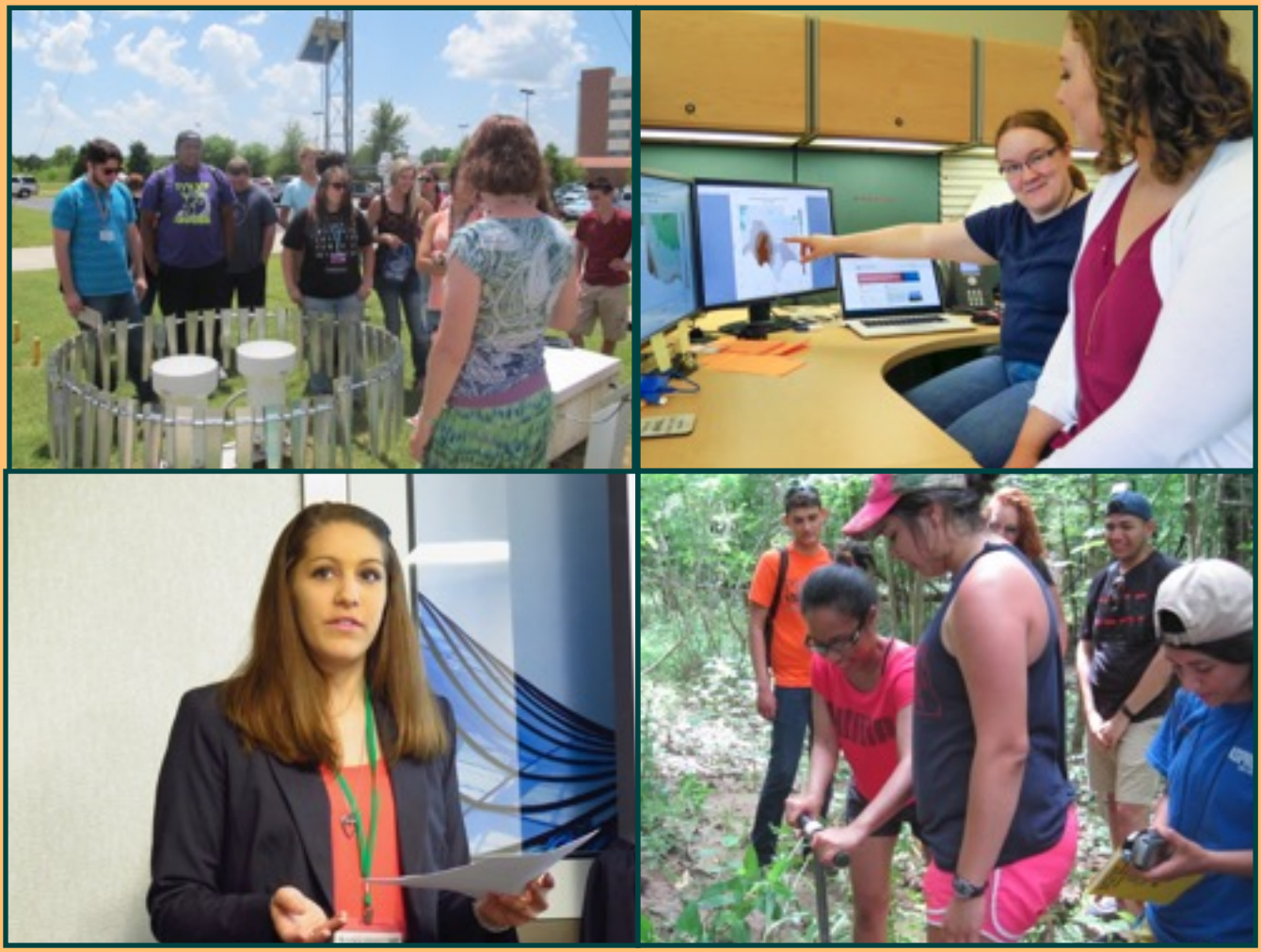
South Central Climate Science Center



2016 Annual Report

March 1, 2016 - February 28, 2017

This year's highlights:

- Enhanced water and drought research initiatives in the Red River and Rio Grande basins.
- Conducted Tribal and early-career educational activities, as well as hosted an undergraduate internship.
- Completed research that helps managers respond to changing fire regimes; shared results at a fire summit.
- Selected to host a new training at the National Adaptation Forum in Saint Paul, MN from May 9-11, 2017.

Helping to solve real problems in a variable and changing climate

The South Central Climate Science Center is one of eight regional Climate Science Centers that are managed by the U.S. Geological Survey (USGS). Established in 2012, the South Central Climate 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 Science Center collaborates with a wide range of scientists and decision-makers in tribes, state and Federal agencies, universities, and non-governmental organizations.

Our research

The USGS Climate Science 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 and Funding

Enhancing our Communications

New to the South Central Climate Science Center (South Central CSC) in 2016 is Ms. Jessica Blackband (right), our communications specialist. Ms. Blackband is housed at the host institution in Norman, Oklahoma. She completed a strategic communications plan and is working to maximize the impact of SC-CSC science by communicating research outcomes to audiences that include researchers, practitioners, and policy makers. She works closely with researchers to convey their findings in a manner that is accessible and useful to stakeholders. (See page 15 more additional information.)

Consortium Researchers and Students

Our office has expanded in Norman (left) as we win new grant awards from USGS and other sources. To formalize the relationship with researchers conducting non-USGS-funded yet CSC-relevant work in the region, the SC-CSC began an "Affiliate Program" in May 2014. Benefits of affiliate membership include notification of new requests for proposals and the ability to have new research or publications featured on the SC-CSC website and Facebook page. Currently, our affiliate program has 43 members, as shown in the table below

Associated:	Faculty, PIs, Affiliates	Staff	Post-docs	Grad Students	Undergrad Students
University of Oklahoma	17	8	3	4	10
Texas Tech University	29	4	3	5	1
Louisiana State University	15	1	—	6	1
Chickasaw Nation	1	2	—	7	13
Choctaw Nation of Oklahoma	3	—	—	—	2
Oklahoma State University	6	—	2	1	—
NOAA's GFDL	5	—	—	—	—

South Central CSC Base Funding

During Year 5 (March 1, 2016 - February 28, 2017), the non-federal members of the SC-CSC consortium expended $747,177 of the budgeted amount of $747,386 (99.9%) for our "hosting agreement".

Year 5:	Received	Expended	Percent Expended
University of Oklahoma	$256,883	$254,859	99.2%
Texas Tech University	$161,241	$161,241	100%
Louisiana State University	$118,868	$118,665	99.8%
Chickasaw Nation	$114,200	$114,194	100%
Choctaw Nation of Oklahoma	$0	$0	—
Oklahoma State University	$96,194	$96,194	100%

Across the first five grant years, the non-federal members of the SC-CSC consortium expended $3,521,109 of the budgeted $3,527,473 (99.8%).

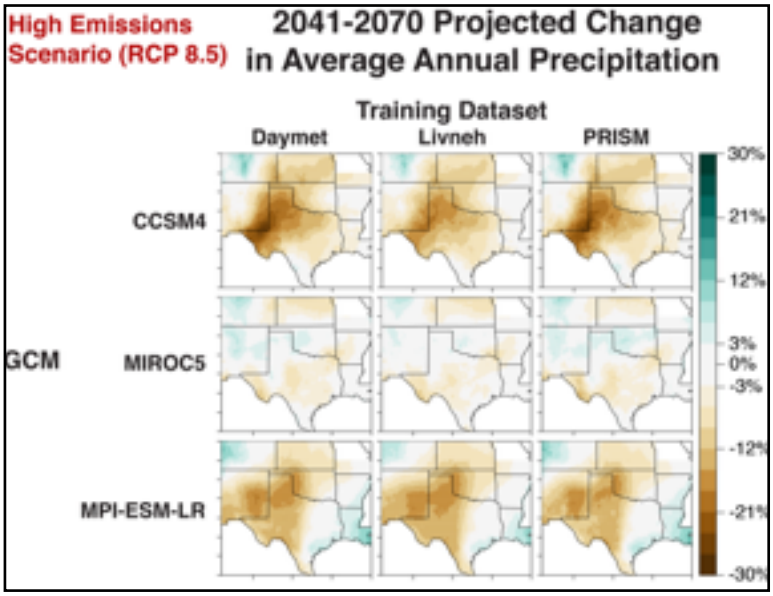
Consortium Research Projects

Characterizing Components of Uncertainty in Downscaled Climate Projection (PI - McPherson, OU)

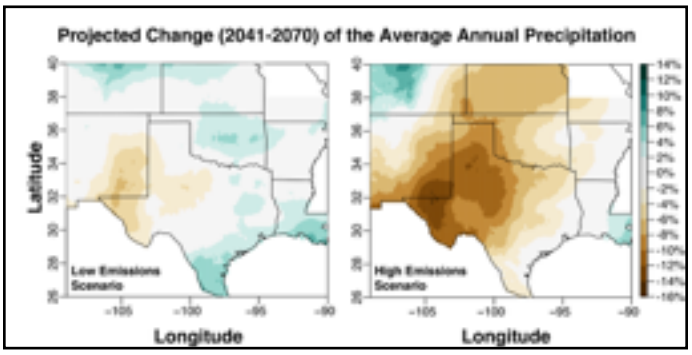
Global climate models (GCMs) provide useful guidance on projected changes in climate, but are much too coarse for local adaptation decisions. To address this issue, researchers at the South Central CSC are partnering with researchers at the National Oceanic & Atmospheric Administration's Geophysical Fluid Dynamics Laboratory to statistically downscale climate projections for the region. Because downscaling methods are not perfect, there is a layer of uncertainly in addition to the uncertainties from the GCMs themselves. The uncertainties only grow when the downscaling output is used as input in modeling efforts to assess the local impacts of climate change.

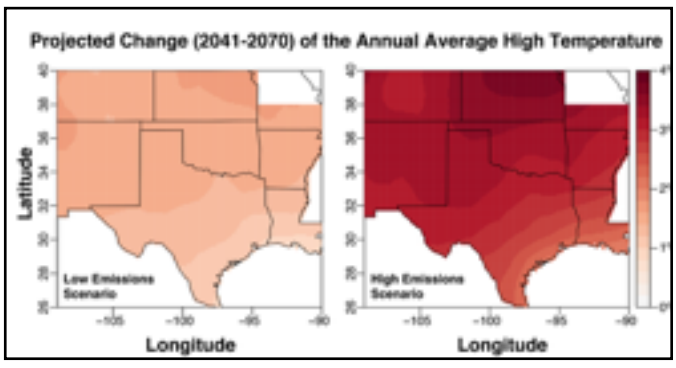
As a result, it is critical to understand how to evaluate these uncertainties. In a project known as 3ˆ5, these researchers are developing and evaluating statically downscaled climate data reflecting multiple sources of uncertainty. At the end of this two-year project, the researchers will propose a refined and expanded method for the evaluation of uncertainties in downscaled datasets.

The project team use three different GCMs (CCSM4, MICRO5, and MPI-ESM-LR), each run with three different representative concentration pathways (RCPs). The resultant datasets are then statistically downscaled using three different techniques that are each trained with three different gridded observation datasets (Daymet, Livneh, and PRISM). The final output is three different variables (daily minimum temperature, daily maximum temperature, and daily precipitation) statistically downscaled for the South-Central U.S. An example of this process is shown (right) for projected change in annual precipitation under the RCP 8.5 (high emissions scenario). This particular grouping of downscaled data was developed using the equidistant quantile mapping (EDQM) downscaling technique.



In the first year of this project, the team completed the first statistically downscaled dataset using the EDQM downscaling technique. The images shown below are the ensemble mean by RCP for the projected changes in average annual precipitation (left) and





average annual high temperature (right).

Consortium Research Projects

Dendrochronology Reveals Response of Coastal Pine Trees to Various Climate Parameters (Graduate Student - Tucker, LSU)

Tree rings can provide a window into the climate of the past. The study of tree-rings, called dendrochronology, involves examining tree-ring patterns to understand past environmental and climatic changes. Dendrochronology studies typically take place in drought-prone regions and other areas where tree growth is sensitive to environmental conditions, such as the edges of their geographical range. Research pioneered by LSU scientists reveals that trees growing along the Gulf of Mexico coast are sensitive to saltwater that moves onto the shore through sea-level rise, hurricanes, winds, and waves. These climatically sensitive trees provide another place for dendrochronolgists to conduct their research in order to document and study past climatic and environmental change. Clay Tucker, a South Central CSC early-career fellow and funded graduate student is leading this research effort. He recently published his first paper from his Master's project in the *Journal of the Coastal Research*.

Empowering Fire Professionals to Understand and Manage Changing Fire Regimes (PI - Shafer, OU)

Fire is a natural and necessary component of the South Central Plains ecosystem. However, fire suppression, paired with more frequent and intense droughts in the region, have resulted in a build-up of dry fuel loads (e.g., dead wood), resulting in fires that burn hotter and impact the landscape more severely. Uncontrolled wildfires have cost the region several billion dollars over the past five years. Further, fire suppression has resulted in substantial losses in native-plant biodiversity and wildlife habitat, which also has costly implications. In Oklahoma along, it's estimated that $157 million will be required to restore rangelands to their native conditions. Of further concern is the fact that projected changes in climate indicate that the region will continue to experience hotter and drier conditions, meaning that fire risks will continue to increase unless proper management strategies, such as prescribed fire, are implemented.

Dr. Mark Shafer, Director of the Southern Climate Impacts Planning Program at OU, partnered with researchers at OSU and Texas A&M to investigate how climate change might impact the suitability of particular days for prescribed burning, as well as how it might impact the number of days with high wildfire potential. Knowing this information will help land managers respond to the changing fire regimes. As part of the project, Dr. Shafer and his colleagues co-hosted a Prescribed Fire Summit in 2016 that provided a forum for discussion across the region about prescribed burning. The Summit was an opportunity for participants to share techniques, concerns, and build a network for shared resources. Participants expressed interest in seeing these events occur on a bi-annual basis to keep them informed about fire management in a changing climate. To date, no significant trends in the number of days suitable for prescribed fires were found.

Results from their project were also shared at the Summit. The researchers noted the great spatial variability that prescribed burn associations use in weather and climate thresholds and how adjusting those could expand opportunities for prescribed burns.

Consortium Research Projects

Climate Change and the Lesser Prairie-Chicken

Relative Importance of Climate Variables to Lesser Prairie-Chicken Vital Rates (Postdoc - Earl, OSU)

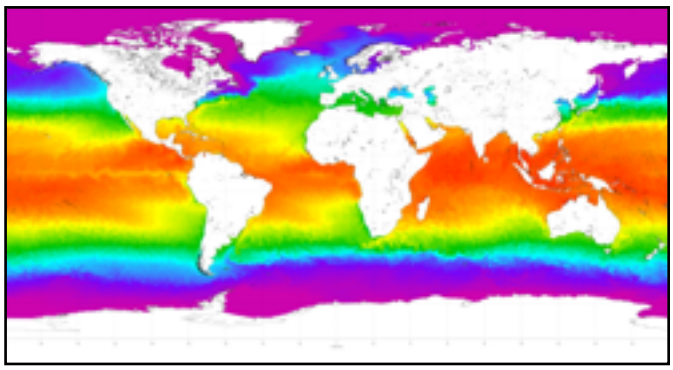
Climate change is expected to affect climate means, extremes, and variability, but the relative importance of these different types of climate variables to population vital rates is still unclear. These relationships will ultimately determine the effects that climate change will have on wildlife population dynamics. Researchers at OSU, led by Dr. Julia Earl, used a quantitative synthesis of published vital rates to explore these relationships. In their initial findings, they noted that geographic variables and life history were better predictors of population vital rates than any of the climate variables investigated.

Effects of Climate Change on the Lesser Prairie-Chicken Geographic Distribution (Graduate Student - Peterson, OSU)

Species distribution models are useful for predicting where the climatic niches (i.e., favorable locations based on climatic variables) of species will exist in the future as a result of climate change. However, if populations of a given species occupy different climatic niches in separate areas of their geographic distribution, this may influence future projections. Lesser prairie-chickens have two distinct populations in their geographic distribution, and the distinct populations have likely adapted to different climatic conditions. Researchers at OSU are running species distribution models for the species as a whole and the two separated populations. Their goal is to better understand how adaptations to different climatic conditions may affect the entire species distribution under climate change. Individuals from the Natural Resources Conservation Service and the Oklahoma Department of Wildlife Conservation have already shown interest in using the results of this research to help improve long-term conservation outcomes of this species.

Variability of Bias in Gridded Sea-Surface Temperature Data Products (Graduate Student - Ouellette, LSU)

There are several sea surface temperature (SST) data products available from NOAA, NASA, and the Hadley Centre in the UK that are produced using measurements of different techniques (e.g., ship-of-opportunity SST measurements, buoys, and satellite-derived SST estimates). While all the SST data products are based on the same data sets, they often use different interpolation methods to produce their globally complete product. Scientists at LSU are investigating the output produced by these different methods and how the differences may impact paleoclimate reconstructions using these data sets. Such an evaluation is increasingly important as more scientists partake in projects aimed at investigating paleoclimate that use these SST data products in their reconstructions of past climate variability. Furthermore, this research has implications for other areas of climate research that use these SST data products as well. This includes climate model inter-comparison projects, such as the CMIP-5, and regional climate studies that use paleoclimate data.



Consortium Research Projects

Predicting Water Temperature Extremes and Variability in Depressional Wetlands (Postdoc - Earl, OSU)

Worldwide, wetlands provide billions of dollars in benefits to coastal communities. These benefits include water retention and storage, flood control, water purification, and habitat for game and non-game species. Precipitation and air temperature are two environmental factors that impact the water volume, hydro-period (i.e., how long the wetland contains water), and water temperature of these essential ecosystems. Water temperature can alter ecosystem processes, impact water quality, and the influence the survival and growth of aquatic organisms. Air temperature averages and extremes are expected to increase, but it is unclear how this will impact water temperature in wetlands. To investigate this, researchers at OSU characterized and examined the effects of wetland characteristics (e.g., size, depth, vegetation) on water temperature variability and extremes. To do this, they deployed temperature sensors in depressional wetlands in central Oklahoma to record temperatures at the surface and benthic zone (lowest point in a body of water at a given location). Preliminary results indicate that water buffers the more extreme changes in air temperature, with greater buffering at the bottom of the wetlands than near the surface.

Hot Playgrounds and Children's Health (PI - Vanos, TTU)

One of the biggest threats posed to human health by climate change is an expected increase in incidences of extreme heat. Children are particularly vulnerable to these events and may experience heat stroke, dehydration, or other health problems without adequate sun protection. Dr. Jennifer Vanos, an assistant professor in the Department of Geosciences at Texas Tech University, studies how the built environment, particularly playgrounds, can be designed to mitigate the impacts of extreme heat on children's health. She led a team of researchers to compare the temperatures of two playgrounds as measured using two different methods: remote sensing data (provided an estimation for the surface temperature of objects from a distance) and touch-scale analysis (determined the surface temperature of objects using hand-held instruments). Dr. Vanos' team found that using remote sensing data to measure surface temperatures is not as accurate as using data from touch-scale measurements. When measuring at a touch-scale, surface temperatures were found to be higher by more than 10°C, potentially causing harm to the children interacting with certain equipment and surfaces on playgrounds. This result implies that touch-scale measurements can provide more accurate assessments of how hot temperatures might impact human health at local scales. Dr. Vanos and her team have shown that when designing urban structures, shade should be considered as a mechanism for mitigating heat stress on the structures and their users.

Consortium Grant Funding

In December 2016, the USGS issued a request for proposals for FY16 science funding, resulting in three funded proposals for the South Central CSC region:

Characterizing Components of Uncertainty in Downscaled Climate Projection
Renee McPherson (University of Oklahoma), PI – 18 months, $94,380

Translational Science Support
Renee McPherson (University of Oklahoma), PI – 12 months, $74,521

Initiating the Development of Regional Demonstration Fields for Implementing of Soil Practices that Maximize Soil Health and Drought Resilience
John Zak (Texas Tech University), PI – 12 months, $12,000

Utilizing the collaborative infrastructure created by the South Central CSC consortium, additional proposals were developed for solicitations from other agencies. Selected submitted proposals include the following:

Energy Flux Equipment for Student Fieldwork in Coastal and Agricultural Environments
Victor H. Rivera-Monroy (Louisiana State University), PI – **Funded**, 12 months, $78,984, Louisiana State University Student Technology Fee Project

Effects of the Conservation Reserve Program and Anthropogenic Features on the Long Distance Movements and Mortality Risk of Lesser Prairie-Chickens
Julia Earl (Oklahoma State University), PI – **Funded**, 24 months, $68,000, Natural Resources Conservation Society (subcontracted through Pheasants Forever)

The GeoCarb Mission
Berrien Moore (University of Oklahoma), PI – **Funded**, 5 years, $166 million, National Aeronautics and Space Administration's Earth System Science Pathfinder program

Understanding the Benefits of Crop Residues and Bed Design for Improving Soil Moisture, Reducing Heat Load and Daily Temperature Variability while Increasing Soil Health in a Drylands and Irrigated Cotton Rotation System
John Zak (Texas Tech University), PI – **Funded**, 12 months, $40,000, Cotton Inc.

PREEVENTS: Developing a Framework for Seamless Prediction of Sub-Seasonal to Seasonal Extreme Precipitation Events in the United States
Elinor Martin (University of Oklahoma), PI – **Pending Funding Availability** 5 years, $1,925,453, National Science Foundation's Prediction of and Resilience against Extreme Events program

Understanding and Quantifying Carbon Export to Global Oceans through Deltaic Systems (CEDS)
Victor H. Rivera-Monroy (Louisiana State University), co-PI – **Under Review**, 24 months, $750,000, National Aeronautics and Space Administration's Experimental Program to Stimulate Competitive Research

Nutrient Utilization and Carbon Storage in Coastal Marshes Across a Human-Induced Salinity Gradient
Victor H. Rivera-Monroy (Louisiana State University), co-PI – **Under Review**, 24 months, $300,000, Coastal Protection and Restoration Authority's (CPRA) Center of Excellence for Louisiana - The Water Institute of the Gulf

Climate Extremes and Thresholds: Effects on Vital Rates and Population Dynamics
Julia Earl (Oklahoma State University), PI – **Pre-proposal Under Review**, 4 years, $200,000, National Science Foundation's Population and Community Ecology Cluster

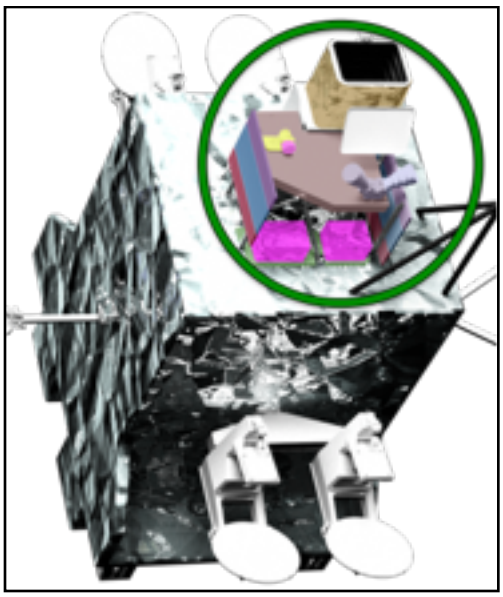
FACET: Complex Interactions of Uplift, Dust Deposition, and Hydroclimate on Karst Landscape Evolution on Simple Carbonate Platforms: Understanding Drivers of Landscape Change
Kristine L. DeLong (Louisiana State University), PI – **Under Review,** 3 years, $443,778, National Science Foundation's Division of Earth Sciences, Tectonics, and Geomorphology and Land Use Dynamics program

Sources, Transport, and Sinks of Organic and Inorganic Materials for the Construction of Sediment Mass Balances in the Barataria Basin - A Radiotracer and Modeling Approach
Victor H. Rivera-Monroy (Louisiana State University), PI – **Under Review**, 24 months, $300,000, Coastal Protection and Restoration Authority's (CPRA) Center of Excellence for Louisiana - The Water Institute of the Gulf

Grant Funding Highlight: Geostationary Carbon Cycle Observatory

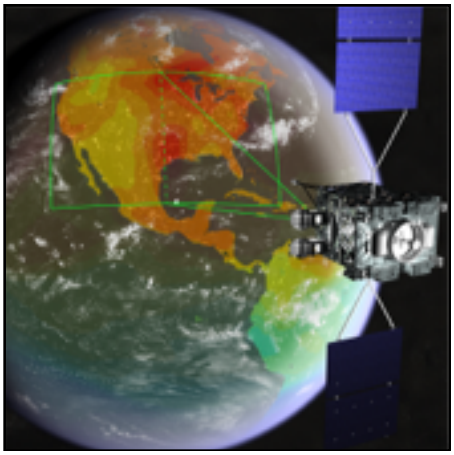
The First Geostationary Vegetation, Atmospheric Carbon Mission

In December 2016, the National Aeronautics and Space Administration (NASA) chose to fund the Geostationary Carbon Cycle Observatory (GeoCarb) mission put forth by University of Oklahoma researchers as the second Earth Venture mission under the Earth System Science Pathfinder program. Led by Dr. Berrien Moore of the South Central CSC, the proposal was competitively selected from 15 proposals submitted to NASA for small orbital investigations of the Earth system. This 5-year project, worth $166 million, is focused on measuring key greenhouse gases and vegetation health from space and will advance our understanding of Earth's natural exchanges of carbon between the land, atmosphere, and ocean.



SC-CSC researchers, in collaboration with other researchers from OU, Lockheed Martin, SES Government Solutions Company, Colorado State University, NASA's Ames Research Center, NASA's Goddard Space Flight Center, and NASA's Jet Propulsion Laboratory, will develop an instrument to be placed on a geostationary satellite. The green circle in the image to the right illustrates the placement and initial design of the instrument on the communications satellite. The sensor will monitor plant health and vegetation stress and examine the natural sources and processes that control carbon dioxide, carbon monoxide, and methane in the atmosphere. Colleagues and laboratories in France, Australia, and Mexico are also planning to contribute to this project. Funding for the mission includes the initial development, launch of the mission, and data analysis.

The OU-led team will build this advanced payload that will be launched on an already planned commercial communications satellite launch in summer 2021. By leveraging this existing launch, the team takes otherwise unused launch and spacecraft capacity to advance science and provide a societal benefit. The instrument aboard this satellite will make observations over the Americas from an orbit of approximately 22,000 miles above the equator. If successful, this mission will strengthen NASA's partnerships with the commercial satellite industry and provide a model that can be adopted to expand these observations to other parts of the world.



Benefits to the broader research community include developing a better understanding of the sources and process of these greenhouse gases to use in modeling applications for more accurate climate projections. For the South Central CSC in particular, our science team will be able to use the new GeoCarb data to estimate vegetation health and help land managers assess drought patterns or wildfire potential. In addition, GeoCarb data could be input into ecological models to determine the effects of land management practices on carbon sequestration. We hope to work with the GeoCarb team to develop more accurate drought monitoring tools that can provide natural resource managers information about where vegetation is most stressed.

Building up the Next Generation of Scientists

2016 Undergraduate Summer Internship

Our 2016 summer undergraduate internship for students of under represented minorities interested in science, technology, engineering, and mathematics fields was held from Sunday, May 22, 2016 to Saturday, June 11, 2016. We selected 10 undergraduate students to participate in this internship (8 female, 2 male; 6 Hispanic, 1 American Indian, 1 African American).

In the 2016 summer internship, the students began in Baton Rouge, Louisiana, and concluded the internship 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 CSC 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, and 2016 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 2017!

2016 Regional Graduate Student and Early Career Researcher Training

Every other year, the South Central CSC conducts a regional training for early-career researchers, graduate students, and post docs whose research has a climate component. These trainings equip participants with tools for engaging meaningfully with public and private stakeholders, as well as researchers across disciplines. Participants hear from regional and national climate experts and regional stakeholders, explore climate issues in the field, and network with their peers.

The 2016 training was hosted by TTU in Lubbock, TX. Speakers included Dr. Katharine Hayhoe, Associate Professor and atmospheric scientist at TTU; Dr. Kater Hake, Director of Cotton Incorporated; Dr. Keith Dixon, Research Meteorologist at GFDL; and many others. Participants visited U.S. Dept. of Agriculture research facilities, wineries, and other locations to hear directly from community members impacted by climate and land use changes. The participants also worked in groups to practice developing stakeholder-focused, interdisciplinary research proposals.

According to one individual who participated in the 2016 training, “it was valuable to gain insight to the challenges we [researchers] face in terms of communication of science to stakeholders.”

Tribal Engagement

The South Central CSC's Tribal Engagement Plan was released on September 22, 2014, as USGS Circular 1396. It 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 CSC intends to take, such as including Tribal leaders in an advisory capacity, offering trainings for Tribal staff, and engaging with Tribal educators. In addition, the Tribal Engagement Plan details a strategy for ensuring that researchers engage with Tribes in culturally appropriate ways. In 2016, the South Central CSC continued to fulfill the commitments outline in the Tribal Engagement Plan, particularly through regional and national inter-agency and inter-Tribal coordination and leveraging of resources. OU hosted several workshops for faculty and staff to learn how to be culturally competent when looking to partner with tribes on research and outreach projects.

Tribal Capacity Building

Climate Change and the Louisiana Tribes

In May 2016, representatives from the South Central CSC and LSU conducted a two-day climate science training for Louisiana Tribes at the Coushatta Heritage Building in Elton, LA. There were 15 members of Louisiana Native American Tribes in attendance. The event was the first such training to be offered in LA. Guest speakers included Dr. Barry Keim (Louisiana State Climatologist), Kyle Brehe (Southern Regional Climate Center), and Nicole Coursee (LSU Disaster Science Management). The training provided a venue for tribal representatives to network with climate scientists and other professionals, and to strengthen their ability to address the needs of their communities in a changing world.

Climate Change and the New Mexico Pueblos and Tribes

Researchers at LSU also conducted a three-day training in October 2016 with New Mexico Pueblos and Tribes at the Pueblo of Jemez community center. There were 34 attendees from 14 Pueblos and Tribes in New Mexico, Arizona, Minnesota, and Kansas. After the Water Blessing Ceremony by a local spiritual leader, the participants engaged in a conversation about Traditional Knowledge of Climate Change. Attendees discussed historical aspects dating back to Chacoan times, and other migrations following moisture, to more contemporary times and man-made contributions to climate change. This conversation included the intersection and clashing of Native and non-Native values, traditions and science, technology and nature, harmony and confusion, and belief and trust. Presenters included Dr. Micha Rahder (LSU), Dr. Kristine Delong (LSU), Jacob Warner (LSU), Kim Merryman (OU SC-CSC), Dr. Dave DuBois (New Mexico State University), and Edward Schuyler (University of Arizona).

As a result of this training, the Southwest Water and Climate Change Working Group was formed. This group is a consortium of nonprofits, academic institutions, and tribal environmental administrators. Their goal is to assist Tribes, individuals, and organizations in building resiliency against a changing climate.

Tribal Engagement

Engaging with Tribal Youth

Tribal College Conference

In April 2016, South Central CSC faculty and staff co-hosted the first annual Tribal College Conference Series on Climate Change at the College of the Muscogee Nation. The conference, titled "Native American Water and Food Security Research," focused on climate variability research in Oklahoma and the potential implications for Indigenous and Tribal communities. There were 98 individuals, primarily tribal college students, in attendance at the conference. Attendees heard from notable professionals in native science research, including Dr. Dan Wildcat from Haskell Indian Nations University. Native American student research projects were highlighted during a poster session, and the top three posters received an award sponsored by the Oklahoma Tribal Conservation Advisory Council.

Intertribal Youth Climate Leadership Congress

With support from USGS, two South Central CSC Native American interns received travel grants to participate in the second annual Intertribal Youth Climate Leadership Congress in July 2016. This 5-day workshop was for Native American high school students across the Nation who show an interest and dedication to combating the effects of climate change in their communities. Participants were taught about climate science, traditional ecological knowledge, and how a changing climate is impacting Native environmental health and ways of life across the country.

Darby Perry and Bianca Hill, both juniors at OU, attended the workshop and served as Junior Faculty. Darby conducted a fire climatology demonstration, while Bianca presented an ocean acidification demonstration to the students. Both Darby and Bianca had a wonderful time getting to know the students, chaperons, faculty, and staff over the course of the week, and they had an opportunity to learn about how different Tribes are being impacted by a changing climate.

Building Capacity for Long-Term Research Relationships with Tribes

On September 28-29, 2016, the South Central CSC partnered with OU, the Chickasaw Nation of Oklahoma, and the Choctaw Nation of Oklahoma to host two interactive workshops designed to provide researchers with a framework of best practices for working in Indian Country. The workshops, titled "Shifting Landscapes: Protocol Training for Building Long-Term Research Relationships in Oklahoma Indian Country," were attended by over 50 people (including graduate students, faculty, and Tribal members). Those who attended the workshop increased their understanding of the historical context of Oklahoma Indian County and learned how to build research relationships, work collaboratively with tribal organization, and nurture respectful relationships.

Building Collaborations and Partnerships

2nd Region 6 Transportation-Climate Summit

On November 14th, the Southern Plains Transportation Center hosted the 2nd Region 6 Transportation-Climate Summit in partnership with the South Central Climate Science Center and the National Weather Center. Weather, climate, and transportation experts from across the region discussed the climate variability and severe weather challenges facing the transportation sector and explore interdisciplinary solutions. Over 100 people (left), including students, faculty, and state and federal agency representatives, attended the meeting. Dr. Elinor Martin, assistant professor in OU's School of Meteorology and the South Central CSC, gave the keynote address.

Building Partnerships with Industry

Faculty and graduate students at Texas Tech University in the biological sciences and plant and soil sciences, along with researchers at the Lubbock U.S. Department of Agriculture Agricultural Research Service (USDA ARS), are working together with local cotton producers and Cotton Inc. to understand how to maintain soil health and sustainability with increasing climate variability. Through this partnership, scientists are providing information that directly addresses producer needs. Producers concerned about climate variability on the Southern High Plains are looking for innovative techniques that will reduce irrigation demand, increase carbon storage, and provide for increased soil health. Cotton Inc. is using the approach developed by the TTU group for helping address climate challenges across the cotton growing regions of the U.S. The research group is led by Dr. John Zak, Co-Director for the TTU-CSC and a member of the Executive Committee for the South Central CSC. The importance of these efforts is highlighted in the comment below from a key cotton producer in our team:

"Your group at TTU has the expertise and provides the science that allows us to understand how we can deal with climate variability and keep our soils productive. Without your data, we would not be able to tell if what we do on the land will have any lasting affect to help reduce costs, improve productivity and save water." RN Hooper cotton producer, Petersburg, TX

Translating Downscaled Data to Decision Makers

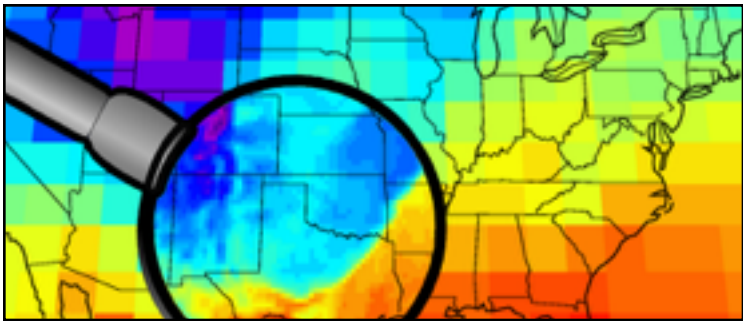
Dr. Adrienne Wootten (right) came on board at the main office of the South Central CSC in Norman, OK in early 2017. She complements the existing expertise in global climate modeling, statistical and dynamical downscaling, and regional climate analyses. Dr. Wootten has been working alongside our partners at NOAA's Geophysical Fluid Dynamics Lab (GFDL) and serves as the liaison between the CSC and GFDL. With Dr. Keith Dixon at GFDL, she conducts research activities of mutual interest to the CSC and GFDL related to the production, accuracy, and uncertainty of downscaled climate projections for variables of interest to stakeholders and the climate modeling community alike. She also interacts directly with stakeholders, translating science to decisions.

Building Collaborations and Partnerships

Benefits and Challenges of a Federal Lab in the Consortium

The National Oceanic & Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (NOAA-GFDL, located in Princeton, NJ) has been part of the South Central Climate Science Center (CSC) consortium since the SC-CSC's inception – an award that was announced in October 2011. As a world-leader in weather and climate modeling, NOAA-GFDL specializes in building and interpreting state-of-the-art computer-based models relevant for society. NOAA-GFDL researchers bring to the South Central CSC consortium expertise that helps insure in-depth understanding of the robustness and limitations of climate predictions and projections to the consortium. This expertise ensures that climate projections are used effectively in impact studies, response modeling applications, and stakeholder guidance developed by the South Central CSC.

In 2016, NOAA-GFDL's Federal PIs continued to work with USGS and consortium colleagues to address the challenge of how to effectively and efficiently transfer and translate high quality, scientifically credible information as it flows from the realm of large-scale climate science to a wider set of researchers and stakeholders interested in more regional and local-scale impacts. The primary thrust has been the analysis of and communications about multi-decadal climate projections, especially those refined by statistical downscaling techniques.



As a Federal research lab specializing in computer modeling of weather and climate, NOAA-GFDL fills a rather unique niche within the interdisciplinary South Central CSC. However, that uniqueness is not without some challenges related to organizational and budgetary frameworks. Despite these challenges, GFDL researchers have continued to collaborate with the South Central CSC consortium members and advance NOAA and USGS goals. For example, GFDL developed downscaled climate projections that were essential for drought mitigation planning efforts by the Chickasaw and Choctaw Nations in the Red River Basin. In addition, Dr. Keith Dixon presented via Skype his "Spanning Time and Spatial Scales: Modeling Our Planet's Climate" presentation as part of the 2016 Regional Graduate Student and Early Career Researcher Training in Lubbock, TX.

Together with their South Central CSC colleagues, GFDL researchers affiliated with the South Central CSC continue to focus on developing a solid understanding of the physical climate that serves as the foundation for data and informational products of value to the greater South Central CSC community. In this regard, the ongoing partnership remains an example of what the USGS CSC refers to as developing "actionable science" [ref: https://nccwsc.usgs.gov/content/actionable-science] and what NOAA's Oceanic and Atmospheric Research (OAR) branch refers to as part of working toward providing "unbiased science to better manage the environment, nationally, and globally" [ref: About NOAA Research on http://www.noaa.gov/research].

Communicating Science

SC-CSC Communications Strategy

Jessica Blackband, South Central CSC communications specialist, developed and implemented a communications strategy for the consortium. Although the South Central CSC had strong communications tactics and tools in place, we felt that a more streamlined and focused strategy would help improve outcomes and make the best possible use of our resources. The first step in developing a comprehensive communications strategy was to finalize a Strategic Communications Plan for the CSC. Members of Gregg Elliot Consulting did the initial work in the summer of 2016, interviewing CSC partners and stakeholders to determine key communications needs and areas for improvement. Ms. Blackband then worked closely with senior staff in the CSC to craft this feedback into the final Strategic Communications Plan. The plan presents three goals for the South Central CSC: (1) strengthen existing partnerships and forge new partnerships where appropriate, (2) promote, facilitate, and improve the use of climate science in natural and cultural resource management decisions, and (3) increase use of social sciences/human dimensions in developing targeted communications and co-producing science. The messaging guidance included in the Plan is shown below. A condensed version of the plan is being developed for public release and will be made available in 2017 on the SC-CSC website.

Messaging Guidance by Priority Audience

	Partners	Mid-Level Resource Managers	Planners 3-5 years ahead	Policy/ Decision-Makers	Tribes	Public and Students
Messaging Themes	Professional network, research support, science-to-action	Coordination, resource base, decision-support	Decision-support, research partners	Cost-effectiveness, natural resource stewardship	Capacity-building, research relationships	Cost-effectiveness, learning opportunities
Framing the CSC's Relationship to Audience	An interdisciplinary network of professional contacts and colleagues who can help me improve my research and broaden its impact.	A trusted source of information that works with you to develop the tools, methods, and data you need to adapt to climate change. A partner in science that considers your agency's specific needs.	A trusted research partner that works with you to develop information you need to prepare for climate change. A partner in research that considers your unique questions and needs.	Leverages funding, staff, and resources from a variety of institutions to develop cost-effective science that benefits human communities and ecosystems.	Long-term investment in building tribal capacity for independent research and adaptation efforts; empowering next generation of tribal natural resource leaders.	A trusted source of information about how climate change will impact where I live, an institution that provides early career scientists with resources for training and education.
Desired Action/ Outcome	Willingness to collaborate across disciplines to produce novel science; eagerness to engage in co-production and actionable science.	Excitement about and engagement with co-production. Generate own research questions and seek CSC help in answering them.	Excitement about and engagement with co-production. Generate own research questions and seek CSC help in answering them.	Seek science advice from CSC related to policy decisions. Actively advocate for the CSC within the political sphere.	Development of tribal climate adaptation plans; increased collaborative relationships between tribal governments and research universities.	High levels of interest from students in training opportunities.
Include Messaging in…	RFP, website, webinars, social media, publications, newsletters	Factsheets, webinars, introductory phone calls, website, tools, newsletter	Factsheets, webinars, introductory phone calls, website, tools, newsletter	Factsheets, emails, press releases, website	Tribe media outlets, newsletters, trainings, factsheets, curricula	Facebook posts, emails, job postings, trainings

Outreach and Education

Open Online Course: Managing for a Changing Climate

In Fall 2016, OU staff and faculty from the South Central CSC developed 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 CSC reached over 500 individuals with this online course, ranging from students at other CSC 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 2017, we plan to add additional videos to cover renewable energy, expand on our impacts videos, and introduce useful adaptation techniques. To view the course videos and materials, visit: https://janux.ou.edu/course.tag-nextthought-com-2011-10-nti-courseinfo-fall2016-geogmetr-3523.html.

Go Green and Make a Difference

TTU researchers partnered with the Girl Scouts of Texas Oklahoma Plains to host an event for the girls involved in the program, focusing on climate science. Around 65 Girl Scouts from the ages of 6-17 and their families attended the event. Seven local organizations came to this event to show what the girls could be doing to help build a healthier community. The girls were split into two groups: the first group watched a movie on weather and climate and the second group went to the organization booths. The booths focused on water, recycling, renewable energy, gardening and composting, wildfires and disasters, and recycling.

Interactive Bear Foraging

Dr. Sue Fairbanks from OSU conducted two "Interactive Bear Foraging Activity" sessions during the Stillwater Nature Camp for approximately 50 campers in 1st through 8th grade. Dr. Fairbanks taught the students about black bears in Oklahoma, including how they hibernate in the winter and need to eat a lot of food in the summer and fall to build up fat energy for the winter. She explained that the bears in Oklahoma are almost entirely vegetarian, so they eat a lot of berries, fruit, and acorns. Since these food sources are sensitive to climate, she taught them how climate change could affect their food availability and hibernation patterns.

Global Weirding Series 2016-2017

Dr. Katharine Hayhoe, TTU Professor and South Central CSC co-PI, partnered with KTTZ Public Media to create a PBS digital series titled, "Global Weirding: Climate, Politics, and Religion." In this series, Dr. Hayhoe tackled common myths related to science, religion, and culture at the intersection of politics and climate change. Season One, which was released in Fall 2016, consisted of 12 episodes that have racked up a total of over half a million views on YouTube and Facebook. Due to its success, Dr. Hayhoe and KTTZ are currently producing a second season (to be released in Fall 2017). Season One videos can be viewed on the Global Weirding YouTube channel: https://www.youtube.com/channel/UCi6RkdaEqgRVKi3AzidF4ow.

Selected publications

DeLong, K.L., J.A. Flannery, R.Z. Poore, T.M. Quinn, C.R. Maupin, K. Lin, C. Shen, 2016. Refining temperature reconstructions with the Atlantic coral *Siderastrea siderea. Palaeogeography, Palaeoclimatology, Palaeoecology,* 462:1-15, doi: 10.1016/j.palaeo.2016.08.028.

Dixon, K.W., J.R. Lanzante, M.J. Nath, K. Hayhoe, A. Stoner, A. Radhakrishnan, V. Balaji, **C.F. Gaitán**, 2016. Evaluating the stationarity assumption in statistically downscaled climate projections: Is past information an indicator of further results? *Climatic Change*, 135:395-408.

Earl, J.E., S. Fuhlendorf, 2016. Relative importance of climate variables to population vital rates: A quantitative synthesis for the lesser prairie-chicken. *PLoS One,* 11(9): e0163585.

Earl, J.E., E. Harper, D.J. Hocking, M.S. Osbourn, T.A.G. Rittenhouse, R.D. Semlitsch, 2016. Effects of timber harvest on small mammals in experimental forestry plots. *Animal Biology,* 66:347-362.

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. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 466:100-109.

Klemm, T., R.A. McPherson, 2017. The development of seasonal climate forecasting for agricultural producers. *Ag. Forest Meteor.,* 232:384-399.

Meenakshi, J., M. Bhat, **V.H. Rivera-Monroy**, E. Castañeda, M. Simard, **R.R. Twilley**, 2016. The role of economic, policy, and ecological factors in estimating the value of carbon stocks in Everglades mangrove forests, South Florida, USA. *Environmental Science and Policy,* 66:160-169.

Mullens, E., R.A. McPherson, 2016. A multi-algorithm reanalysis-based freezing precipitation dataset for climate studies in the South-Central U.S. *Journal of Applied Climatology and Meteorology,* doi: 10.1175/JAMC-D-160180.1.

Pino, J.V., **R.V. Rohli**, **K.L. DeLong**, G.L. Harley, **J.C. Trepanier**, 2016. Using proxy records to document Gulf of Mexico tropical cyclones from 1820-1915. *PLoS One,* 11(11): e0167482, doi: 10.1371/journal.pone.0167482.

Qiao, L., C.B. Zou, C. Gaitán, Y. Hong, **R. McPherson**, 2017. Analysis of precipitation projections over the climate gradient of the Arkansas-Red River Basin. *Journal of Applied Meteorology and Climatology,* 15:1325-1336.

Salas, A.L., V.A. Seamster, K.G. Boykin, N.M. Harings, **K.W. Dixon**, and 1 Department of Fish, Wildlife and Conservation Ecology, New Mexico State University, Las Cruces, New Mexico 88003, USA, 2017. Modeling the impacts of climate change on Species of Concern (birds) in South Central U.S. based on bioclimatic variables. *AIMS Environmental Science,* 4:358-385, doi: 10.3934/environsci.2017.2.358.

Shreck, B., A. Vedlitz, 2016. The public and its climate: Exploring the relationship between public discourse and opinion on global warming. *Society & Natural Resources,* doi: 10.1080/08941920.2015.1095380.

Solís, P., **J. Vanos**, **R. Forbis**, 2016. The decision-making/accountability spatial incongruence problem for research linking environmental science and policy. *Geographical Review,* 106(4), doi: 10.1111/gere.12240.

van Gestel, N., N. Dhungana, D. Tissue, **J. Zak**, 2016. Seasonal microbial and nutrient responses during a five-year reduction in the daily temperature range of soil in a Chihuahuan Desert ecosystem. *Oecologia,* 180:265-277, doi: 10.1007/s00442-015-3452-x.

Selected conference presentations

Adams-Smith, D., K.W. Dixon, J. Lanzante, January 2017: "Effects of Statistical Downscaling on Extreme Value Statistics" - *American Meteorology Society Annual Meeting,* Seattle, WA

Bertrand, D., R. McPherson, October 2016: "Future Hydrologic Extremes in the Red River Basin" - *Southwest Division of the American Association of Geographers,* Denton, TX

Dixon, K.W., May 2016: "Climate Modeling: Research to Operations" - *National Weather Service National Climate Services Meeting,* College Park, MD

Dixon, K.W., M.J. Nath, J. Lanzante, January 2017: "Exploring the Sensitivities of Projected Climate Indices to Statistical Downscaling Choices" - *American Meteorology Society Annual Meeting,* Seattle, WA

Earl, J.E., L.R. Pauley, R.D. Semlitsch, July 2016: "Frogs as Fertilizer? Effects of Metamorphic Amphibians on Plant Growth" - *Joint Meeting of Ichthyology and Herpetology,* New Orleans, LA

Griffis-Kyle, K., February 2017: "Climate Change and Nature Centers: How You Can Make A Difference" - *Association of Nature Center Administrators Regional Meeting,* Fort Davis, TX

Ignac, B., R. McPherson, A. Bamzai, March 2016: "Climate Change in the Mind of a College Student: A Cross-Sectional Study on Climate Change Perceptions at the University of Oklahoma" - *Association of American Geographers*, San Francisco, CA

Klemm, T., R. McPherson, October 2016: "Improving Seasonal Climate Forecasting for Winter Wheat Producers in the South-Central U.S." - *Southwest Division of the American Association of Geographers,* Denton, TX

Magee, C., R. McPherson, October 2016: "Decision Support Systems: An Interdisciplinary Geospatial Perspective to Tornado Warning Forecast Areas" - *Southwest Division of the American Association of Geographers,* Denton, TX

McPherson, R., August 2016: "Overview of the U.S. Department of the Interior's Climate Science Centers" - *Nanjing University-University of Oklahoma (NJU-OU) Symposium on Weather and Climate Research,* Nanjing, People's Republic of China

Ouellette, G., K.L. DeLong, December 2016: "Variability in Bias of Gridded Sea Surface Temperature Data Products: Implications for Seasonally-Resolved Marine Proxy Reconstructions" - *American Geophysical Union Fall Meeting,* San Francisco, CA

Qiao, L., November 2016: "Woody plants impact runoff and water resources in the southern Great Plains" - *National Climate Science Center Student and Early Career Training,* Amherst, MA

Stoner, A., January 2017: "Comparing the Performance of Multiple Statistical Downscaling Approaches using a Perfect Model Framework" - *American Meteorological Society Annual Meeting,* Seattle, WA

Tucker, C.S., G.L. Harley, **J.C. Trepanier, K.L. DeLong**, March 2016: "Dendrochronology reveals response of coastal pine trees to various climate parameters in Grand Bay National Estuarine Research Reserve, Mississippi, USA" - *American Association of Geographers Annual Meeting*, San Francisco, CA

Wagner, M., R. McPherson, November 2016: "Statistical Drought Prediction" - *National Climate Science Center Student and Early Career Training,* Amherst, MA

van Gestel, N., November 2016: "A New Approach to Synthesizing Results from Global Change Experiments" - *National Climate Science Center Student and Early Career Training,* Amherst, MA

Activities Planned for 2017

- Evaluate global climate model projections across the region, evaluate statistical downscaling methods, and develop 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 decision processes;
- Help management planners better understand how climate projections can inform their decisions, either directly or indirectly through impacts studies;
- Educate and train management partners and support Tribal engagement across the region, including training the new Bureau of Indian Affairs' Tribal liaisons, hosting Tribal workshops and student conferences, and pursuing funding opportunities in collaboration with Tribal partners;
- Enhance collaborations with Tribes and Tribal organizations in New Mexico;
- Enhance stakeholder engagement efforts, particularly with our newly generated downscaled climate projections;
- 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; and,
- Continue the systematic update to our consortium website layout and content.

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

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