

# Carolinas Climate Connection

Carolinas Integrated Sciences & Assessments, a NOAA RISA Team

Integrating Climate Science and Decision Making in the Carolinas



## Focus on Drought

*The Carolinas have seen precipitation extremes on both ends of the spectrum in 2016. Hurricane Matthew brought devastating floods to the eastern portions of the two states, while above average temperatures and rainfall deficits led to exceptional drought in the western regions.*

*This edition of the Carolinas Climate Connection focuses on drought and its impacts here in the Southeast. Articles include information about the meteorological and climatological context of this year's event, an overview of some of the related impacts, and links to a variety of resources to support various types of drought information needs.*

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## Upcoming Events

Coastal GeoTools  
February 6-9, 2017  
North Charleston, SC

NC Water Resources Research  
Institute Annual Conference  
March 15-16, 2017  
Raleigh, NC

NC Coastal Conference  
April 4-5, 2017  
Raleigh, NC

National Adaptation Forum  
May 9-11, 2017  
St. Paul, MN

## Save the Date

The Southeast & Caribbean Climate Community of Practice will host its next in-person meeting in April 2017. Details to come in the New Year.

## Carolinas Climate Listserv

Subscribe to the Carolinas Climate Listserv to learn about the latest climate research and information, upcoming events, funding opportunities, and other relevant news for the Carolinas.



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UNIVERSITY OF  
SOUTH CAROLINA

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## Getting to Know Your RISA

*Featured Team Member: Peng Gao*

Peng received his Bachelor Degree in Agriculture focusing on soil, plants and fertilization from Yangzhou University, China. He holds a Master's Degree in Soil Science at the Institute of Soil Science, at the Chinese Academy of Sciences. He completed his Ph.D. in Geography at the University of South Carolina in 2013. Peng has a broad background in the disciplines of landscape ecology, biogeography, climate change, and soil science. He is particularly interested in the applications of GIS, remote sensing, spatial data mining, and statistical methods to address basic and applied questions of these disciplines.

Peng joined CISA as a post doc researcher in 2013. His work focuses on climate extremes such as heavy rainfall and flooding. He has examined the performance of climate models from the North American Regional Climate Change Assessment Program (NARCCAP) in simulating and capturing the spatial variability of extreme precipitation. He currently is working on assessing the exceedance probability of the extreme rainfall in October 2015 across the Carolinas at the basin level.

When not working, Peng spends his time swimming and climbing.



Peng hiking at River Front Park in Columbia, SC.

## The 2016 Carolinas Climate Resilience Conference: Applying Lessons Learned

*By: Ellie Davis*

After the September 2016 Carolinas Climate Resilience Conference, CISA surveyed attendees on their experiences, learning outcomes, and follow-up plans to assess the achievement of conference goals and to learn how the CISA team might further support climate adaptation in the Carolinas. Forty-six percent of attendees completed the post-conference survey.

With fourteen U.S. states as well as the District of Columbia represented, there was quite a diverse group of participants in attendance, allowing for exchange of ideas and information across sectors and geographic boundaries. New connections and expanded networks were some of the most often mentioned responses to survey questions about the most valuable aspects of the conference. Respondents also said that they were connected to new resources and knowledge and provided with practical examples of climate adaptation strategies that have been implemented in other communities.

As follow-up to the conference, we were curious about how people would use the information and connections they gained at the event. Almost half of the respondents to this question replied that they would be following up with new connections to investigate opportunities for collaboration. A quarter of the respondents said the tools and resources from the conference would be put to use in their work. Especially encouraging was the 13% of respondents who said they would share the information with a broader audience.

The survey also asked for participant feedback about ongoing challenges and methods for overcoming potential roadblocks to adaptation. As for challenges, major themes in responses included: the political climate in the Carolinas, a lack of funding for climate adaptation work, and needs for enhanced climate communications and public awareness of climate issues. Respondents indicated a need for hosting a “frank discussion of the politics within the Carolinas” and considering whether resilient actions are considered an “expense or investment” by decision makers. Suggestions for overcoming these challenges included: a need for legislation and political will, funding opportunities, and best practices for climate science communication and public education.

By encouraging communication and collaboration, the 2016 CCRC was able to expand the resilience dialogue with valuable knowledge, resources, and tools that apply to the Carolinas and beyond. The feedback we received from the conference survey will help guide future workshops and meetings that CISA plans to host in the upcoming year. To learn more about attendee perspectives and feedback about the event, check out the final conference report, available on the [CCRC website](#).



CISA graduate student Junyu Lu and post doc Peng Gao man the CISA exhibitor booth at the 2016 Carolinas Climate Resilience Conference.



 Coastal Resilience  
@CoastalResilCtr

 Following

Susan Joy Hassol: Effective climate comms:  
Simple, clear messages, repeated often,  
through various, trusted sources [#CCRC2016](#)

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## The 2016 Carolinas Drought

Contributions from Greg Carbone (CISA), Jordan McLeod (SERCC), and Rebecca Ward (NC State Climate Office)

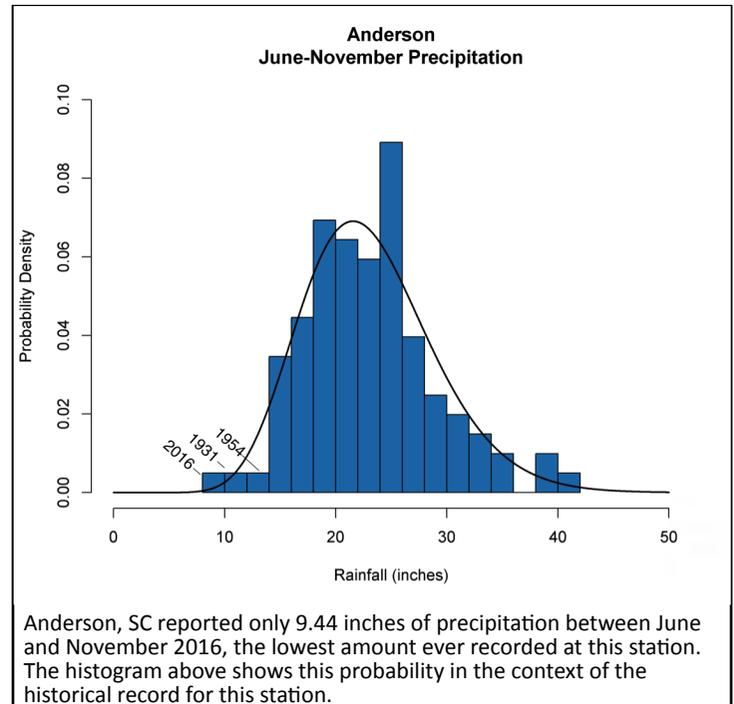
### Meteorological and Climatological Context

During the summer of 2016, the jet stream shifted farther to the north than normal and led to persistent high pressure over the Southeast region. This type of upper-level ridge is not uncommon over central and eastern portions of the U.S. during summer and early autumn, but this year's version was unusually strong and persistent. Although La Niña conditions have been developing in the Pacific Ocean, it has been a very weak episode so far, and the effects of La Niña on atmospheric circulation patterns over the U.S. are typically most pronounced during winter.

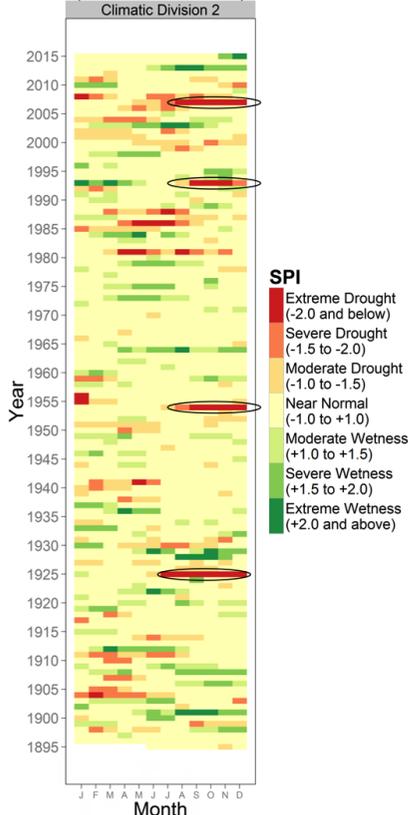
This high pressure system created less opportunity for the development of thunderstorms, which are a primary source of rainfall for the Southeast during the summer months. Well-above-average temperatures were also observed, which further exacerbated the drought conditions by increasing levels of evapotranspiration. In fact, the Carolinas observed their second warmest summer on record. Widespread warmth and dryness continued into the autumn season, with no drought-busting rainfall from tropical cyclones. Thus, the region saw a shift from short-term, meteorological drought over the summer to longer-term, hydrological drought in autumn.

Several locations in the Southeast have experienced record streaks of days with no measurable precipitation. According to the Southeast Regional Climate Center's seasonal climate report, precipitation totals during autumn were 10% to 50% of normal across drought-stricken portions of the region, including the western Carolinas. Greenville-Spartanburg, SC observed its second highest number of 81 days during autumn with no measurable precipitation. Charlotte, NC tied its second highest number of 79 days during autumn with no measurable precipitation. Stations in Alabama set even longer records. Eufaula Wildlife Refuge, located 75 miles southeast of Montgomery, saw 91 consecutive days with no rain.

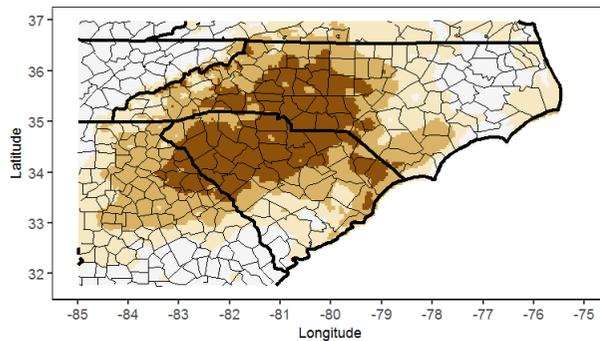
Some stations in western portions of the Carolinas received the lowest or near lowest 6-month rainfall totals for the period, June-November. Anderson, SC, for example, received only 9.44 inches, the lowest ever recorded at this station (see figure above). Statistically, a value this low has only a 1-in-600 chance of occurrence in any given year. Other examples of prolonged summer and fall droughts occurred during the long time series in the western part of the Carolinas, including 1925 and 1954 (see figures below).



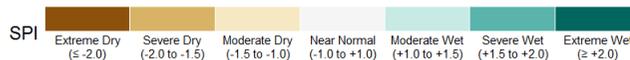
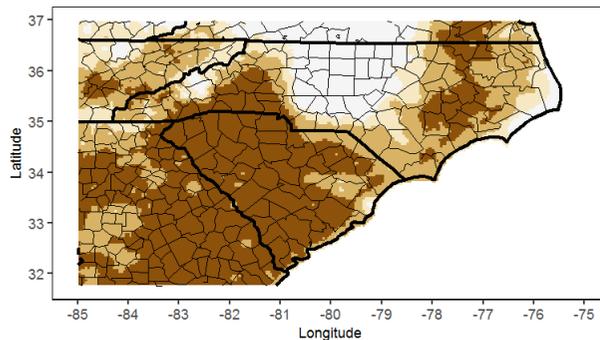
6-month Standardized Precipitation Index (SC Climate Division 2)



6-Month SPI for November 1925



6-Month SPI for November 1954



The figures to the left show previous periods of drought in the Carolinas, similar to that we've experienced in the summer and fall of 2016.

The colors in the heat map (far left) show the departure of total precipitation over 6 months relative to what is expected, as measured by the Standardized Precipitation Index for SC Climate Division 2. The 1925, 1954, and 2007 droughts are circled in black.

The maps of North and South Carolina show the spatial extent and severity of the 1925 and 1954 droughts.

This analysis will soon be publicly available in a new Atlas of Hydroclimate Extremes that is being developed by CISA researchers. Maps, graphics, and images will provide a visual narrative of the historical character of drought in the Carolinas to be used for educational and planning purposes. Learn more about the development of the atlas in the 2016 1st Quarter Carolinas Climate Connections newsletter.

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## The 2016 Carolinas Drought (cont.)

### Drought Impacts: Seen and Unseen

#### Surface Water Impacts:

Streamflow is one of the earliest indicators of drying conditions. US Geological Survey streamflow gages show surface water levels well below normal across the Carolinas. During fall 2016, conservation measures were implemented in the areas most impacted with multiple NC public water systems requesting that customers conserve water or issuing mandatory water use restrictions. Lakes in the Duke Energy Catawba-Wateree reservoir system are currently in Stage 1 Drought. On its [lake levels information page](#), Duke Energy asks customers to be mindful of water use and to conserve energy to save water used in hydroelectric power generation. Residents who water their lawns with lake water are asked to limit watering to Tuesdays and Saturdays. Groundwater levels are also depleted in some locations, especially where there are shallow wells.



NASA MODIS satellite imagery of wildfire smoke taken on November 27, 2016.

#### Agricultural Impacts:

Pasture land and hay have been particularly impacted for the agriculture sector. NC Weather and Crops Reports note that cattle producers are using “valuable hay reserves at a time of the year that grazing should still be an option”. The SC Department of Agriculture has developed a “[hay exchange](#)” website, connecting those farmers who need hay with those who have it. Other weather and crop reports note that emerging crops need moisture to become well-established and insect populations causing crop damage.

#### Societal Impacts:

Citizen science volunteers participating in the CISA-led CoCoRaHS condition monitoring project are providing supplemental information about on-the-ground impacts they are observing. These volunteers submit daily precipitation measurements and weekly qualitative reports describing how the rainfall they have, or have not, received has impacted the local environment and their communities. Rebecca Ward, Extension Climatologist with the State Climate Office of North Carolina and also the NC SCO representative on the NC Drought Management Advisory Council, reads the reports each week to assess how on-the-ground reports compare to other, objective drought indices the NC DMAC uses to designate the states drought status.

### Relief in Sight?

Portions of the Southeast are beginning to see some relief as several frontal systems moved through the region in late November and early December. The US Drought Monitor map released on December 15, 2016 shows a one-category improvement from extreme drought (D3) to severe drought (D2) across portions of the South Carolina Upstate. However, nearly 75% of the SC is designated as abnormally dry (D0) or higher. In North Carolina, although cooler temperatures and recent rainfall have provided some relief, drought monitor authors did not feel that conditions had improved enough to downgrade the drought state in the western portions of the state. Abnormally dry conditions in NC continue to extend into the Piedmont.

## Connecting Drought Impacts to Indicators

**Drought Impacts - Vulnerability thresholds in monitoring and Early-warning Research (DrIVER):** Several National Drought Mitigation Center (NDMC) staff members have been working with international colleagues on a research project to compare and better understand how the indicators of physical drought link to the impacts experienced by communities, the environment, and the economy. The intent of the project is to generate findings that can be used to enhance drought monitoring and early warning systems. North Carolina was selected by the NDMC as the U.S. case study site due to the NC Drought Management Advisory Council’s (NC DMAC) lengthy experience and expertise in state-level drought monitoring. The research team has conducted [workshops](#) (2014, 2016) and webinars with representatives from the NC DMAC and water utilities in the Neuse and Cape Fear River Basins. In the first workshop, participants identified general needs for enhancing drought monitoring, preparedness, and response. These include improved systems of local drought impact collection and archiving, studies of the links and relationships between local impacts and hydroclimate indicators of drought, activities to assess the applicability of impacts information to planning and modeling efforts, and enhanced regional communications and collaboration on drought-related messaging and education. At the 2016 workshop, the DrIVER team presented follow-up research that examined the relationship between drought impact reports submitted to the [Drought Impact Reporter](#) and drought status during the North Carolina 2007-2008 drought. Participants provided feedback on the research and additional ways such information could be useful for North Carolina resource managers and decision makers. The [project page](#) will have updated information as the project wraps up in 2017.

#### Wildfires:

Recent wildfires throughout the Southeast are the result of this prolonged period of dryness. According to the [SERCC November monthly climate report](#), 180,000 acres were burned over the course of the month. The intensity of the fires was influenced even more so by the autumn leaf fall, which provided more fuel allowing the fires to spread quickly. Additionally, outbreaks of insects such as the southern pine beetle and hemlock wooly adelgid have caused large stands of trees to die. Evacuations took place in Henderson County and Buncombe County, NC due to the 7,142-acre Party Rock Fire near Lake Lure. Gatlinburg, TN saw devastating destruction to property and loss of 12 lives due to the wildfires. An [interactive web map](#) created by Sevier County officials allows users to see if their home or business was damaged by the fires. These wildfire also caused widespread public health impacts from smoke that travelled as far away as Raleigh, NC and Charleston, SC. The image to the left shows NASA satellite imagery of smoke plumes sweeping across the Carolinas as wildfires continue to burn.

### Sample Condition Monitoring Report

#### Watauga County, NC, November 26, 2016

The lack of significant rain is having increasingly serious consequences. While we did have 0.07 inches of rain this week, when added to the 0.17 we’ve had over the past month, it does not add up to enough. We have had some serious wildfires in the county (thankfully not near enough to endanger us but it did create some very unhealthy air). The pond level has dropped below the outflow for the first time in my memory. All of the small streams are dried up, a few of the larger streams still show a small trickle of water. Little water is flowing in the larger streams or in the upper reaches of the Watauga River. The soil is dried out and we no longer encounter soft patches on the trails in the area. The Christmas trees that are being cut are all showing dried out trunks and will need copious amounts of water as soon as they get taken home. We are seeing white tailed deer on a daily basis and they are grazing for food right up to our cabin. The dogs bark and want to play but the deer are ignoring them while pursuing food. There is a ban on all burning and we are looking forward to some precipitation, hopefully sooner rather than later.

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## Drought Resources In and For the Carolinas

CISA conducts a variety of research projects and activities related to the assessment of drought and its impacts in the Carolinas. For more information about some of CISA's drought projects, check out the [CISA website](#).

Below is a list of various other agencies and organizations that lead drought planning and response in the Carolinas and throughout the U.S. CISA works with these groups to conduct decision-relevant research that informs their work.

### State Resources

**Drought Committees:** Both North Carolina and South Carolina have statewide committees that monitor and evaluate drought conditions for their respective states. The websites show drought designations by county and provide links to drought-relevant information such as precipitation data, climate outlooks, reservoir levels, and streamflow and groundwater conditions.

- North Carolina Drought Management Advisory Council
- South Carolina Drought Response Committee

**State Climate Offices:** These agencies are major contributors on the drought committees for their respective states.

- Drought page of the [State Climate Office of North Carolina](#)
- Drought information from the [South Carolina State Climatology Office](#)

### Regional Resources

**The National Integrated Drought Information System:** NIDIS supports the Coastal Carolinas Drought Early Warning System (DEWS).

The Coastal Carolinas DEWS is a collaborative, interagency effort to improve drought resilience in the Carolinas, with an emphasis on coastal areas. Many of the activities focus on improving understanding of drought's effects on coastal resources and communities and developing information to enhance drought monitoring and planning. Specific projects include activities to: develop a coastal salinity index, assess fire risks in the coastal zone, develop a Carolinas-specific atlas of historical climate events and their impacts, and collect drought impacts information through the Community Collaborative Rain, Hail and Snow (CoCoRaHS) citizen science network. More information is available about the CC DEWS and each of these projects [here](#). CISA is working with NIDIS and a variety of other agencies and organizations, including those listed here, to develop a strategic plan for the CC DEWS to lay out priority research and projects for the region.

**NOAA's Southeast Regional Climate Center:** SERCC is located at the University of North Carolina at Chapel Hill and is directed by CISA PI Chip Konrad. SERCC was established in 1989 to provide timely and high quality climate data and information to public and private users.

The SERCC website provides access to a range of products and resources such as temperature and precipitation data, regional climatologies, and extreme event reports. The SERCC produces a [quarterly climate impacts and outlooks report](#) for the Southeast. These reports include summaries of information about climate conditions and events, including those relevant to drought. The [Southeast Region December Quarterly Climate Impacts and Outlook](#) provides the most up-to-date information about current drought conditions and the winter outlook. In October 2016, SERCC published a [fact sheet](#) explaining how the 2016 Southeast drought evolved and highlighting some of the major impacts to water resources, agriculture, and forests.

**The USDA Southeast Regional Climate Hub:** SERCH is located at the NC State University campus in Raleigh. SERCH provides science-based information and technical information to farmers, ranchers, and forest land managers to help them increase the resilience of working lands address the challenges associated with climate variability and change.

The SERCH website provides links to [resources and tools](#) that can assist agricultural and forest land managers adapt to climate. [SERCH Lights](#) is an alert system that allows the subscriber to receive information regarding monthly drought outlooks and cattle heat stress forecasts. In early 2016 the USDA Forest Service published the comprehensive science synthesis [Effects of Drought on Forests and Rangelands in the United States](#). A 2-page [factsheet](#) summarizing relevant findings for the Southeast is also available.

**DOI Southeast Climate Science Center:** The SE CSC is located at the NC State University campus in Raleigh. The SE CSC provides scientific information and tools relevant to resource managers and their work to monitor and address the impacts of climate change and other global change processes.

The SE CSC sponsored the [Southeast Ecological Drought Workshop](#) on November 16-17, 2016. [Ecological drought](#) refers to a prolonged and widespread deficit in soil moisture or biologically available water that stresses ecosystems. The [CSC network](#) has selected ecological drought as a research focus area. The Southeast workshop was one of several meetings designed to compile existing knowledge about the ecological impacts of drought and provide recommendations for future drought planning and research. Although the Southeast is considered to have abundant water resources, drought can affect the timing, location, and amount of rainfall, adversely affecting both terrestrial and aquatic habitats and species. Interactions with regional stressors such as hydrologic alteration (e.g., dams, reservoirs), population growth, and increasing development can exacerbate drought's effects and challenge ecosystem recovery from and resilience to drought. Findings from the workshop will be presented in a Southeast-focused fact sheet and in a national report; these materials will be available in 2017.

### Other Resources

**Current conditions:**

- [US Drought Monitor](#)

**Outlooks and Forecasts:**

- NOAA's Climate Prediction Center provides [monthly and seasonal outlooks](#) for the country.
- The [ENSO Blog](#) available on NOAA's [Climate.gov](#) website provides information about how El Niño and La Niña affect our weather and climate, including their role in drought.
- National Drought Mitigation Center (NDMC) conducts a range of efforts to support drought [monitoring and planning](#).