SOUTHERN CLIMATE *MONITOR*

MAY 2011 | VOLUME 1, ISSUE 5

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 This publication was prepared by SRCC/SCIPP with support in part from the U.S. Department of Commerce/NOAA, under award NA080AR4320886 and other grants. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA.

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THE HURRICANE'S ARSENAL: EXTREME WINDS, HEAVY RAIN AND STORM SURGE

Hal Needham, Southern Climate Impacts Planning Program

Notable Examples from the SCIPP Region

Hurricanes and tropical storms threaten the Gulf Coast and Eastern Seaboard of the United States every year. Some of the most destructive hurricanes and tropical storms in U.S. history have struck the SCIPP region, along the coasts of Louisiana, Mississippi and Texas. Extreme winds, heavy rainfall and high storm surges are three weapons these storms use to inflict casualties and economic losses.

Winds in the most destructive hurricanes, classified as Category-5 hurricanes on the Saffir-Simpson Scale, exceed 155 miles per hour. Winds of this intensity cause severe structural damage to buildings, destroy nearly all trees and utility poles, and shatter nearly all windows (Schott et al. 2010). Hurricane Camille inflicted severe damage on the Mississippi Coast in 1969, as this Category-5 hurricane produced wind gusts of at least 190 miles per hour near Bay St. Louis (U.S. Weather Bureau 1969).

Hurricanes and tropical storms also produce inland flooding, as rainfall totals in the most extreme cases are measured in feet instead of inches. Tropical Storm Claudette produced the heaviest 24-hour rainfall in U.S. history, as this system dumped 42 inches of rain in 24 hours near Alvin, Texas, in 1979 (National Hurricane Center 1979). More recently, Tropical Storm Allison inundated portions of Houston with more than 30 inches of rain in 2001, inflicting nearly $5 billion in damage (Stewart 2002).

Hurricane-generated storm surges are the deadliest and costliest natural disasters in both the SCIPP region and the nation. The 1900 Galveston Hurricane, for example, generated a 20-foot storm surge that took the city of Galveston by surprise, inflicting more than 6,000 casualties in the most deadly natural disaster in U.S. history (Rappaport and Fernandez-Partagas 1995). More recently, Hurricane Katrina generated a 27.8-foot surge that slammed the Mississippi Coast (Knabb et al. 2006), producing the highest surge level in U.S. history. This surge completely destroyed portions of the Mississippi Coast and overwhelmed the levees in New Orleans, Louisiana, killing 1500 people and inflicting over $80 billion (U.S.) in damage in the most costly hurricane in our nation's history (Blake et al. 2007).

Hurricane Season 2011

Hurricane season is upon us! The official hurricane season for the Atlantic basin begins on June 1 and lasts until November 30. Although the most active period for hurricane development generally occurs from mid-August until the end of September, severe hurricanes have struck the SCIPP region as early as June. For example, Hurricane Audrey slammed into the Gulf Coast near the Texas-Louisiana border as a Category-4 hurricane on June 27, 1957, taking many people by surprise and claiming more than 400 lives (Blake et al. 2007). Therefore, it is important that people living along the Gulf Coast stay informed about the development of hurricanes and tropical storms throughout the entire hurricane season.
It is especially important to stay informed this year because The National Oceanic and Atmospheric Administration (NOAA) is predicting that the 2011 hurricane season will be more active than normal. NOAA forecasts 12 to 18 named storms, 6 to 10 hurricanes, and 3 to 6 major hurricanes this hurricane season (National Oceanic and Atmospheric Administration 2011a). This prediction exceeds the typical seasonal average of 11 named storms.

Warmer-than-normal sea surface temperatures in the main development region of the Atlantic basin will likely encourage hurricane development, as warm ocean water fuels hurricanes (National Oceanic and Atmospheric Administration 2011b,

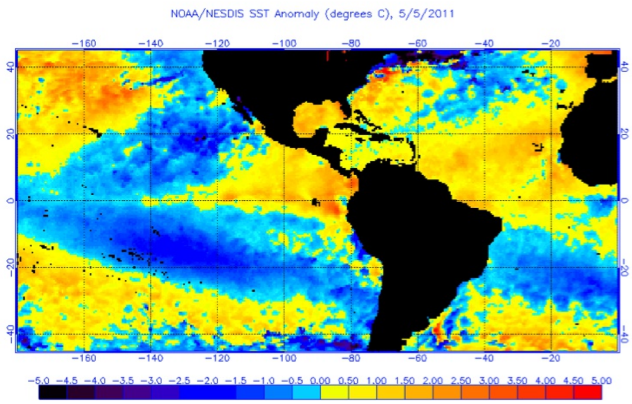

Fig. 1 An image of sea surface temperature anomalies as of May 5, 2011. Yellow, orange and red colors represent sea-surface temperatures that are warmer than normal, while various shades of blue depict sea surface temperatures that are colder than normal. Warmer-than-normal sea surface temperatures in the Atlantic and cooler-than-normal sea surface temperatures in the Equatorial Pacific are creating an environment conducive for Atlantic hurricane development.

See Fig. 1). A lingering La Nina pattern, in which cooler-than-normal sea surface temperatures prevail in the Equatorial Pacific Ocean, will also likely encourage Atlantic hurricane activity (National Oceanic and Atmospheric Administration 2011b, See Fig 1). Such conditions limit wind shear in the Atlantic, producing a more conducive environment for the development and growth of Atlantic hurricanes. It should be noted, however, that NOAA predicts a transition out of La Nina this hurricane season, which will likely prevent the 2011 season from being as active as 2010, when La Nina conditions prevailed and 19 named storms developed.

SURGEDAT

The SCIPP program recently created SURGEDAT, the world's most comprehensive storm surge database. SURGEDAT identifies the location and height of maximum storm surge levels in more than 440 surge events around the world since 1880. This dataset began as a study of storm surge activity along the U.S. Gulf Coast. SURGEDAT incorporated data from 62 sources, including 28 Federal government sources, numerous academic publications, and more than 3,000 pages of newspaper, to identify more than 200 historic surge levels along the U.S. Gulf Coast.

SURGEDAT found that the western Gulf of Mexico, including the coasts of Texas, Louisiana and Mississippi, observes some of the largest storm surges in the world. Only the Bay of Bengal in Bangladesh and India, and portions of Queensland, Australia, have ever observed surges larger than Hurricane Katrina's 27.8-foot surge.

Figure 2 depicts a map of historical storm surge activity along the Gulf Coast. Each point on the

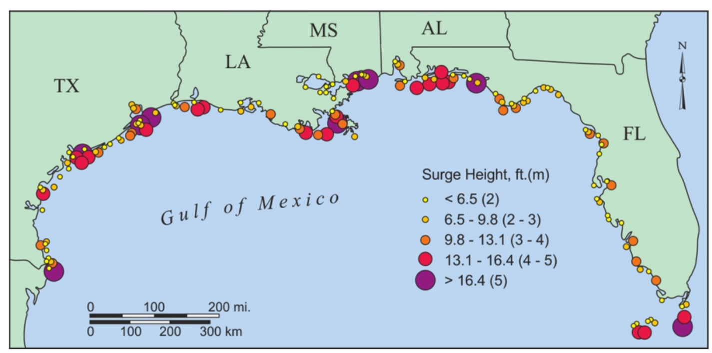

Fig. 2. The western Gulf of Mexico has observed more storm surge activity than the eastern Gulf since 1880. This graphic depicts the locations and heights of peak surge levels in more than 200 surge events. Each circle represents a unique surge event; larger circles depict higher storm surges.

map represents a unique surge event; larger circles depict higher surge levels. This spatial analysis reveals that the western Gulf of Mexico observes substantially higher surges than the eastern Gulf, as seven out of nine Gulf Coast surges that have exceeded 16.4 feet (5 meters) occurred in the western Gulf.

The SURGEDAT database, an interactive surge map, and metadata files that provide links to all data sources used in this research, are available on the Web at: http://surge.srcc.lsu.edu. This website also hosts a storm surge blog, which discusses storm surge potential in active hurricanes and tropical storms, based on historical comparison to past surge events. Such discourse brings storm surge history to life, hopefully improving surge forecasts and enhancing public awareness of storm surge potential.

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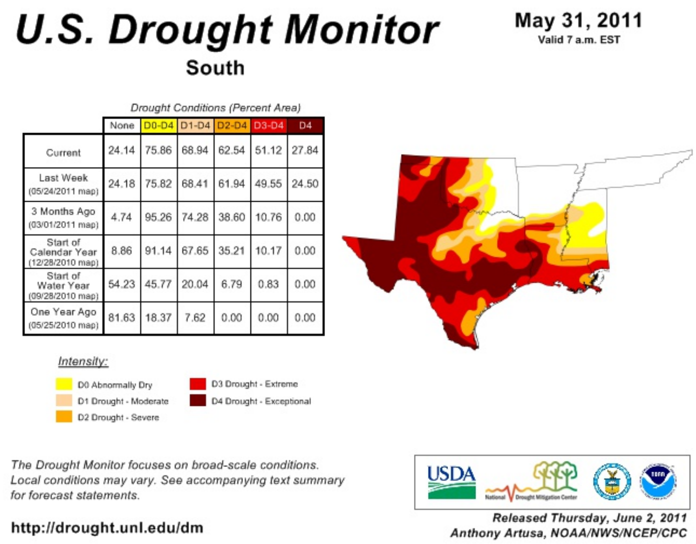
DROUGHT CONDITIONS

Luigi Romolo, Southern Regional Climate Center

Extreme dryness throughout most of the Southern Region has led to little change in drought conditions for the month of May. Unfortunately, most of the precipitation that fell in the region, occurred in areas that were mostly drought-free. Such was the case for Arkansas, Tennessee and eastern Oklahoma. Within the region, the total areal coverage of drought has changed very little over the past month. In northwestern Texas, drier than normal conditions have led to an expansion of exceptional drought. This was also the case for east-central Texas and west-central Louisiana.

Dry conditions prevailed in southern Louisiana, and as a result, much of that region is now experiencing extreme drought conditions. There were some minor improvements in central Oklahoma, with a reduction in the amount of extreme drought there; however much of the area is still considered to be abnormally dry or in moderate drought.

In Texas, the drought has already caused more than $1 billion in agricultural losses, and costs are expected to reach the $4 billion mark, which was seen in 2009, if conditions do not improve significantly during the summer of 2011. Wheat production this season has been less than 50 percent of normal production, with only irrigated crops having any success. Likewise, the outlook is bleak for cotton. In most areas where farmers are not relying on irrigation, planting has been delayed because of a lack of soil moisture. The overall 2011 cotton yield in both the High Plains and Low Rolling Plains is expected to be between 50 - 75 percent of the 2010 cotton yield. The drought has had a large impact on livestock as well. Ranchers across Texas are facing the tough decision of whether to continue the supplemental feeding of cattle or to sell their livestock. (Information is provided by the Texas State Office of Climatology.)

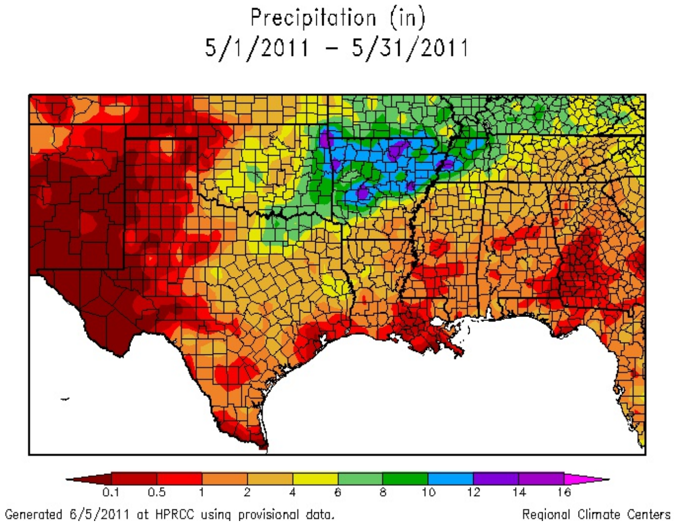


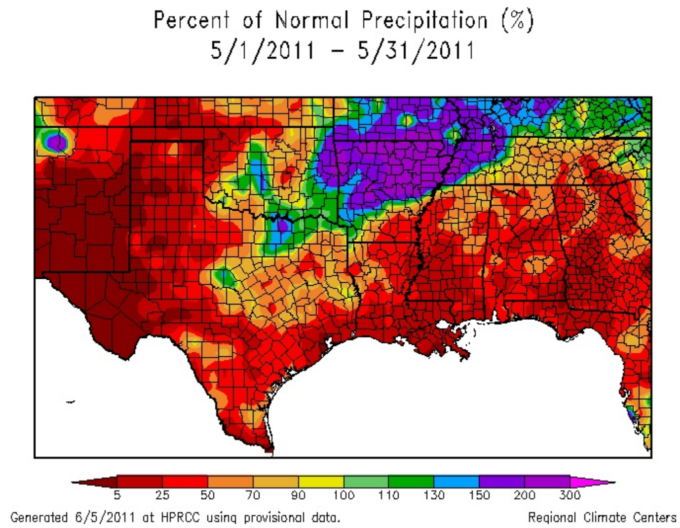
Drought conditions in the Southern Region. Map is valid for May 2011. Image courtesy of the National Drought Mitigation Center.

PRECIPITATION SUMMARY

Luigi Romolo, Southern Regional Climate Center

With the exception of Arkansas, western Tennessee and northeastern Oklahoma, the month of May was an extremely dry month in the SCIPP Region. A majority of the region averaged below 50 percent of normal precipitation for the month. The driest areas for the month include western and southern Texas, southern Louisiana and Mississippi. The majority of stations in those areas averaged less than 25 percent of normal precipitation for the month. In the Trans Pecos climate division of Texas, most stations did not see any measurable precipitation for the entire month. In Arkansas, wetter than normal conditions were observed. Many stations in the state, with the exception of the extreme south, reported between 150 to 200 percent of normal values. This was also the case for the western tip of Tennessee and the northeastern corner of Oklahoma. State averaged precipitation totals for the month were as follows: Arkansas received 8.46 inches (214.89 mm); Louisiana received 1.58 (40.13 mm); Mississippi received 1.85 inches (46.99 mm); Oklahoma received 4.18 inches (106.17 mm); Tennessee received 4.87 inches (123.70 mm); and Texas received 1.57 inches (39.88 mm). Arkansas experienced its eleventh wettest May on record (1895-2011). Louisiana experienced its sixth driest May on record (1895-2011), while Mississippi experienced its eighth driest May on record (1895-2011). The only other ranking in the region that fell outside the middle quartiles was Texas, which experienced its tenth driest May on record (1895-2011).



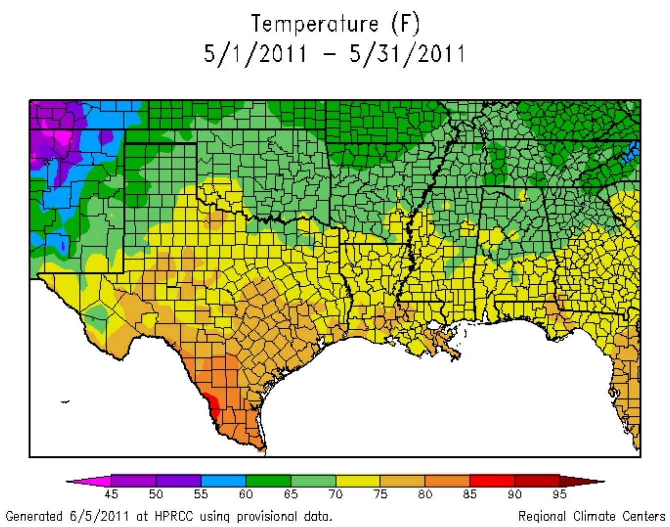


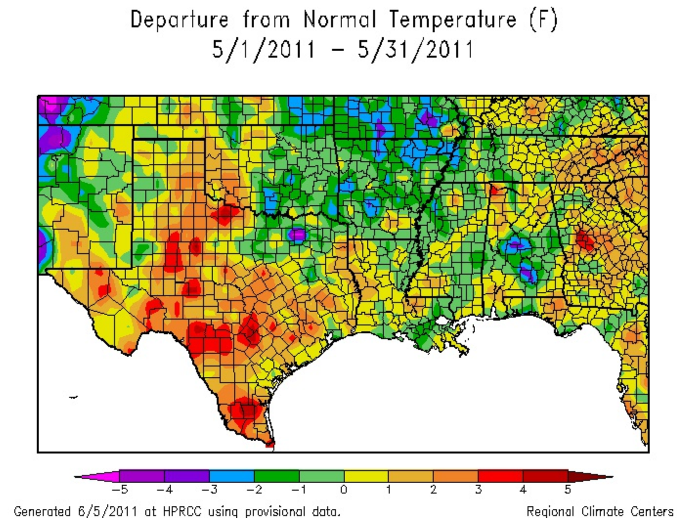
Total precipitation values (left) and the percent of 1971-2000 normal precipitation totals (right) for May 2011.

TEMPERATURE SUMMARY

Luigi Romolo, Southern Regional Climate Center

For the bulk of the Southern Region, the month of May was a relatively average month with respect to temperature. With the exception of Arkansas and Texas, most of the region averaged within about 2 degrees F (1.11 degrees C) of the monthly average. State average temperatures in the region were as follows: 67.20 degrees F (19.56 degrees C) in Arkansas; 73.70 degrees F (23.17 degrees C) in Louisiana; 70.50 degrees F (21.39 degrees C) in Mississippi; 67.40 degrees F (19.67 degrees C) in Oklahoma; 65.90 degrees F (18.83 degrees C) in Tennessee; and 74.10 degrees F (23.39 degrees C) in Texas. In Arkansas, temperatures averaged 2-4 degrees F (1.11-2.22 degrees C) below normal, and it was the thirtieth coldest May on record (1895-2011). Conversely, Texas experienced a warmer than normal month, with many stations averaging 2-4 degrees F (1.11-2.22 degrees C) above the monthly average. For Texas, it was the twenty-first warmest May on record (1895-2011).





Average temperatures (left) and departures from 1971-2000 normal average temperatures (above) for May 2011, across the South.

CLIMATE PERSPECTIVE

State	Temperature	Rank	Precipitation	Rank
Arkansas	67.2	30th Coldest	8.46	11th Wettest
Louisiana	73.7	56th Warmest	1.58	6th Driest
Mississippi	70.5	43rd Coldest	1.85	8th Driest
Oklahoma	67.4	48th Coldest	4.18	49th Driest
Tennessee	65.9	50th Coldest	4.87	51st Wettest
Texas	74.1	21st Warmest	1.57	10th Driest

State temperature and precipitation values and rankings for May 2011. 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 (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	%Norm
El Dorado, AR	81.8	58.8	70.3	-1.1	93.0	5/28	41.0	5/4	2.64	-2.67	50
Little Rock, AR	79.4	58.9	69.2	-0.8	91.0	5/30	46.0	5/5+	11.08	6.18	226
Baton Rouge, LA	86.8	62.9	74.9	1.0	95.0	1/6	43.0	5/4	0.59	-4.58	11
New Orleans, LA	86.1	68.4	77.2	1.8	92.0	5/30+	56.0	5/6	0.78	-3.65	18
Shreveport, LA	84.2	62	73.1	0.2	96.0	5/28	45.0	5/4	2.47	-2.60	49
Greenwood, MS	81.8	58.6	70.2	-2.1	92.0	5/30+	40.0	5/17	1.98	-3.21	38
Jackson, MS	83.8	59.6	71.7	0.3	95.0	5/28	41.0	5/4	0.83	-3.90	18
Tupelo, MS	80.2	58.5	69.3	0.1	92.0	5/30	41.0	5/5	3.36	-2.26	60
Oklahoma City, OK	79.9	57.2	68.5	0.3	94.0	5/9+	36.0	5/3	9.21	3.95	175
Ponca City, OK	78.6	56.5	67.6	-0.5	94.0	5/9	34.0	5/2	0.65	-4.11	14
Tulsa, OK	78.1	58.2	68.2	-1.0	93.0	5/22	38.0	5/3	3.55	-2.37	60
Knoxville, TN	78.4	56.7	67.5	1.7	93.0	5/30+	37.0	5/5	1.64	-2.90	36
Memphis, TN	79.2	60.4	69.8	-0.7	93.0	5/30	46.0	5/17+	7.12	2.12	142
Nashville, TN	77.1	56.3	66.7	-0.2	93.0	5/30	38.0	5/5	4.38	-0.53	89
Amarillo, TX	83.9	49.3	66.6	1.5	104.0	5/29	33.0	5/3	0.08	-2.32	3
El Paso, TX	88.1	60.4	74.2	0.7	99.0	5/29+	43.0	5/2	0.00	-0.36	0
Dallas, TX	83.2	61.7	72.5	-0.5	97.0	5/28	42.0	5/3	7.95	2.95	159
Houston, TX	88.9	68.1	78.5	2.8	98.0	5/26	50.0	5/4	0.33	-4.63	7
San Antonio, TX	89.5	67.3	78.4	2.7	100.0	5/27+	47.0	5/3	0.84	-3.71	18

Summary of temperature and precipitation information from around the region for May 2011. 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.

SOUTHERN CLIMATE 101

Have a question about Southern U.S. climate? Let us know and we may feature the answer in a future issue of the Monitor!

In future issues of the Monitor, we will select a user submitted climate question and provide a reply, to appear in this spot on the back page of the Monitor. Though any aspect of climate is fair game, we will give greatest consideration to questions pertaining to extreme weather & climate events, recent conditions, and climate-related issues relevant to the South Central U.S. - specifically the states of Oklahoma, Texas, Arkansas, Louisiana, Tennessee, and Mississippi. For instance, perhaps you recently experienced a significant winter storm and you were curious how rare it was from a historical perspective. Contact us at **monitor@southernclimate.org** and we will consider your question among all the others we receive. In the subject line of your message, please use "Southern Climate 101." We look forward to your submissions!

Have a climate question, but do not want it to be answered in a public forum? No problem! Feel free to contact us at one of the options listed below, and we will do our best to address your question.

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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 225-578-502. For questions or inquiries regarding research, experimental tool development, and engagement activities at the Southern Climate Impacts Planning Program, please contact us 405-325-7809 or 225-578-8374.