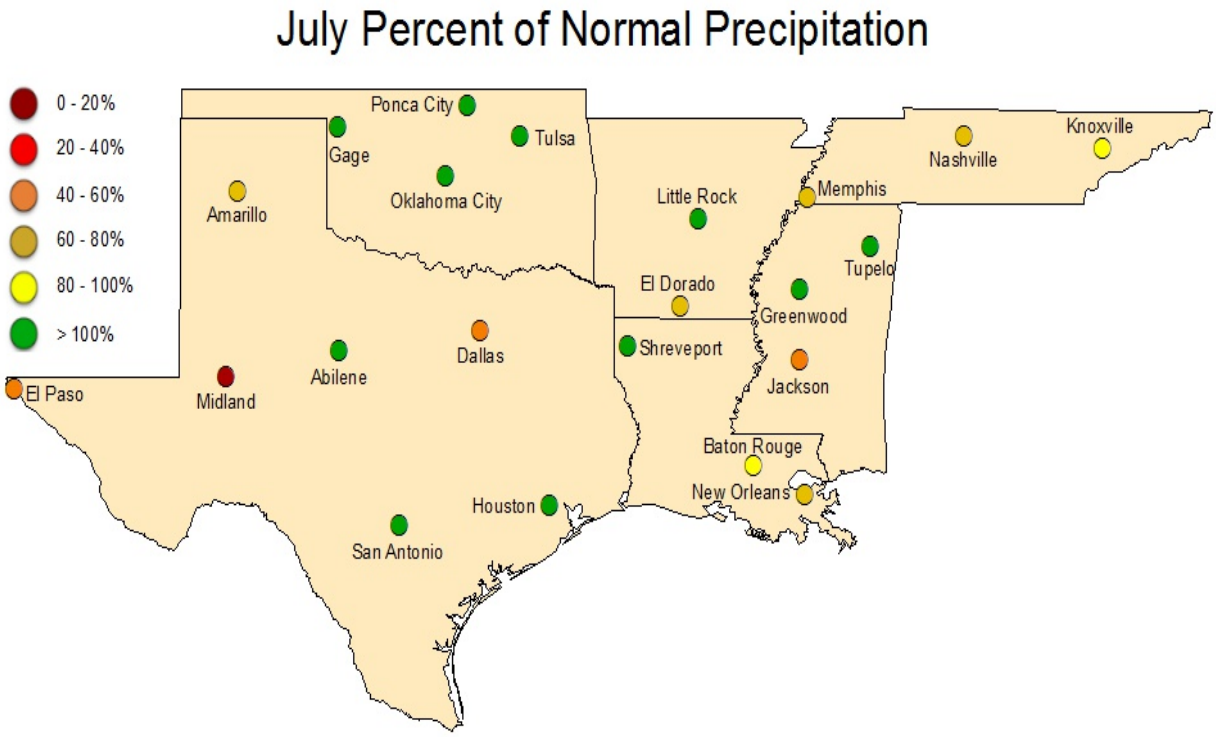


Percent of 1971-2000 normal precipitation totals for July 2014 across the South.

Regional Climate Perspective in Pictures



July 2014 Temperature Departure from Normal from 1971-2000 for SCIPP Regional Cities



July 2014 Percent of 1971-2000 Normal Precipitation Totals for SCIPP Regional Cities

Climate Perspective

State	Temperature	Rank (1895-2011)	Precipitation	Rank (1895-2011)
Arkansas	75.70	1rst Coldest	4.20	44th Wettest
Louisiana	80.20	9th Coldest	5.80	51st Wettest
Mississippi	77.70	2nd Coldest	3.99	35th Wettest
Oklahoma	78.20	7th Coldest	4.44	21st Wettest
Tennessee	73.60	3rd Coldest	4.01	48th Driest
Texas	81.80	45th Coldest	2.48	50th Wettest

State temperature and precipitation values and rankings for July 2014. Ranks are based on the National Climatic Data Center's Statewide, Regional, and National Dataset over the period 1895-2011.

Station Summaries Across the South

Station Summaries Across the South

Station Name	Temperatures								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	%Norm
El Dorado, AR	87.6	67.0	77.3	-4.6	96	7/13+	59	7/16	2.86	-1.27	69
Little Rock, AR	86.5	68.5	77.5	-4.9	96	7/14	62	7/18+	7.24	3.93	219
Baton Rouge, LA	90.8	71.4	81.1	-0.6	95	7/26	62	7/17	5.79	-0.17	97
New Orleans, LA	89.9	74.9	82.4	-0.3	95	7/2	70	7/31+	4.50	-1.70	73
Shreveport, LA	89.9	71.1	80.5	-2.9	99	7/13	64	7/21	4.26	0.27	107
Greenwood, MS	87.1	66.5	76.8	-5.6	94	7/12	58	7/30+	5.59	1.40	133
Jackson, MS	89.0	69.0	79.0	-2.4	95	7/26	59	7/30	2.14	-2.55	46
Tupelo, MS	86.4	66.7	76.5	-4.1	94	7/14	58	7/30	6.06	2.41	166
Gage, OK	89.2	66.0	77.6	-3.0	105	7/26	57	7/31	2.90	1.08	159
Oklahoma City, OK	89.4	69.0	79.2	-2.8	100	7/26	62	7/17+	4.18	1.24	142
Ponca City, OK	87.6	67.1	77.4	-5.5	100	7/26+	57	7/15+	4.45	1.02	130
Tulsa, OK	88.4	67.9	78.2	-5.3	101	7/13	57	7/3	4.42	1.46	149
Knoxville, TN	84.8	65.2	75.0	-2.7	93	7/14	54	7/30	4.68	-0.03	99
Memphis, TN	86.5	69.5	78.0	-4.5	95	7/14	62	7/16	2.57	-1.65	61
Nashville, TN	87.6	65.9	76.8	-2.3	95	7/13+	56	7/5	2.38	-1.39	63
Abilene, TX	94.4	72.5	83.5	0.0	101	7/27+	65	7/19	2.46	0.76	145
Amarillo, TX	87.7	65.4	76.5	-1.7	100	7/25	58	7/31	1.82	-0.86	68
El Paso, TX	96.7	72.8	84.8	1.5	104	7/20+	68	7/29+	0.69	-0.80	46
Dallas, TX	93.7	73.9	83.8	-1.2	103	7/27	65	7/20+	0.98	-1.14	46
Houston, TX	93.1	74.3	83.7	0.1	99	7/28	72	7/30+	5.41	2.23	170
Midland, TX	95.1	71.7	83.4	1.7	102	7/30	67	7/18	0.33	-1.56	17
San Antonio, TX	94.7	75.0	84.9	0.5	99	7/29+	72	7/18+	3.25	1.22	160

Summary of temperature and precipitation information from around the region for July 2014. Data provided by the Applied Climate Information System. On this chart, "depart" is the average's departure from the normal average, and "% norm" is the percentage of rainfall received compared with normal amounts of rainfall. Plus signs in the dates column denote that the extremes were reached on multiple days. Blueshaded boxes represent cooler than normal temperatures; redshaded boxes denote warmer than normal temperatures; tan shades represent drier than normal conditions; and green shades denote wetter than normal conditions.

The Skin Effect of Lightning

Barry Keim, Louisiana State Climatologist, Louisiana State University

Lightning kills about 50 people every year in the United States, and the Gulf South, especially Florida, accounts for much more than their fair share of these victims. However, did you know that if you're caught in a violent thunderstorm, and cannot make it indoors, that the interior of your car is a relatively safe haven from the dangers of lightning? YUP, it's true. I bet your first line of thinking is that the rubber tires on the car protect you. Well, if you thought that, you'd be wrong. The protection comes from something called the "skin effect," which essentially means that when lightning strikes a car, usually on the roof or antenna, the energy travels around the exterior of the car, then moves through or around the tires (even despite the rubber), and is dissipated into the ground. As such, the lightning remains on the "skin" of the car, and it does not directly penetrate into the car. However, lightning can and will travel through the electrical system of the car and it would best to avoid contact with the steering wheel or a plugged-in cell phone. Note however, that after a car is struck by lightning, it is best to check the car as soon as possible because fuel can sometimes be ignited leading to a fire, or worse an explosion. In addition, one or more of the tires are frequently flattened by the lightning. Lightning can also find its way into the small defrosting wires in the rear windows of some cars, which will blow out the window. Although most cars are indeed safe havens from lightning, realize that fiberglass cars, convertibles, or even metal cars with the windows down are not going to help you much in this instance. So, when in a violent thunderstorm, feel somewhat secure while in the confines of your automobile. Please contact me with any questions or comments at keim@lsu.edu.

Figure 1. Lightning striking a tree. Image is in the public domain as it was taken by a NOAA employee and can found at <http://commons.wikimedia.org/wiki/File:Lightning_hits_tree.jpg>.

Monthly Comic Relief

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