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Southern Climate Monitor

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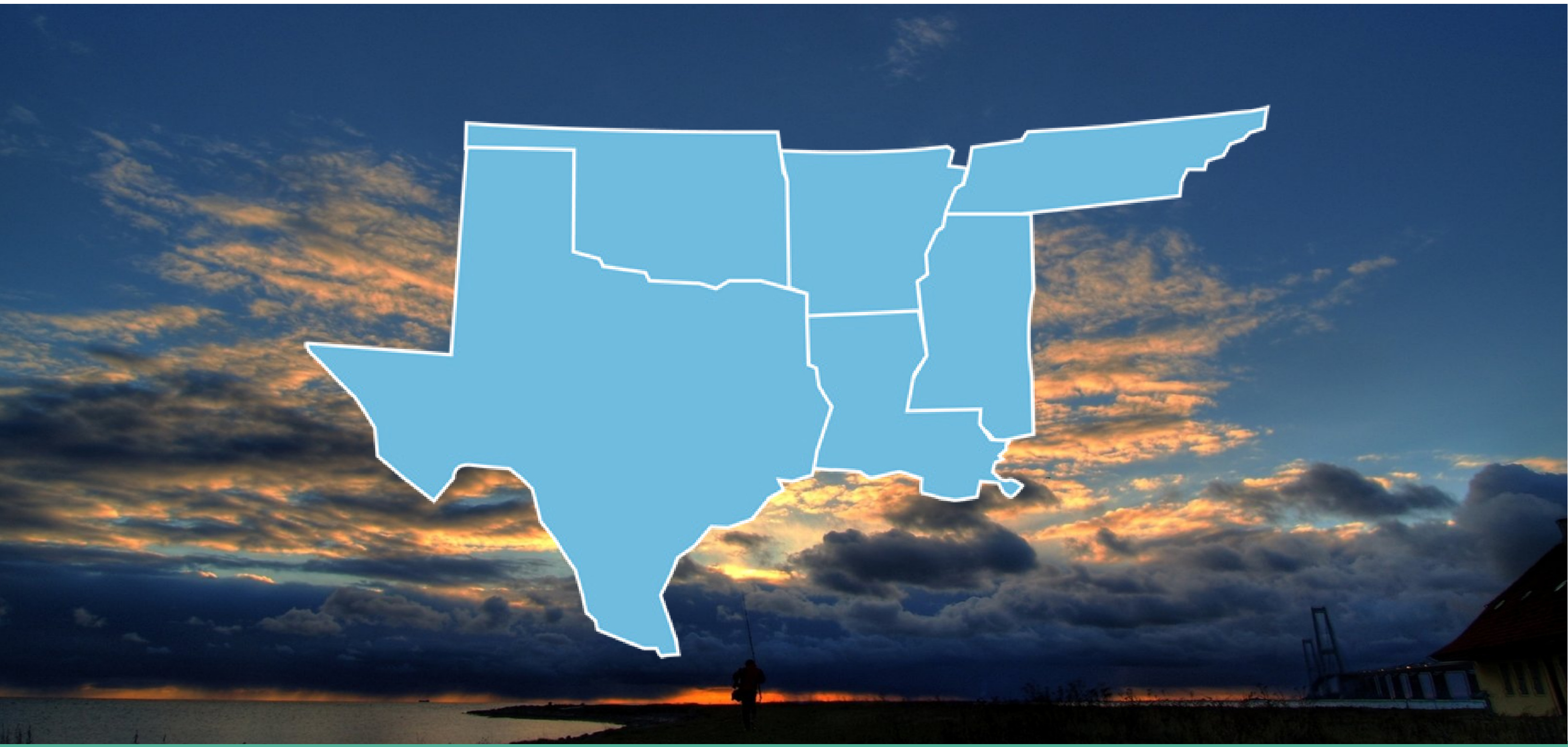


In This Issue:

The Southern Climate Monitor is available at
www.srcc.lsu.edu & www.southernclimate.org

Hydrologic Forecast Uncertainty – An Implementation at the National Weather Service Lower Mississippi River Forecast Center

David Schlotzhauer, Lower Mississippi River Forecast Center Hydrologist

Forecasting is an uncertain business. The forecasting done at the National Weather Service (NWS) includes weather and water media. Much of the weather forecasting is now driven by numerical models that strive to replicate mathematically the behavior of the atmosphere. There are different models that give slightly different answers due to varying assumptions to model the desired behavior. Slightly differing answers can also be obtained by varying the inputs to an individual model. These varied outputs can be combined into an ensemble to provide a range of possible outcomes and related likelihoods. It is important to the users of forecasts to know how reliable a forecast is as well as the plus or minus giving a range of what might happen. Ensemble forecasting is becoming a common enough concept that it is moving from the scientific literature to more mainstream discussions…just Google "meteorological forecast uncertainty"…and is routinely providing what-if information to the end users.

Water forecasting, such as that done at the NWS River Forecast Centers (RFC), seeking to predict flow and stage, is also based on numerical models using either hydrologic or hydraulic equations. Atmospheric modeling of rainfall (where, when, how much) is a major input to the water forecasting, but the water models add another level of uncertainty to the flow and stage forecasts. The National Weather Service has a work in progress to parallel the atmospheric ensembles, called the Hydrologic Ensemble Forecast System (HEFS) (http://www.nws.noaa.gov/os/water/RFC_support/HEFS_doc/HEFS_Overview_0.1.2.pdf). HEFS incorporates meteorologic uncertainty in the form of varied precipitation inputs to the streamflow models, and provides some calculation of uncertainty within the streamflow models. However, as just mentioned, HEFS is in development and testing and not available for operational forecasting. So, how can uncertainty be incorporated into an RFC's forecasts?

The lower end of the Mississippi River is within the bounds of the Lower Mississippi RFC (LMRFC) area of responsibility. From Cairo, IL on the Ohio River and Cape Girardeau, MO on the Mississippi River on downriver, daily stage forecasting extending 28 days into the future is performed by the LMRFC (see Figure 1 and Table 1 for forecast locations). The official forecast is based on two days of forecasted precipitation falling over the entire area that drains water into the Mississippi River (including the Ohio, Missouri, and Arkansas Rivers). The LMRFC is using this stretch of river and the associated forecast locations to test an experimental method for determining and displaying hydrologic forecast uncertainty.

Two methods are used, that are combined into a "Part A" and "Part B." Part A is directed at inputting a variable amount of forecasted precipitation into the river models. Small drainage basins (on the order of tens or hundreds of square miles in area) are sensitive to the location of rainfall, i.e. a shift in location of tens of miles could mean the difference between rain or no rain on a basin. Therefore, for most forecasting, the LMRFC uses only 24 hours of

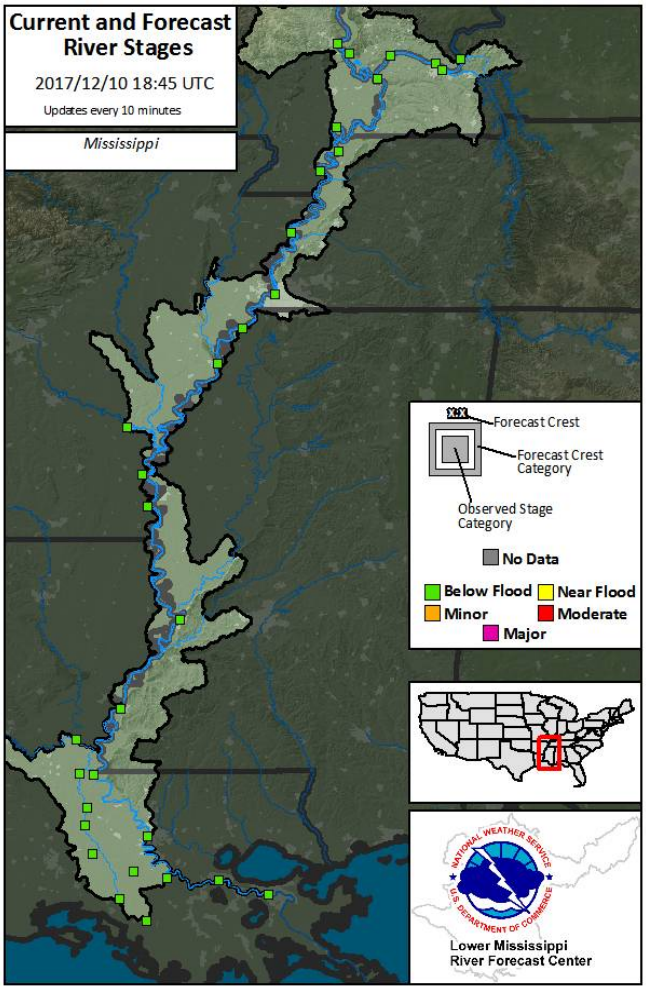


Figure 1: LMRFC forecast locations along the lower Mississippi River (see also Table 1).

forecasted precipitation in its modeling and for the official Mississippi River forecasts uses 48 hours of forecasted precipitation. We have found, however, that because the Mississippi River basin is so large (over a million square miles in area), the forecast modeling is not nearly as sensitive to locational errors. So, an extended period of precipitation can be used as input. Specifically, 16 days of precipitation (provided by the North American Ensemble Forecast System) provides much more accurate output in the seven to 28 day timeframe.

Part B consists of looking at the past forecast errors. Looking back, we can find the error between the forecasted stage and the stage that actually occurred. Then for each day, 1 – 28, the errors are compiled and a percentile

Cairo, IL	Memphis, TN	Natchez, MS
Cape Girardeau, MO	Tunica, MS	Red River Landing, LA
New Madrid, MO	Helena, AR	Baton Rouge, LA
Tiptonville, TN	Arkansas City, AR	Donaldsonville, LA
Caruthersville, MO	Greenville, MS	Reserve, LA
Osceola, AR	Vicksburg, MS	New Orleans, LA

Table 1: List of LMRFC Mississippi River Forecast Locations

distribution is built. Using an uncertainty concept analogous to how the National Hurricane Center builds a forecast uncertainty cone, the LMRFC is using a 67% error range. Based on past forecast performance we find and display a range that statistically includes 67% (2/3) of forecast error. The 67% error range is bounded by the 16.7th percentile and the 83.3rd percentile. Errors range from small early in the forecast period and grow toward the 28th day. This use of the percentile range also provides a biasing to correct the forecast "direction," which in the case of the river stages generally raises the expected forecast values over time.

Figure 2 presents an example of the forecasts for Cairo, IL. The upper graph uses two days of precipitation as model input and the lower graph 16 days. In both, the forecast is shown by the solid line and error bounds by the shaded area. Two things are notable on the graphs. First, the forecast using two days of precipitation is generally lower than the forecast using 16 days. This results from not accounting for enough precipitation input in the forecast period. Second, the 2 day precipitation forecast falls below the error bound much sooner than the 16 day precipitation forecast, indicating the 16 day input provides a more accurate forecast over time.

The use of multiple varied inputs to forecasting is an accepted method for judging the accuracy of forecasting. It is more than just "commonly used"; in fact, this methodology is a standard method for modeling the atmosphere to forecast the weather. Unfortunately, the process has not quite reached operational status for hydrologic forecasting. However, by utilizing the combination of varied (in this case increased time of) precipitation input to the model and the past forecast error statistics, a more accurate forecast with a defined error bounds is generated.

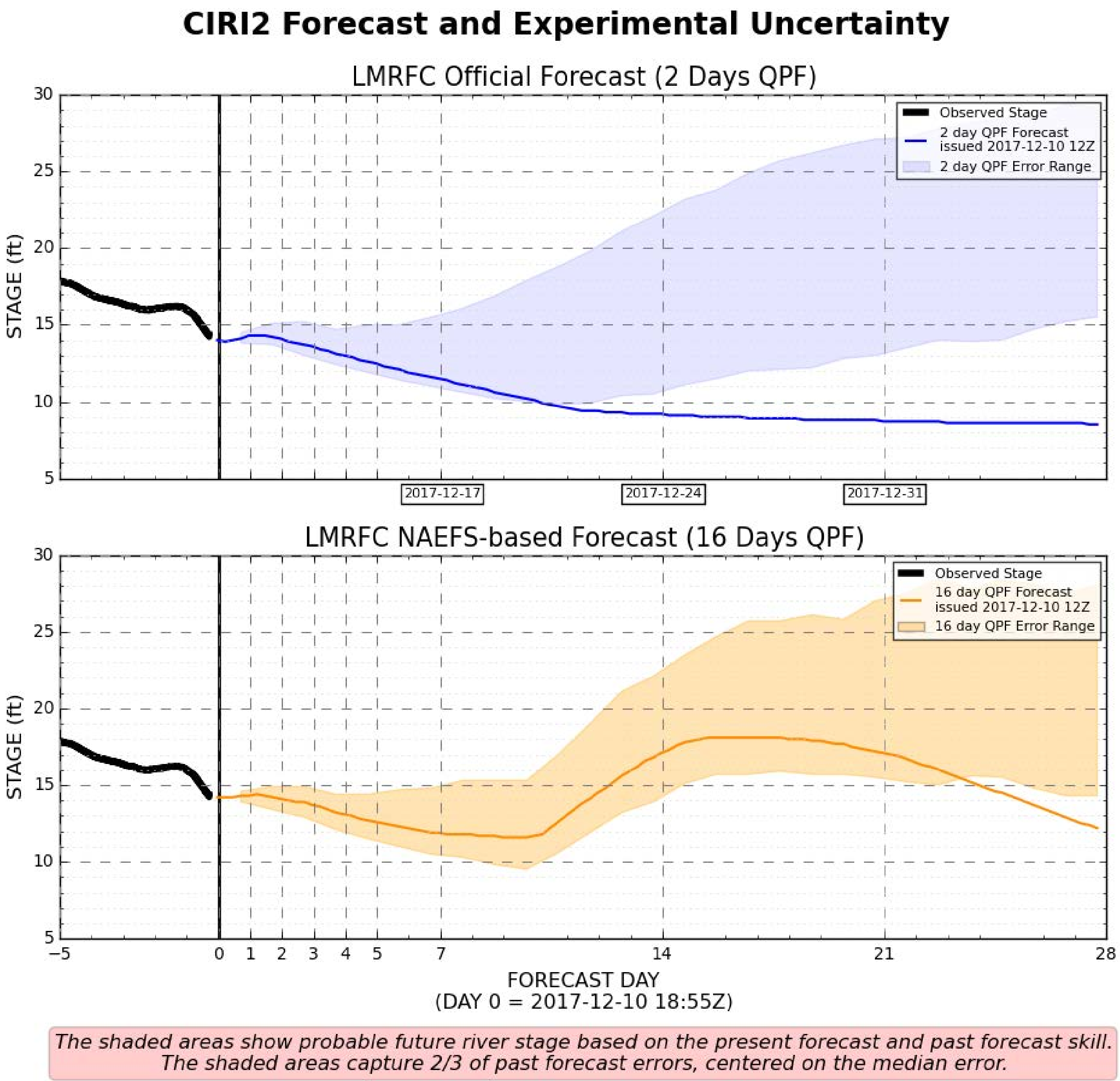


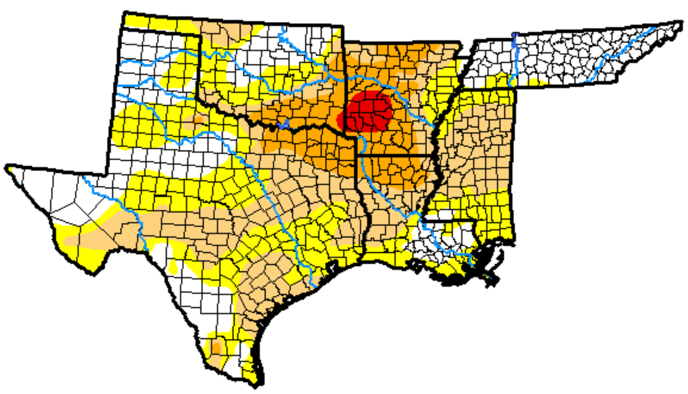
Figure 2: Example of graphics showing comparison of 2-day vs 16-day QPF forecasts and associated forecast error for Cairo, IL location. (Current forecasts for all locations along the lower Mississippi River can be found at http://www.weather.gov/lmrfc/experimental_28day_mississippi_plot).

Drought Update

Kyle Brehe and Rudy Bartels,
Southern Regional Climate Center

During November 2017, drought conditions worsened from October to extreme drought (D3) in southwest Arkansas and severe drought (D2) in southeast Oklahoma, north Louisiana, northeast Texas, and north, central, and southern Arkansas. Moderate drought (D1) developed or expanded in north central and southeast Oklahoma, north and central Mississippi, north, central, and southwest Louisiana, and east, central, and southern Texas. Areas experiencing abnormally dry conditions (D0) are east Arkansas, north and south Mississippi, south Tennessee, south Louisiana, central and northwest Oklahoma, and in parts of Texas. From October to November, no areas with drought conditions improved.

Wind seemed to be the major meteorological hazard in November with roughly 44 wind events throughout the region, 37 of which occurred on November 18. There were four tornadoes during the month of November, all four occurred in Tennessee on November 18. The five other states did not have any tornado reports in November. There were 22 hail events reported in November, 19 of which occurred on November 3 throughout southeastern Arkansas, northwestern Mississippi, and northeastern Louisiana.



Released Thursday, November 30, 2017
David Simeral, Western Regional Climate Center

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	27.70	72.30	41.44	13.44	1.59	0.00
Last Week *11-21-2017*	38.90	61.10	29.21	9.39	0.00	0.00
3 Months Ago *08-29-2017*	97.51	2.49	0.44	0.00	0.00	0.00
Start of Calendar Year *01-03-2017*	53.95	46.05	27.69	11.09	1.11	0.00
Start of Water Year *09-26-2017*	72.17	27.83	2.38	0.02	0.00	0.00
One Year Ago *11-29-2016*	35.60	64.40	49.52	32.07	13.67	1.34

Intensity:

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

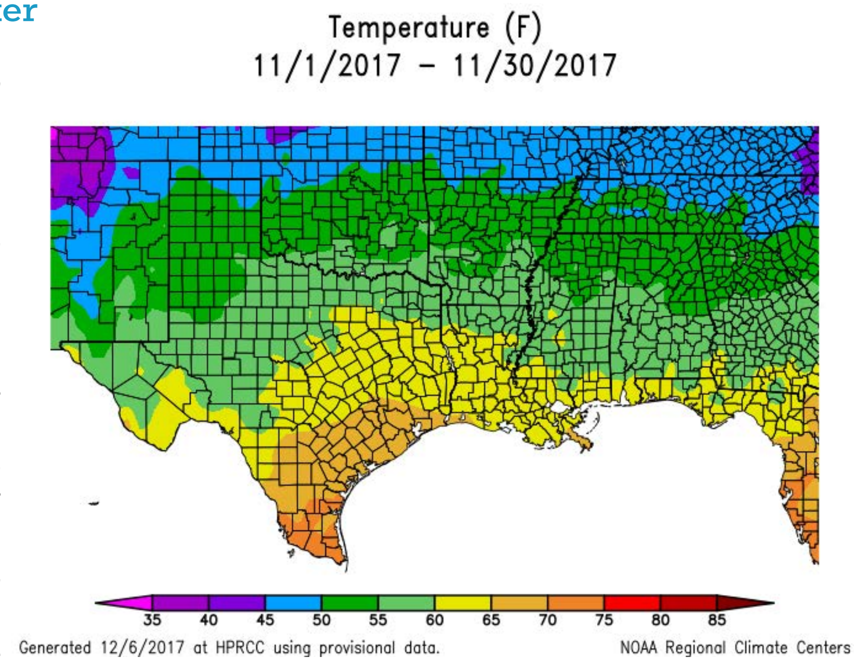
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Above: Drought Conditions in the Southern Region. Map is valid for November 28, 2017. Image is courtesy of the National Drought Mitigation Center.

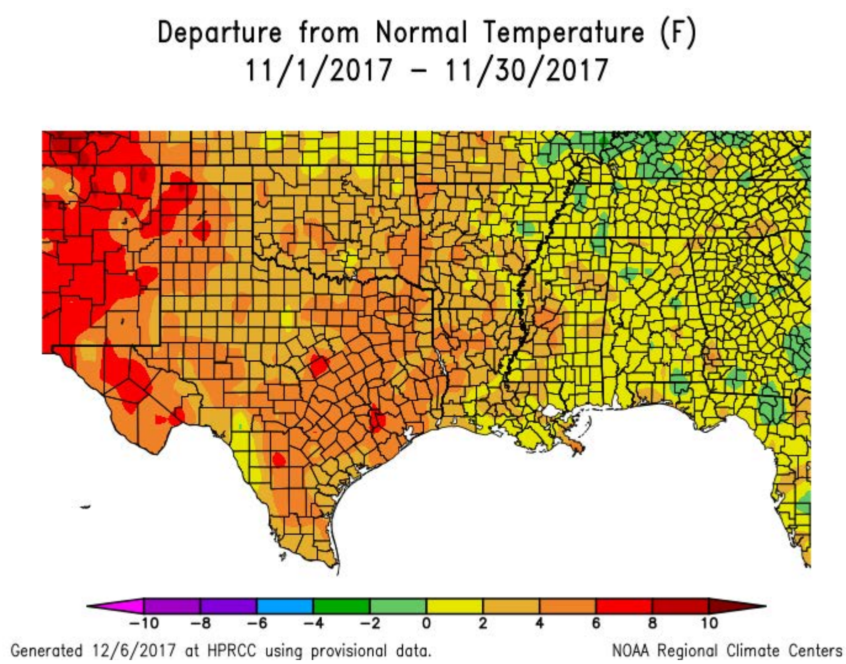
Temperature Summary

Kyle Brehe and Rudy Bartels,
Southern Regional Climate Center

November temperatures were warmer than normal for most of the region. There were areas of 6 to 8 degrees F (3.33 to 4.44 degrees C) above normal in parts of Texas and panhandles of Texas and Oklahoma. Most of Texas, Oklahoma, Louisiana, and western and central Arkansas were 2 to 6 degrees F (1.11 to 3.33 degrees C) above normal. Eastern Arkansas, southeastern Louisiana, southern and central Mississippi, and most of Tennessee experienced slightly above normal temperatures. In contrast, parts of western Tennessee, northeast Arkansas, northeast Mississippi, and southwest Texas experienced slightly below normal temperatures. The statewide monthly average temperatures were as follows: Arkansas – 53.60 degrees F (12.00 degrees C), Louisiana – 61.70 degrees F (16.50 degrees C), Mississippi – 59.60 degrees F (13.83 degrees C), Oklahoma – 52.80 degrees F (11.56 degrees C), Tennessee – 50.00 degrees F (10.00 degrees C), and Texas – 60.40 degrees F (15.78 degrees C). The statewide temperature rankings for November were as follows: Arkansas (twentieth warmest), Louisiana (seventeenth warmest), Mississippi (twenty-fifth warmest), Oklahoma (tenth warmest), Tennessee (thirty-second warmest), and Texas (fifth warmest). All state rankings are based on the period spanning 1895-2017.



Average November 2017 Temperature across the South

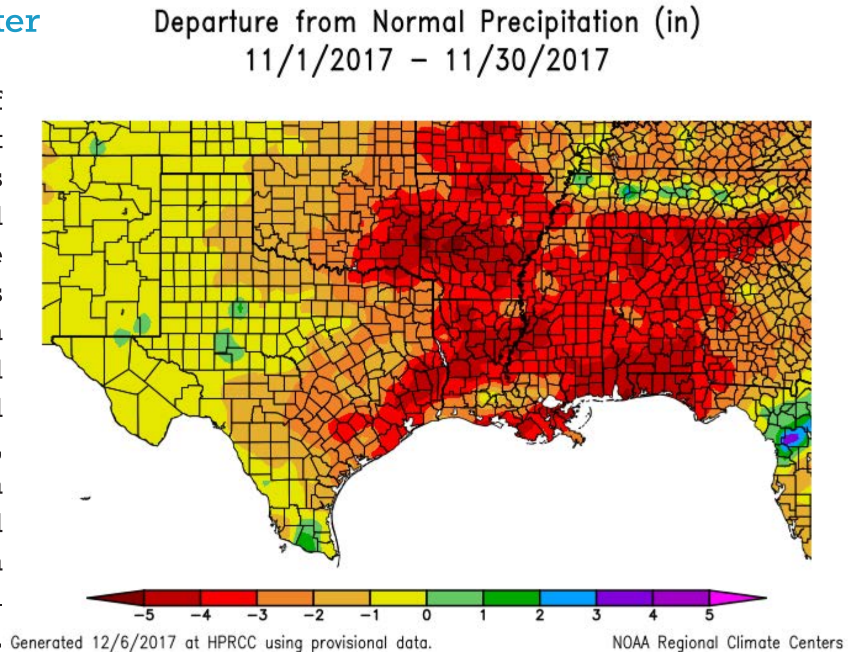


Average Temperature Departures from 1981-2010 for November 2017 across the South

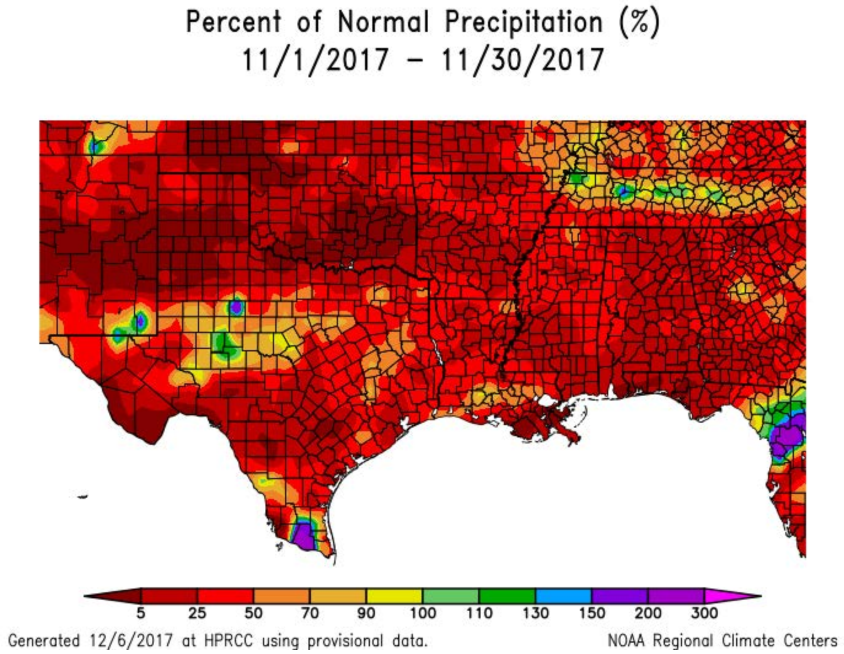
Precipitation Summary

Kyle Brehe and Rudy Bartels,
Southern Regional Climate Center

Precipitation values for the month of November were below normal for most of the Southern Region. All of Arkansas and Oklahoma, most of Louisiana and Mississippi, and parts of Tennessee and Texas received 50 percent or less of normal precipitation. There were a few areas of 5 percent or below normal precipitation in northern, western, and southern Texas, southeastern Louisiana, and northern and southeastern Oklahoma. In contrast, parts of central and southern Texas and northern and central Tennessee received 110 – 150 percent of normal precipitation. There was an area of 200 - 300 percent above normal precipitation in extreme southern Texas. The state-wide precipitation totals for the month were as follows: Arkansas – 1.09 inches (27.69 mm), Louisiana – 1.51 inches (38.35 mm), Mississippi – 1.21 inches (30.73 mm), Oklahoma – 0.23 inches (5.84 mm), Tennessee – 2.82 inches (71.63 mm), and Texas – 0.71 inches (18.03 mm). The state precipitation rankings for the month were as follows: Arkansas (fourth driest), Louisiana (tenth driest), Mississippi (third driest), Oklahoma (fifth driest), Tennessee (thirty-second driest), and Texas (sixteenth driest). All state rankings are based on the period spanning 1895-2017.

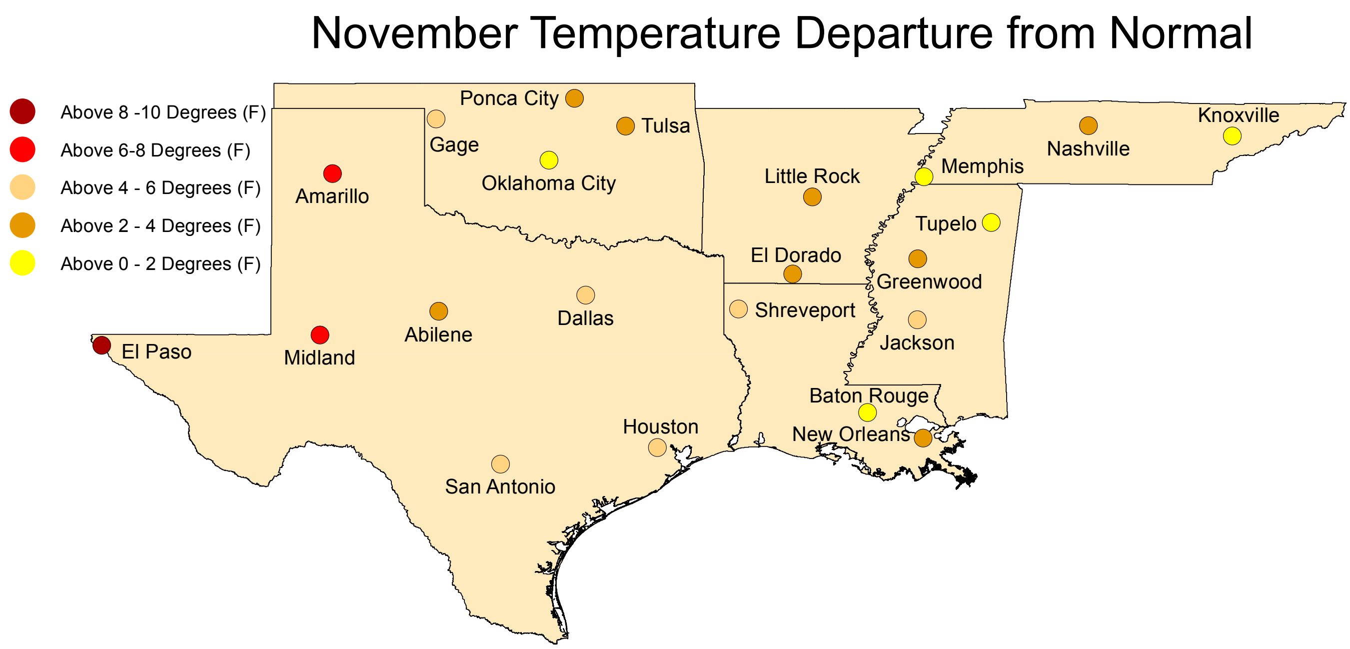


November 2017 Total Precipitation across the South

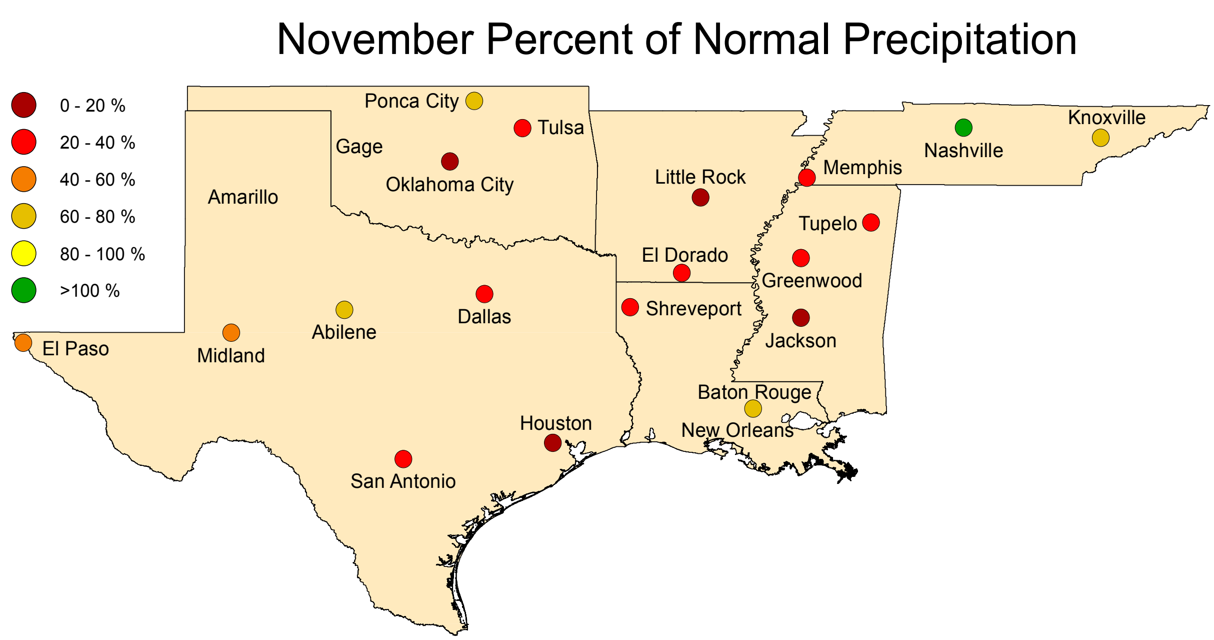


Percent of 1981-2010 normal precipitation totals for November 2017 across the South

Regional Climate Perspective in Pictures



November 2017 Temperature Departure from Normal from 1981-2010 for SCIPP Regional Cities



November 2017 Percent of 1981-2010 Normal Precipitation Totals for SCIPP Regional Cities

Climate Perspective

State	Temperature	Rank (1895-2017)	Precipitation	Rank (1895-2017)
Arkansas	53.6	20th Warmest	1.09	4th Driest
Louisiana	61.7	17th Warmest	1.51	10th Driest
Mississippi	59.6	25th Warmest	1.21	3rd Driest
Oklahoma	52.8	10th Warmest	0.23	5th Driest
Tennessee	50.0	32nd Warmest	2.82	32nd Driest
Texas	60.4	5th Warmest	0.71	16th Driest

State temperature and precipitation values and rankings for November 2017. Ranks are based on the National Climatic Data Center's Statewide, Regional, and National Dataset over the period 1895-2017.

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	69.7	45.6	57.7	3.8	85	11/03	26	11/23	1.47	-3.42	30
Little Rock, AR	67.0	43.3	55.2	2.6	85	11/03	29	11/23+	0.42	-4.86	8
Baton Rouge, LA	74.0	50.6	62.3	1.9	85	11/06+	33	11/24	2.70	-1.40	66
New Orleans, LA	74.1	55.7	64.9	2.2	84	11/04+	37	11/24	0.06	-4.43	1
Shreveport, LA	72.6	49.5	61.0	4.7	88	11/06+	30	11/23	1.43	-3.10	32
Greenwood, MS	69.6	43.4	56.5	2.2	84	11/03	23	11/23	1.83	-2.69	40
Jackson, MS	73.1	48.4	60.8	5.1	86	11/06+	30	11/24+	0.96	-3.80	20
Tupelo, MS	66.4	41.6	54.0	1.1	81	11/05	24	11/23	1.61	-3.09	34
Gage, OK	65.8	35.0	50.4	4.7	86	11/17	20	11/19	0.02	-1.10	2
Oklahoma City, OK	64.3	40.8	52.5	1.9	82	11/17	28	11/22	0.07	-1.91	4
Ponca City, OK	62.6	40.0	51.3	3.6	82	11/24	20	11/22	1.32	-0.49	73
Tulsa, OK	65.1	42.3	53.7	3.4	83	11/17+	25	11/22	0.64	-2.17	23
Knoxville, TN	61.1	40.2	50.6	0.9	77	11/05	26	11/20	3.19	-0.82	80
Memphis, TN	65.0	44.9	54.9	1.7	83	11/02	29	11/23	1.81	-3.68	33
Nashville, TN	63.0	41.3	52.1	2.3	82	11/05	24	11/23	4.46	0.15	103
Abilene, TX	69.7	45.3	57.5	2.9	89	11/05	28	11/19	0.90	-0.51	64
Amarillo, TX	67.7	38.0	52.9	6.6	84	11/27+	25	11/19	T	-0.80	0
El Paso, TX	75.3	47.1	61.2	8.1	83	11/14	39	11/20	0.28	-0.21	57
Dallas, TX	72.9	51.9	62.4	5.8	94	11/05+	35	11/23	0.81	-1.90	30
Houston, TX	77.9	56.5	67.2	4.9	89	11/06	38	11/24+	0.50	-3.84	12
Midland, TX	73.3	45.2	59.3	6.4	90	11/06	29	11/19	0.40	-0.29	58
San Antonio, TX	77.4	55.7	66.5	5.4	91	11/05	36	11/23	0.53	-1.75	23

Summary of temperature and precipitation information from around the region for November 2017. 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.

How Far Can We See on the Horizon?

Barry D. Keim- Louisiana State Climatologist, Louisiana State University

Have you ever stood at the beach and wondered just how far the water drops off the horizon (see Figure 1)? It appears to be quite a distance, but since you have you really have no reference point, and very little experience making such judgements, it's difficult to estimate, and it's all pretty mysterious. Surely early scientists wondered plenty about this, while contemplating the many mysteries of the universe, and whether we actually live on a flat earth. Mariners obviously knew better. Well, the answer to this question is that given the curvature of the earth, the average person (5 feet, 7 inches tall) standing on a beach can see across the water approximately 2.9 miles before the ocean drops out of site. However, with taller objects, like a ship on the ocean, the general rule of thumb is that they can be seen at a distance of 12 miles. This would also be the case if a person was standing at a similar elevation on the beach. The higher your perspective, the farther you can see, so the Shaq's perspective is much farther than most of the rest of us vertically challenged individuals.

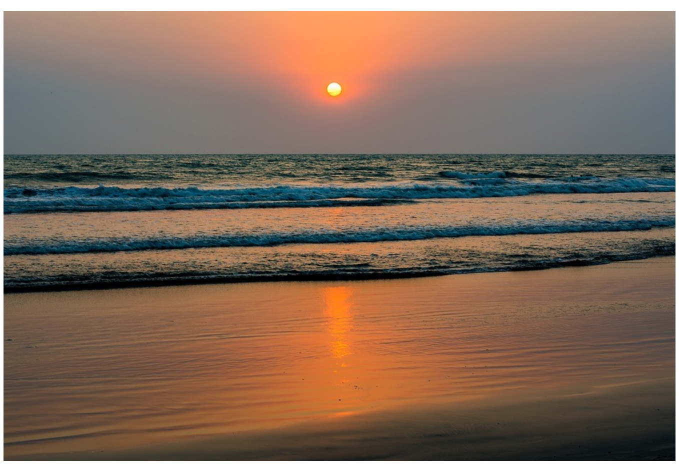


Figure 1. Beach scene provided by pixabay and is available at https://pixabay.com/en/sunset-beach-ocean-sea-2721671/.

The formula to calculate this distance is as follows:

Distance to the horizon= √((Height Above Surface)/0.5736)

Remember that things fall out of vision due to the curvature of the earth. It is not because our eyes can't see that far. In fact, when you look at the moon, it is approximately 239,000 miles from earth and we see that just fine. Also, the sun is located about 93 million miles from the earth. Apparently, the farthest thing(s) we can observe with the naked eye is the Andromeda Galaxy which is located at 780 kiloparsecs (2.5 million light years away) from earth, which is a tad bit farther than the 2.9 miles on the horizon where we can see water. Perceptions of distance can be a tricky thing and the beach example is one of the trickiest – which is made even more complicated by the many adult beverages consumed on most beaches across the world. Margarita anyone? Please contact me with any questions at keim@lsu.edu.

References:

https://www.quora.com/When-I-look-out-into-the-ocean-how-far-away-is-the-horizon-How-much-of-the-ocean-can-I-actually-see

Southern Climate Monitor Team

Kyle Brehe, Regional Climatologist
Southern Regional Climate Center (LSU)

Ty Dickinson, Student Assistant SCIPP (OU)

Margret Boone, Program Manager SCIPP (OU)

Alan Black, Program Manager SCIPP (LSU)

Contact Us

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For any questions pertaining to historical climate data across the states of Oklahoma, Texas, Arkansas, Louisiana, Mississippi, or Tennessee, please contact the Southern Regional Climate Center at (225)578-5021.

For questions or inquiries regarding research, experimental tool development, and engagement activities at the Southern Climate Impacts Planning Program, please contact us at
(405)325-7809 or (225)578-8374.

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From Our Partners

South Central Climate Science Center

November 30, 2017 : Celebrating 5 Years

The South Central CSC successfully completed its first 5 years as a Center this past March. Since 2012, the South Central CSC had the privilege of collaborating with diverse partners to understand the impacts of climate extremes on natural and cultural resources across the region. Working closely with land and water resource managers, South Central CSC researchers produced a wide variety of tools, datasets, and educational programs. They've modeled how species of concern will respond to a changing climate, empowered managers with projections of sea level rise impacts on wetlands, developed new methods for monitoring and responding to drought, and much more. The South Central CSC also cultivated a regional climate learning community in person and online; for example, its Managing for a Changing Climate online course has reached over 500 participants worldwide. Additionally, tribal liaisons employed by the Center have hosted over 28 trainings for members of over 91 federally recognized tribes. These trainings focused on building tribal capacity with the end goal of facilitating native-led climate resilience efforts. For more information on South Central CSC activities contact Emma Kuster, Program Coordinator (405-325-0539 or emmakuster@ou.edu), or Jessica Blackband, Communications Specialist (jblackband@ou.edu). You may also check out their website at http://www.southcentralclimate.org/.

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