Southern Climate Monitor

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SCIPP
Southern Climate Impacts Planning Program
A NOAA RISA Team

In This Issue:

Southern Regional Climate Center — Data * Service * Research | OU | LSU | NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

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

The OCO-2 Mission

Sean Crowell, University of Oklahoma, School of Meteorology

On July 2, just before 3am Pacific time, the Orbiting Carbon Observatory 2 (OCO-2) was launched successfully into orbit. The original scheduled launch was the previous morning, but the launch was delayed for 24 hours due to a malfunction in the acoustic vibration suppression system in the launch pad. Nevertheless, the second attempt was successful, and for the first time in history, the US has a mission in space with the explicit purpose of measuring carbon dioxide (CO_2) with extremely high levels of precision.

History

The original Orbiting Carbon Observatory was selected as a NASA Earth Systems Science Pathfinder Project, and was scheduled to launch in 2009. However, the satellite failed to achieve escape velocity due to a malfunction in the launch vehicle, and the spacecraft fell back to Earth. In the wake of the failed launch, both the US Congress and the President directed NASA to attempt the mission again. Five years later, the successor mission, OCO-2, made it into orbit riding a Boeing Delta II 7320-10C launch vehicle.

The years in between the two launches were not wasted. The Japanese Aerospace Exploration Agency (JAXA), along with partners, launched the Greenhouse Gas Observing Satellite (GOSAT) in 2009, and both the American and Japanese teams began developing and refining algorithms to utilize the measurements being taken by GOSAT to better understand where CO_2 comes from and where it goes, the sources and sinks of CO_2. Five years later, scientists have an even better grasp on how to use OCO-2 data to answer some of the most pressing science questions related to the

Figure 1: The moment of launch for the Delta II rocket as OCO-2 (inside the nose cone of the vehicle) begins to leave the launch pad and Vandenberg Air Force Base (image courtesy of David Crisp of JPL).

carbon cycle and the interconnections with the other components of the climate system.

Instrument

OCO-2 does not measure CO_2 directly. Rather, it is what is known as a remote sensor. Like weather radar, OCO-2 measures incoming radiation, which is related to things happening in the atmosphere. Unlike weather radar, which measures the amount of radiation that returns from an emitted pulse, OCO-2 measures reflected sunlight off of the surface of the earth. The sunlight passes through the Earth's atmosphere and reflects back into space. Scientists use the amount of light at carefully selected wavelengths to deduce how much CO_2 lies between the satellite and the surface of the Earth, a quantity that is known as column integrated CO_2 mixing ratio. This quantity is the number of carbon dioxide molecules divided by the total molecules in the column of air between the satellite and the surface. Since CO_2 molecules absorb radiation at these carefully selected frequencies, and we know how much radiation is being emitted by the sun, the amount of CO_2 in the atmosphere can be retrieved from a measurement of reflected sunlight.

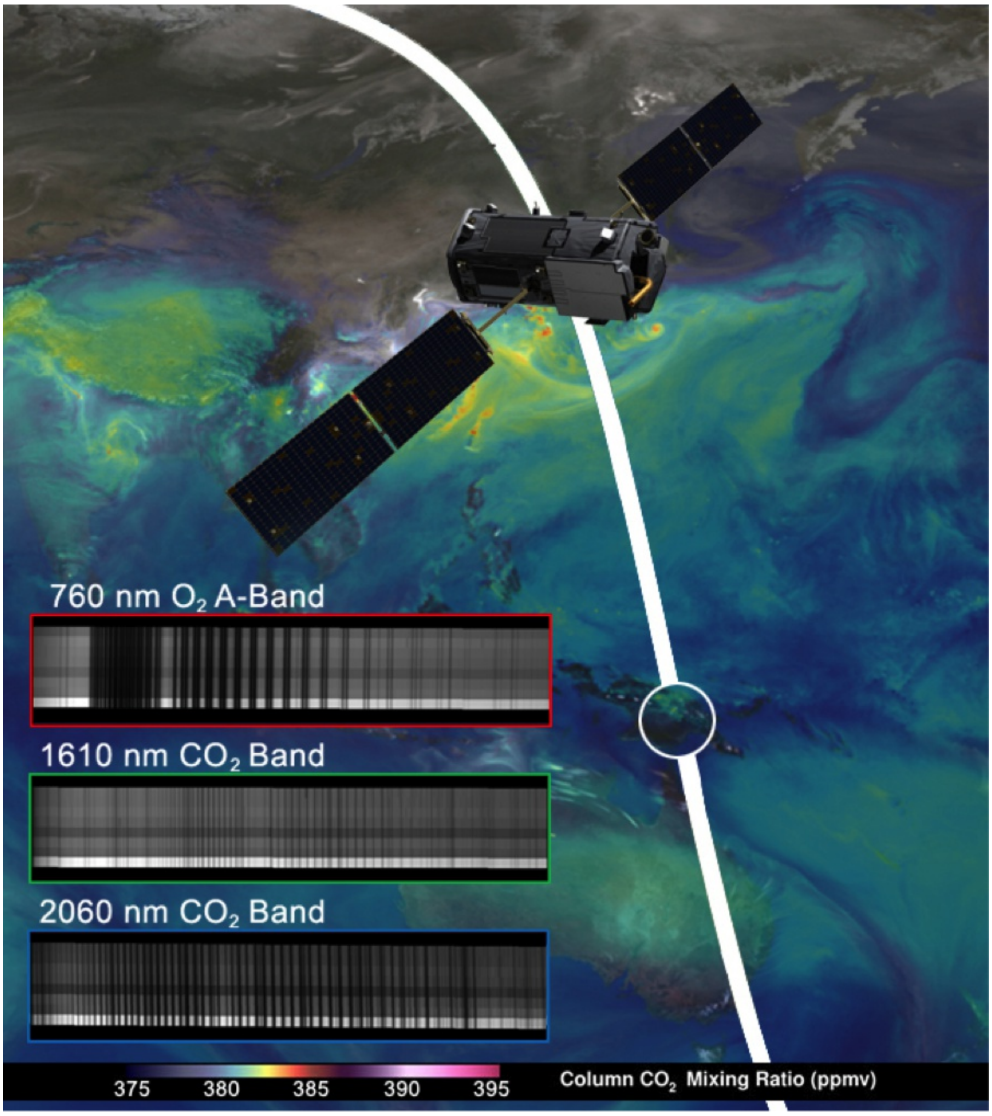


Figure 2: A "first light" image from an initial sample transmitted from OCO-2 to the ground data processing facilities. Pictured are three portions, or "bands," of the electromagnetic spectrum to which OCO-2 is sensitive. The dark segments indicate wavelengths in which all or nearly all the reflected sunlight is absorbed by the atmosphere, and hence very little radiation is measured by OCO-2.

In reality, the temperature and humidity of the atmosphere play a big role in absorption by CO_2, and clouds and aerosols complicate the problem by scattering light, so the estimate of column integrated CO_2 requires a complex physics-based radiation model to properly take all of these factors into account. The complexities of the real atmosphere add uncertainty to the estimate of CO_2 that will be derived from OCO-2 measurements, and these uncertainties are always taken into account when scientists seek to understand phenomena and make predictions.

Existing Observations

In addition to GOSAT, there are other observational systems in place around the world that measure CO_2 and a host of other trace gases for climate research, air quality monitoring and other purposes. Some of these measurements, called in situ measurements, consist of regular samples of air that are analyzed in a laboratory to deduce the amount of CO_2 molecules in a local parcel of air. Another class uses a laser to measure absorption, in the way that OCO-2 uses reflected sunlight, but again for local air, rather than the whole atmospheric column. Finally, the Total Column Concentration Observing Network (TCCON) measures trace gases (including CO_2) much like a satellite would, but the instrument stares directly at the sun, rather than measuring reflected sunlight.

Goals of Measurements

The specific goals of taking so many measurements of CO_2 are numerous, but all are intended to better understand where the carbon in the atmosphere comes from, or its sources, and where it goes, its sinks. Since CO_2 is a long lived, stable gas, it can be traced over long distances between sources and sinks, provided a good estimate of the wind speed and direction throughout the atmosphere. The sources and sinks of the CO_2 determine the application of interest. Terrestrial ecologists are interested in how ecosystems use CO_2 as a nutrient for increasing biomass, and how they return it to the atmosphere when photosynthesis shuts down at nighttime. Marine ecologists are interested in similar processes, but for aquatic communities such as algae and plankton. Regulatory agencies such as the Environmental Protection Agency, want to know how much of the CO_2 in the atmosphere is coming from anthropogenic sources, such as coal-fired power plants, in order to assess violations and to plan future activities.

The product each of these communities is seeking from OCO-2 is the same: a global or regional map of the amount of CO_2 being taken from the atmosphere or being released to the atmosphere, which are known as surface fluxes of CO_2. With this value in hand for a region or ecosystem, there is a net constraint on all of the small-scale processes going on within that region, and so the components that make up that net flux can be more precisely understood. By better understanding these components, we can better predict what the future holds with projections that are in turn folded into climate projections. Since the carbon cycle and future human activities make up some of the largest uncertainties in climate projections, OCO-2 is doing its part to help us to better plan for adaptation and mitigation in a warming world.

Drought Update

Luigi Romolo
Southern Regional Climate Center

Drought conditions in the Southern Region did not vary much over the past month. In northern Texas, dry conditions have led to a slight expansion of extreme drought, and there was also a slight expansion of severe and moderate drought in the central counties of Texas. August was a very quiet month for severe weather. There were no tornadoes reported throughout the month.

In Texas, statewide, reservoirs continued to decline, dropping by nearly three percent. Continued dryness through central and south-central Texas has lead these areas to see few reports of adequate soil moisture, both at topsoil and subsoil levels. The High Plains have improved since the beginning of the summer, but still struggle with subsoil moisture shortages. Outside of the statistics, there are concerns over the future of the Texas rice belt, , with new well drilling expected to drain groundwater at an unsustainable rate and ushering the end of rice crops in the Lower Colorado River Valley (Information provided by the Texas Office of State Climatology).

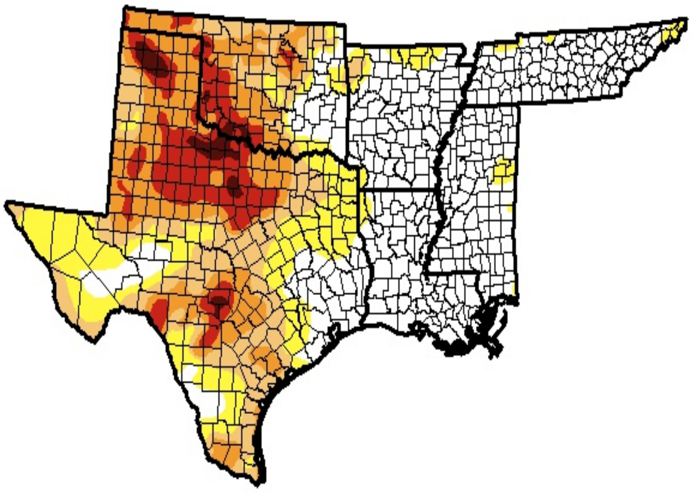
Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	42.82	57.18	40.69	25.29	10.37	1.69
Last Week *8/26/2014*	44.55	55.45	40.81	25.76	10.29	1.69
3 Months Ago *6/3/2014*	31.04	68.96	46.47	33.59	21.79	7.22
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 *9/3/2013*	25.37	74.63	60.57	42.02	10.78	1.55

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**



Released Thursday, September 4, 2014
David Simeral, Western Regional Climate Center

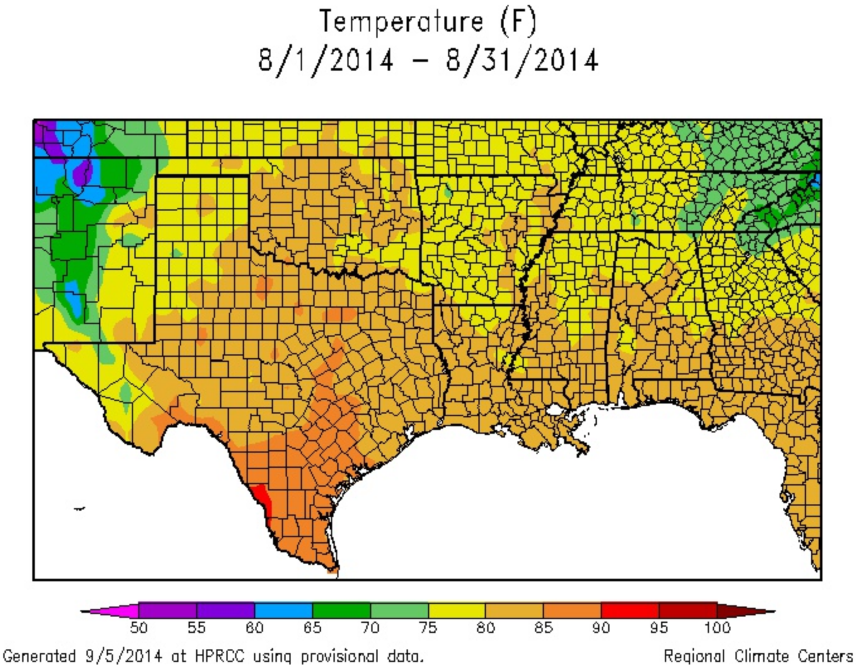
USDA National Drought Mitigation Center

Above: Drought Conditions in the Southern Region. Map is valid for September 2, 2014. Image is courtesy of National Drought Mitigation Center.

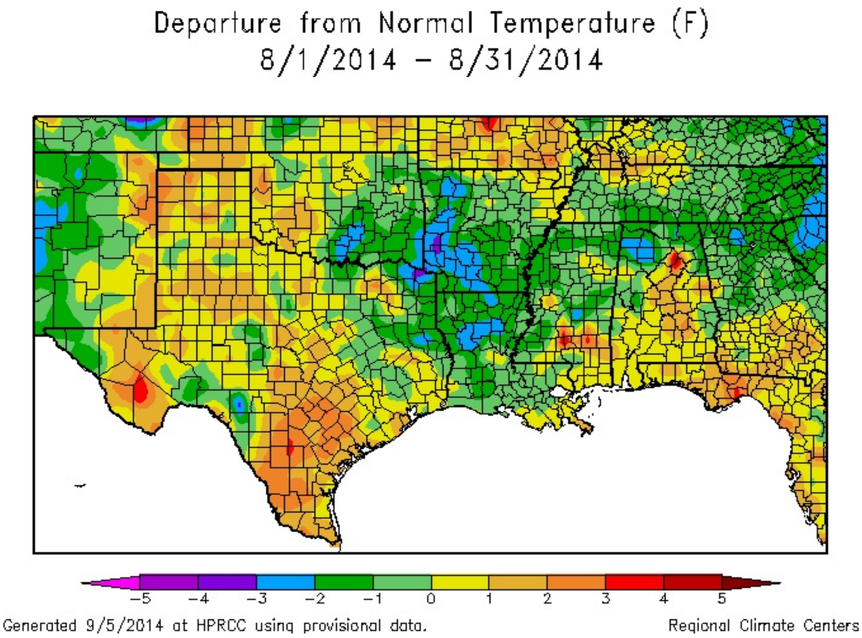
Temperature Summary

Luigi Romolo
Southern Regional Climate Center

August average temperatures varied spatially across the Southern region. Central and eastern portions of the region experienced a slightly cooler than normal month, whereas much of Texas and western Oklahoma experienced a slightly warmer than normal month. The coldest departures from normal were observed in south western Arkansas, where stations averaged approximately two to four degrees F (1.11 to 2.22 degrees C) below normal. Conversely, stations in the southern tip of Texas averaged between two and three degrees F (1.11 and 1.67 degrees C) above expected values. Similar positive anomalies were also observed in the Trans Pecos Climate Division of Texas, and in the Texas and Oklahoma panhandles. The state wide average temperatures for August are as follows: Arkansas reported 78.80 degrees F (26.00 degrees C), Louisiana reported 81.50 degrees F (27.50 degrees C), Mississippi reported 79.90 degrees F (26.60 degrees C), Oklahoma reported 80.90 degrees F (27.16 degrees C), Tennessee reported 75.90 degrees F (24.39 degrees C), and Texas reported 82.70 degrees F (28.17 degrees C). All state rankings of temperature fell within the two middles quartiles.



Average August 2014 Temperature across the South

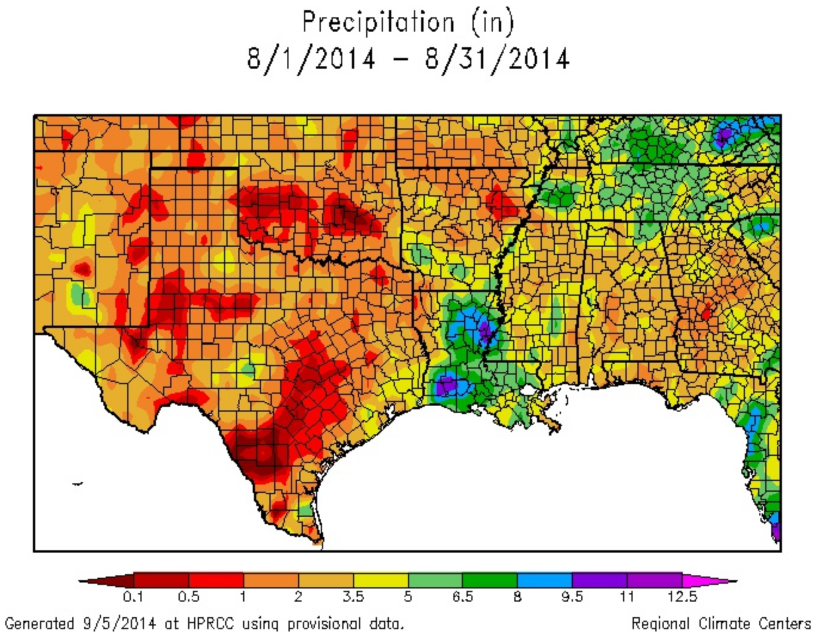


Average Temperature Departures from 1971-2000 for August 2014 across the South

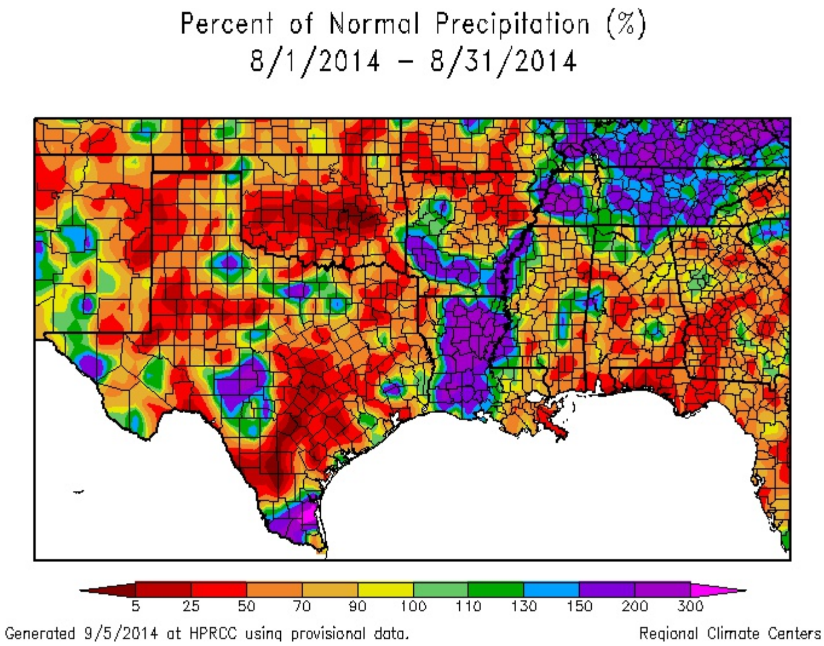
Precipitation Summary

Luigi Romolo
Southern Regional Climate Center

The August precipitation in the Southern Region tells a tale of extreme values, with very few stations reporting near normal precipitation totals for the month. Much of Louisiana experienced a very wet month, with precipitation totals ranging from 150 to 200 percent of normal. Similar values were recorded throughout much of Tennessee and southern Arkansas. Small portions of Texas also observed high precipitation totals for the month. This includes the southern tip and west central counties of the state. In Oklahoma and northern Arkansas, however, conditions were quite dry, with most stations reporting less than a quarter of the monthly normal. This was also the case for many counties in the south eastern and north western counties of Texas. The state wide average precipitation totals for the month of August are as follows: Arkansas recorded 2.83 inches (71.89 mm), Louisiana recorded 5.91 inches (150.11 mm), Mississippi recorded 3.46 inches (87.89 mm), Oklahoma recorded 1.53 inches (38.86 mm), Tennessee, recorded 5.01 inches (127.25 mm), and Texas recorded 1.71 inches (43.43 mm). For Tennessee it was the nineteenth wettest August on record (1895-2014), while Louisiana experienced its thirtieth wettest August on record (1895.-2014). Conversely, Oklahoma experienced its seventeenth driest August on record (1895-2014). All other state rankings fell within the two middle quartiles.

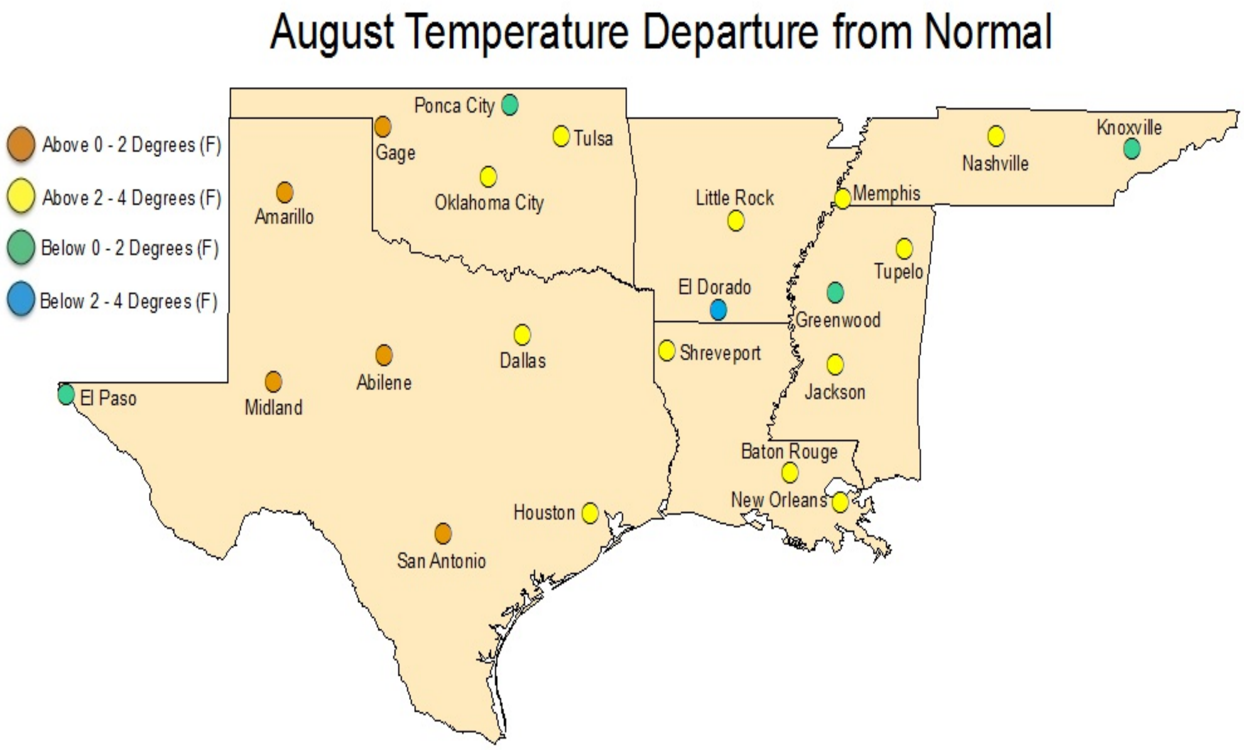


August 2014 Total Precipitation across the South

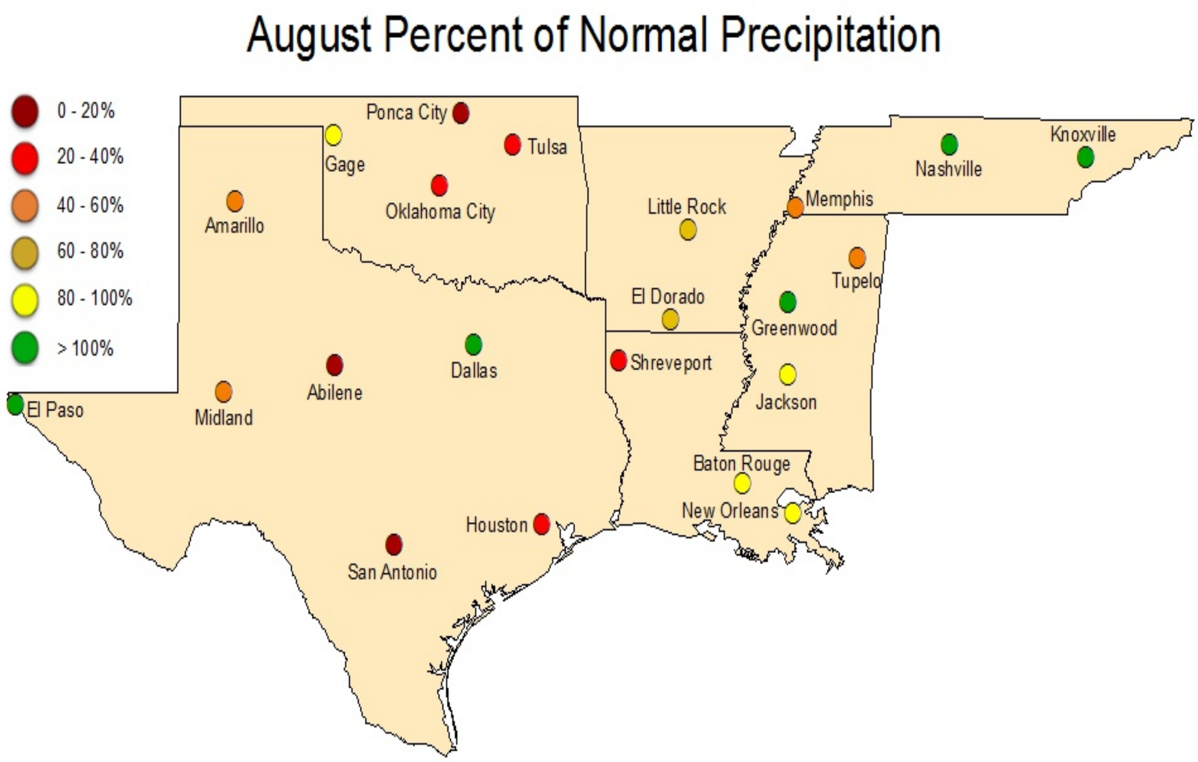


Percent of 1971-2000 normal precipitation totals for August 2014 across the South

Regional Climate Perspective in Pictures



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



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

Climate Perspective

State	Temperature	Rank (1895-2011)	Precipitation	Rank (1895-2011)
Arkansas	78.80	48th Coldest	2.83	48th Driest
Louisiana	81.50	53rd Coldest	5.91	30th Wettest
Mississippi	79.90	49th Coldest	3.46	44th Driest
Oklahoma	80.90	58th Warmest	1.53	17th Driest
Tennessee	75.90	53rd Coldest	5.01	19th Wettest
Texas	82.70	47th Warmest	1.71	41st Driest

State temperature and precipitation values and rankings for August 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	88.7	69.4	79.1	-2.1	93	8/28+	62	8/14+	2.36	-0.86	73
Little Rock, AR	91	72.1	81.5	0.2	97	8/25+	65	8/14	2.01	-0.92	69
Baton Rouge, LA	92	72.8	82.4	1	96	8/24+	65	8/15+	5.65	-0.21	96
New Orleans, LA	92.2	76.5	84.4	1.8	96	8/23	72	8/15	5.5	-0.65	89
Shreveport, LA	93.2	72.8	83	0.1	99	8/25	63	8/15	0.57	-2.14	21
Greenwood, MS	90.3	69.2	79.7	-1.6	96	8/24+	59	8/14	3.03	0.59	124
Jackson, MS	92	70.8	81.4	0.5	97	8/24+	61	8/14	3.52	-0.14	96
Tupelo, MS	90.9	70.1	80.5	0.9	97	8/23+	60	8/14	1.37	-1.3	51
Gage, OK	96.2	67.1	81.6	2.4	103	8/24+	58	8/12+	2.07	-0.41	83
Oklahoma City, OK	94.9	69.1	82	0.8	101	8/25+	65	8/23+	0.82	-1.66	33
Ponca City, OK	93.2	70.2	81.7	-0.2	102	8/25	58	8/12	0.63	-2.73	19
Tulsa, OK	93.7	71.9	82.8	0.6	102	8/22	60	8/13	0.98	-1.87	35
Knoxville, TN	85.6	66.3	76	-1	91	8/29+	58	8/14	4.01	1.12	139
Memphis, TN	91.7	73.4	82.5	1.3	100	8/24	63	8/14	1.8	-1.2	60
Nashville, TN	90.2	69.1	79.6	1.7	97	8/6	59	8/14	5.47	2.19	167
Abilene, TX	96.7	72.9	84.8	2.2	103	8/7	64	8/3+	0.3	-2.33	12
Amarillo, TX	93.2	65.3	79.3	3	104	8/31	58	8/1	1.76	-1.18	60
El Paso, TX	90.4	69.7	80.1	-1	100	8/31	64	8/22+	1.8	0.05	103
Dallas, TX	96.4	76	86.2	1.8	104	8/8	67	8/2	4.34	2.31	214
Houston, TX	94	75.2	84.6	1.3	99	8/25	71	8/2	1.24	-2.59	32
Midland, TX	95.8	72.1	83.9	3.5	103	8/7	67	8/4	0.77	-1	43
San Antonio, TX	99.4	76.7	88.1	3.9	102	8/21+	70	8/3	0.08	-2.49	3

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

A Chalmation Hurricane Visionary

Barry Keim, Louisiana State Climatologist, Louisiana State University

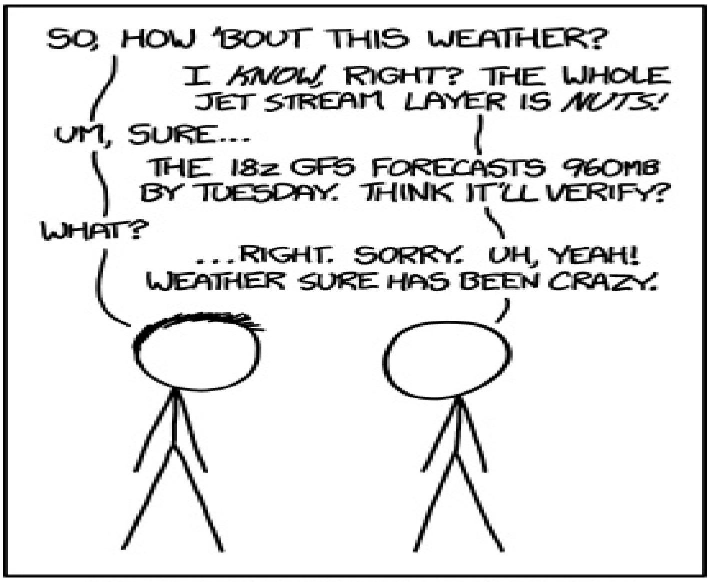
Chalmette once had a hurricane specialist all its own, who had no formal training in meteorology, but who got it all right – and it was no accident. His name was Elwood H. Keim – my dad! He was a visionary, a planner, and never met an insurance policy that he didn't like. This was especially true when it came to hurricanes. The story goes something like this. My dad married Joyce Mary Shannon in October of 1955, and moved downriver to Chalmette from the Big City. He woke up from his honeymoon night to find cows roaming in his backyard. Needless to say, but Chalmette was still quite rural in 1955. Ten years later, his/our humble home took on 4 feet of water in Hurricane Betsy. And by the way, Betsy hit on my second birthday, on September 9th, 1965. My family rebuilt, like most other families in Da Parish. However, my dad had a loftier goal of eventually building a larger, more hurricane-proof home, to better position himself and his family for the future. This was to be a home that would serve as an insurance policy unto itself. Even back in the 1960s, before there was a Saffir-Simpson Hurricane Scale, and sophisticated storm surge models, there were grumblings and concern from hurricane experts that a storm surge of 20 feet or more could one day strike New Orleans. My dad took this under advisement, and planned to build his new family home in 1968 to be able to accommodate this potential 20 foot surge. He used enough lumber and nails in this one house to probably build three homes – complete with steal beams, and for you builders out there….he used 1 X 8s placed at a 45 degree angle for the exterior sheathing. Afterall, this house needed to be hurricane-proof, and that included wind as well. After bringing in a large quantity of fill, I

Figure 1. The Keim residence is the white brick two-story on the right of the image. Photo was taken in the throes of Hurricane Katrina flooding by Arnold Crabtree.

estimate that the house's first floor was built at about 3 feet above mean sea level – quite high for this part for Chalmette, though nose-bleeds were still not a problem! It was also built on pilings for stability. It had two stories, with a third floor attic that you could stand upright in and that had a real stairway leading up to it. This way, even the elderly could find their way to the third floor. I estimate that the base of the 3rd floor was very near 21 feet above mean sea level – near the worst-case scenario storm surge estimates of the day. Oh, and the house had dormer windows in the attic, which provided easy roof access, just in case a roof rescue was needed. All of this was to provide more than adequate living space, but also to provide the insurance policy that if the region severely flooded, that his family and any other inhabitants would have a fighting chance at surviving the experience. Even when Hurricane Camille hit the region in 1969, my dad invited his entire extended family to this house to "weather the storm," and relatives came from all across the city to this so-called safe haven in Chalmette…in CHALMETTE!!?! Well, my dad passed away in 1997, and for better or worse, he obviously never saw the ravages of Hurricane Katrina. However, in Figure 1, it is interesting to see how well his design worked, despite the fact that my mom evacuated to Baton Rouge for this storm. With Katrina, the house took on about 9 feet of water, and with the house being about 3 feet above mean sea level, the water level in the region rose to about 12 feet above mean sea level. The house….well, the third story had 9-feet of freeboard! All of the "insurance" he built into this house did payoff in some ways, as most everything we stored on the second story and the attic survived the storm. Plus, the house still stands – on the ready for the next event, which I hope never comes. Please contact me with any questions at keim@lsu.edu.

Figure 1. The I-10/I-610 interchange in New Orleans in the throes of Hurricane Katrina flooding. Image taken by U.S. Coast Guard, Petty Officer 2nd Class Kyle Niemi. Image is in the public domain and can be found at http://en.wikipedia.org/wiki/Effects_of_Hurricane_Katrina_in_New_Orleans#mediaviewer/File:KatrinaNewOrleansFlooded_edit2.jpg.

Monthly Comic Relief



WEATHER GEEKS HAVE IT TOUGH.

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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 at 405-325-7809 or 225-578-8374.