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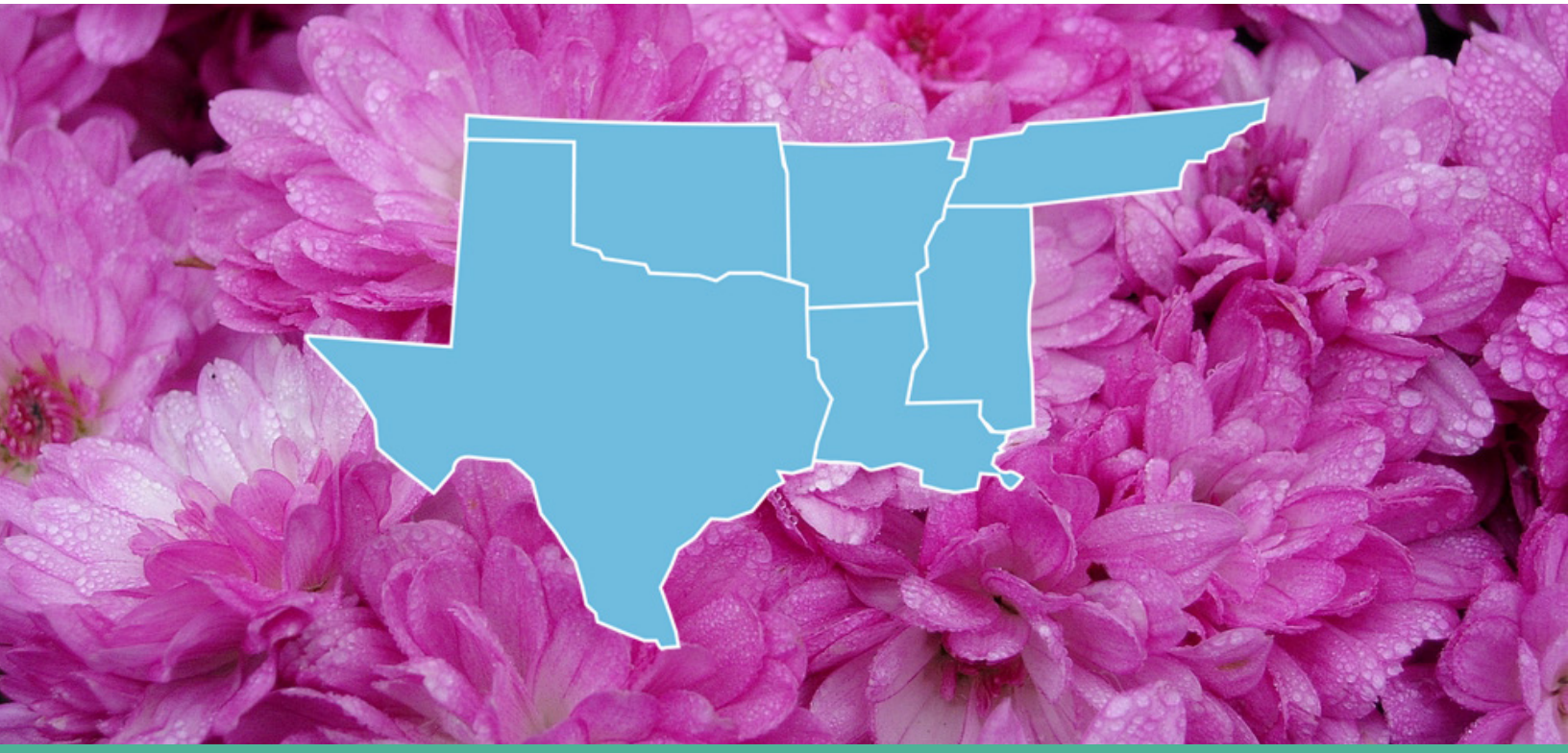

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2016 Severe Weather Season: Below-Normal Tornadoes Across the Southern U.S.?

Carly Kovacik, Meteorologist/General Forecaster, NWS Peachtree City, Georgia

The Southern Plains has long held a reputation for severe weather, especially during the spring season (i.e., March-May). In fact, a portion of the Southern Plains (Oklahoma and Texas) has been commonly referred to as "Tornado Alley" because of the high number of tornadoes that occur there each year. In addition, recent research has also coined another area of high tornado frequency across the South, "Dixie Alley," which includes the states of Louisiana, Arkansas, and Mississippi. You may have asked the question "Why do these areas tend to experience more tornadoes than other regions across the United States (U.S.)?" The answer lies in the position of the jet stream. The jet stream has a large effect on the global pattern of the atmosphere. The jet stream itself is belt of strong winds found at high altitudes. Typically, colder air is found north of the jet stream, while warmer resides to the south of the jet stream. During the winter months, the jet stream dips further south into mid-latitudes, while during the summer months, it retreats to high latitudes. It is during the transition between these seasons, where the jet stream can have an interesting influence across the southern U.S. As the jet stream begins to retreat north in the spring, it is often located across the southern U.S., providing a focus for instability and Gulf moisture transport to fuel thunderstorm development. Under the correct environmental conditions, these thunderstorms can become severe, sometimes resulting in what is known as a "severe weather outbreak" where multiple severe thunderstorms are capable of producing damaging wind, large hail, and tornadoes. Due to the high popularity amongst weather enthusiasts, the media, etc. most of the focus during severe weather season is on tornadoes.

Interestingly, the 2016 spring season has featured a well below-average tornado count thus far (Figure 1). Although the full scientific reasoning behind this can be debated, it may be partially attributed to the effects of El Niño, a phenomenon in which the sea surface temperatures across the equatorial Pacific Ocean are above-normal, ultimately affecting the position of the jet stream. The 2015-2016

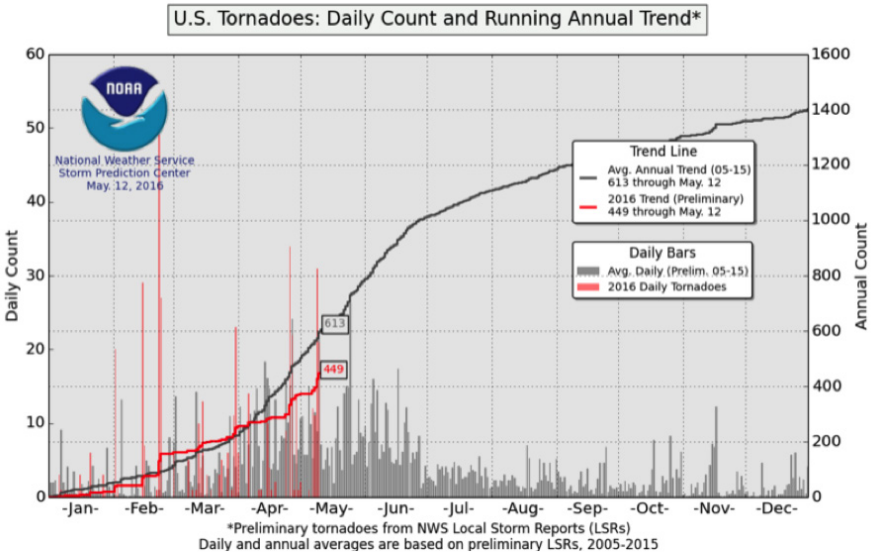


Figure 1. Daily (bar graph, Average Daily: grey bars, 2016 Daily: red bars) and running annual trend (Average: solid grey line, 2016: solid red line) of U.S. tornado frequency. Image courtesy of the Storm Prediction Center.

El Niño rivaled that of some of the strongest ones of its kind. The effects of El Niño are usually most noticeable during the winter season, where the southern U.S. typically experiences cooler and wetter than normal conditions. These effects commonly carry over into spring, although the current El Niño has weakened significantly. But there is more to El Niño than its temperature and precipitation effects in the southern U.S., and there is more to the atmosphere itself than El Niño. Research has long shown that the typical spring severe weather season features a broad scale trough across the western U.S./Rocky Mountains. Most of 2016 has featured a complete opposite pattern, with a ridge anchored over the Eastern Pacific/Western U.S. (Vagell 2016). This inhibits the transport of the necessary Gulf moisture to fuel thunderstorm development. This pattern development may be attributed to some extent to El Niño, but there's more to the puzzle than that, which can make severe weather and long-term forecasting increasingly complicated. This article will not delve into the specifics as to why the pattern has been less favorable for severe weather, but rather will present the storm data gathered thus far this season and briefly compare it to previous years. It is important to realize that these reports are not exhaustive for the 2016 severe weather season, as the data for the month of May have not yet been fully compiled.

All 2016 Weather Hazards: Tornado, Wind, and Hail Reports

There are three criterion that may be met in order for the National Weather Service to issue a severe thunderstorm warning. These criterion include one or more of the following: hail one inch or larger in diameter, wind speeds equal to or exceeding 58 miles per hour, or an indication of tornadic potential (which could then be upgraded to a tornado warning). These criterion can be indicated via a WSR-88D radar or a storm spotter and are typically issued for duration up to one hour. Each warning will always include: storm location, towns affected, and the primary weather threat. The National Weather Service will later gather storm reports for each warning issued and then submit it for public use. Figure 2 shows the total number of all severe weather reports gathered by the National Weather Service, including wind, hail, and tornadoes, across the country from January 1-May 12, 2016. Most reports thus far this year have come from the Central/Southern Plains, the Midwest, and the Southeast/Mid-Atlantic. The states containing the most severe weather reports include: Texas with 833 reports, Mississippi with 335 reports, and Oklahoma with 354 reports. Although population does play a role in these results, this information can be used as a general guide as to where the majority of severe storms have tracked over the past several months.

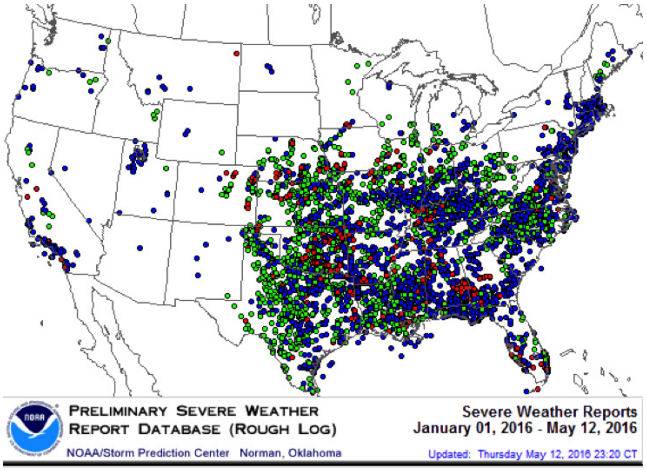


Figure 2. All severe weather reports from January 1-May 12, 2016, including damaging wind (blue dots), hail (green dots), and tornadoes (red dots). Image courtesy of the Storm Prediction Center.

For some, it may be hard to draw solid conclusions about each severe weather threat based on the image provided above. It is possible to sub-divide Figure 2 by threat to gain a clearer perspective as to the spatial extent and coverage of tornadoes, damaging wind, and large hail, respectively.

2016 Tornado Reports:

When a severe thunderstorm or tornado warning has been issued, or tornadic-like damage has been reported from a reliable source, the National Weather Service will conduct a field survey of the area in question. If tornado damage can be determined/verified, the National Weather Service will rate the intensity of the tornado on a scale of 0 (weak) to 5 (violent). This scale is referred to as the Enhanced-Fujita Scale. These reports are then documented and are easily retrievable on the Storm Prediction Center webpage. Compiling all tornado reports so far in 2016 (through May 12) reveals that 449 tornadoes have been documented across the U.S. (Figure 3). This is well below the average of 613 (refer back to Figure 1). The most tornado reports have come from Alabama with 59 reports, followed by Mississippi with 49 reports, and Oklahoma with 45 reports. Most of the tornadoes this year have occurred in mid-late February, and late April-early May. Of the reports, 93% have been rated EF1 or lower.

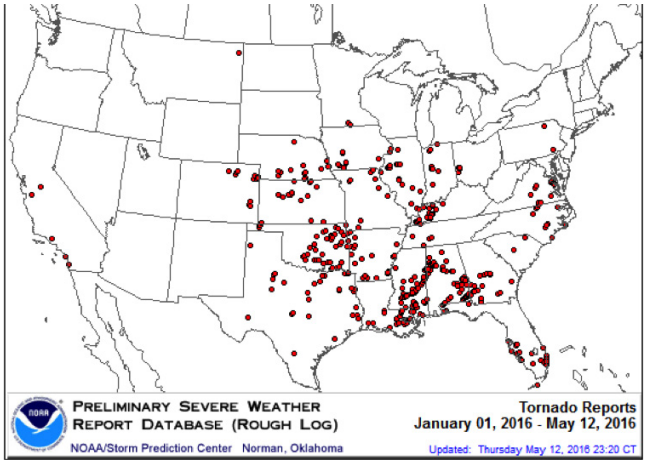


Figure 3. Tornado reports from January 1-May 12, 2016. Each red dot is attributed to a report of a tornado. Image courtesy of the Storm Prediction Center.

2016 Wind and Hail Reports:

To verify severe wind or hail within a thunderstorm, the National Weather Service will not conduct a field study, but rather contact local 911 centers, emergency managers, or nearby businesses for reports. These reports are then documented and made publicly available in a similar fashion to that of tornado reports. Contrary to tornadoes, the reports reveal that 2016 has featured normal to slightly above-normal wind and hail events this year. The states with the highest number of wind reports include: Kentucky and Mississippi tied with 174 reports, Alabama with 167 reports, and Florida with 164 reports. Most of the damaging winds have occurred in late February and late April. Of all of the severe wind reports, 94% have included speeds less than 65 knots. Figure 4 shows the distribution of damaging wind reports across the U.S. (left image), along with a comparison of 2016 wind data to that of previous years (right image.)

In terms of severe hail events, Texas leads the nation in 2016 with 473 reports, followed by Kansas with 207 reports, and Oklahoma with 182 reports. Of all of the severe hail events reported across the U.S. so far this year, 92% of them have been below 2 inches in diameter. Figure 5 shows the distribution of severe hail reports across the U.S. (left image), along with a comparison of 2016 hail data to that of previous years (right image).

While the data presented above are subject to change as new reports are received, 2016 has overall featured a below-average number of tornadoes, but a near-normal number of severe wind and hail reports. Although it is possible that El Niño may have played a role to some degree in this, it is important to realize that El Niño is only a piece of the puzzle. The atmosphere is driven by a number of complex factors, making it hard to pinpoint explicit details within a seasonal or shorter-term forecast. The main aim of this article was to present the current information and data gathered from the 2016 severe weather season and provide a general comparison to previous years. The spring

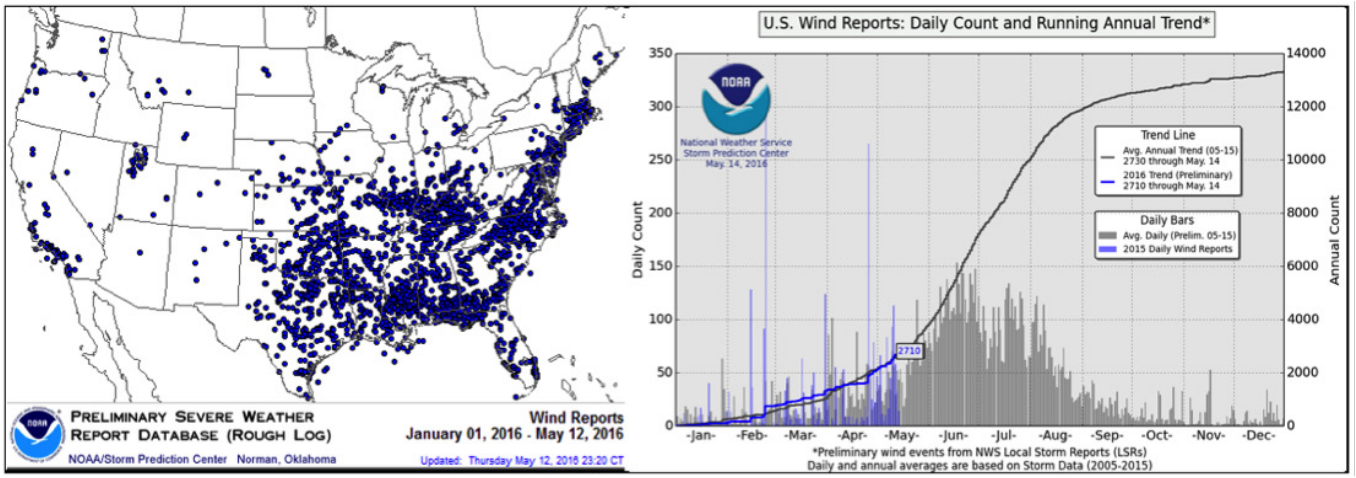


Figure 4. Damaging wind reports from January 1-May 12, 2016, with each blue dot representing a report of damaging wind (left image), and a comparison of 2016 wind reports (bar graph=daily data, line graph=trend data) to those of previous years (right image). Image courtesy of the Storm Prediction Center.

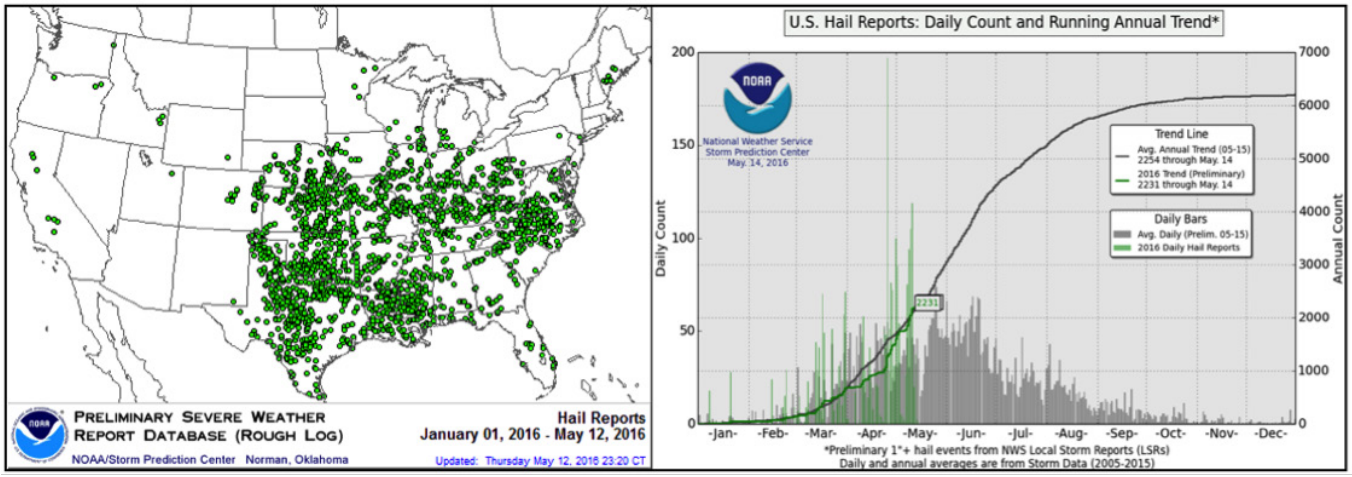


Figure 5. Severe hail reports from January 1-May 12, 2016, with each green dot representing a report of severe hail (left image), and a comparison of 2016 hail reports (bar graph=daily data, line graph=trend data) to those of previous years (right image). Image courtesy of the Storm Prediction Center.

severe weather season is not quite over. While it is not feasible to make assumptions at a storm-scale level at this moment, several model ensembles show the potential for a western U.S. trough to develop towards the latter part of May. Should this verify, that would be a favorable synoptic setup for severe weather potential across the southern U.S. It's important to remember that many other atmospheric ingredients are also necessary for this to occur. The primary severe weather season across the Southern U.S. should begin to wind down in June as the jet stream become displaced further north, taking with it some of the more favorable severe weather ingredients.

To learn more, visit the provided references:

Storm Prediction Center, cited 2016: Annual Severe Weather Report Summary 2016 [Available online at http://www.spc.noaa.gov/climo/online/monthly/2016_annual_summary.html#.]

Storm Prediction Center, cited 2016: Storm Prediction Center WCM Page. [Available online at http://www.spc.noaa.gov/wcm/.]

Vagell, Quincy, 2016: U.S. Tornadoes April 2016 Tornado Outlook [Available online at http://www.ustornadoes.com/2016/03/22/april-2016-tornado-outlook/.]

For questions, feel free to contact Carly Kovacik at carly.kovacik@noaa.gov

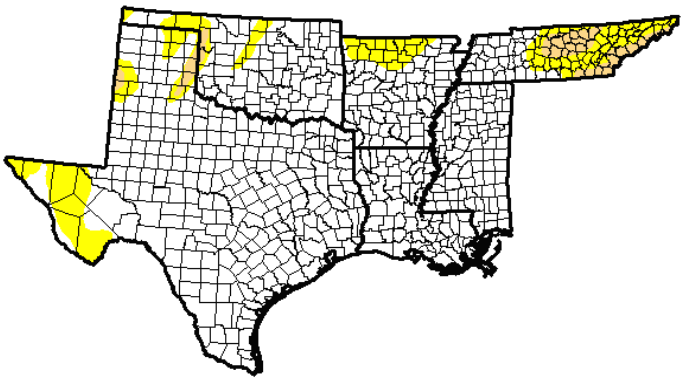
Drought Update

Luigi Romolo,
Southern Regional Climate Center

Drought conditions across the Southern Region have improved in western Oklahoma and northwestern Texas. Above normal rainfall has helped alleviate soil moisture storage deficits and that section of the region is almost drought-free. Drier than normal conditions in Tennessee, however, have led to the expansion of some moderate drought in the central and eastern counties of the state.

Heavy rainfall on the seventeenth and eighteenth of April crippled the city of Houston, with stations reporting well over ten inches of rainfall. Radar estimates for the event suggest between ten and fifteen inches. According to CNN, at least five people were reported dead from flooding. The flooding also forced hundreds of residents out of their homes, and caused power outages all over the city. Approximately 1200 residents were rescued due to dangers from high water. In Harris County, over 1000 homes were flooded.

Severe weather report days occurred throughout the month, with notable occurrences on April 15 and 16, and April 26. On April 15 and 16, several tornadoes were reported across west central and central Texas. There were no reports of injuries or fatalities. On April 26, dozens of tornadoes were reported across eastern and central Oklahoma and northwestern Arkansas. Most of the damage was limited to trees and power lines. There were no reports of injuries or fatalities.



Released Thursday, May 5, 2016
Brian Fuchs, National Drought Mitigation Center

Above: Drought conditions in the Southern Region. Map is valid for May 3, 2016. Image is courtesy of National Drought Mitigation Center.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	86.25	13.75	2.74	0.00	0.00	0.00
Last Week *4/26/2016*	79.83	20.17	2.52	0.35	0.00	0.00
3 Months Ago *2/2/2016*	98.82	1.18	0.00	0.00	0.00	0.00
Start of Calendar Year *12/29/2015*	97.72	2.28	0.00	0.00	0.00	0.00
Start of Water Year *9/29/2015*	36.88	63.12	37.43	18.31	5.72	0.00
One Year Ago *5/5/2015*	69.59	30.41	22.78	13.98	5.16	1.48

Intensity:

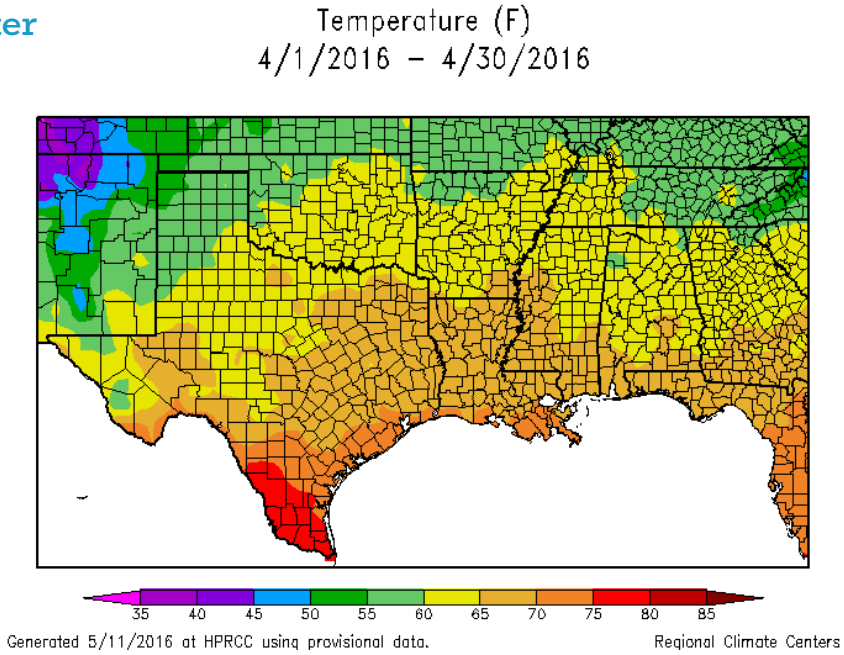
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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

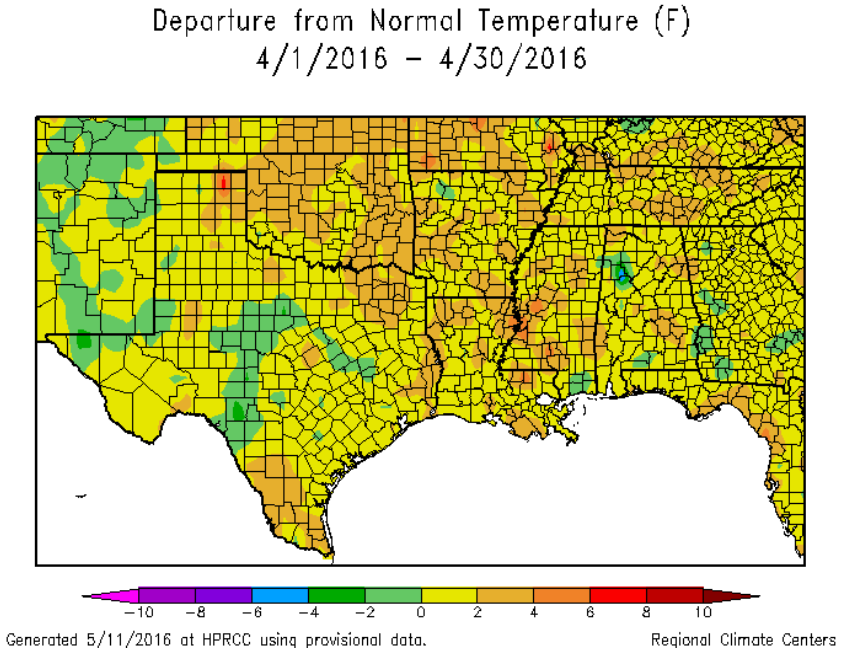
Temperature Summary

Luigi Romolo,
Southern Regional Climate Center

As was the case in February and March, April average temperatures in the Southern Region were consistently above normal for all six states. Temperature anomalies were generally 0-3 degrees F (0-1.67 degrees C) above normal across the entire region. Some areas of eastern Oklahoma and northern Arkansas averaged between 4-6 degrees F (2.22-3.33 degrees C) above the expected monthly normals. The statewide monthly average temperatures were as follows: Arkansas reporting 62.60 degrees F (17.00 degrees C), Louisiana reporting 68.10 degrees F (20.06 degrees C), Mississippi reporting 65.30 degrees F (18.50 degrees C), Oklahoma reporting 61.50 degrees F (16.39 degrees C), Tennessee reporting 59.70 degrees F (15.39 degrees C), and Texas reporting 66.00 degrees F (18.89 degrees C). All state rankings fell on the warmer side of normal. For Louisiana and Oklahoma, it was the twenty-ninth warmest April on record, while Mississippi experienced their thirtieth warmest. For Arkansas and Tennessee, it was their thirty-second and thirty-third warmest April on record, respectively. The state of Texas experienced its thirty-fourth warmest April. All state rankings are based on the period spanning 1895-2016.



Average April 2016 Temperature across the South

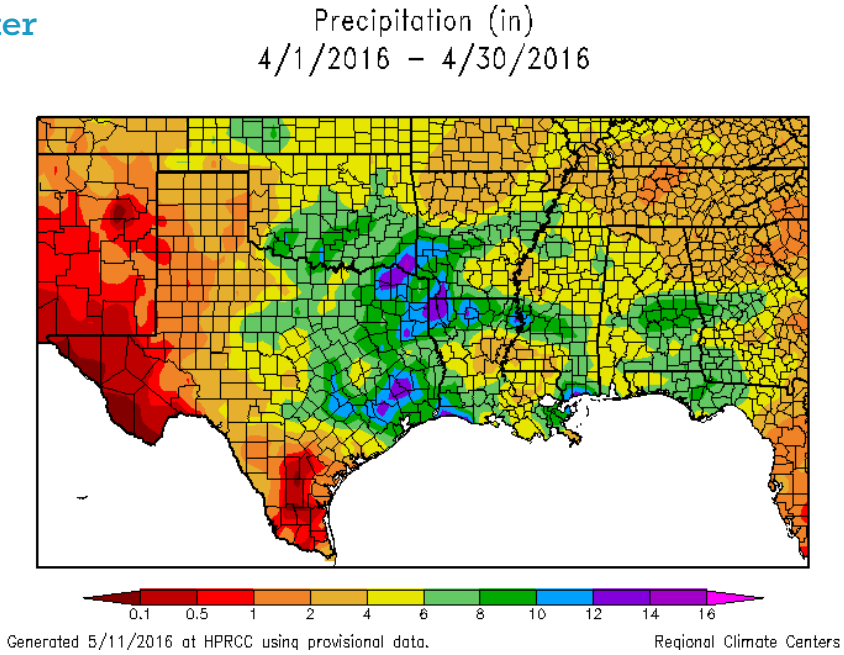


Average Temperature Departures from 1971-2000 for April 2016 across the South

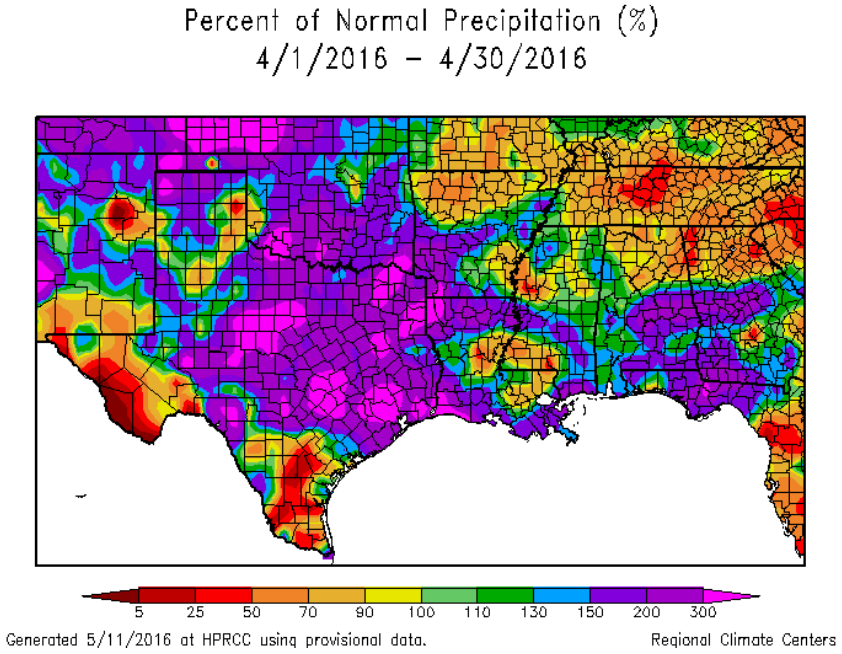
Precipitation Summary

Luigi Romolo,
Southern Regional Climate Center

April precipitation in the Southern Region varied spatially across the Southern Region. Much of Texas experienced a much wetter month than normal, with a majority of stations reporting over twice the normal amount of precipitation for the month. Conditions were also quite wet in northeastern and southwestern Louisiana, and southwestern Arkansas. Conversely, conditions were quite dry in Tennessee, where most stations averaged roughly fifty to seventy percent of normal precipitation. This was also the case for the western Texas panhandle and along the southern tip of Texas. The state-wide precipitation totals for the month are as follows: Arkansas reporting 5.39 inches (136.91 mm), Louisiana reporting 6.67 inches (169.42 mm), Mississippi reporting 5.64 inches (143.26 mm), Oklahoma reporting 5.74 inches (145.80 mm), Tennessee reporting 3.09 inches (78.49 mm), and Texas reporting 4.22 inches (107.19 mm). The state precipitation rankings for the month are as follows: Arkansas (forty-fifth wettest)), Louisiana (twenty-seventh wettest), Mississippi (forty-sixth wettest), Oklahoma (tenth wettest), Tennessee twenty-third driest), and Texas (ninth wettest). All state rankings are based on the period spanning 1895-2016.

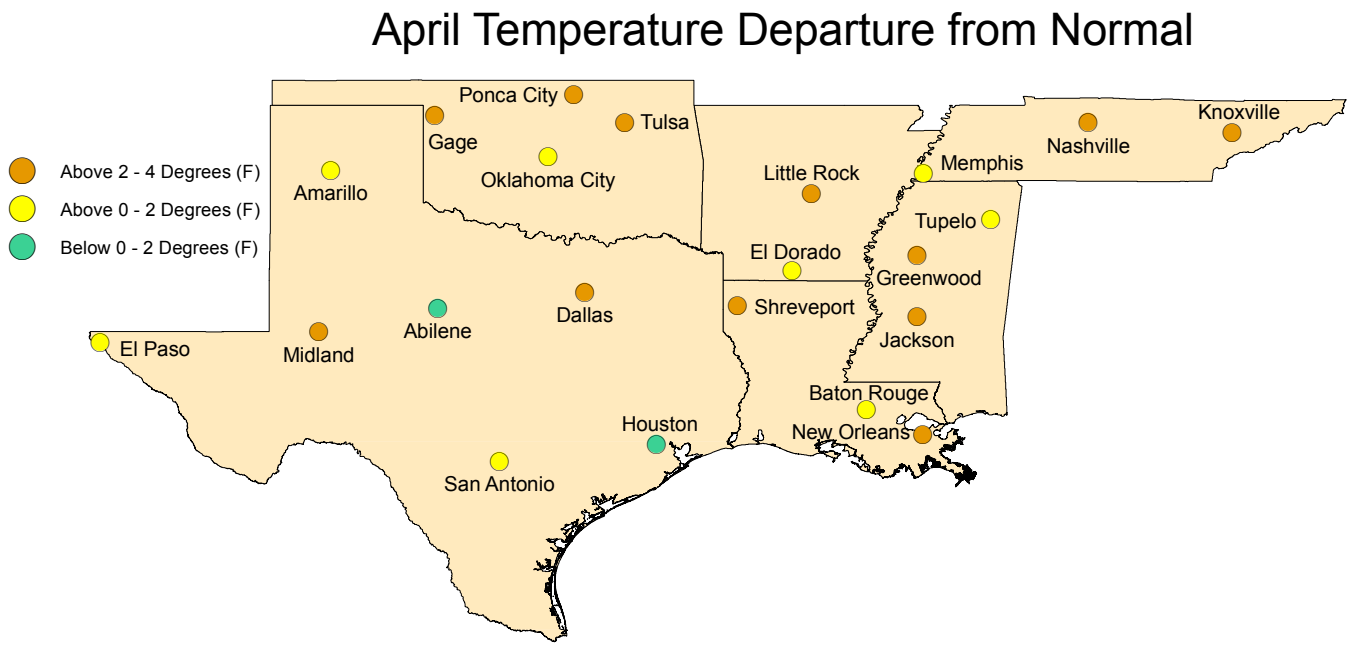


April 2016 Total Precipitation across the South

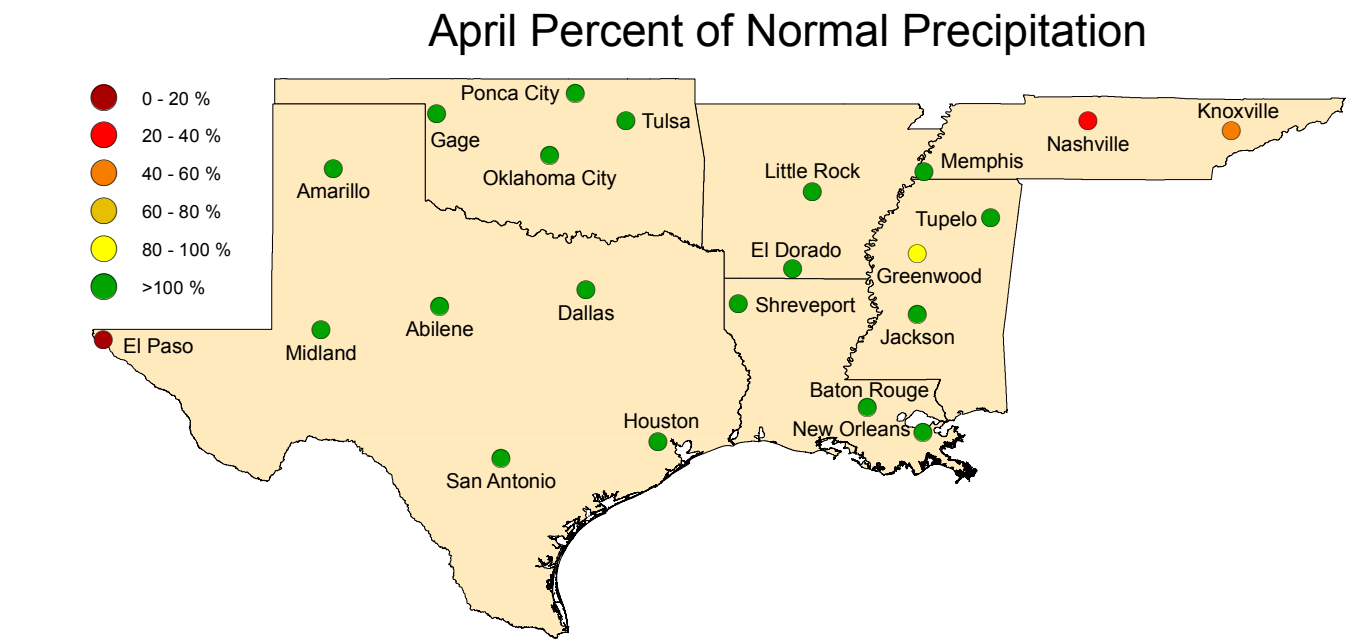


Percent of 1971-2000 normal precipitation totals for April 2016 across the South

Regional Climate Perspective in Pictures



April 2016 Temperature Departure from Normal from 1971-2000 for SCIPP Regional Cities



April 2016 Percent of 1971-2000 Normal Precipitation Totals for SCIPP Regional Cities

Climate Perspective

State	Temperature	Rank (1895-2011)	Precipitation	Rank (1895-2011)
Arkansas	62.60	32nd Warmest	5.39	45th Wettest
Louisiana	68.10	29th Warmest	6.67	27th Wettest
Mississippi	65.30	30th Warmest	5.64	46th Wettest
Oklahoma	61.50	29th Warmest	5.74	10th Wettest
Tennessee	59.70	33rd Warmest	3.09	23rd Driest
Texas	66.00	34th Warmest	4.22	9th wettest

State temperature and precipitation values and rankings for April 2016. Ranks are based on the National Climatic Data Center's Statewide, Regional, and National Dataset over the period 1895-201 1.

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	75.5	53.6	64.6	1.2	85	04/28	38	04/03	8.16	4.07	200
Little Rock, AR	74.4	54.8	64.6	2.5	84	04/28	43	04/02	7.73	2.59	150
Baton Rouge, LA	79.8	59.0	69.4	1.3	89	04/29	41	04/03	4.74	0.28	106
New Orleans, LA	79.1	63.9	71.5	2.4	87	04/29	51	04/03	9.89	5.28	215
Shreveport, LA	78.6	57.3	67.9	2.7	87	04/28+	40	04/03	13.30	9.11	317
Greenwood, MS	75.9	55.1	65.5	2.1	88	04/28	39	04/09	4.35	-0.78	85
Jackson, MS	77.0	55.8	66.4	2.3	88	04/28	41	04/09+	7.25	2.29	146
Tupelo, MS	74.5	52.7	63.6	1.5	86	04/28	38	04/09	5.85	1.07	122
Gage, OK	73.8	45.4	59.6	2.8	90	04/05	25	04/02	2.67	0.93	153
Oklahoma City, OK	74.0	50.3	62.1	1.1	87	04/05	32	04/02	7.31	4.24	238
Ponca City, OK	73.4	47.9	60.6	2.2	89	04/10	28	04/02	3.83	0.39	111
Tulsa, OK	74.5	52.0	63.2	2.6	87	04/05	34	04/02	5.89	2.10	155
Knoxville, TN	73.1	49.5	61.3	2.5	86	04/20	30	04/10	2.38	-1.63	59
Memphis, TN	74.2	55.5	64.8	1.9	85	04/28+	43	04/02	5.97	0.47	109
Nashville, TN	74.6	50.2	62.4	3.4	87	04/26	37	04/10+	1.12	-2.88	28
Abilene, TX	75.4	52.9	64.2	-0.4	88	04/25	36	04/02	6.24	4.60	380
Amarillo, TX	72.3	42.8	57.5	1.2	85	04/25+	33	04/01	3.33	1.93	238
El Paso, TX	79.4	52.4	65.9	1.3	89	04/05	36	04/03+	0.04	-0.19	17
Dallas, TX	78.2	58.1	68.1	2.6	89	04/11	43	04/03	4.60	1.57	152
Houston, TX	78.9	59.1	69.0	-0.5	86	04/29+	42	04/03	14.39	11.08	435
Midland, TX	80.5	53.5	67.0	2.8	92	04/25+	36	04/02	1.45	0.80	223
San Antonio, TX	80.4	59.0	69.7	0.4	90	04/27+	42	04/02	6.19	4.09	295

Summary of temperature and precipitation information from around the region for April 2016. 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.

Colorado State Forecasts Average 2016 Hurricane Season

Barry Keim, Louisiana State Climatologist, Louisiana State University

Our forecasters at Colorado State University have issued their early forecast for the 2016 hurricane season. They are calling for a near-average season in the North Atlantic Basin, which includes both the Caribbean and Gulf of Mexico. So what does that mean? Well, an average season is about 12 named storms, of which 6.5 should become hurricanes, and of these hurricanes, 2 should become major hurricanes. For this upcoming season, Philip Klotzbach and Bill Gray's forecast is slightly differenct calling for 12 named storms, 5 hurricanes, and 2 major. All in all, this forecast is near average, but note that this does not include the storm that got out of the gate a few months early with January's Hurricane Alex. That storm kicks to the 2016 forecast up to 13 named storms (Table 1). The major factors contributing to this forecast are that our current El Nino is expected to weaken and disappear by early summer, and there is a 50 percent chance of a La Nina forming by fall. In addition, tropical sea surface temperature are running a little warmer than normal, but the northern Atlantic is actually cooler than normal. The combination of these factors, which has a lot of push and pull factors, leads the experts to think they will all counter-balance each other and the season should end up normal, or average. BUT, as the weather experts continue to scream, all it takes is one storm to ruin your entire season.....and in Da Parish, I think we all know the true meaning of the saying. If you have any questions, feel free to contact me at keim@lsu.edu.

Table 1. Tropicial Season Forecast for 2016 from the Tropical Meteorology Project at Colorado State University. Graphic can be found in the Klotzbach and Gray report at http://tropical.atmos.colostate.edu/Forecasts/2016/apr2016/apr2016.pdf.

ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2016

Forecast Parameter and 1981-2010 Median (in parentheses)	Issue Date 14 April 2016	Observed Activity Through March 2016	Total Seasonal Forecast (Including Alex)*
Named Storms (NS) (12.0)	12	1	13
Named Storm Days (NSD) (60.1)	50	2	52
Hurricanes (H) (6.5)	5	1	6
Hurricane Days (HD) (21.3)	20	1	21
Major Hurricanes (MH) (2.0)	2	0	2
Major Hurricane Days (MHD) (3.9)	4	0	4
Accumulated Cyclone Energy (ACE) (92)	90	3	93
Net Tropical Cyclone Activity (NTC) (103%)	95	6	101

*Hurricane Alex formed in January 2016. Over the remainder of the document, our seasonal forecast numbers refer to TCs forming after Alex.

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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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