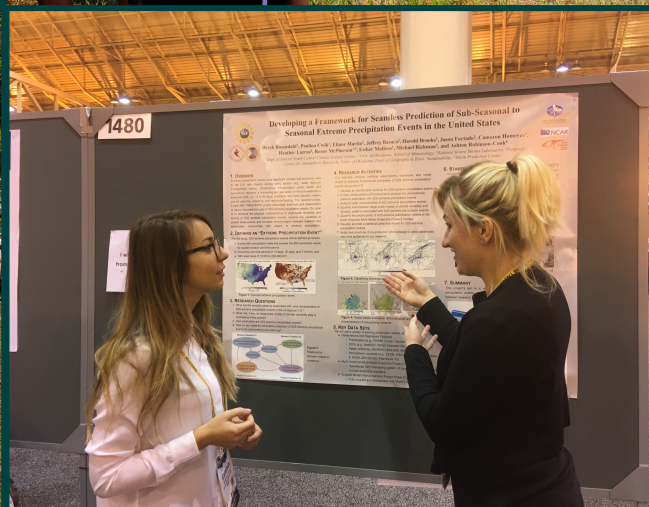




SOUTH CENTRAL CLIMATE ADAPTATION SCIENCE CENTER



2017 Annual Report

March 1, 2017 - February 28, 2018

This year's highlights:

- Continued development of downscaled climate projections for our region
- Conducted Tribal educational activities, as well as hosted an undergraduate internship
- Hosted trainings to teach resource managers how to understand and use climate projections
- Co-hosted the Rio Grande/Rio Bravo Forum, bringing together decision-makers and researchers



Helping to solve real problems in a variable and changing climate

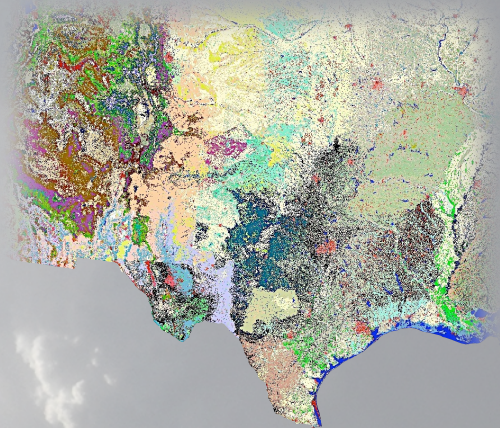
The South Central Climate Adaptation Science Center (formally South Central Climate Science Center) is one of eight regional Climate Adaptation Science Centers that are managed by the U.S. Geological Survey (USGS). Established in 2012, the South Central Climate Adaptation Science Center is a research collaboration between the USGS, University of Oklahoma, Texas Tech University, Chickasaw Nation, Choctaw Nation of Oklahoma, Oklahoma State University, Louisiana State University, and the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration. The South Central Climate Adaptation Science Center collaborates with a wide range of researchers and decision-makers in tribes, state and Federal agencies, universities, and non-governmental organizations.

Our research

The USGS Climate Science Adaptation Centers are working across regions of the United States to develop and bring critical science results to managers and stakeholders concerning impacts of climate variability, trends, and extremes with the goal of developing strategies to minimize economic, sociological, and ecological consequences. Priority science activities include measurement, modeling, and decision support that are related to the impacts of climate on natural and cultural resources.

Our region

Water, energy, agriculture, native peoples, and rapidly growing metropolitan areas intersect with a highly variable and changing climate to frame many of the risks, challenges, and opportunities for natural and cultural resources in the south-central United States. National parks, scenic waterways, tribal and trust lands, and other protected areas are prevalent across the region. Spatial and temporal changes in the south-central's climate are linked to changes in biodiversity; key wildlife habitats; wetlands quality and extent; stream sedimentation and flow; range and density of heritage and invasive species; cultural and natural landscapes; water quality; pathogen outbreaks; and health of ecosystem services. Changes in the region also result from other stressors; hence, responses to climate change must be examined in combination with land cover/use change, habitat fragmentation, increasing population, pollution, invasive species, increasing demand for natural resources, and other stressors.



The south-central U.S. encompasses 20 ecoregions, resulting from a significant gradient in annual average precipitation, from 60 inches in coastal areas to 6 inches in the deserts.



Personnel

New Program Coordinator

New to the South Central Climate Adaptation Science Center (South Central CASC) in 2017 is Emma Kuster (right), our Program Coordinator. Her duties include the coordination of grant submissions to USGS and other agencies, connecting researchers and stakeholders across the region, organizing research workshops and committee meetings, and conducting the day-to-day activities of the South Central CASC. Kuster has also helped update our *Managing for a Changing Climate* course by revising course materials and making changes to the management of course structure. Kuster also planned and facilitated our 2017 Undergraduate Summer Internship for Underrepresented Minorities.



Consortium Researchers and Students



In 2017, Dr. Mike Langston became the Acting USGS Director for the South Central CASC after Dr. Kim Winton retired in April. We also added Kristen Donahue, USGS Research Coordinator, and Dr. Elizabeth Glenn, USGS Partnerships Ecologist, to the team. Donahue and Glenn have both been instrumental in developing new relationships with natural and cultural resource managers across our region.

Associated:	Faculty, PIs, Affiliates	Staff	Post-docs	Grad Students	Undergrad Students
University of Oklahoma	13	7	3	4	3
Texas Tech University	10	2	2	1	1
Louisiana State University	15	1	—	5	—
Chickasaw Nation	1	2	—	1	10
Choctaw Nation of Oklahoma	3	—	—	—	—
Oklahoma State University	6	—	1	2	2
NOAA's GFDL	1	4	—	—	—



Personnel

New Tribal Liaison

Atherton Phleger (right), our second Tribal Liaison, is also new to the South Central CASC in 2017. Phleger manages the CASC's tribal engagement activities in New Mexico. He highlights the CASC's presence as an important resource for scientific data and tools for our tribal partners in New Mexico. In this role, Phleger has facilitated workshops, meetings, and youth activities; co-authored grants to secure funding for research and outreach activities; and worked with South Central CASC researchers to ensure that they are developing ethical research relationships with tribal partners.



USGS Director Dr. Kim Winton Retires After Long Career in Environmental Leadership and Public Service

This year, we celebrated the career and accomplishments of our former USGS Director, Dr. Kim Winton, as she moved into the next phase of her life: retirement! Winton dedicated her career to advancing environmental science, building partnerships for the application of this science to real-world problems, and mentoring young researchers.

Winton is an Oklahoma native. She earned her Bachelor's degree in zoology and went on to be the first woman to receive a Master's in agronomy from Oklahoma State University. She also was the first woman to receive a Doctorate in agronomy from the University of Arkansas. She would continue paving the way for women and minorities in science throughout her career.

Winton spent her early career in the agrochemical industry, where she conducted research with an emphasis on the environmental impact of pesticides. She also conducted field biological research for five years in Mississippi and managed the contracting of environmental field, lab, and analytical chemistry research for 10 years in Greensboro, NC. Prior to joining the South Central CASC, Winton directed the USGS Oklahoma Water Science Center for 10 years.

She took on the role of USGS Director at the South Central CASC in 2012. In this position, Winton leveraged her expertise in partnership building and applied environmental science to address the impacts of a changing climate in Oklahoma, Texas, Louisiana, and New Mexico.

Winton has big plans for her retirement, including continuing to show her award-winning herd of miniature donkeys at competitions across the region, and spending time with her husband, parents, and four grandchildren. She is also interested in training both horses and dogs to be therapy animals for those in need of help. We are so grateful for everything that Winton has done for the South Central CASC and the broader natural resources community, and wish her the absolute best in the years to come!





Consortium Research Projects

Developing Effective Drought Monitoring Tools for Farmers and Ranchers in the South-Central U.S. (PI - Shafer, OU)

The south-central U.S. is one of the main agricultural regions in North America: annual agricultural production is valued at \$44 billion dollars. These lands also support substantial hunting grounds and food for migratory waterfowl. In this working landscape, private landowners and producers are critical partners in drought mitigation and management. As climate conditions change, the region is expected to experience more frequent and severe droughts, causing significant impacts to agriculture and broader consequences for land management.



In partnership with the Southern Climate Impacts Planning Program (SCIPP), this South Central CASC-funded project evaluated six commonly used drought monitoring indices to determine which did the best job of anticipating potential impacts on major crops in the region. All indices were compared to crop yields to assess variability among the indicators. Two indices, the Standardized Precipitation-Evapotranspiration Index and Z-index, performed best for the purpose of tracking drought in the south-central U.S. However, results also showed that a single drought index may not capture all aspects of drought in our region; decision-makers need to evaluate multiple drought indices to determine which is most applicable for their location and crop of interest.

With the help of SCIPP, guidance will be provided to farmers, ranchers, and water resource managers about how to best monitor drought for different scenarios.

Projecting the Economic and Ecological Impacts of Invasive Kudzu in Oklahoma under Future Climate Conditions (Graduate Student - Harron, OSU)

Kudzu (*Pueraria montana*) is a rapidly growing vine, which was introduced in 1879 in the U.S. as an ornamental species. Kudzu became popular due to its ornamental appeal, but was declared a noxious weed in 1997 because of the damage it does to the natural environment. With warmer temperatures projected for the future, the range of Kudzu is expected to continue to expand and cause further damage to native ecosystems.

Paulina Harron, a South Central CASC-funded graduate student (pictured below), has recently started studying the future distribution of Kudzu and its ecological and economic impacts in the U.S. in a changing climate. Alyssa Whiteman, an undergraduate student, has been collecting and analyzing data on Oklahoma stakeholder perceptions regarding best management practices that could help prevent the further spread of Kudzu in Oklahoma. Whiteman led a focus group at the 2018 Oklahoma Natural



Resources Conference in which conducted a SWOT (strengths, weaknesses, opportunities, and threats) analysis for different management practices. Brody Pollard, also an undergraduate student, assists Harron in the data collection to capture the current distribution of Kudzu in Oklahoma. Using the information provided by these students, Harron will perform economic modeling and distribution modeling to determine the impacts of Kudzu in Oklahoma under the influence of warming temperatures.

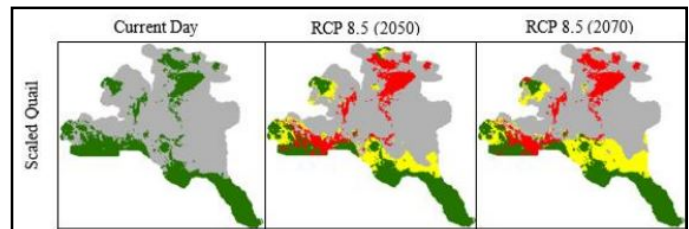


Consortium Research Projects (continued)

Modeling the Effects of Climate and Land-Use Change on Crucial Wildlife Habitat (PIs - Caldwell, NM Cooperative Fish & Wildlife Research Unit; Boykin, NMSU; Dixon, NOAA's GFDL)

Changing temperature and precipitation patterns in the south-central U.S. pose short- and long-term challenges for wildlife managers. Planning for an uncertain climate future requires tools that give managers the power to visualize the species-specific impacts of potential future climate scenarios. In a recently completed project funded by the South Central CASC, researchers at New Mexico State University, the New Mexico Cooperative Fish & Wildlife Research Unit, and NOAA's Geophysical Fluid Dynamics Laboratory compared what is known about the climate needs of 20 key species, including the black-tailed prairie dog and the lesser prairie-chicken, with future climate projections to assess the vulnerability of these species to climate variability.

For each species studied, the researchers produced climate suitability maps under two different climate scenarios and on two different timescales. The maps (example below) are green where and when climate conditions are suitable for the species, red where currently suitable conditions are expected to become unsuitable, and yellow where the species might gain suitable habitat. The researchers also overlaid the maps with land-use change projections developed by the Environmental Protection Agency. They found that even where impervious surfaces are expected to increase (e.g., urbanization), none of the species studied were in danger of losing their climatically suitable habitat as a consequence. In general, most of the species studied are expected to experience a decline in suitable habitat, with the northern pygmy mouse, gray-checked whiptail, and lesser prairie-chicken experiencing some of the greatest losses in habitat.



These maps have been incorporated into the publicly accessible New Mexico state-level CHAT (Crucial Habitat Assessment Tool). CHATs are being used by states across the western U.S. to facilitate conservation and project planning, and are useful to decision-makers at all levels of government. Incorporating information about the potential impact of climate and land use change on species distributions into this tool ensures the accessibility of this critical information.



Reconstructing Past Ocean-Atmosphere Interactions using Coral Microatolls (Sp. *Siderastrea siderea*) (Graduate Student - Ouellette, LSU)

Understanding how the surface of the ocean has varied in the past can provide researchers and managers with insight into how ocean-atmosphere interactions may evolve under future climate conditions. Many scientists in paleoclimatology use coral skeletons that inhabit the ocean near the surface in order to reconstruct sea-surface variability.

Gil Ouellette, a South Central CASC-funded doctoral candidate at Louisiana State University, observed that trace-element ratios in the massively growing starlet coral *Siderastrea siderea* reliably reflect sea-surface temperature conditions. These corals also contain other indicators that reflect environmental changes in addition to temperature, such as changes in aerosols in the atmosphere. Using these indicators, Ouellette focused on reconstructing sea-surface temperatures and other oceanographic and climate conditions in the Caribbean and Gulf of Mexico region. For example, Ouellette was able to successfully reconstruct sea-surface temperatures and Saharan dust transport in the northern Caribbean Sea from *Siderastrea siderea* microatolls off the coast of Haiti.

The reconstructions show substantial changes in the extent of the western hemisphere warm pool during the early 20th century compared to today. Since climate in the south-central U.S. is impacted by warm pool conditions in the tropical Atlantic, these reconstructions help researchers understand and decision-makers plan for how the climate in this region may change over time.



Consortium Research Projects (continued)

The Effects of Climate and Land-Use Change Across Soil Boundaries: Identifying Linkages Between Soil, Fungi, and Milkweed Health (Graduate Student - Duell, OSU)

The more than 100 species of milkweed native to the U.S. are essential food sources for pollinators; in fact, monarch caterpillars dine exclusively on milkweed before transforming into monarch butterflies. However, key soil processes important for the long-term survival of milkweed may be impacted by warming temperatures and intensifying drought conditions. Eric Duell, a South Central CASC-funded graduate student at Oklahoma State University, is working to better understand the relationship between soil health and milkweed to help managers anticipate climate impacts to this ecologically important plant.



Researchers have known for years that the arbuscular mycorrhizal fungi help countless species of plants to capture key nutrients, but there is a relative lack of information regarding the interactions of fungi and milkweeds. Duell is filling this information gap by assessing how 15 milkweed species commonly found in Kansas, Oklahoma, and Texas interact with the fungi. Preliminary data suggest extremely high variation in the interactions between the milkweed and the fungi, even within the same genus. This experiment will be built upon in 2018 to assess the role of the fungi in the production of plant secondary-defense compounds that are found in milkweeds. In a second experiment currently in progress, Duell is examining the impact of reduced soil moisture on three common species of milkweed and three non-milkweed flowering plant.

Grassland management practices, grazing, and fire can also impact milkweed. A third experiment was conducted in the summer of 2017 as a NSF-REU project by Noah Mustafa, under the guidance of Duell and Dr. Gail Wilson, to examine the impacts of these management elements on milkweed floral resources and defenses. These preliminary data show that annual burning increased biomass production of several milkweed species, largely due to increases in reproductive biomass, but decreased anti-herbivore defenses. Floral resources were also assessed, and although burning did not affect nectar production or quality, fertilization decreased nectar production and increased the sucrose concentration of the nectar. These projects together will broaden our region's understanding of the factors that impact milkweed health.

Tailoring Seasonal Climate Forecasts for Winter Wheat Production (Graduate Student - Klemm, OU)



Winter wheat is a key food and forage product across the south-central region that provides vital habitat for wildlife. Farmers often make decisions on when to plant and harvest winter wheat several weeks to a few months in advance, and rely on seasonal climate forecasts to determine the timing in which they carry out their activities. However, the agricultural community has criticized seasonal forecasts because they lack the specificity to effectively support agricultural decision-making.

Research conducted by Toni Klemm, a South Central CASC doctoral candidate at the University of Oklahoma, explored ways in which seasonal climate forecasts can be tailored to better serve the needs of winter wheat producers in the south-central U.S. He surveyed agricultural advisors to learn directly from the agricultural community how and when production decisions are made. This project was primarily funded by the University of Oklahoma and NSF, with help from USGS.

The results of this survey showed that decision-making regarding winter wheat is driven strongly by seasonality and tied closely to the timing of certain management practices (e.g., planting or harvesting). The agricultural advisors surveyed also expressed a need for forecasts that address both averages and extremes. Klemm also analyzed seasonal forecasts themselves and found that the NOAA Geophysical Fluid Dynamics Laboratory's seasonal forecast model had greater absolute error than a seasonal persistence forecast, highlighting current shortcomings of the model in the south-central U.S. This research has paved the way for the development of more useful seasonal climate forecasts, empowering producers to make more cost-effective and sustainable decisions in a highly variable climate.



Consortium Research Projects (continued)

Enhancing Local Wetland Adaptation to Sea-Level Rise and Coastal Development (PI - Osland, USGS, Wetland & Aquatic Research Center)

Putting science on the ground sometimes means hitting the road. In early June, Sinead Borchert, under the direction of Dr. Michael Osland, set off on a tour of the Gulf of Mexico coast. Wetlands in this region are on the move in response to sea-level rise and land-use change, presenting a serious challenge for managers. Borchert's mission was to share research funded by four Landscape Conservation Cooperatives and the USGS Wetland & Aquatic Research Center on how wetlands are expected to move over time and to explore possibilities for the use of this research in local conservation decision-making.

Tidal saline wetlands are an abundant feature of the northern Gulf of Mexico coast, where they buffer storm surge, filter water, reduce flooding, provide fish and wildlife habitat, and store carbon. Sea-level rise is expected to force these ecosystems to move inland, but there is still a lot of uncertainty about how and where they will move. The researchers identified where future urban development and future tidal saline wetland migration are expected to occur under five different potential sea-level rise scenarios.



The South Central and Southeast CASCs recognized the importance of this wetland migration science to coastal managers and funded Osland and Borchert to develop customized decision-support products for specific communities. Borchert traveled to Texas, Louisiana, Mississippi, Alabama, and Florida to speak with hundreds of public, private, and non-profit resource managers about the wetland migration work and gain a better understanding of the management contexts along the coast. She received many requests for localized maps and other decision-support products, which she delivered in the summer of 2017.

Identifying Best Agricultural Management Practices for Maintaining Soil Health and Sustainability Under Changing Climate Conditions (PI - Zak, TTU)

The Texas High Plains have some of the highest concentrations of cotton production in the U.S. However, in the wake of multi-year droughts, producers want to understand how they can maintain soil health under extreme temperatures to improve productivity. Recent research conducted at Texas Tech University suggests that climate variability may have implications for soil health and microbial content. Improving soil health through good management practices not only helps agricultural production, but also helps reduce stress on valuable water resources.

A public-private partnership between the South Central CASC, USDA Climate Hub, National Resources Conservation Service scientists, and Cotton Inc. has developed in-demand soil health demonstration plots. These demonstration plots test various management practices and monitor their impact on soil temperature and health. Furthermore, these fields are linked to other producers across the region to

address soil health and increased water infiltration under increasing precipitation variability. It is contributing substantially to our collective understanding of the interactions between climate variability, soil health, and agricultural productivity in the Southern High Plains while equipping stakeholders with the knowledge they need to make appropriate management decisions. Producers travel to observe these plots and learn how to maintain optimum soil health under extreme temperatures.

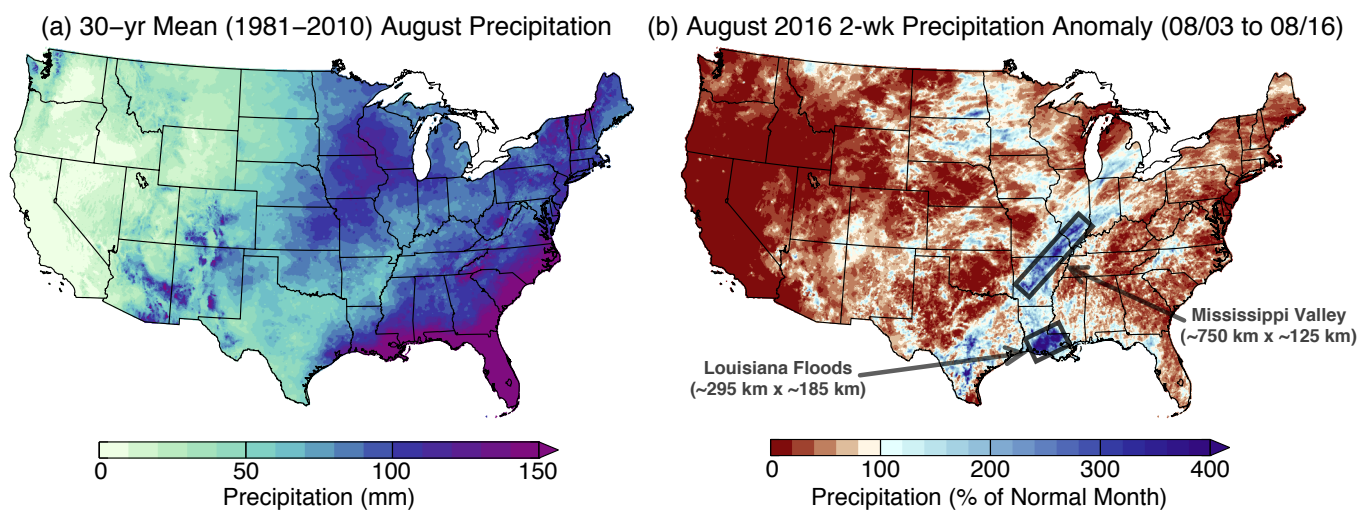




Grant Funding Highlight: Prediction of Extreme Precipitation Events

Developing a Framework for Seamless Prediction of Sub-Seasonal to Seasonal Extreme Precipitation Events in the United States

Sub-seasonal to seasonal (S2S) extreme precipitation events (defined as events lasting 14 days to 3 months) can affect human life and cost the economy billions of dollars to restore the impacted area. Fast-moving water, contaminated water supplies, terrestrial and aquatic species health impacts, and severe erosion are just a few of the risks associated with these extreme events. In 2015 and 2016, five of the 18 multi-billion dollar natural disasters were the result of excessive precipitation. Unfortunately, events such as these are difficult to forecast at a timescale that is useful for decision-makers whose job it is to plan and prepare. Our understanding of the fundamental climate processes that drive these S2S extreme events is limited. In addition, societal and ecosystem resilience to these events cannot be increased without established, two-way communication between the researcher and stakeholder communities.



Last year, the University of Oklahoma was awarded a \$1.9 million, 5-year grant to develop a framework for predicting these S2S extreme precipitation events. Led by Dr. Elinor Martin (South Central CASC Co-PI) at the University of Oklahoma School of Meteorology, a team of researchers will be studying the weather and climate processes that drive S2S extreme precipitation events, ultimately improving our ability to model and forecast such events. To improve societal resilience, the researchers aim to increase communication between the researcher and decision-maker communities with regards to such events. Workshops that engage stakeholders,

including water managers and tribal environmental professionals, from the onset of the project will steer the science to focus on what is most useful to the individuals who use and rely on these forecasts. The first stakeholder workshop is scheduled for July 2018.

By the end of the project, the research team aims to have a set of predictive models with the potential to reduce mortality, morbidity, and damages caused by S2S extreme precipitation events. Understanding the processes that drive these events today will ultimately help future researchers project how these events may change in future climates.





Building up the Next Generation of Scientists

2017 Undergraduate Summer Internship

Our 2017 summer undergraduate internship for students of underrepresented minorities interested in science, technology, engineering, and mathematics fields was held from Sunday, July 9, 2017 to Saturday, July 29, 2017. We selected 10 undergraduate students to participate in this internship (8 female, 2 male; 5 Hispanic, 1 American Indian, 3 African American).

The 2017 summer internship began in Baton Rouge, Louisiana, and concluded in Lubbock, Texas. Interns were involved in hands-on activities related to climate research that allowed them to see the direct impacts of climate variability and change on the West Texas Southern High Plains, prairie and forest ecosystems and tribal cultures in Oklahoma, and the bayous, delta, and coastline of Louisiana.

Internship participants traveled across the south-central U.S. to visit university campuses and field locations and interact with researchers conducting cutting-edge research. They had the opportunity to learn how to collect and analyze field data. Additionally, they gained an understanding of the breadth of climate science work being done throughout the south-central region. Student interns were expected to conduct research activities related to the science mission of the South Central CASC during their three-week internship.



While in the internship, they learned about opportunities to work with the U.S. Geological Survey or go to graduate school. Many of the graduates of the program during the summers of 2014, 2015, 2016, and 2017 originally did not have interest in graduate school, had not conducted any scientific research, and, in some cases, had not left their home state. After the program, many chose to apply to graduate school or seek out other undergraduate research programs. We look forward to continuing this internship in the summer of 2018!

Communicating Science

Leveraging Communications Tools to Further the CASC Mission

As detailed in the Strategic Communications Plan, finalized in February 2017, the South Central CASC uses communications tools to facilitate the effective translation of climate science to resource management decision-making. This year, South Central CASC communications staff enhanced digital communications efforts by developing a monthly newsletter which launched in May 2017. This newsletter, which consistently achieves open rates double Mailchimp's industry average, includes feature stories about CASC activities, research highlights, links to opportunities and resources, news about staff and student accomplishments, and information about partner activities. Communications staff also supported researchers in the development of a climate projections training at the National Adaptation Forum that is now in-demand elsewhere in the country (and Canada). Additionally, communications staff worked with National Climate Adaptation Science Center partners to begin developing project-based communications plans in order to provide more tailored support to CASC researchers as they work to collaborate with a variety of end-users. The communications team is now gearing up for a redesign of the South Central CASC website (expected to launch in Fall 2018).



Tribal Engagement

The South Central CASC's Tribal Engagement Plan was released on September 22, 2014, as USGS Circular 1396. The Plan describes how we will engage and facilitate partnerships with the 68 federally recognized Tribes within our region. The Tribal Engagement Plan emphasizes the collaborative nature of science and outlines concrete steps that the South Central CASC intends to take, such as offering trainings for Tribal staff and engaging with Tribal educators. In addition, the Shifting Landscapes document details a strategy for ensuring that researchers engage with Tribes in culturally appropriate ways. OU hosts several workshops for faculty and staff to teach these communities how to be culturally competent when looking to partner with tribes on research and outreach projects. In 2017, the South Central CASC continued to fulfill the commitments outlined in the Tribal Engagement Plan, particularly through regional and national inter-agency and inter-Tribal coordination and leveraging of resources.

Tribal Capacity Building

Climate Change and the Louisiana Tribes

South Central CASC personnel organized and led the second climate literacy training for Native American Tribes in Louisiana in May 2017. Fourteen representatives from four Louisiana Tribes (Pointe-au-Chien, Tunica-Biloxi, Coushatta, and United Houma Nation) attended the two-day training. Due to feedback gathered from the first training in May 2016, the training was held at LSU to allow for hands-on activities with different climate data sets. Several exercises were prepared to provide the participants an opportunity to download climate information and prepare one-page climate information sheets for their tribal locations.



Climate Change and the New Mexico Pueblos and Tribes



In July 2017, the new Bureau of Indian Affairs Southwest CASC liaison, in conjunction with the American Indian Higher Education Consortium, led the first ever "Tribal Climate Change Action Camp" at the Navajo Technical College in Crownpoint, NM. South Central CASC staff assisted with planning and conducting many of the activities at the camp, including several presentations and demonstrations. As part of the camp curriculum, attendees developed mini grant proposals to work on projects back in their communities. These included projects such as rain barrel outreach and phenology education for youth.

With the new addition of Atherton Phleger as the New Mexico Tribal Liaison at the South Central CASC, we expect stronger engagement with New Mexico Pueblos and Tribes in the coming years. Phleger is housed in our Norman, OK office, but commonly spends one to two weeks per month in New Mexico to enhance our engagement with Native American communities in our region.



Tribal Engagement

Engaging with Tribal Youth

Second Annual Tribal College Conference Series on Climate Change

In March 2017, South Central CASC staff co-hosted the second annual Tribal College Conference Series on Climate Change at the Pawnee Nation College in Oklahoma. Tribal college students and community members heard from several notable native professionals including Kyle Whyte and Janie Simms Hipp. Students also participated in a three minute speed talk competition in which awards were sponsored by the Oklahoma Tribal Conservation Advisory Council.

Building Capacity for Long-Term Research Relationships with Tribes

Communicating Climate Change for Tribes

The South Central CASC partnered with the Inter-Tribal Environmental Council (ITEC) to offer a two-day training titled “Communicating Climate Change for Tribes.” Thirty tribal professionals from 16 tribes all across the region (plus one tribe from outside of the region) participated in the training in April 2017. Guest speaker Dr. Katherine Hayhoe from Texas Tech University gave a presentation titled “Communicating and Connecting with Audiences on Climate Change.” During this training, the tribal staff also learned about community outreach and obtaining tribal leadership buy-in for environmentally-focused projects.



Shifting Landscapes: Guidance for Researchers Working in Indian Country

As part of the ongoing commitment to work ethically and effectively with tribal nations in our region, South Central CASC staff developed a series of trainings and products designed to assist researchers who wish to work in Indian Country. The first of these trainings, titled “Shifting Landscapes: Protocol for Building Long-Term Research Relationships in Oklahoma Indian Country,” took place September 28, 2017 at OU’s Bizzell Library. Approximately 15 researchers attended this first training (offered both in-person and virtually). During Year 5 and Year 6, South Central CASC staff worked with Todd Fuller and others at OU’s Center for Research Program Development and Enrichment to begin developing an accompanying protocol guidebook. The guidebook, titled “Shifting Landscapes,” contains cultural and historical context, information on collaborative methodologies, tools and strategies for building effective working relationships, and protocols and principles for designing ethical research projects. While focused on the tribal nations and institutions in Oklahoma, the guidebook contains information relevant to any non-native researcher working in Indian Country.

More activities under the “Shifting Landscapes” banner are planned for Year 7, including trainings focused specifically on interacting with tribal leadership in a research context, and the completion and distribution of the protocol guidebook.



Engaging with Stakeholders in their Planning Process

The Chickasaw and Choctaw Nations Plan for Drought

Much of Oklahoma experienced an exceptional drought that lasted from Fall 2010 to Spring 2015. During that time, some communities came close to depleting their water supplies. Many of these communities rely on wells, springs, or rivers that originate from the aquifer for a portion of their water supply. Many of the ranchers in the state were forced to sell part of their herd at reduced prices because they could not afford to purchase and haul in hay from long distances to feed their herd. Tourism, the third largest industry in Oklahoma, declined because many of the recreational areas are based on water features that became dry or had low lake levels. The oil and gas industry was very active during this time, drilling horizontal wells in the Woodford shale. Unfortunately, this exacerbated the issue since these wells required a great deal of water for fracking.

The Chickasaw and Choctaw Nations of Oklahoma submitted and successfully received a grant from the Bureau of Reclamation to develop a drought contingency plan for the Arbuckle-Simpson region. A regional task force consisting of major water providers was formed to develop a plan to alleviate the effects of drought on more than 140,000 people that rely on the Arbuckle-Simpson aquifer as their primary source of water.

An advisory group also was established to provide technical expertise and consisted of representatives from the Bureau of Reclamation, the National Park Service (Chickasaw National Recreation Area), the Nature Conservancy, the Southern Climate Impacts Planning Program, the South Central Climate Adaptation Science Center, the Oklahoma Water Resources Board, the U.S. Department of Agriculture Climate Hub, the Oka' Institute, and the Noble Foundation.

The aquifer covers approximately 500 square miles and serves as the primary source of water for 25 water providers in the region. The task force focused on strategies that would reduce the impacts of future drought events on municipalities, rural water districts, the agricultural community, recreational areas, and the industry and energy sectors.

One of the grant requirements was to incorporate climate change into the contingency plan. Since the Chickasaw and Choctaw Nations of Oklahoma are consortium members of the South Central CASC, they have worked with us on numerous projects related to climate adaptation in the region. The Nations also had a previous grant looking at the impacts of a changing climate on flows in the Red River Basin that was funded through the South Central CASC. For the drought contingency plan, the Southern Climate Impacts Planning Program provided the nations with historical climate data for Oklahoma Climate Division 8. The U.S.

Department of Agriculture Climate Hub gave a presentation at one of the stakeholder meetings on the impacts of drought to the agricultural industry and provided data on the impacts of previous droughts on agricultural production in the region.

Through this grant, the task force developed a set of criteria to monitor the severity of drought. They also developed a set of trigger points that are based on the monitoring data, which would initiate implementation of response actions to alleviate the impacts of the ongoing drought. The task force evaluated mitigation strategies for each water provider and each user to reduce the impacts of any future droughts.





Building Collaborations and Partnerships

Rio Grande/Rio Bravo Forum

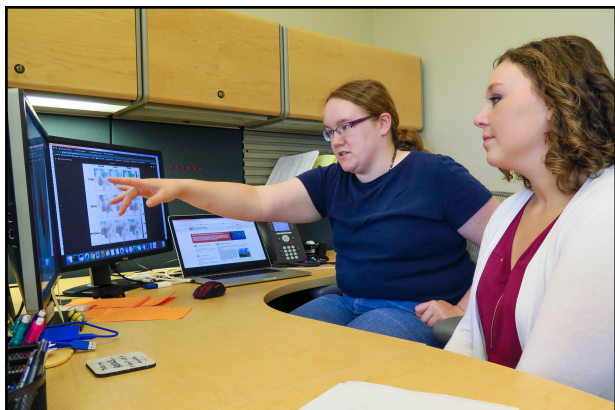
In November 2017, the South Central CASC had the privilege of co-hosting a binational Rio Grande/Rio Bravo Forum in El Paso, TX. The Rio Grande/Rio Bravo provides freshwater for people, fish, and wildlife in the U.S. and Mexico. At the Forum, researchers and stakeholders with ties to the basin discussed emerging challenges facing the resource and opportunities for research to address these challenges. Attendees also discussed the state of river science on both sides of the southern border; a variety of South Central CASC funded research projects were used to support and inform these discussions. Next steps include the formation of a Basin Advisory Committee that will guide future South Central CASC research to ensure that it meets stakeholder needs.



We are so grateful to our partners on the Organizing Committee who made this event such a success, including the World Wildlife Fund, Tecnológico de Monterrey, Instituto Mexicano Tecnológico de Agua, Rio Grande Joint Venture/Alianza Regional de Conservación del Rio Bravo, the Desert Landscape Conservation Cooperative, and the Coca-Cola Company.

Climate Data to Improve Decision-Making: Collaborating with the NOAA Geophysical Fluid Dynamics Lab

NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) has been an essential part of the South Central CASC's consortium of partner organizations since its inception in 2012. As world leaders in global and regional climate modeling, NOAA GFDL researchers provide climate science knowledge and technical expertise necessary to close critical climate information gaps in the south central region. GFDL researchers have conducted novel scientific analyses and led the South Central CASC's development of localized climate projections that resource managers in the region need to make informed decisions. With South Central CASC funding, they are developing projections and maps that provide users with potential future temperature and precipitation changes through 2100. South Central CASC stakeholders have already incorporated this information into their planning efforts to address local management concerns. For example, in 2017 the Citizen Potawatomi Nation incorporated the projections into their new Climate Adaptation Plan. Moving forward, we anticipate the South Central CASC partnership with NOAA's GFDL will continue to be foundational to South Central CASC research and science communication efforts.





Outreach and Education

Incorporating Future Climate Projections in Adaptation Planning

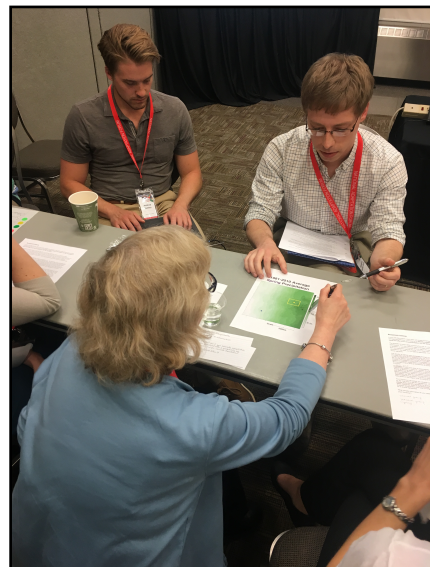
In recent years, numerous climate projections have been made available for use in impact assessments and adaptation planning. However, the breadth of available projections presents a daunting challenge to managers and scientists who are trying to determine which projections are appropriate for a particular decision context. This is a high-stakes issue, given that improper use of climate projections could lead to decisions that are not cost effective at best and maladaptive at worst. Our stakeholders, such as individuals from the DOI Fish and Wildlife Service, have expressed interest in learning how to best use climate projections in their planning processes.

Early career scientists from the Climate Adaptation Science Centers came together to develop a new interactive workshop aimed at creating clarity about the wise use of climate projections in decision-making and building relationships between climate scientists and climate information users. The workshop debuted at the National Adaptation Forum on May 11, 2017 in St. Paul, MN titled “Incorporating Future Climate Projections for Adaptation Planning: A Layman’s Guide.”

The session was led by researchers from the network of regional Climate Adaptation Science Centers across the U.S. who walked through the basic types of climate projections and discussed how the decision context influences their use. The focus of the workshop was a hands-on activity in which participants explored the application of climate projections to a management challenge. Through this interactive experience, participants gained confidence in using climate model projections in their decision making process and recognized the importance of consulting climate scientists when working with this kind of information.

More recently, this role-playing activity was adapted to several other learning venues. In summer 2017, undergraduate students in our internship program participated in the activity. Shortly thereafter, students in our Managing for a Changing Climate course experienced an abbreviated version of the workshop to help them understand how stakeholders can use climate data in their decisions. While these students had no real-life management experience, they were able to understand the need for an ensemble of projections after conducting the activity. In October 2017, Natural Resources Canada applied a shortened version of the role-playing activity in their Annual National Roundtable on Disaster Risk Reduction after a member of their team attended our original training and sought out our assistant in developing the training for their use.

Based on the feedback from participants in all of these venues, the team is developing additional management challenges across other sectors, such as emergency management and public health. The team also is designing introductory and advanced versions of the activity to reduce the difficulty in facilitating groups with different climate-projection experience levels.





Outreach and Education

Open Online Course: Managing for a Changing Climate

In Fall 2017, OU staff and faculty from the South Central CASC once again offered an online, interactive course designed to provide an integrative understanding of the components of the climate system. Videos included a diverse set of speakers from all across the south-central U.S. The South Central CASC reached over 200 individuals with this online course, ranging from students at other CASC and LCC institutions to natural resource managers and Tribal environmental professionals. The course covered an overview to the physical climate system, an introduction to downscaling techniques and how to use them, and known impacts of a changing climate. In 2018, we plan to add additional videos to cover climate adaptation planning, impacts of climate change on ocean circulations, and energy economics. To view the course videos and materials, visit: <https://janux.ou.edu/course.tag-nextthought-com-2011-10-nti-courseinfo-fall2017-geog-metr-3523.html>.

Climate Cinema

Each month, South Central CASC researchers at TTU host an event for the public that features movies, including science fiction or documentaries. The movies are always extreme weather or climate based, and followed by informal discussions led by members of the TTU-Climate Science Center depending upon movie topic. The movies are held at Alamo Cinema in Lubbock, TX, and roughly 100-200 individuals attend each month!



Ask Me Anything on Reddit - The Underwater Forest

On July 16, 2017, LSU researcher Dr. Kristine DeLong participated in a 3.5 hour long Ask Me Anything session on Reddit regarding the short film “The Underwater Forest.” Individuals from a wide range of backgrounds and ages tuned in to listen and ask questions. The Underwater Forest is an ancient forest off the coast of Alabama that was lost to the sea a long time ago (~60,000 years ago). Since the forest is preserved, it acts as a time capsule and gives us a glimpse of what environmental conditions were like back then.

Film available here: <http://www.thisisalabama.org/underwaterforest/>.

Engaging Youth with Science

All across our consortium, South Central CASC researchers and staff engage with youth through school events and summer camps. Last year, Emma Kuster from OU attended two Climate Expo events at Irving Middle School in Norman, OK to teach over 400 seventh graders about ocean acidification. She also attended the Oklahoma EPSCoR Women in Science Conference, along with South Central CASC student Darby Perry, to talk with over 1000 middle school girls about climate science. Dr. Kristine DeLong from LSU showed “The Underwater Forest” short film to 40 high school and middle school students at Saturday Science (put on by LSU’s Department of Physics and Astronomy). April Taylor from the Chickasaw Nation shared with 24 students in the Mosaico Program at Truman Primary different hands-on activities that showed how climate can impact our environment.





Selected publications

Daniel, J.S., J. Jacobs, H. Miller, **A. Stoner**, et al., 2017. Climate change: Potential impacts on frost-thaw conditions and seasonal load restriction timing for low-volume roadways. *Road Materials and Pavement Design*, <https://doi.org/10.1080/14680629.2017.1302355>.

Duel, E.B., G.W.T. Wilson, K.R. Hickman, M.J. Greer, (submitted). Implications for future climate scenarios: Warmer, drier conditions favor invasive grasses over functionally similar native species. *Plant Ecology*.

Flannery, J.A., J.N. Richey, K. Thirumalai, R.Z. Poore, **K.L. DeLong**, 2017. Multi-species coral Sr/Ca based sea-surface temperature reconstruction using *Orbicella faveolata* and *Siderastrea siderea* from the Florida Straits. *Paleogeography, Paleoclimatology, Paleoecology*, 466:100-109, <http://dx.doi.org/10.1016/j.palaeo.2016.10.022>.

Greene, D., R. McCleery, 2017. Multi-scale responses of fox squirrels to land-use changes in Florida: Utilization mimics historic pine savannas. *Forest Ecology and Management*, 391:42-51, DOI: 10.1016/j.foreco.2017.02.001.

Hee, J., K. Hayhoe, 2017. Observed and CMIP5 modeled influence of large-scale circulation on summer precipitation and drought in the South-Central United States. *Climate Dynamics*, 49:1-18, DOI: 10.1007/s00382-017-3534-z.

Hu, X.M., M. Xue, **R.A. McPherson, E. Martin, D.H. Rosendahl**, L. Qiao, 2018. Precipitation dynamical downscaling over the Great Plains. *Journal of Advances in Modeling Earth Systems*, 10:421-447, <https://doi.org/10.1002/2017MS001154>.

Klemm, T., R.A. McPherson, 2017. The development of seasonal climate forecasting for agricultural producers. *Agricultural and Forest Meteorology*, 232:384-399, <http://dx.doi.org/10.1016/j.agrformet.2016.09.005>.

Lanzante, J.R., K.W. Dixon, M.J. Nath, C.E. Whitlock, D. Adams-Smith, 2018. Some pitfalls in statistical downscaling of future climate. *Bulletin of the American Meteorological Society*, 99:791-803, DOI: 10.1175/BAMS-D-17-0046.1.

McHugh, T.A., Z. Compson, **N. van Gestel**, N. Hayer, L. Ballard, M. Haverty, J. Hines, N. Irvine, D. Krassner, T. Lyons, E.J. Musta, M. Schiff, P. Zint, E. Schwartz, 2017. Climate controls prokaryotic community composition in desert soils of the southwestern United States. *FEMS Microbiology Ecology*, 93(10), DOI: 10.1093/femsec/fix116.

Mullens, E.D., R.A. McPherson, 2017. A multi-algorithm reanalysis-based freezing precipitation dataset for climate studies in the south-central U.S. *Journal of Applied Meteorology and Climatology*, 56:495-517.

Osland, M.J., L.C. Feher, J. Lopez-Portillo, R.H. Day, D.O. Suman, J.M.G. Menendez, **V.H. Rivera-Monroy**, (submitted). Mangrove forests in a rapidly changing world: Global change impacts and conservation opportunities along the Gulf of Mexico coast. *Estuarine and Coastal Shelf Science*.

Ramesh, R., G. Perry, M. Farmer, K.L. Griffis-Kyle, 2017. Limited data used to make valid inference about targeting sites for conservation: A case study in urban amphibian ecology. *Herpetological Review*, 48(1):1-5.

Rivera-Monroy, V.H., T. Danielson, E. Castaneda-Moya, B.D. Marx, **X. Zhao**, R. Ravieso, E. Gaiser, (submitted). Everglades mangrove forest long-term demography and stem productivity: Resistance to hurricane disturbance. *Forest Ecology and Management*.

Solis, P., J. Vanos, R. Forbis, 2017. The decision-making / accountability spatial incongruence problem for research linking science and policy. *The Geographical Review*, 104(4):680-704, DOI: 10.1111/gere.12240.

Tucker, C.S., J.C. Trepanier, G. Harley, **K.L. DeLong**, 2017. Maritime slash pine trees (*Pinus elliottii* var. *elliottii* Engelm) record tropical cyclone activity along the northern Gulf of Mexico from 1909-2014. *Journal of Coastal Research*, <https://doi.org/10.2112/JCOASTRES-D-16-00177.1>.



Selected conference presentations

Bertrand, D., R. McPherson, September 2017: “Projecting hydrologic extremes” – *Oklahoma Floodplain Managers Conference*, Norman, OK

Dixon, K.W., J.R. Lanzante, D. Adams-Smith, December 2017: “Examining the performance of statistical downscaling methods: Toward matching applications to data products” – *American Geophysical Union Fall Meeting*, New Orleans, LA

Duell, E.B., A. O’Hare, G.W.T. Wilson, June 2017: “Improving grassland restoration efforts: the power of soil amendments” – *Soil Ecology Society Meeting*, Ft. Collins, CO

McPherson, R.A., D.H. Rosendahl, J. Blackband, E. Mullens, A. Wootten, January 2018: “Engaging stakeholders in embracing uncertainty in climate projections for adaptation planning” – *13th Symposium on Societal Applications: Policy, Research, and Practice (American Meteorological Society)*, Austin, TX

Ouellette, G., K. DeLong, A. Herrmann, C.Y. Huang, C.C. Shen, April 2017: “African dust plumes recorded as rare Earth elemental concentrations in coral microatolls” – *Association of American Geographers Annual Meeting*, Boston, MA

Phleger, A., December 2017: “Climate impacts to New Mexico cultural resources” – *Respecting Place: Cultural Resource Fund Gathering* (invited talk), Bernalillo, NM

Rivera-Monroy, V., T. Danielson, E. Castandeda-Moya, M. Kelsall, E. Gaiser, R. Travieso, X. Zhao, J. Kominoski, November 2017: “Effects of phosphorus availability and hurricane disturbance interactions on the elemental stoichiometry of mangrove litterfall” – *Coastal Estuarine Research Federation 24th Biennial Conference*, Providence, RI

Rosendahl, D.H., P. Cwik, E.R. Martin, J.B. Basara, H.E. Brooks, J.C. Furtado, C.R. Homeyer, H. Lazrus, R.A. McPherson, E. Mullens, M.B. Richman, A. Robinson-Cook, December 2017: “Developing a framework for seamless prediction of sub-seasonal to seasonal extreme precipitation events in the United States” – *American Geophysical Union Fall Meeting*, New Orleans, LA

Schroers, M., A. Wootten, D.H. Rosendahl, R.A. McPherson, January 2018: “Future projections of heat waves and cooling degree days in large cities across the South-Central United States” – *9th Conference on Environment and Health (American Meteorological Society)*, Austin, TX

Van Gestel, N., December 2017: “Increased carbon throughout but no net soil carbon loss in field warming experiments: Combining data assimilation and meta analysis” – *American Geophysical Union Fall Meeting*, New Orleans, LA

Vara, M.A., K. DeLong, A. Herrmann, G. Ouellette, J.N. Richey, December 2017: “Assessment of the coral temperature proxies for *Orbicella favelata* in the southwestern Gulf of Mexico” – *American Geophysical Union Fall Meeting*, New Orleans, LA

Vargas, D., V. Acosta Martinez, B. McMichael, J. Zak, June 2017: “Reduction in daily soil temperature ranges increase microbial community dynamics in a drylands cotton production system in West Texas” – *Soil Ecology Society Meeting*, Ft. Collins, CO

Zak, J.C., B. McMichael, K. Hake, January 2018: “Linking daily temperature ranges with microbial benefits in a no-till cotton system on the Southern High Plains” – *Beltwide Cotton Meeting*, Dallas, TX

Zhao, X., V. Rivera-Monroy, T. Cheng-Feng, R. Twilley, C. Willson, X. Zuo, E. Castandeda-Moya, C. Corando-Molina, November 2017: “Modeling water and salt budgets (2002-2016) in mangrove forests (Everglades, FL) impacted by hydrological restoration” – *Coastal Estuarine Research Federation 24th Biennial Conference*, Providence, RI



Activities Planned for 2018

- Continue evaluating global climate model projections across the region, evaluating statistical downscaling methods, and developing best practices for impacts researchers and resource managers on how to apply the output from these data sources in partnership with other regional and national efforts;
- Bring the new projections to DOI agencies to infuse climate planning information into adaptation planning processes;
- Engage stakeholders directly to provide scientific expertise, climate projections, and other information for climate adaptation planning;
- Educate and train management partners and support Tribal engagement across the region, including hosting Tribal workshops and student conferences and pursuing funding opportunities in collaboration with Tribal partners;
- Further enhance collaborations with Tribes and Tribal organizations in New Mexico;
- Continue to strategically develop large-scale inter-institutional and inter-disciplinary regional proposals to establish a broader funding base;
- Link students across the region by leading an undergraduate summer internship for under-represented minorities and launching an online open course on managing for climate impacts;
- Rebrand with the new title of “South Central Climate Adaptation Science Center,” and,
- Continue the systematic update to our consortium website layout and content.

Visit our website at <http://southcentralclimate.org/>

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