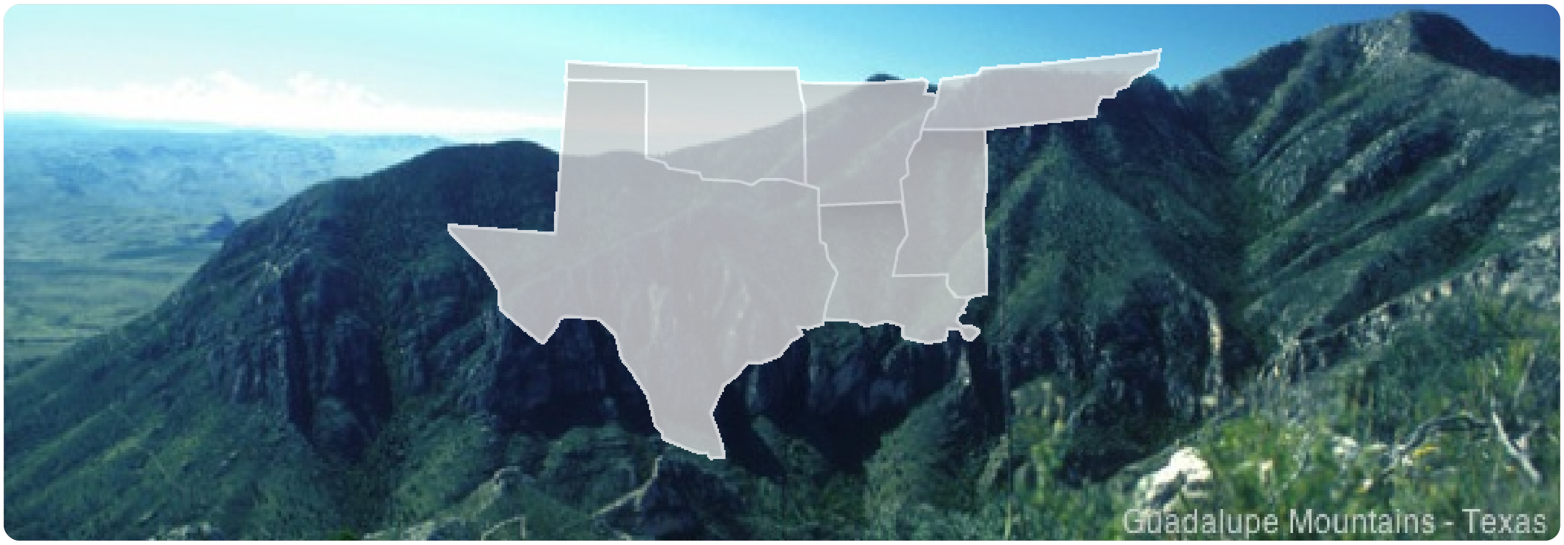

SOUTHERN CLIMATE *MONITOR*

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IN THIS ISSUE:

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QUANTIFYING VULNERABILITY TO WEATHER AND CLIMATE HAZARDS IN THE UNITED STATES

Robert Gottlieb, University of Oklahoma

The United States, and the SCIPP region in particular, is home to some of the world's most dangerous weather. From tornadoes to drought, weather and climate hazards have far-reaching impacts on communities across the country. However, not all hazards will affect all people the same way. This research uses quantitative methods to identify areas that have higher or lower vulnerability to weather and climate hazards. For this study, vulnerability refers to the general ability of human populations to mitigate and respond to the effects of hazards. Through quantitative analysis, maps can be created to show the varying degrees of vulnerability. Such a tool can help emergency managers, decision makers, and stakeholders identify areas that may need the most attention for mitigating and adapting to hazard impacts.

Hazard and Social Data

The key to this is study is using two different types of data – hazard climatologies and social data from the U.S. Census Bureau. This allows a look at which areas experience the most severe and frequent hazards, which areas have the greatest socio-economic vulnerability, and where the combination of these results in the greatest threat. Seven different hazards are included – tornadoes, hail, high winds from severe thunderstorms, high winds from hurricanes, storm surge, drought, and wildfires. This is certainly not a complete list of hazards, but other hazards are very difficult to use due issues in data availability and quality. The records used in this study go up to the end of 2010. The hazards, their data sources, and the extent of their records are listed in Table 1.

Social data come from the 2010 Census and the most recent five-year American Community Survey (ACS), which covers 2005-2009. Forty-one different variables with a wide variety of properties were used. In the next section, it will be shown that a large number of Census Bureau variables be condensed into a smaller number of important themes for easier analysis. Many different indices exist for determining vulnerability based on socio-economic conditions. The method used here is the most objective for determining what variables are important.

Methods

This analysis is performed at the county level for the contiguous United States. For each hazard, the hazard is divided into different categories of

Hazard	Source	Years Used
Tornadoes	National Climatic Data Center	1980-2010
Hail	National Climatic Data Center	1980-2010
Thunderstorm wind	National Climatic Data Center	1980-2010
Hurricane winds	National Hurricane Center	1931-2010
Hurricane surge	National Hurricane Center	Projected Data
Drought	National Drought Mitigation Center	2000-2010
Wildfires	NASA/U.S. Forest Service	2001-2010

Table 1:The hazards included in this study, their sources, the years for which reports were used.

severity, if needed. For example, tornadoes are split into two categories: EF 0-1 and EF 2-5. Then, for each category the frequency of hazards in each county is determined. The frequencies are scaled to give a score ranging from 0 to 100. The scores for the categories for each hazard are weighted and combined. There is no official way to weight the categories, but after testing it seems the most logical and effective way is to use the physical attributes of the hazards. For example, the weighting for tornadoes is based on their wind speed. For each county, the hazard scores are added up, and then rescaled from 0 to 100 again.

The social data is organized using a modified version of the Social Vulnerability Index (SoVI), which was developed at the University of South Carolina. The SoVI uses a statistical method called principal components analysis (PCA). Without getting into details, PCA helps organize a large number of variables into a smaller number of categories that are made up of a few of the original variables. This makes it easier to identify the most important themes in the data. In this case, it reveals what social conditions contribute the most to differences in hazard vulnerability. There are many different ways to decide the number of components to keep, and several of these have tested. The component scores that come out of PCA are similar to standard deviations. The component scores are combined to create a social vulnerability score for each county, and that is also rescaled from 0 to 100. The resulting hazard and social vulnerability score for each county is multiplied together.

Results

Four regions of highest vulnerability have been determined. They are rural areas of the Plains, urban areas, the Southeast, and parts of the Intermountain West. In the western part of SCIPP region, much of the area's higher vulnerability is driven by a high dependence on agriculture. The addition of hurricanes creates high vulnerability for the Gulf Coast. In general, the SCIPP region experiences all of the hazards that have been included in this study.

By using PCA, the social themes that are believed to be most important in this vulnerability analysis are socio-economic status, age of the population, reliance on agriculture, and infrastructure. This is largely consistent with previous studies.

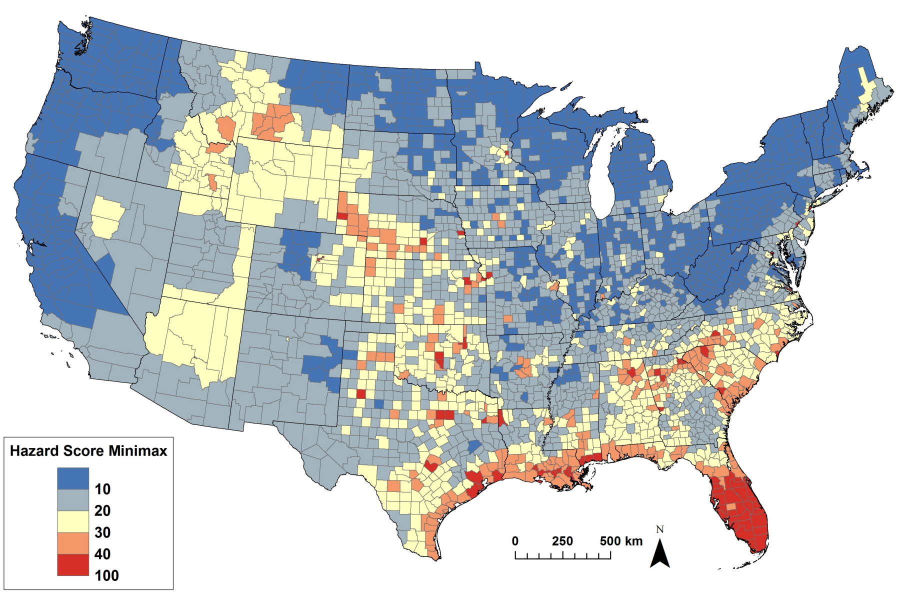


Figure 1: Hazard vulnerability scores for the contiguous U.S. using physical weights.

There are many different ways to combine and weight the vulnerability scores, but a few sample maps are displayed here.

Conclusions

Quantitative methods and mapping can quickly reveal important patterns in hazard vulnerability over a large area. Vulnerability associated with both the occurrence of hazards and socio-economic conditions should be considered. While numerical methods can be useful, they are not meant to replace the qualitative methods that are used in research, emergency management, and other practices. The scale of this project is ambitious, and it cannot capture the local knowledge that experienced professionals bring to their particular areas and efforts. It cannot fully capture complex social processes that affect the vulnerability of a person or community. However, the tool described here can be a useful addition to the repertoire of emergency managers, decision makers, and other interested parties.

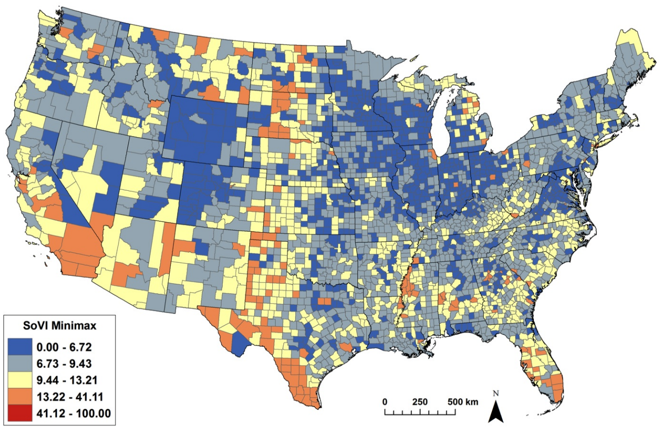


Figure 2: Social vulnerability scores for the contiguous U.S. when retaining four components of vulnerability.

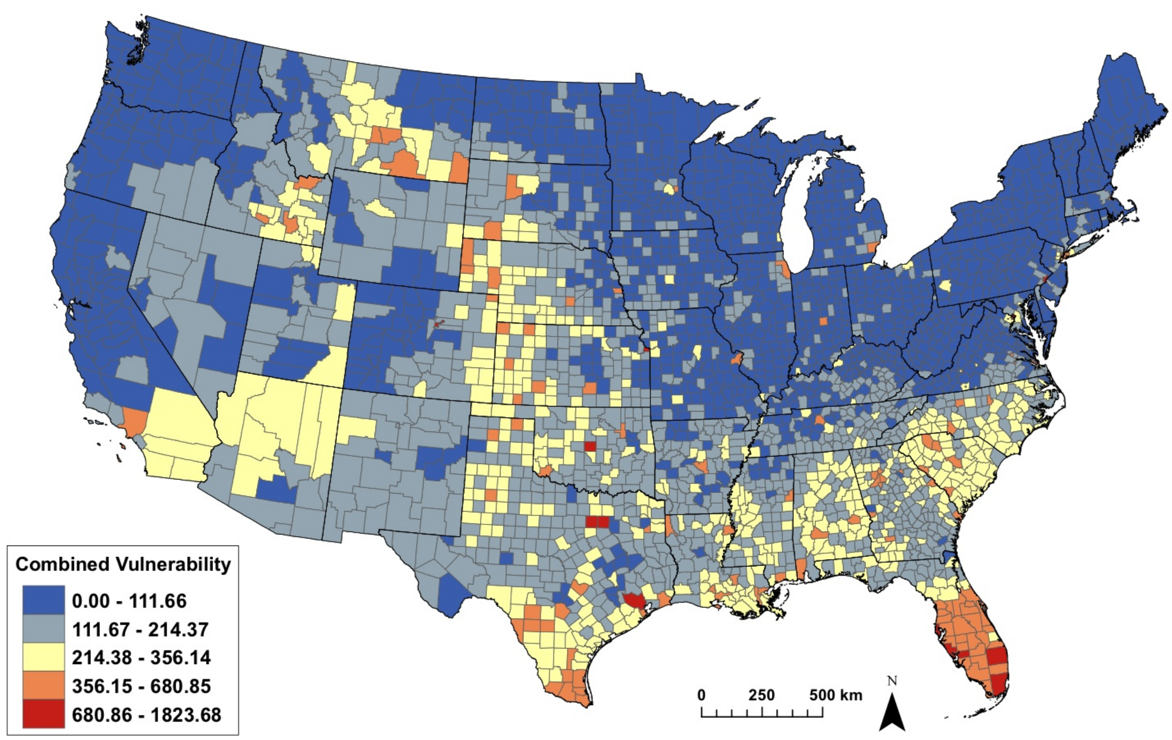
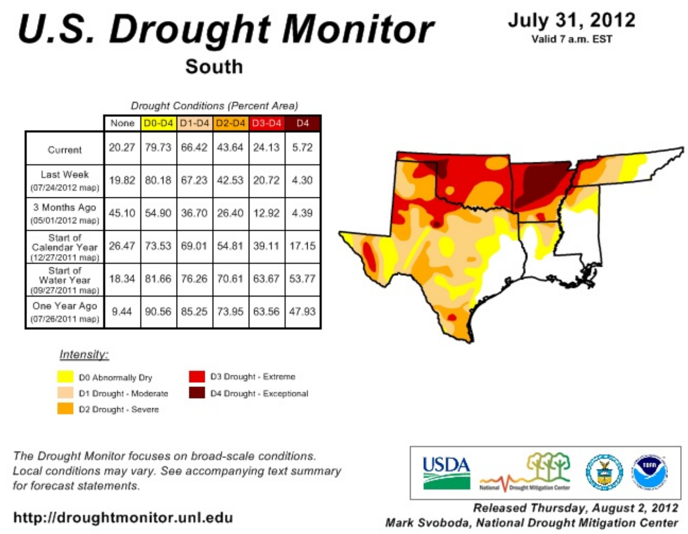


Figure 3: Combination of hazard vulnerability scores for the contiguous U.S.

DROUGHT CONDITIONS AND SEVERE WEATHER

Luigi Romolo, Southern Regional Climate Center

Drought conditions in the Southern Region have both improved and deteriorated. Improvements occurred in northern Louisiana, whereby now only a small area in the northeast is in drought. There was also a significant amount of improvement in eastern Tennessee, in that much of the central and eastern counties saw a one to two category improvement. Drought conditions in Mississippi remained fairly unchanged from last month. Due to heavy rainfall totals, eastern Texas experienced a one category improvement, and much of the southeastern part of the state is now drought free. Conditions in the remainder of the state are relatively equivalent to what was observed last month. In contrast, conditions did get worse in Arkansas. Over eighty percent of the state in now in extreme or exceptional drought. Drought has also worsened in Oklahoma, where over seventy percent of the state is now in extreme or exceptional drought, with the entire state being in moderate drought or worse.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	20.27	79.73	66.42	43.64	24.13	5.72
Last Week (07/24/2012 map)	19.82	80.18	67.23	42.53	20.72	4.30
3 Months Ago (05/01/2012 map)	45.10	54.90	36.70	26.40	12.92	4.39
Start of Calendar Year (12/27/2011 map)	26.47	73.53	69.01	54.81	39.11	17.15
Start of Water Year (09/27/2011 map)	18.34	81.66	76.26	70.61	63.67	53.77
One Year Ago (07/26/2011 map)	9.44	90.56	85.25	73.95	63.56	47.93

Above: Drought Conditions in the Southern Region. Map is valid for July 31, 2012. Image is courtesy of the National Drought Mitigation Center.

Dry, and hot conditions in Oklahoma have made the state vulnerable to wildfires. According to KJRH News in Tulsa, Oklahoma, over 28,000 acres (113.31 square km) have been burned in a blaze in Kiowa County. Oklahoma Forestry Services reports that all counties in the state are under a burn ban.

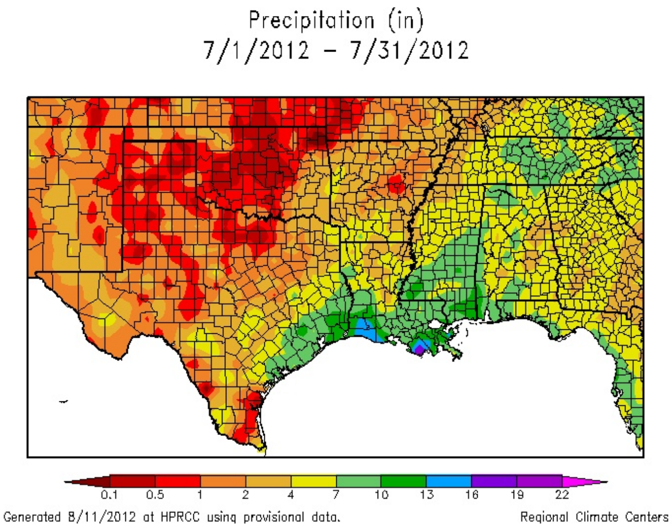
In Texas, fires, driven by lightning and dry grasses, burned near Byers in Clay County and in McFadden Wildlife Refuge in Jefferson County; while the former was stopped before any significant damage was caused, the wildlife refuge saw at least 150 acres (0.61 square km) burned. Further, a fire reported at Bluff Creek has burned over 2700 acres (10.93 square km), though no monetary damage report has been issued. Elsewhere, country-wide drought issues are having an effect on ranchers, whose livestock numbers have dropped by 2% in the Panhandle due to elevated corn prices and less grazing acreage. Farmers' losses have been mitigated somewhat by intermittent rainy conditions. Legislation aimed at further mitigating these effects by reducing the processing time for emergency declaration, reducing the emergency loan interest rate by 1.25 percent, and granting subsidies to various crop farmers. The Texas State Water Plan has plans written in it to pursue various projects, totaling $53 billion, to develop projects to bring water to various parts of the state that are seeing increased demand and competition for water from all sectors (Information provided by the Texas Office of State Climatology).

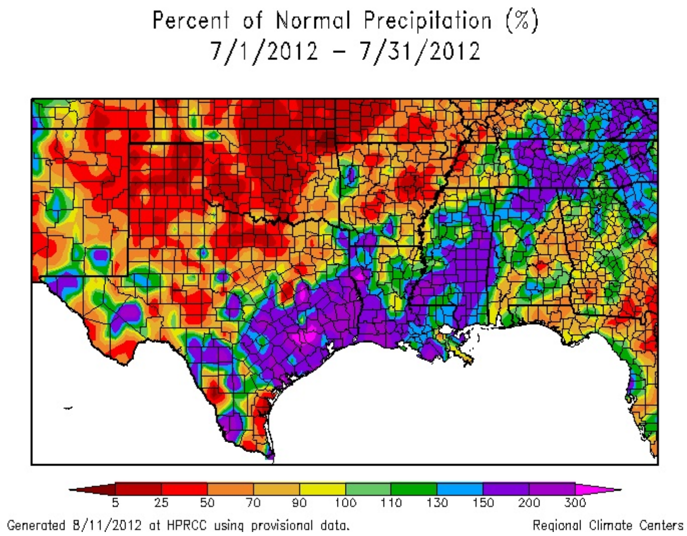
There was only one tornado report for the month in the Southern Region. There were no reports of injuries or damages. The twister occurred in Calcasieu Parish, near Lake Charles, Louisiana.

PRECIPITATION SUMMARY

Luigi Romolo, Southern Regional Climate Center

July precipitation in the Southern Region varied spatially such that the northeastern half of the region experienced a much drier than normal month, while the southeastern half of the region experienced a much wetter than normal month. In southern Louisiana, precipitation totals for the month averaged between 150 and 200 percent of normal. Similar values were observed throughout most of Mississippi, southeastern Texas, and eastern Tennessee. State average July precipitation totals were as follows: 2.86 inches (72.64 mm) in Arkansas, 7.72 inches (196.09 mm) in Louisiana, 7.03 inches (178.56 mm) in Mississippi, 1.25 inches (31.75 mm) in Oklahoma, 6.20 inches (157.48 mm) in Tennessee, and 2.72 inches (69.09 mm) in Texas. State precipitation rankings worth mentioning include Louisiana and Mississippi, which both experienced their eighteenth wettest July on record (1895-2012). Tennessee experienced its twentieth wettest July on record (1895-2012), and Oklahoma experienced its seventeenth driest July on record (1895-2012).



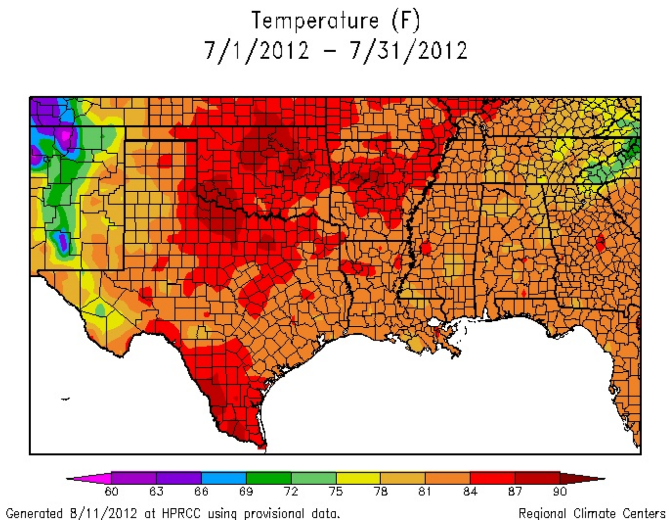


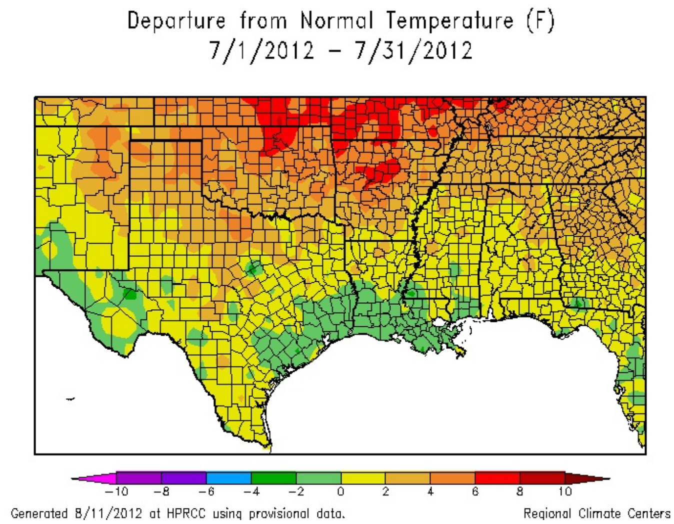
Total precipitation values (left) and the percent of 1971-2000 normal precipitation totals (right) for July 2012.

TEMPERATURE SUMMARY

Luigi Romolo, Southern Regional Climate Center

With the exception of southern Louisiana, southeastern Texas, and the western Texas panhandle, the majority of the Southern Region experienced a slightly warmer than normal July. The highest temperature anomalies were observed in northeastern Oklahoma and northern Arkansas, where temperatures averaged anywhere from 4 to 8 degrees F (2.22 to 4.44 degrees C) above normal. In Tennessee, temperatures ranged between 4 and 6 degrees F (2.22 and 3.33 degrees C) above normal. Similar values were also observed in western Oklahoma and northern Texas. For Arkansas, it was the sixth warmest July on record (1895-2012) with a state wide average temperature of 84.10 degrees F (28.94 degrees C). Tennessee reported its seventh warmest July on record (1895-2012). The state wide average temperature for Tennessee was 80.40 degrees F (26.89 degrees C). Oklahoma averaged 85.50 degrees F (29.72 degrees C), which was their ninth warmest July on record (1895-2012). The other state wide average temperatures include: 82.10 degrees F (27.83 degrees C) in Louisiana, 81.80 degrees F (27.67 degrees C) in Mississippi, and 83.40 degrees F (28.56 degrees C) in Texas.





Average temperatures (left) and departures from 1971-2000 normal average temperatures (right) for July 2012, across the South.

WHAT IS DEW POINT?

Barry D. Keim, Louisiana State Climatologist

When it comes to humidity, there is no place like South Louisiana to experience it in great abundance. Well, actually, there is a more humid place, but more on that later. I've often heard people speak of the 90° weather and the 100% humidity in our region. Well actually folks, in South Louisiana, that is physically impossible, outside of your bathroom while you're taking a shower. Another pet peeve of mine is how misunderstood relative humidity is among the general public. In the South Louisiana, a typical summer morning will have near 90-100% relative humidity, when the temperature is coolest, while in the afternoon, it will drop to something closer to 50-60%, as temperatures rise. That's because relative humidity is dependent on temperature, and when the temperature is warmer, it requires much more moisture in the air to maintain high levels of relative humidity.

A much better indicator of the amount of moisture in the air is the dew point, or dew point temperature. The dew point temperature is technically a measure of the amount of moisture in the air, by equating it to the air temperature required to create 100% relative humidity, assuming no moisture is added to the air. So, if the air temperature is 95°, and dew point temperature is 75°, then the 95° degree air would need to be cooled to 75° to reach the dew point, hence fog or dew would form and you will have reached 100% relative humidity. Table 1 shows the human comfort level for various dew point temperatures. In summer, in Louisiana, our dew point temperatures generally run between 70° and 80°. As shown in the table, this range, from a human comfort perspective, goes from extremely uncomfortable to even deadly near the upper end of the scale for sensitive people. However, in the other seasons, the dew point is typically much less, even dropping into the 20°s after cold fronts pass our way in winter. The most humid place on earth is on the shores of the Red Sea in Saudi Arabia, where air temperatures frequently exceed 100°, while the dew point can get up over 90°. In fact, the world's highest dew point ever was 95° - recorded at Dhahran, Saudi Arabia. This is caused by massive evaporation off of the very hot Red Sea. So, if it's any consolation, there are more oppressive places than Da Parish, when it comes to humidity. I know it doesn't feel like it when you're mowing the lawn. Nevertheless, it's summer in South Louisiana, so stay cool as best you can.

Dew point °F	Human perception[1]	Rel. humidity at 32 °C (90 °F)
> Higher than 80 °F	Severely high. Even deadly for asthma related illnesses	65% and higher
75–80 °F	Extremely uncomfortable, fairly oppressive	62%
70–74 °F	Very humid, quite uncomfortable	52–60%
65–69 °F	Somewhat uncomfortable for most people at upper edge	44–52%
60–64 °F	OK for most, but all perceive the humidity at upper edge	37–46%
55–59 °F	Comfortable	38–41%
50–54 °F	Very comfortable	31–37%
< 49 °F	A bit dry for some	30%

Table 1. Dew point temperatures and human comfort given this amount of atmospheric moisture. Also, relative humidity for ranges of dew points, if the air temperature is 90°F. Table from Wikipedia.

NOAA INCREASES 2012 HURRICANE SEASON FORECAST

Barry D. Keim, Louisiana State Climatologist

The National Oceanographic and Atmospheric Administration raised their expectations for the 2012 hurricane season for their earlier forecast in late May. The new forecast calls for between 12-17 named storms (including Tropical Storms), 5-8 hurricanes, of which 2-3 should become major hurricanes. The outlook from this past May called for 9-15 named storms. Clearly, one reason for the uptick in the forecasted numbers stems from the early jumpstart to this hurricane season, which had 2 named storms in May, before the season even officially began. In addition, an El Nino is still likely to form this season, but is apparently developing a little slower than originally expected. Note that El Nino events create an environment that is not conducive for hurricane formation in the Atlantic. When you put these factors together, it leads to a forecast that is a little worse than what was expected back in May. Also note that we are only now moving into the busiest part of the hurricane season, which extends from mid-August to early October. It is during this window of time where many of the great hurricanes have hit this area, including Hurricanes, Betsy, Camille, Andrew, Katrina, Rita, Gustav, etc. Hang on to your boots.

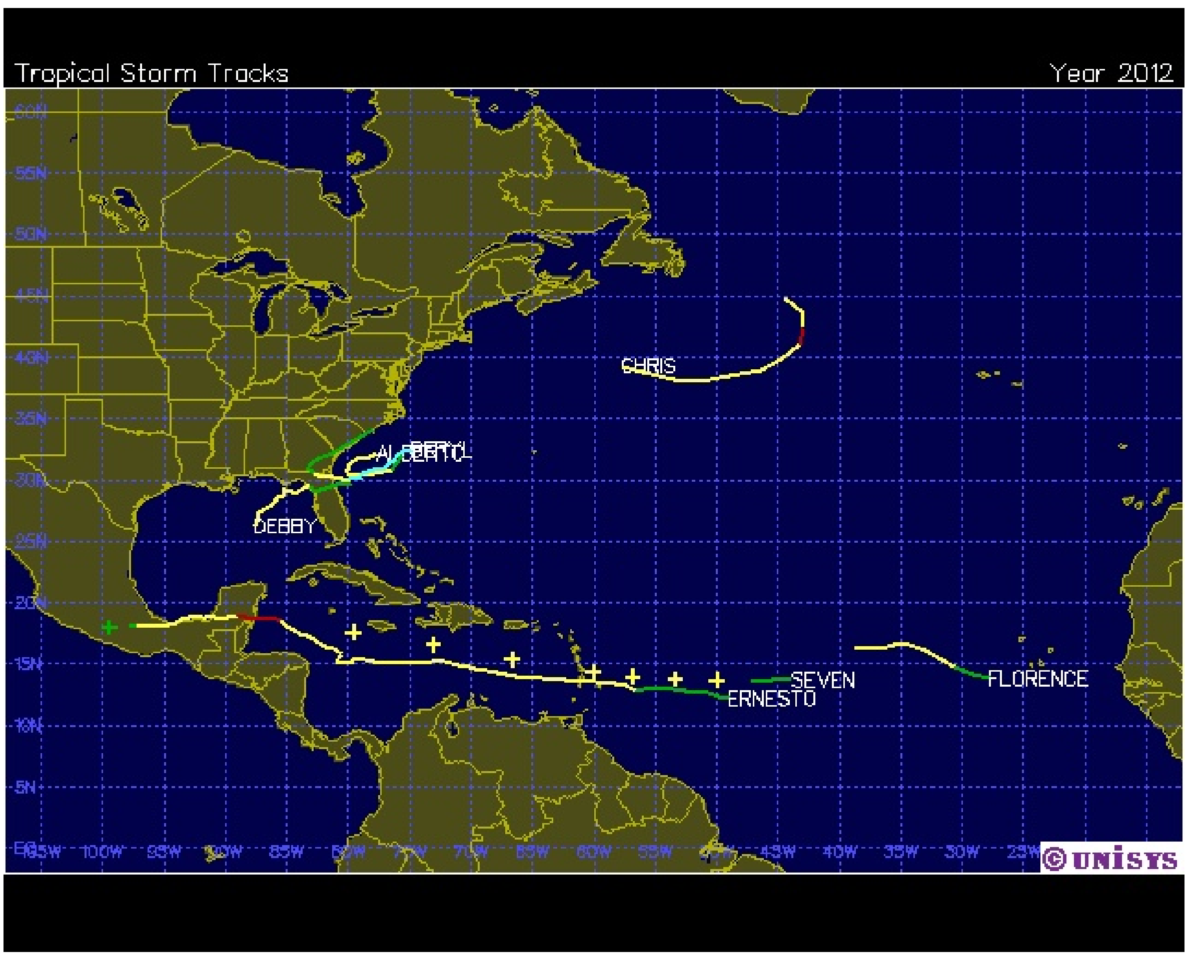


Figure 1. Tropical Storms and hurricane tracks for the 2012 season from 1 May through 10 August. Graphic from the following source: http://weather.unisys.com/hurricane/atlantic/2012/index.php

CLIMATE PERSPECTIVE

State	Temperature	Rank (1895-2011)	Precipitation	Rank (1895-2011)
Arkansas	84.10	6th Warmest	2.86	38th Driest
Louisiana	82.10	55th Warmest	7.72	18th Wettest
Mississippi	81.80	30th Warmest	7.03	18th Wettest
Oklahoma	85.50	9th Warmest	1.25	17th Driest
Tennessee	80.40	7th Warmest	6.20	20th Wettest
Texas	83.40	30th Warmest	2.72	37th Wettest

State temperature and precipitation values and rankings for July 2012. 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 Name	Temperatures								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	%Norm
El Dorado, AR	93.5	72.0	82.8	0.8	102	07/29	68	07/13	2.47	-1.66	60
Little Rock, AR	99.1	75.6	87.3	5.0	111	07/30	71	07/29	1.46	-1.85	44
Baton Rouge, LA	92.0	74.6	83.3	1.6	97	07/29	71	07/14	6.60	0.64	111
New Orleans, LA	90.8	75.5	83.2	0.5	96	07/03	71	07/20	11.59	5.39	187
Shreveport, LA	93.6	74.6	84.1	0.7	103	07/29	72	7/13+	5.73	1.74	144
Greenwood, MS	91.9	72.1	82.0	-0.4	100	07/30	68	7/7+	4.61	0.42	110
Jackson, MS	92.9	73.6	83.2	1.9	100	07/04	69	07/13	7.80	3.11	166
Tupelo, MS	94.1	73.2	83.6	3.0	102	7/6+	70	07/29	5.11	1.46	140
Oklahoma City, OK	99.9	73.8	86.9	4.9	109	07/20	65	07/15	0.39	-2.55	13
Ponca City, OK	102.6	75.2	88.9	6.0	111	07/31	65	07/21	0.00	-3.43	0
Tulsa, OK	101.2	76.6	88.9	5.4	112	07/31	66	07/15	1.38	-1.58	47
Knoxville, TN	90.7	71.2	81.0	3.3	105	07/01	67	7/29+	6.27	1.56	133
Memphis, TN	94.5	76.2	85.3	2.8	103	07/05	73	7/29+	2.26	-1.96	54
Nashville, TN	93.9	73.0	83.5	4.4	105	7/6+	68	07/30	8.38	4.61	222
Amarillo, TX	96.0	69.3	82.7	4.5	103	7/31+	66	7/27+	0.26	-2.42	10
El Paso, TX	93.3	71.8	82.6	-0.7	99	07/01	67	7/10+	2.39	0.90	160
Dallas, TX	98.7	76.7	87.7	2.7	107	07/21	71	07/16	0.78	-1.34	37
Houston, TX	90.9	75.0	82.9	-0.7	97	07/31	72	7/15+	4.71	1.53	148
San Antonio, TX	94.9	75.8	85.4	1.0	100	07/31	72	7/15+	3.79	1.76	187

Summary of temperature and precipitation information from around the region for July 2012. 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. Blue-shaded boxes represent cooler than normal temperatures; red-shaded boxes denote warmer than normal temperatures; tan shades represent drier than normal conditions; and green shades denote wetter than normal conditions.

Contact Us

The Monitor is an experimental climate outreach and engagement product of the Southern Regional Climate Center and Southern Climate Impacts Planning Program. To provide feedback or suggestions to improve the content provided in the Monitor, please contact us at monitor@southernclimate.org. We look forward to hearing from you and tailoring the Monitor to better serve you. You can also find us online at www.srcc.lsu.edu and www.southernclimate.org.

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 225-578-502. 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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