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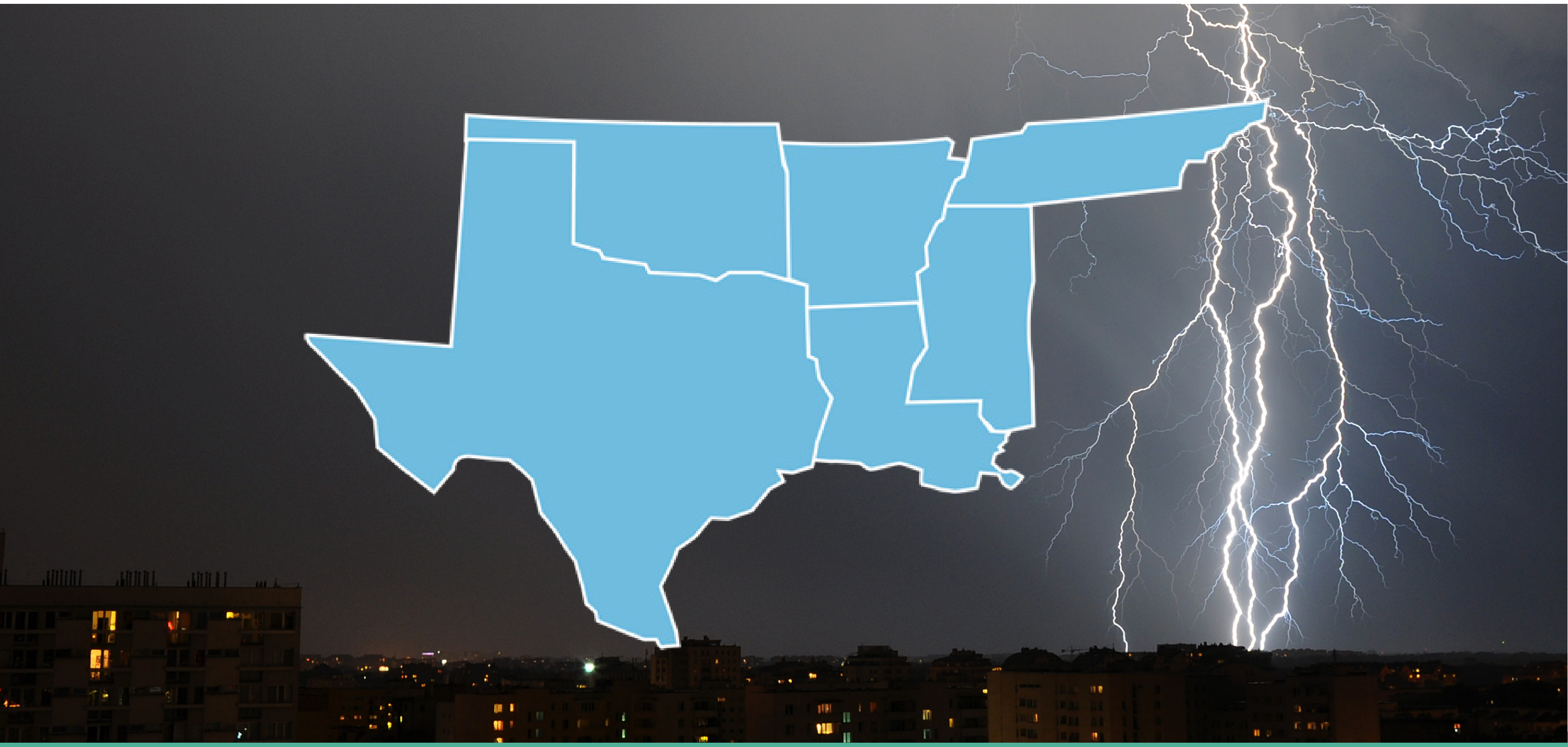

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Training Climate Science Integrators

Gregg Garfin and Julie Brugger, Climate Assessment for the Southwest, University of Arizona

Increasing awareness of climate-related risks to economic activities, ecosystem services, livelihoods and lifestyles, along with an unprecedented volume of easily accessible and widely distributed information, has prompted a demand for timely and reliable climate information and climate services to address risks (NRC, 2010). An important constituent of providing the climate science needed to inform risk management are organizations working at the boundary between science and decision-making ("boundary organizations") and individuals working on the science innovation and the co-production of innovation and information with decision-makers ("integrators" in the sense of Jacobs et al. 2005). For multi-year projects like SCIPP, and others in NOAA's Regional Integrated Sciences and Assessments (RISA) - that conduct experiments in providing climate services - a first wave of climate science integrators (CSIs) have chiefly come up through the ranks learning by trial and error, or with the aid of a wise mentor, but without formal training. Yet, as with any good scientific process, the proof of the process is through the successful reproduction of experimental results - in this case, reproducing success in developing excellent CSIs to work at the science-society interface. In this essay, we report on efforts by a couple of SCIPP's sibling programs to learn about what goes into training the next generation of CSIs - the Hal Needhams, Mark Shafers, and Renee McPhersons of the future.

What do CSIs do?

To develop useful and actionable science, CSIs engage in a number of activities (Ferguson et al. [in press]; Brugger et al.[in press]; Michaels, 2009). Aside from their work as climate scientists, these individuals may serve as (a) information brokers, translating between the worlds of science and practice, (b) informal consultant, performing investigations or limited tasks to answer specific questions raised by clients, (c) short-term partner for building scientific capacity within an organization - sometimes through educational initiatives, (d) collaborator and partner, bringing science know-how in order to solve or contribute to understanding about problems or questions of mutual interest, and (e) networker and matchmaker, helping decision-makers hook up with the right expert or organization.

Lessons from first generation CSIs

We were particularly interested in learning about what leads to the success of science integrators like Joe Barsugli (Western Water Assessment), who are capable with rigorous physical science, such as Joe's work in climate dynamics and modeling, and adept in their interactions with resource managers and the public. This is in contrast with those who communicate climate science, but do not take part in physical science research. In order to understand what makes the Joes tick, we, along with another research team that had similar interests, interviewed a number of what we are calling the first generation of experienced CSIs. We asked about their science integration work, their career paths, how they address the challenges of working at the science-society interface, and what recommendations they have for the upcoming generation of integrators. This work is detailed in a forthcoming paper in the *Bulletin of the American Meteorological Society* (Brugger et al., 2015), and in a publicly-available presentation from the 2015 annual meeting of the American Meteorological Society. Key lessons from the first generation about working with decision-makers include:

1. Be a good listener, because it sets the tone for a respectful relationship, and it allows the scientist to learn about the decision-making context.
2. Understand and respect the people you work with - commonsense advice, which is important, because personal relationships are sometimes key to fostering the use of science.
3. Understand the decision - making context, because often times, science plays only a small role in complex decisions.
4. Be humble - humility is essential for establishing trust.
5. Maintain credibility in both the scientific and stakeholder communities. Maintaining an unbiased approach is as important as solid grounding in one's discipline.
6. Show interest in a variety of things - how else can you learn?
7. Be patient, because both trust and developing a good fit between science and decisions take time.
8. Make time to reflect on this process, so you can absorb lessons from working with stakeholders.

Preparing the next generation

To train a next generation of CSIs we examined existing training courses for professions closely aligned with science-society interface activities. In general, based on what the first generation told us, we identified the following categories of activities needed to do science integration: grounding in climate subject matter or knowledge base, interpersonal skills, communication skills, education skills, and facility in program development and implementation (Figure 1). We also noted that many science integration efforts, like those performed by SCIPP investigators, are multi-disciplinary, and require an appreciation for research methods and cultures, as well as appreciation of decision-makers' context and practice.

Drawing upon two examples of training, here are some ideas about training for CSIs. These examples are representative, but not exhaustive; they demonstrate competencies and skills to that can contribute to CSI effectiveness in their multiple roles.

Cooperative Extension Onboarding
Cooperative Extension has a long history straddling the boundary between science and decision-making. Some extension personnel competencies that are relevant to the CSI work include:

- Community Processes
- Diversity/Pluralism/Multiculturalism
- Educational Programming
- Engagement
- Education Delivery
- Interpersonal Relations
- Leadership
- Organizational Management
- Professionalism
- Subject Matter

Texas A&M University Agrilife Extension portrays a compelling 2-year training program, called "onboarding," in their online materials. The program includes training elements, such as: shadowing colleagues in a neighboring county, completing a journal to reflect on working with clients, receiving active mentoring, consulting

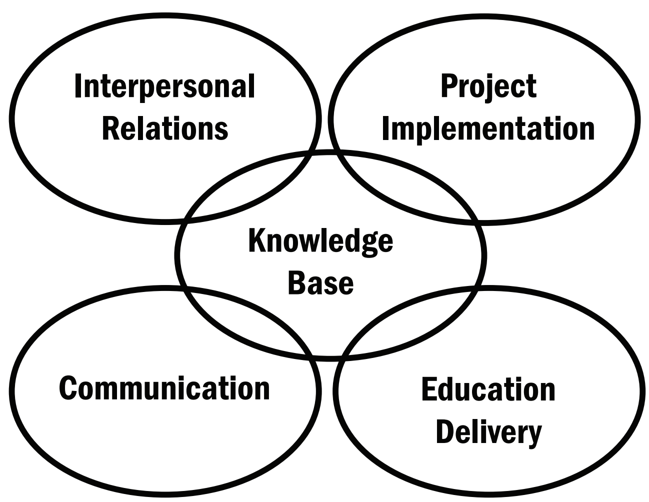

Figure 1. Intersection of climate science integrator skills.

a new agent study guide, and online trainings in adult learning theory and other topics. The new agent study guide guides the budding extension agent in learning about decision context (e.g., demographics, socioeconomic information, key organizations), program evaluation, conducting meetings, getting acquainted with local media officials, and making visits with stakeholders.

Master in Public Health Curricula

Public health professionals often have roles similar to those of CSIs. In fact public health benchside (research) - to - bedside (patient use of information or medicine) frameworks (Dougherty and Conway, 2008) closely resemble the climate service research to operational use frameworks (Brooks, 2013). Many of the Brown University public health master's degree competencies are germane to the work of a CSI (Brown University). For example: grounding in a knowledge base, developing a research program, community service and intervention (e.g., designing, implementing, monitoring and evaluating a program), identifying community service opportunities, developing and maintaining effective linkages with community organizations. These professionals must design research projects; collect and analyze data; understand the importance of collaborating with organizations and communities, and they must translate health services research into policy and practice - much like the work performed by SCIPP CSIs.

The examples from extension and public health correspond well with the lessons from first generation CSIs (Table 1).

How to do it

These examples address the potential *content* of a CSI training program, but then there is the question of *implementing* a program. Based on the wisdom of the first generation, and from examining training programs, there are a variety of techniques that can be part of a program. The first generation CSIs emphasized experiential learning. Some additional ways of delivering the training are mentioned above, such as onboarding, apprenticing (or shadowing a colleague), internships, and formal training (such as that offered by the National Conservation

CSI Lessons	Extension Competencies	Public Health Competencies
Be a good listener	Engagement, Diversity/Pluralism/Multiculturalism,	Community Service, Communication
Understand and respect the people you work with	Diversity/Pluralism/Multiculturalism	Community Service, Communication
Understand the decision-making context	Community and Social Action Processes	Knowledge Base, Community Service
Be humble	Interpersonal Relations	Community Service, Communication
Maintain credibility in both the scientific and stakeholder	Subject Matter, Professionalism	Knowledge Base, Research
Be curious/interested in a variety of things	Professionalism	Community Service, Communication
Be patient	Interpersonal Relations	Community Service, Communication
Reflect on what you are doing	Engagement, Leadership, Information and Education Delivery	Community Service, Communication

Table 1. Relationship between climate science integrator (CSI) lessons learned and competencies from disciplines that also work at the boundary between science and public decision making.

Training Program). Some professional societies, such as the American Meteorological Society (AMS), offer formal and informal training; the AMS Summer Policy Colloquium is one example. Training could be condensed into "boot camp" style intensives, which use time efficiently. Extension offers service learning, which is similar to professional development programs offered by many employers. Cross-training is an intriguing model for gaining familiarity with multiple disciplines and their methods, and to develop understanding and empathy for others' work culture, the constraints under which they operate, and their decision contexts (NRC, 2015). Cross-training is appropriate for acclimating CSIs to multidisciplinary teamwork, and to attuning themselves to stakeholders' sensitivities.

Final Thoughts

Many skills are required by individuals who bridge the gap between science and decision-making. While the first generation of CSIs learned on the job, from an influential mentor, and through other life experiences, we believe that it is possible to prepare future CSIs with training in skills identified by first generation CSIs and by analogous professions. We offer a list of course categories (Table 2). While we are not aware of a complete CSI training program in the United States, there have been efforts to develop at least some aspects of this training. Three examples are Dr. Richard Rood's University of Michigan climate change class, which incorporates multidisciplinary projects and explores real-world applications; the Association of Natural Resources Extension Professionals Climate Science Initiative, which covers a wide array of topics through a webinar series, blog, and conferences; and the University of Arizona's certificate program in Connecting Environmental Science with Decision-Making, which offers courses to develop part of the skillset necessary for integrators between science and society.

Skills
Background in academic studies of boundary organizations, extension, etc.
Making good presentations (delivery, graphics)
Selling/pitching your program, your work, your career
Media relations and the art of the interview
Practicum in learning on the job, through an embedding with a resource management organization, or through an internship
The art of convening workshops, and meeting facilitation
Communication of science
Planning processes
Collaboration and teamwork
Interpersonal skills, dialogue, negotiations
Decision context
Educational program design, evaluation, social science methods
Learning theory
Problem solving and strategic thinking

Table 2. Training topics or courses to develop a set of skills for a well-rounded climate science integrator. These were chosen, in part, from a review of the titles of courses offered through the National Conservation Training Center.

Acknowledgments

The authors are pleased to acknowledge contributions to this work, by Alison Meadow (Univ. of Arizona Center for Climate Adaptation Science and Solutions), and Eric Gordon, Bill Travis, Joe Barsugli, and Imtiaz Rangwala (Western Water Assessment).

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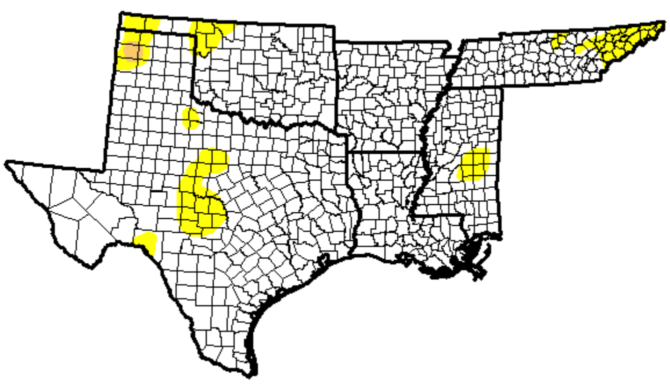
Drought Update

Luigi Romolo,
Southern Regional Climate Center

Historic May rainfall totals in Oklahoma and Texas have resulted in a tremendous improvement of drought conditions in both states. As of June 2, 2015, only 0.32 percent of the Southern Region is in drought, with no states showing any severe (D2), extreme (D3) or exceptional (D4) drought conditions. The May 19th United States Drought Monitor marked the first time since June 22, 2010 that there was no extreme or exceptional drought in the Southern Region. It was also the first time since November 23, 2010 for Texas, and the first time since March 8, 2011 for Oklahoma, that the drought map for each state was not showing any D3/D4 drought.

According to CBS News in Houston, twenty-one people have died there as a result of flash flooding that devastated the city on Memorial Day weekend. Eleven more people are still reported missing. The rainfall occurred overnight on May 24-25. Rainfall totals over 11 inches (279.4 mm) were reported at CoCoRaHS stations throughout the city. The hardest hit areas included the Sugarland and Richmond areas. This storm is being referred to as a one-hundred year flood. The total damage of the storm won't be tallied up for some time, but the storm brought the city to a stand still, flooding interstate highways, homes and leaving thousands of people without power.



Released Thursday, June 4, 2015
David Miskus, CPC/NCEP/NWS/NOAA

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	91.32	8.68	0.32	0.00	0.00	0.00
Last Week 5/26/2015	82.07	17.93	3.09	0.00	0.00	0.00
3 Months Ago 3/3/2015	36.76	63.24	35.83	20.17	10.48	2.47
Start of Calendar Year 12/30/2014	41.57	58.43	33.88	18.43	8.80	2.36
Start of Water Year 9/30/2014	41.74	58.26	35.49	22.66	8.47	1.98
One Year Ago 6/3/2014	31.04	68.96	46.47	33.59	21.79	7.22

Intensity:

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

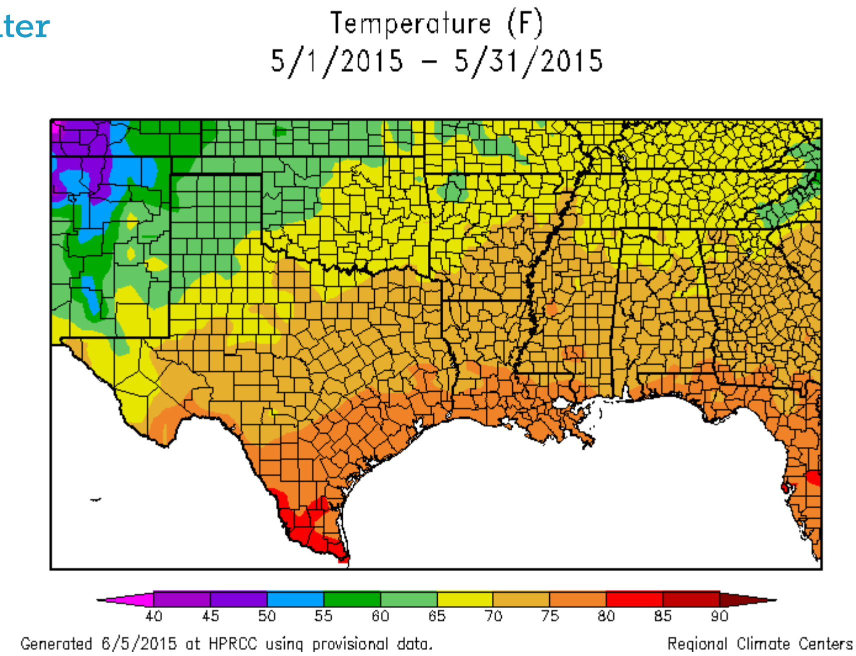
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Above: Drought conditions in the Southern Region. Map is valid for June 2, 2015. Image is courtesy of National Drought Mitigation Center.

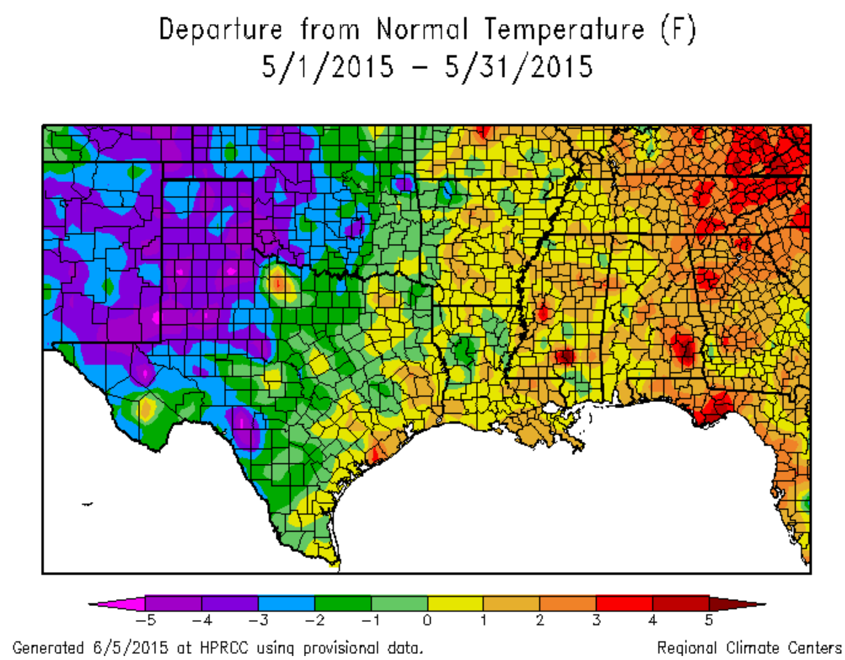
Temperature Summary

Luigi Romolo,
Southern Regional Climate Center

May average temperatures in the Southern Region varied west to east. Western counties in Texas and Oklahoma experienced a cooler than normal month, while eastern counties, particularly in Tennessee and Mississippi, experienced a warmer than normal month. Temperatures in Louisiana and Arkansas ranged from 0-2 degrees F (0-1.11 degrees C) above normal. The coolest anomalies of the region occurred in the western Oklahoma and in north west Texas, where most stations averaged 2-5 degrees F (1.11- 2.78 degrees C) below expected values. This is due, in part to the high number of rain days, which led to more cloudy days and less sunshine hours. The warmest anomalies in the region occurred in eastern Tennessee, with stations averaging between 3-5 degrees F (1.67-2.78 degrees C) above normal. The state-wide average temperatures for the month are as follows: Arkansas averaged 69.30 degrees F (20.72 degrees C), Louisiana averaged 74.9 degrees F (23.83 degrees C), Mississippi averaged 72.4 degrees F (22.44 degrees C), Oklahoma averaged 66.20 degrees F (19.00 degrees C), Tennessee averaged 68.00 degrees F (20.00 degrees C), and Texas averaged 71.6 degrees F (22.00 degrees C). For Tennessee, it was the twenty-fourth warmest May on record (1895-2015). All other state temperature rankings fell within the two middle quartiles.



Average May 2015 Temperature across the South

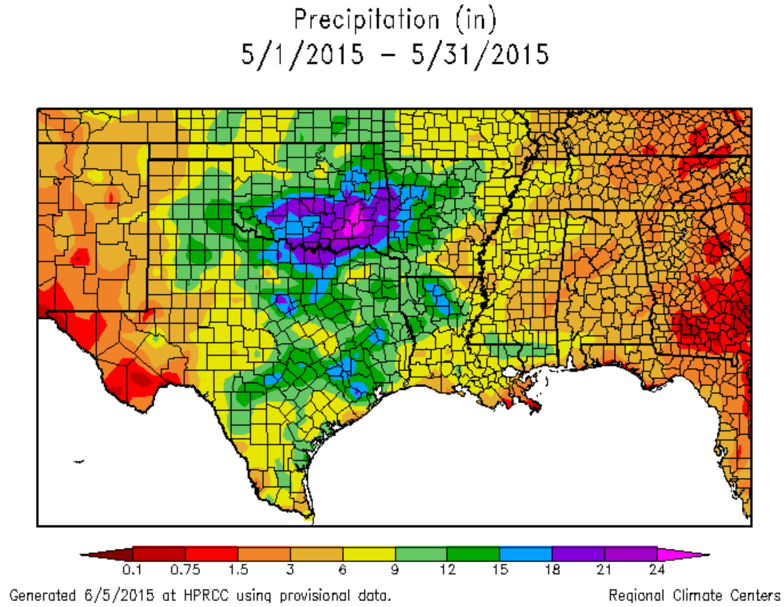


Average Temperature Departures from 1971-2000 for May 2015 across the South

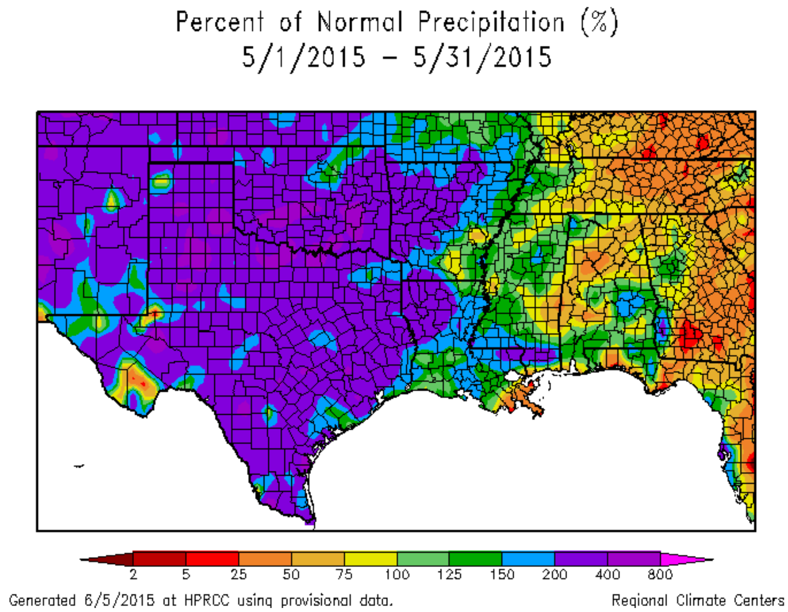
Precipitation Summary

Luigi Romolo,
Southern Regional Climate Center

With the exception of Tennessee, May was an extremely wet month across the Southern Region, with historically high precipitation totals at both the station and state level. The wettest portions on the region included most of southern Oklahoma and northern Texas, where stations saw as much as 28 inches (711.2 mm) of rainfall for the month. In the South Central Climate Division of Oklahoma, several stations reported over 20 inches (508.0 mm) for the month. Similarly, stations in the North Central Climate Division of Texas consistently reported well over 10-11 inches (254.0-279.4 mm). The state-wide average precipitation totals for the month are as follows with: Arkansas reporting 10.35 inches (262.89 mm), Louisiana reporting 8.12 inches (206.25 mm), Mississippi reporting 6.02 inches (152.91 mm), Oklahoma reporting 14.06 inches (357.12 mm), Tennessee reporting 3.65 inches (92.71 mm), and Texas reporting 8.93 inches (226.82 mm). The value of 8.93 inches (226.82 mm) for Texas was not only the wettest May on record, but it was also the wettest month ever, eclipsing the previous value of 6.66 inches (169.16 mm) set back in June of 2004. The state-wide average for Oklahoma was also the wettest month ever. The previous record was 10.75 inches (273.05 mm), which was set in October of 1941. For Arkansas it was the second wettest May on record, and the twelfth wettest May for Louisiana. Mississippi recorded its twenty-sixth wettest May on record. All records are based on data for the period 1895-2015. Putting this rainfall in perspective, the Southern Region averaged over eight inches (203.2 mm) of rain, that's the equivalent of an ankle deep pool of water spread over an area just over half a million square miles (1,294994 square km).

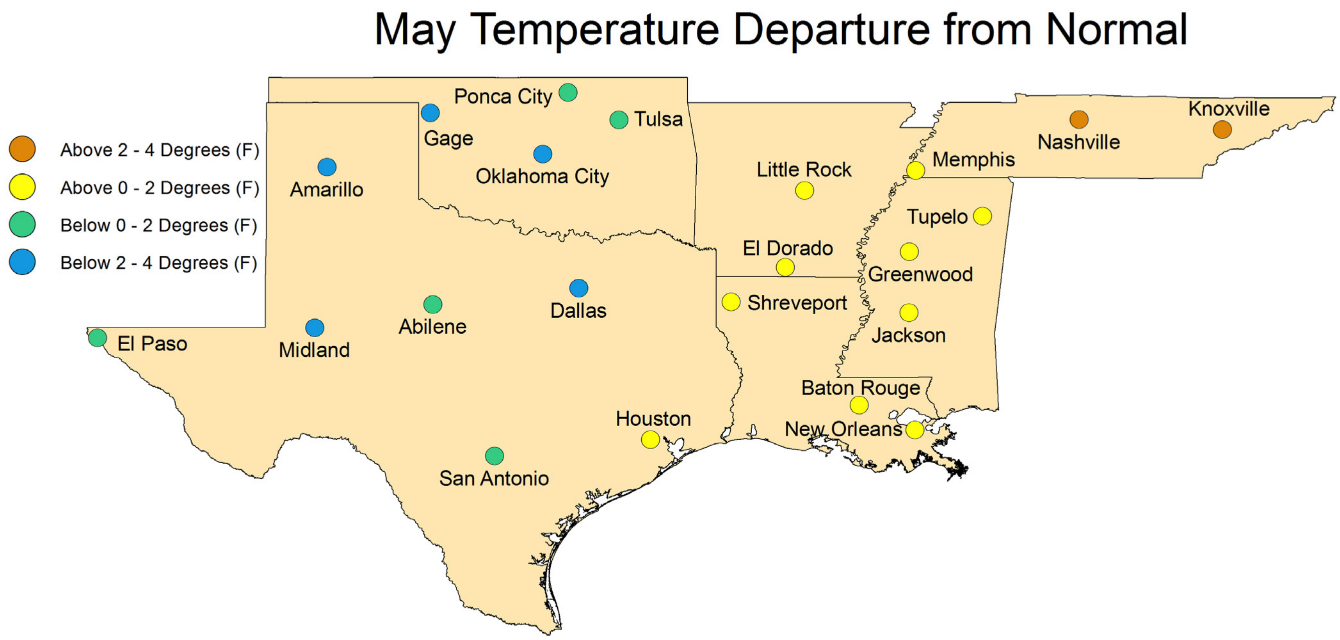


May 2015 Total Precipitation across the South

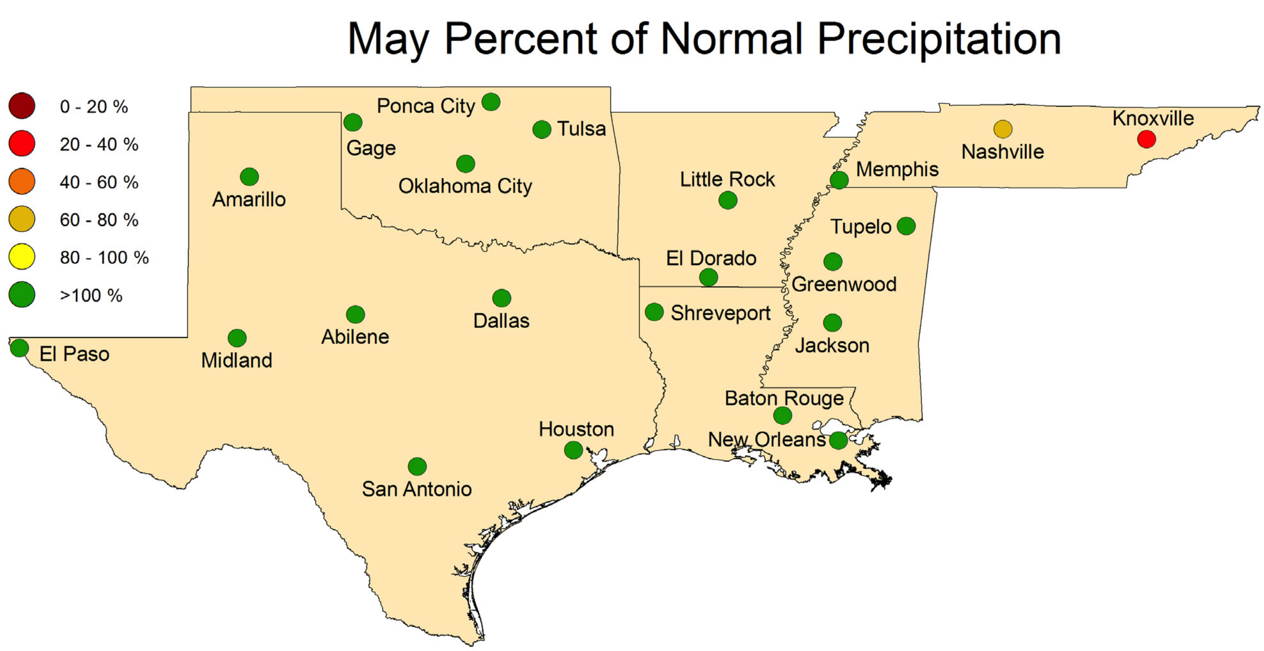


Percent of 1971-2000 normal precipitation totals for May 2015 across the South

Regional Climate Perspective in Pictures



May 2015 Temperature Departure from Normal from 1971-2000 for SCIPP Regional Cities



May 2015 Percent of 1971-2000 Normal Precipitation Totals for SCIPP Regional Cities

Climate Perspective

State	Temperature	Rank (1895-2011)	Precipitation	Rank (1895-2011)
Arkansas	69.30	51st Warmest	10.35	2nd wettest
Louisiana	74.90	29th Warmest	8.12	12th Wettest
Mississippi	72.40	42nd Warmest	6.02	26th Wettest
Oklahoma	66.20	24th Coldest	14.06	1st Wettest
Tennessee	68.00	34th Warmest	3.65	41st Driest
Texas	71.60	35th Coldest	8.93	1st Wettest

State temperature and precipitation values and rankings for May 2015. Ranks are based on the National Climatic Data Center's Statewide, Regional, and National Dataset over the period 1 895-201 1.

Station Summaries Across the South

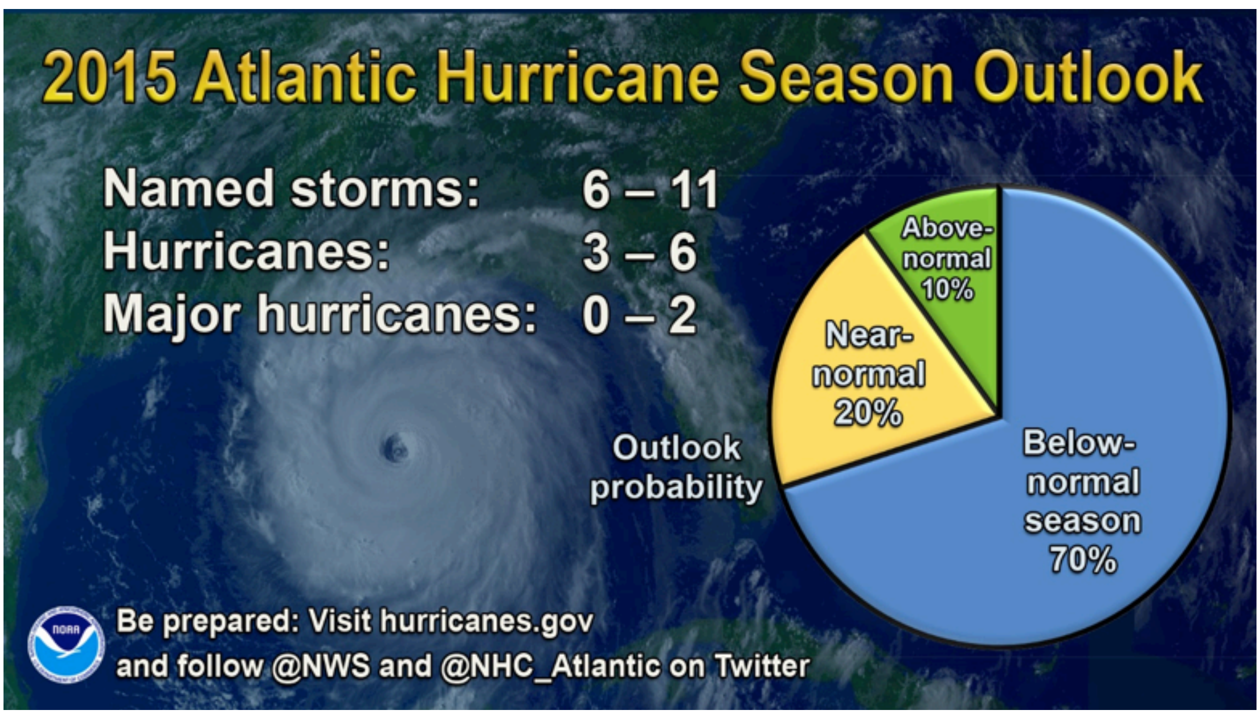
Station Summaries Across the South											
Station Name	Temperatures								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	%Norm
El Dorado, AR	81.8	62.6	72.2	0.9	88	05/14	48	05/02	10.99	5.94	218
Little Rock, AR	81.2	63.2	72.2	1.1	88	05/29	48	05/02	9.45	4.58	194
Baton Rouge, LA	86.5	66.3	76.4	0.7	91	05/28	56	05/02	11.17	6.28	228
New Orleans, LA	86.0	70.5	78.2	1.5	91	05/21	62	05/01	9.14	4.51	197
Shreveport, LA	83.8	65.4	74.6	1.4	90	05/28	55	05/22+	10.97	6.04	223
Greenwood, MS	82.9	62.0	72.5	0.7	89	05/15	46	05/22+	7.00	2.05	141
Jackson, MS	84.5	62.8	73.7	1.4	90	05/10	45	05/02	7.06	2.68	161
Tupelo, MS	82.4	60.6	71.5	0.8	90	05/10	45	05/22+	9.09	3.53	163
Gage, OK	73.9	51.8	62.8	-3.5	86	05/03	38	05/12	6.94	3.67	212
Oklahoma City, OK	76.1	58.7	67.4	-2.5	85	05/18+	50	05/21+	19.48	14.83	419
Ponca City, OK	75.0	57.1	66.1	-1.5	84	05/27+	43	05/21+	10.20	5.39	212
Tulsa, OK	76.4	59.4	67.9	-1.4	87	05/27	47	05/11	14.77	8.86	250
Knoxville, TN	82.3	58.8	70.5	3.3	91	05/11	40	05/01	1.76	-2.75	39
Memphis, TN	81.6	64.1	72.9	1.2	88	05/07	48	05/22	6.02	0.77	115
Nashville, TN	82.4	59.3	70.8	3.4	92	05/10	44	05/22+	3.56	-1.94	65
Abilene, TX	81.6	61.1	71.3	-1.6	93	05/09	52	05/01	5.34	2.16	168
Amarillo, TX	73.7	50.5	62.1	-3.5	85	05/27+	40	05/11	9.29	7.00	406
El Paso, TX	85.6	59.5	72.6	-1.3	96	05/29	51	05/11	0.81	0.34	172
Dallas, TX	79.2	62.6	70.9	-3.0	88	05/28+	54	05/01	16.96	12.06	346
Houston, TX	84.9	69.0	77.0	0.1	91	05/30	57	05/03+	14.17	9.08	278
Midland, TX	83.7	59.4	71.6	-2.0	92	05/08	51	05/21	3.35	1.61	193
San Antonio, TX	84.2	68.5	76.3	-0.6	90	05/27+	54	05/01	8.57	4.56	214

Summary of temperature and precipitation information from around the region for May 2015. 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 wdays. 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.

NOAA Issues Its 2015 Hurricane Season Forecast

Barry Keim, Louisiana State Climatologist, Louisiana State University

The National Oceanographic and Atmospheric Administration's (NOAA) Climate Prediction Center issued its 2015 hurricane season forecast. Given our recent hurricane issues in South Louisiana, it was fitting that the NOAA forecast was revealed at a press conference at the New Orleans Emergency Operation Center at City Hall, with Mayor Mitch Landrieu in attendance. The forecast is similar to the one that came out of Colorado State University in early April calling for a season with below normal activity. NOAA's forecast is calling for 6-11 named storms (12 is average), 3-6 hurricanes (6-7 is average), and of those hurricanes, 0-2 should become major hurricanes (2 is the long term average). Again, the reasons for the forecast of a quiet season is that El Nino is expected to strengthen from weak to moderate over coming months, and that the sea surface temperatures (SST) are expected to be near normal, which represents a shift from many years of above normal SST's. El Nino gives us wind shear to tear up the hurricanes, while the SSTs feed energy and moisture into the storm system. But, all of these forecasts have emphasized the fact that all it takes is one storm to hit your region to make it a busy one for you. AND, I'll re-emphasize the fact that we've been hit here in Louisiana during quiet years – 1992 (Andrew), 1965 (Betsy) and 1957 (Audrey). I also note that NOAA states that there is a 20 percent chance for a near normal season, and a 10 percent chance for the season to be above normal. I still remain cautiously optimistic for this year, but I still have my supply of batteries, flashlights, some canned goods, and other assorted hurricane supplies, just in case. If you have any questions, feel free to contact me at keim@lsu.edu.



National Oceanographic and Atmospheric Administration 2015 hurricane season forecast. Graphic can be found at http://www.noaanews.noaa.gov/stories2015/images/Outlook_2015_FINAL.jpg.

Southern Climate Monitor Team

Luigi Romolo, Regional Climatologist
Southern Regional Climate Center (LSU)

Gina Fujan, Student Assistant SCIPP (OU)

Margret Boone, Program Manager SCIPP (OU)

Hal Needham, Program Manager SCIPP (LSU)

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Monthly Comic Relief