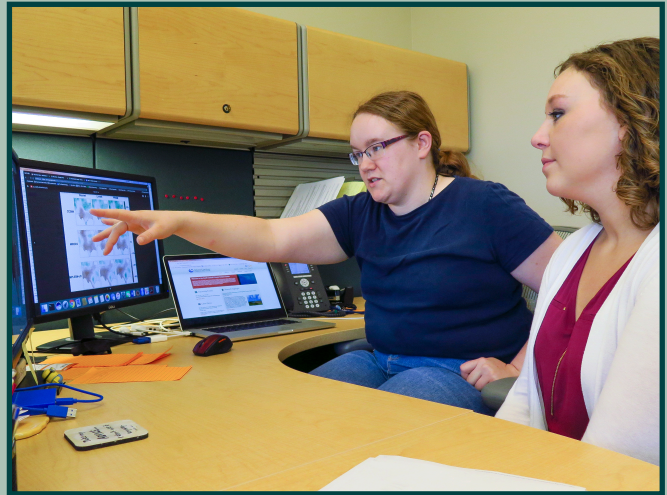




SOUTH CENTRAL CLIMATE SCIENCE CENTER



Helping to solve real problems in a variable and changing climate

Five-Year Report

March 1, 2012 - February 28, 2017

South Central Climate Science Center Five-Year Report: 2012–2017

Prepared by Emma Kuster, Jessica Blackband, Darby Perry, Dr. Renee McPherson, & Dr. Mike Langston, with input from the staff and faculty of the South Central Climate Science Center

Introduction	3
<i>Our Mission</i>	3
<i>Our Region</i>	3
<i>Our Development</i>	4
<i>Our Research Goals and Objectives</i>	5
<i>Stakeholder Advisory Committee</i>	6
<i>Our Essence</i>	6
Personnel	8
<i>South Central CSC Office Roles and Responsibilities</i>	8
<i>Main Office Personnel</i>	9
Funding	11
USGS RFP-Funded Projects	13
<i>Highlighted Projects</i>	13
<i>All USGS RFP-Funded Projects</i>	16
<i>Summary of the USGS Request for Proposal-funded Grants</i>	20
Consortium Base Funding	21
Consortium Leveraged Funding	22
Consortium Research Projects	23
<i>Highlighted Projects</i>	23
<i>All Consortium-Funded Research Projects</i>	27
Key Products	33
Capacity Building	37
<i>Undergraduate Internship</i>	37
<i>Early-Career Professional Development Training</i>	38
<i>Research Experiences for Undergraduates</i>	39
<i>Tribal Engagement</i>	39
Communications and Outreach Activities	41
<i>Communications Plan and Channels</i>	41
<i>Outreach Activities</i>	42

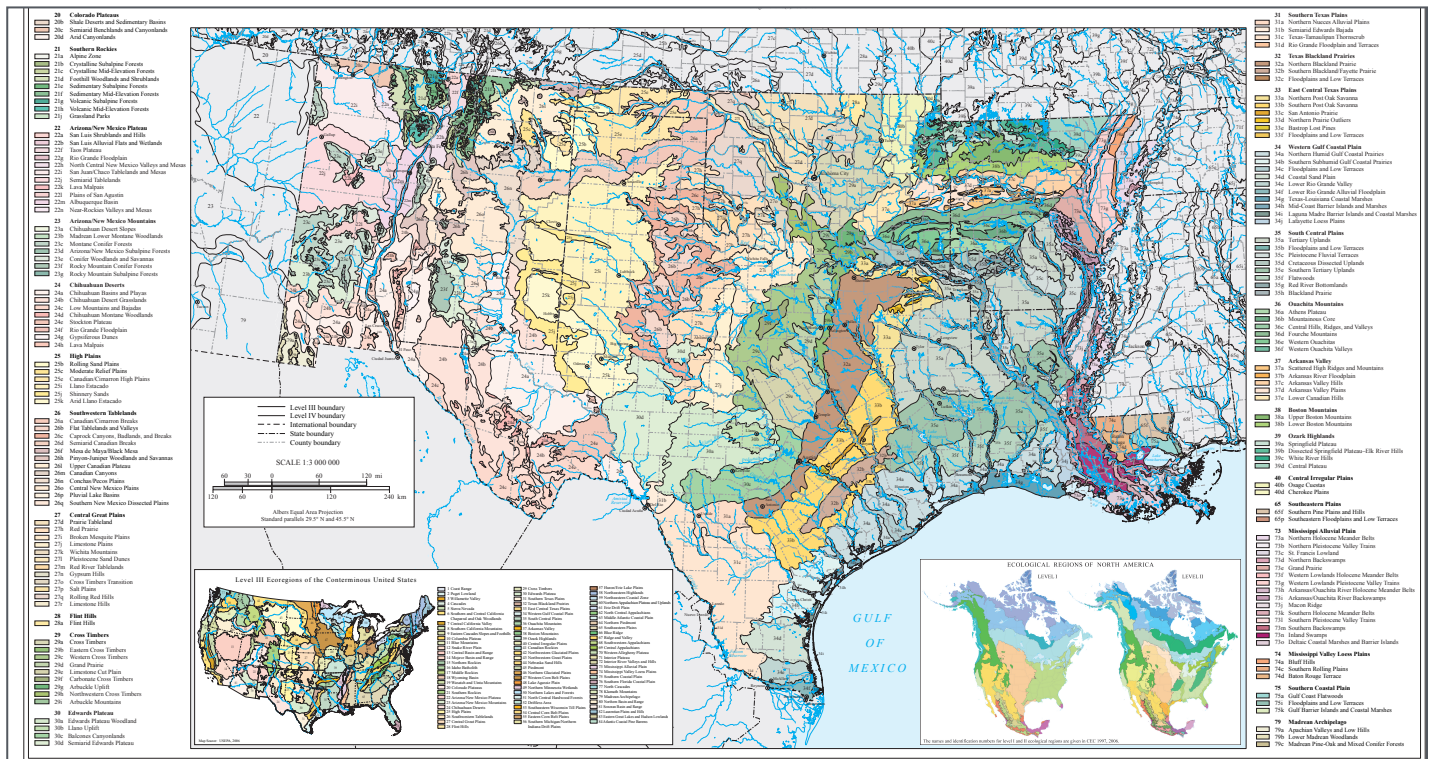
Introduction

Our Mission:

The mission of the South Central Climate Science Center (CSC) is to provide decision makers with the science, tools, and information they need to address the impacts of climate variability and change on their areas of responsibility. The South Central CSC aims to transform how climate science is conducted and applied in the south-central United States. The Center supports big thinking, including multi-institutional and stakeholder-driven approaches to climate variability, change, impacts, mitigation and adaptation research.

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

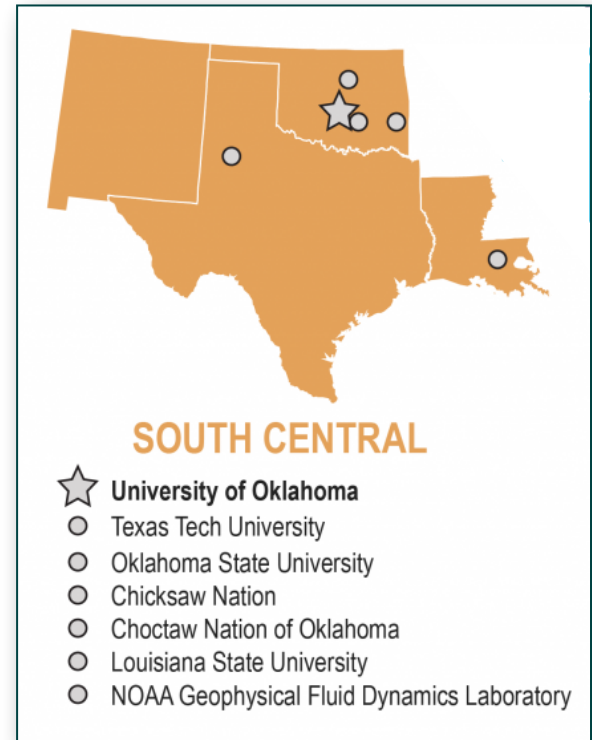


The south-central United States encompasses 20 ecoregions, resulting from a significant gradient in annual average precipitation, from 60 inches in coastal areas to 6 inches in the deserts. Courtesy EPA.

The South Central Climate Science Center is one of eight regional Climate Science Centers (CSCs) managed by the U.S. Geological Survey (USGS). Established in 2012, the South Central CSC 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 National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (right).

The South Central CSC is hosted by and physically housed at the University of Oklahoma (OU), where space is provided for OU, Chickasaw Nation, and USGS employees. The entire consortium has broad expertise in the physical, biological, natural, and social sciences to address impacts of climate change on land, water, fish and wildlife, and cultural resources.

Historically, the south-central United States has not produced a significant amount of climate science research as compared to other regions of the country, and few stakeholders in the region have incorporated climate projections into their decision processes prior to 2012. Thus, the South Central CSC has struggled to meet the new stakeholder demand with only a small team of scientists and communicators.



Region of the South Central Climate Science Center. Courtesy USGS.

Our Development:

Since before the consortium submitted its hosting proposal to the USGS in mid-2011, ***the University of Oklahoma has led regular phone calls with consortium institutions*** to ensure open communication and to enhance planning. During the first few years, these call were weekly; as the Center matured, the calls became biweekly, with USGS and OU personnel taking turns leading the calls. Similarly, after the South Central CSC matured in stakeholders and partnerships, the USGS led bimonthly conference calls with (1) the Stakeholder Advisory Committee and (2) partners' organizations, alternating odd and even months for each group.

On those weeks when there is not a consortium conference call, there is a call between USGS, OU, and NOAA's Geophysical Fluid Dynamics Laboratory (GFDL). GFDL is a critical member of the consortium because of its leadership role nationally and internationally in climate change science. ***The South Central Climate Science Center benefits from GFDL's membership in the consortium through rapid transfer of current scientific knowledge to the region, access to expertise and technology (e.g., supercomputers), and ability to conduct collaborate on science that is in the national interest.*** Similarly, GFDL benefits from more direct connection to stakeholders, especially those decision makers who use GFDL- or NOAA-produced products in their local planning processes. This process supports NOAA's research-to-operations emphasis without significant investment of Federal dollars.

Through regular meetings with the Stakeholder Advisory Committee, interactions with Tribes, conversations with partners, quarterly strategic planning meetings, monthly conference calls with the other seven CSCs and USGS Headquarters (National Climate Change and Wildlife Science Center), and other communications methods, ***the South Central CSC has developed annual science work plans, requests for proposals, annual consortium reports, Tribal engagement plan, communications plan, and five-year strategic science plan.***

During Years 1-4, the University of Oklahoma hosted two-day meetings during the fall that provided a forum for researchers and resource management professionals to discuss inter-disciplinary and inter-institutional climate-related research topics and develop teams in preparation for future requests for proposals. The format of *the annual science workshop was focused on working in intense small groups to develop proposal topic outlines related to climate challenges within the south-central U.S.* Participants were researchers who were engaged in climate-related projects or resource managers who were interested in being active partners in climate-related research. The University of Oklahoma funded most of the workshop, including travel grants for non-Federal employees unable to attend without external funding.

During Years 3-6, the universities within the consortium hosted a three-week internship for underrepresented students in science, technology, engineering, and math (STEM) disciplines (see p. 37). The students were engaged with physical, natural, and social scientists in field trips, research activities, presentations, and social events as they traveled across arid, semi-arid, humid, and coastal ecosystems across Louisiana, Oklahoma, and Texas. *During Years 3 and 5, the CSC led a week-long professional development workshop for early-career professionals* (see p. 38). First hosted by OU, then by Texas Tech, and in 2018 by Louisiana State, the workshop provides real-life examples of resource management decision making and the translation of science to action.

Within the main office suite of the South Central CSC, USGS, OU, and Chickasaw Nation employees conduct weekly staff meetings, host biweekly “journal club” discussions led by students and postdocs, present science talks, host CSC guests, have celebratory events, and conduct day-to-day business as a coordinated team. We mentor individuals within this environment, with more experienced employees mentoring those who are less experienced (e.g., postdocs mentor graduate and undergraduate students). New employees receive training on CSC office policies and learn about the multi-institutional organization’s values: respect, teamwork and cooperation, service, innovation and creativity, student education and mentoring, work/play hard, and diversity. Following guidelines from the National Science Foundation, postdocs have individual development plans that support conference and workshop travel, publications and presentations, technical and leadership skills development, career planning and guidance, mentoring experiences, and other responsibilities that enhance their career trajectory. Other full-time staff have similar oversight, evaluation, and professional development opportunities. In recent years, this career development helped one of our Tribal liaisons to obtain a significant job in her own Tribe and our former university assistant director to earn the position of USGS Deputy Director at the North Central Climate Science Center. Many former students, including summer interns, have either gone onto graduate school or obtained jobs in the broader climate-science community.

Our Research Goals and Objectives:

The South Central CSC provides scientific information, tools, and techniques that stakeholders can use to anticipate, monitor, and adapt to climate change for decisions related to in land, water, wildlife, and cultural resources. We receive guidance for regional science priorities from the Stakeholder Advisory Committee (below), comprised of senior-level Federal and State executives and Tribal leaders from the region.

To address the science needs put forth by stakeholders in the south-central United States, the South Central CSC has defined the following set of objectives that provide a framework for co-producing knowledge:

- 1) use long-term and new observational records as well as understanding of biological and physical processes to describe the consequences of global change on natural resources;
- 2) provide scientifically valid information and tools that can be used to adapt natural resource management strategies to changing environmental conditions; and

- 3) apply these tools to produce regional assessments that are widely used by policy makers, natural resource managers, and the public to address climate change related impacts.

Science priorities established by our partners in the region's natural resources conservation community include:

- 1) climate change adaptation, mitigation, resiliency, and vulnerability assessments;
- 2) climate change effects on ecosystems;
- 3) hydrologic responses to climate change;
- 4) climate change effects on human populations, socioeconomics, urbanization, cultural resources, and agricultural issues;
- 5) improved monitoring networks for resources affected by climate change and management actions;
- 6) improved management and sharing of climate change and geospatial data;
- 7) imperiled and rare communities and invasive species;
- 8) coastal response to sea-level rise and changing geomorphology;
- 9) biological response to climate change and disturbance, conservation design and delivery; and
- 10) land-use and land-cover change.

To learn more about these priorities, please view our Strategic Science Plan, available at: <http://pubs.usgs.gov/of/2013/1143/> (valid 2013-2018). The Strategic Science Plan establishes the science priorities and provides guidance on partner interactions for the South Central CSC.

Stakeholder Advisory Committee:

A hallmark of the South Central CSC is its close coordination with partner organizations. This cooperation prevents duplication of effort or working at cross purposes, and it allows partners to leverage their strengths and resources. To these ends, *the South Central CSC has assembled a Stakeholder Advisory Committee (SAC) that serves to foster communication among partners and provide guidance.* The SAC consists of 22 members who represent a broad swath of conservation, Tribal, and natural and cultural resource agencies from across the region. Membership (table on p. 7) includes representatives from the six Landscape Conservation Cooperatives (LCC) and two U.S. Department of Agriculture (USDA) Climate Hubs in our region. They meet via phone during alternating months and in person during late fall.

Our Essence:

The South Central Climate Science Center has grown from a two-person team (USGS Acting Director and OU Director of Research) on March 1, 2012, to a vibrant and diverse organization. With over 20 employees in the Norman main office alone, *the South Central CSC now embodies a cohesive “marriage” of Federal, University, and Tribal employees* who serve the needs of natural and cultural resource managers in the south-central U.S. We receive high-level support from the University of Oklahoma and are well known throughout much of OU's Administration, especially in the Office of the Vice President for Research. The CSC benefits greatly from its location within the College of Atmospheric and Geographic Sciences, led by Dean Berrien Moore, who formally served as the original principal investigator and University Director for the CSC.

Through cost sharing and non-USGS grant funding, the consortium institutions have delivered a 14:1 return-on-investment to the USGS hosting agreement, even before adding the recent \$166,000,000 award by NASA to Dr. Moore. This ratio has been achieved because of stable funding from the hosting agreement, local and national leadership provided by the USGS, and the consortium's ability to obtain non-USGS funds.

Current Membership of the Stakeholder Advisory Committee (SAC)

First	Last	Affiliation
Bill	Bartush	Gulf Coast Prairie LCC
Jennifer	Beardsley	Bureau of Reclamation, Great Plains Region
Laura	Bowie	Gulf of Mexico Alliance
Meaghan	Bresnahan	US Environmental Protection Agency
James	Broska	Great Plains LCC
David	Brown	US Department of Agriculture, Agricultural Research Service
Daniel	Deerinwater	Bureau of Indian Affairs
George	Geissler	Oklahoma Division of Agriculture, Food, and Forestry
Genevieve	Johnson	Desert LCC
Kevin	Johnson	Southern Rockies LCC
Crystal	Keys	Bureau of Indian Affairs
Cindy	Loeffler	Texas Parks & Wildlife Department

First	Last	Affiliation
Kelley	Meyers	Eastern Tallgrass Prairie and Big Rivers LCC
Chris	Neel	Oklahoma Water Resources Board
Rupert	Nowlin	Cheyenne and Arapaho Tribes
*Allison	Shipp	US Geological Survey
Jean	Steiner	US Department of Agriculture
Michael	Sterling	US Army Corps of Engineers
Greg	Wathen	Gulf Coastal Plains and Ozarks LCC
Mary	Weahkee	New Mexico Office of Archaeological Studies
**Pam	Benjamin	National Park Service
* Chair/Regional Representative for USGS		
**Serves for Patrick Walsh, National Park Service		

Examples of the influence of the South Central Climate Science Center are abundant. Through the CSC's Severe Weather and Climate Change Working Group, ***OU was awarded one of 15 new grants through the National Science Foundation's (NSF) PREEVENTS*** (Prediction of and Resilience Against Extreme Events) program, announced in September 2017. The \$1.8 million award is led by Dr. Elinor Martin, who was hired in a new OU School of Meteorology faculty position that was created by OU President David Boren as part of the University's cost share commitment for the CSC. Earlier still, Drs. Renee McPherson (OU) and Duncan Wilson (Oklahoma State University), CSC co-principal investigators, led the development of a ***successful \$20 million NSF grant entitled Adapting Socio-ecological Systems to Increased Climate Variability***. Through the additional \$4 million cost share from the Oklahoma State Regents for Higher Education, ***OU hired four new faculty members, including Drs. Jennifer Koch and Jadwiga Ziolkowska, who now are part of the CSC research team*** working to improve the management and coordination of water resources in the Rio Grande Basin — one of our key science areas. Undergraduate students who participated in the South Central CSC's internship program were linked to graduate school or employment opportunities through their short time with us. Other undergraduate students have traveled the world in study abroad programs thanks to three annual \$5,000 scholarships offered by the CSC. These scholarships resulted from an ***anonymous \$330,000 donation to the OU Foundation for the South Central Climate Science Center***. Numerous other examples will be highlighted throughout this report and the ensuing external review.

In summary, the vision, diversity, collegiality, and persistence of the Federal, University, and Tribal personnel at the South Central Climate Science Center has resulted in an organization with substantial impact throughout the region. There are many opportunities for growth and strengthening the CSC in the future, including broadening and deepening relationships with stakeholders. We look forward to the challenge!

Personnel

South Central CSC Office Roles and Responsibilities:

There is a diverse set of individuals (Federal and non-Federal) working at the main office in Norman, Oklahoma, to ensure that the entire South Central Climate Science Center functions effectively and efficiently. The principles outlined below guide the relationship between OU and USGS.

OU's internal administrative duties:

- Office management, including the coordination of office assignments, development of office policies, maintenance of furniture for the Center, and maintenance of office supplies;
- Administration of all non-USGS computers in the office, as well as data storage for large datasets;
- Management and administration of all subcontracts from OU to consortium members (Texas Tech, Louisiana State, Oklahoma State, and Chickasaw Nation); and
- Annual reporting to fulfill the host institution agreement requirements.

USGS's internal administrative duties:

- Distribution of request-for-proposal funds through annual competition;
- Grant management for all USGS-funded projects (e.g., collection of quarterly and annual reports, collection of data management plan, etc.); and
- Convene annual face-to-face Strategic Advisory Committee (SAC) meetings, as well as as-needed meetings. Lead monthly conference calls with SAC members.

Collaborative responsibilities:

- Decide on the organizational structure of the Center, including the organization of staff meetings and consortium conference calls, and assignment of tasks to employees;
- Management of Center employees, including discussion of hiring plans for vacant positions at the host institution;
- Communication efforts to highlight work accomplished by the consortium; and
- Stakeholder engagement, including presentations and attendance at meetings put on by stakeholders.



*Members of the South Central Climate Science Center team in early 2017. (Undergraduates were missing because of classes.)
Courtesy Toni Klemm.*

Main Office Personnel:

The tables on pages 9 and 10 outline the personnel who have served in the Norman main office of the South Central Climate Science Center. Funding sources listed are the USGS National Climate Change and Wildlife Science Center (NCCWSC), USGS Hosting Agreement for the CSC, USGS grants funded through annual funding calls or direct funding, the University of Oklahoma (OU), the Chickasaw Nation, the Bureau of Indian Affairs (BIA), the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), U.S. Department of Transportation (DOT) through the Southern Plains Transportation Center, and the National Science Foundation (NSF) through the Research Experiences for Undergraduates (REU) or Experimental Program for Stimulating Competitive Research (EPSCoR).

We have employed 56 full- or part-time people in the main office since March 1, 2012. Of those, 30 are people of color, 35 are female, and 8 are international, making the South Central CSC the most diverse organization in the National Weather Center confederation (<http://nwc.ou.edu>) from its inception in 2012. Over 15 Native students and four Native scientists (1 B.S., 2 M.S., 1 Ph.D.) have been employed at the CSC main office in its short lifetime.

Main Office Personnel for the South Central Climate Science Center

Name	Title	Start Date	End Date	Funding Source	Role
Aparna Bamzai	Assistant Director	8/2012	1/2017	USGS Hosting Agreement	Program Management
Darrian Bertrand	Graduate Research Asst.	8/2015	9/2017	NOAA	Research
Jessica Blackband	Communications Specialist	9/2016	Present	OU, USGS grant	Communications
Nicolas Carter	Undergrad. Assistant	3/2016	12/2016	Chickasaw Nation, BIA	Graphic Design
Amelia Cook	Undergrad. Assistant	10/2016	1/2017	Chickasaw Nation, BIA	Tribal Youth Outreach
Cameron Conyers	Undergrad. Research Asst.	3/2016	6/2017	Chickasaw Nation, OU	Research
Paulina Cwik	Graduate Research Asst.	5/2017	Present	NASA	Research
Jace Eidson	Undergrad. Research Asst.	9/2016	Present	Chickasaw Nation	Technical Support
Jessica Forthman	Undergrad. Research Asst.	2/2017	8/2017	Chickasaw Nation, BIA	Drought Planning
Hannah Fortner	Undergrad. Assistant	8/2016	Present	Chickasaw Nation	Reporting
Aaron Fournier	Undergrad. Assistant	3/2015	Present	Chickasaw Nation	Office Assistant
Carlos Gaitán	Postdoc/Research Scientist	1/2013	8/2016	OU	Research
Dana Gillson	Undergrad. Research Asst.	5/2016	7/2016	NSF REU	Research
Bianca Hill	Undergrad. Assistant	3/2017	9/2016	Chickasaw Nation, BIA	Tribal Youth Outreach
Ben Ignac	Undergrad. Research Asst.	2/2015	7/2016	OU	Office Asst./Research
Brennah Jones	Undergrad. Assistant	1/2017	Present	Chickasaw Nation, BIA	Tribal Youth Outreach
Kelly Jones	Undergrad. Research Asst.	8/2016	5/2017	OU	Office Asst./Research
Toni Klemm	Graduate Research Asst.	8/2012	Present	NSF EPSCoR, USGS, OU	Research
Kim Klockow	Graduate Research Asst.	8/2006	8/2013	NOAA	Research
Emma Kuster	Program Coordinator	2/2017	Present	USGS Hosting Agreement	Program Management
Mike Langston	Acting USGS Dir./Deputy	2/2014	Present	USGS NCCWSC	Administration
Hunter Luna	Undergrad. Research Asst.	4/2015	8/2017	Chickasaw Nation	Research
Chloe Magee	Graduate Research Asst.	8/2015	7/2017	NSF EPSCoR, NASA	Research
Stephen Marsh	Graduate Research Asst.	6/2017	7/2017	Chickasaw Nation	Research
Elinor Martin*	Assistant Professor	8/2014	Present	OU	Research
Monica Mattox	Manager of Gov. Affairs	4/2017	Present	OU	Government Affairs
Kristina Mazur	Undergrad. Research Asst.	5/2016	7/2016	NSF REU	Research
Renee McPherson	Univ. Director/Assoc. Prof.	3/2012	Present	OU, USGS Hosting Agreement	Administration

**Located in the National Weather Center building. (Continued on following page.)*

Main Office Personnel for the South Central Climate Science Center (continued)

Name	Title	Start Date	End Date	Funding Source	Role
Kim Merryman	Tribal Liaison	2/2016	5/2017	OU, USGS grant	Tribal Engagement
Jo Ann Miller-Dudgeon	Sr. Executive Assistant	6/2012	4/2013	OU	Administration
Berrien Moore*	Dean/Univ. Director	3/2012	2/2017	OU	Administration
Esther Mullens	Postdoctoral Associate	9/2014	Present	OU, DOT, NSF EPSCoR, USGS Hosting Agreement	Research
Tiana Nguyen	Undergrad. Research Asst.	9/2017	Present	OU	Office Assistant
Addison Nichols	Undergrad. Research Asst.	2/2013	6/2015	OU	Office Assistant
Constanine Nyalenda	Undergrad. Assistant	5/2015	5/2016	NASA	Media
Darby Perry	Undergrad. Assistant	2/2015	Present	OU	Office Assistant
Atherton Phleger	Tribal Liaison	8/2017	Present	OU, BIA	Tribal Engagement
Mia Riddle	Undergrad. Assistant	3/2015	1/2016	BIA	Media
Derek Rosendahl	Postdoctoral Associate	6/2012	Present	OU, USGS grant, NASA, USGS Hosting Agreement	Research
Natalie Ruiz Castillo	Undergrad. Research Asst.	5/2015	7/2015	NSF REU, NSF EPSCoR	Research
Terri Sarsycki	Financial Administrator	4/2013	Present	OU	Administration
Mark Shafer*	SCIPP Dir/Asst. Prof.	3/2012	Present	OU, USGS grant	Research
Melanie Schroers	Undergrad. Research Asst.	5/2017	7/2017	NSF REU	Research
Allison Shipp	Interim USGS Director	3/2012	7/2012	USGS NCCWSC	Administration
Jacob Smith	Undergrad. Assistant	9/2013	12/2013	OU	Office Assistant
Mark Stacy	Research Informatics	4/2014	9/2017	NSF EPSCoR	Technical Support
Blair Tarman	Undergrad. Research Asst.	3/2016	6/2016	Chickasaw Nation, BIA	Tribal Youth Outreach
April Taylor	Tribal Liaison	6/2012	Present	USGS Hosting Agreement	Tribal Engagement
Wade Taylor	Undergrad. Research Asst.	6/2017	7/2017	Chickasaw Nation	Research
Melissa Wagner	Graduate Research Asst.	9/2016	Present	OU, NASA	Research
Ryann Wakefield	Undergrad. Research Asst.	5/2015	7/2015	NSF REU	Research
Diana Wang	Graduate Research Asst.	7/2014	8/2015	OU	Research
Grant Williams	Undergrad. Research Asst.	5/2014	7/2014	NSF REU, NSF EPSCoR	Research
Duncan Wilson	Research Scientist	7/2015	7/2017	OU, NSF EPSCoR	Research
Kim Winton	USGS Director	8/2012	4/2017	USGS NCCWSC	Administration
Adrienne Wootten	Postdoctoral Associate	1/2017	Present	USGS grant	Research

**Located in the National Weather Center building.*

Funding

The South Central Climate Science Center is funded through several streams: (1) USGS base funding to the USGS employees and programs at the CSC; (2) USGS funding for the Hosting Agreement to the University of Oklahoma and its consortium members; (3) USGS funding for competitive grants issued through a request-for-proposals by the USGS Director of the South Central CSC; and (4) leveraged funds from the consortium institutions, including external grants, cost share, or other funding mechanisms. All USGS funds are expended in accordance with the Science Plan. Consortium or external funds are acquired and expended in a manner that is compatible with the growth of the CSC in needed areas of research and interdisciplinary exchanges, the building of capacity within partner organizations or stakeholder communities, or the recruitment and development of early-career professionals in climate-related disciplines.

USGS Budget for the South Central Climate Science Center

Funding Type	Year 1 (FY 2012)	Year 2 (FY 2013)	Year 3 (FY 2014)	Year 4 (FY 2015)	Year 5 (FY 2016)	Total
USGS Base Funding	\$249,899	\$187,999	\$376,102	\$305,902	\$321,994	\$1,441,896
USGS Personnel	\$231,935	\$164,277	\$340,455	\$273,829	\$260,944	\$1,271,440
USGS Travel & Operating Expenses	\$17,964	\$23,722	\$35,647	\$32,073	\$61,050	\$170,456
Hosting Agreement	\$753,563	\$685,109	\$757,723	\$775,511	\$796,093	\$3,767,999
Universities & Tribes	\$706,053	\$637,305	\$709,621	\$727,108	\$747,386	\$3,527,473
NOAA GFDL	\$47,510	\$47,804	\$48,102	\$48,403	\$48,707	\$240,526
USGS Competitive Grants	\$665,162	\$1,460,519	\$1,105,796	\$1,176,247	\$1,164,299	\$5,572,023
Total	\$1,668,624	\$2,333,627	\$2,239,621	\$2,257,660	\$2,282,386	\$10,781,918

Grants Competition:

A description of the USGS grants competition is important here, as it is a primary mechanism for the USGS to direct research in ways that are responsive to the needs of stakeholders. Annually, the grants competition begins with our Stakeholder Advisory Committee setting funding priorities. *The SAC meets annually during late fall to consider the general science priorities delineated in the South Central CSC Strategic Science Plan and, from those, derive a list of funding priorities for the subsequent funding cycle.* These priorities are included in the public issuance of a Request for Proposals (RFP) and provide general guidance to potential proposal writers. The priorities list allows submitters to understand the topics that the SAC considers of greatest value each year. The list is not meant to be exhaustive, however, and good proposals on any climate topic are accepted.

The Request for Proposals typically is developed in conjunction with the NCCWSC and other CSCs. In addition to an introductory section that itemizes the requirements for submissions, a section is devoted to the priorities (developed by our stakeholders) and criteria used by the South Central CSC. These broad RFPs are distributed widely through various communication channels of NCCWSC, the CSCs, partner organizations, and their respective networks to encourage submissions from the largest possible pool of researchers.

Several weeks after the RFP is distributed, proposers submit one-to-two-page Statements of Interest (SOI). A select group of South Central CSC stakeholders (approximately 10) review and numerically rate the SOIs. Based on these rating scores, 10 to 20 principal investigators are invited to submit full proposals. These full proposals are reviewed by a similar set of stakeholders using roughly the same process as for the SOIs. Reviewers provide two types of ratings: (1) based on the quality of the proposal and the researchers' qualifications, and (2) based on the value of the research to their organization or constituency. The USGS

Director of the South Central CSC then selects the proposals for funding based on the scores assigned by the reviewers, alignment with the funding priorities developed by our stakeholders, available funds, and knowledge of the principal investigator's past performance on grants.

Directed Funding and Drought Grants

On occasion, it has been necessary to fund some projects directly without engaging in a broad competition. In most of these cases, a specific research or outreach need has been brought to our attention by a stakeholder and, in the judgment of the USGS Director, it merited an award to address it. These are referred to as "directed grants." *These grants are always reviewed by a group of subject matter experts to ensure quality work.*

In one instance, during the spring of 2015, additional funding for drought research was awarded by Congress to the CSC network. To award this money in a responsible manner that met the needs of our stakeholders in a short time, the South Central CSC held a "targeted grants competition." This consisted of a request-for-proposals that focused on the Rio Grande (Bravo) basin. More specifically, the requests targeted drought impacts on the social, ecological, and hydrological systems of the basin. This RFP was distributed to a limited number of highly qualified researchers in order to limit the number of responses for the sake of time. *The resulting SOIs and full proposals were subjected to the same review process as with the annual grants competition.*

Aligning Research with Stakeholder Needs

In all cases, regardless of the method used, *every effort is made to ensure that research projects are of high quality and that the resulting products answer questions that meet our stakeholders' research needs.* Not only do we have our stakeholders (via the SAC) set the annual funding priorities, we also provide guidance in our RFP that strongly encourages researchers to partner with local stakeholders in the development and execution of their research projects (i.e., co-production of science). In fact, this criterion is used by reviewers to rate the proposals. Furthermore, researchers are regularly asked to present the results of their projects to our partners on our bi-monthly Partner's call (that includes all SAC members). This communication serves as a form of accountability to let the stakeholders judge for themselves whether the research meets their needs.

In addition to the valuable input from our SAC, the South Central CSC also solicits input from many stakeholders and partners across the region. *Many of the staff, including and especially our Tribal liaisons, spend numerous hours each month traveling to meetings across the region to meet with and listen to the needs of stakeholders.* Other staff routinely participate in LCC workshops and Steering Committee meetings to listen to the needs of their cooperators.

The South Central CSC has found that it is difficult for some researchers to communicate the results of their work with those who might apply their results. Because this interaction is fundamental to successful actionable science, we have begun to develop means to enhance this communication. *We embedded our Communications Specialist into an ongoing project to help facilitate the communication between the researchers and stakeholders.* As a result of this pilot project and the knowledge gained, the South Central CSC now has begun a process to work with researchers early in their project and assist them with developing plans for effectively communicating with their partners and stakeholders. While it is too early to judge the results of this effort, our initial discussions with researchers demonstrate that they welcome the help and are quite receptive.

USGS RFP-Funded Projects

We have highlighted several projects that were funded through the USGS grants submitted through the requests for proposals (RFP). For more information on all of the projects associated with the South Central CSC, please visit our website (<http://southcentralclimate.org>).

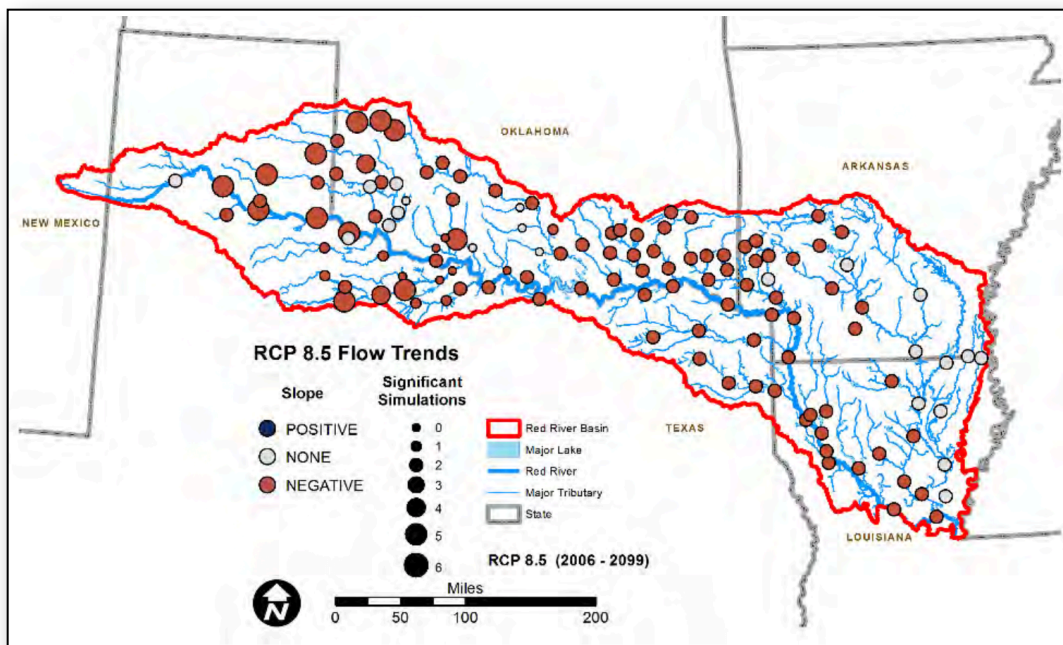
Impacts of Climate Change on Water Flows in the Red River Basin

PI: Wayne Kellogg (Chickasaw Nation)

The Red River Basin has experienced severe drought and exceptional flooding in the recent past, both of which caused impacts to industry, agriculture, tourism, and the environment. To address the interests of scientists and natural resource managers in the area, **researchers at the University of Oklahoma and the Choctaw and Chickasaw Nations developed projections of future hydrology for the Red River Basin.** Using different possible future scenarios, the researchers determined the impact of climate change on the flows of the Red River Basin and its tributaries.

The main tasks in the project included: 1) developing downscaled climate change scenarios; 2) developing a rainfall-runoff model; and 3) expanding and refining an existing water management tool. Three global climate models (GCMs) were identified and applied on a scale suitable for hydrologic models. Running the three GCMs with three representative concentration pathways (RCPs) and downscaling each of those with three different statistical techniques, the **researchers generated 27 different climate simulations through the year 2099.** Each simulation was fed into a rainfall-runoff model that was developed specifically for this project. The output of the hydrologic model were used as input into RiverWare's water availability model to determine the **impact of climate change on regulated flows, lake levels, and water availability.**

From the simulations and the results of the RiverWare model, the researchers noted a projected increase in temperature for the area, higher mean annual rainfall in the eastern portions of the basin with less rainfall in the western portions of the basin, lower median flow in the western portions of the basin, and longer periods with lower reservoir levels across the basin.



Trends in regulated flow of the downscaled ensemble mean for RCP8.5. Period of record used for the statistical analysis is 2006–2099. Figure courtesy of the Chickasaw Nation.

Improving Predictions of Water Supply in the Rio Grande under a Changing Climate

PI: Dave Gutzler (University of New Mexico)

The Rio Grande provides water resources for more than 13 million people between Colorado and the Gulf of Mexico. ***The northern section of the Rio Grande is highly dependent on the amount of snowpack in the Rocky Mountains.*** Water supply outlooks developed by the U.S. Natural Resources Conservation Service are generated through combining snowpack-snowmelt models with models depicting the natural variation in precipitation. Stakeholders use these outlooks currently to make critical water-allocation decisions in the basin.

To ensure that these outlooks are as accurate as possible for water management planning, there is a need to better understand the snowpack-snowmelt relationship and how it might be influenced by climatic variations. Researchers combined historical data and climate model projections to develop enhanced prediction models relating winter snowpack to subsequent snowmelt runoff in the upper Rio Grande.

Project results identify changes to streamflow predictability over the past several decades and assess future predictability. This work will inform the development of more reliable water supply outlooks essential for planning purposes in the Rio Grande Basin, such as reservoir management and irrigated agriculture.

Empowering Fire Professionals to Understand and Manage Changing Fire Regimes

PI: Mark Shafer (University of Oklahoma)

Fire is a natural and necessary component of the South Central Plains ecosystem, but fire suppression and more frequent droughts in the region have resulted in a build-up of dry fuel loads. ***Uncontrolled wildfires have cost the region several billion dollars over the past five years.*** Fire suppression has resulted in substantial losses in native plant biodiversity and wildlife habitat. Projected changes in climate indicate that the region will continue to experience hotter and drier conditions. As such, fire risks will continue to increase unless proper management strategies, such as prescribed fire, are implemented. 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.

To develop effective fire management responses, the ongoing research into the changing scope and intensity of fire regimes across the region must be better connected to management practitioners and their expertise.

Researchers on this project analyzed historical climate observations and future projections to identify days that are suitable for prescribed burns as well as days of high wildfire potential. 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. Results of the project were presented at the ***Prescribed Fire Summit in 2016***, which brought together leading researchers, agencies, and land owners. As part of the summit, fire experts discussed the safe and proper application of fire in a changing and variable climate. ***Participants expressed interest in seeing these events occur on a bi-annual basis to keep them informed about fire management in a changing climate.***



Enhancing the Capacity of Coastal Wetlands to Adapt to Sea-Level Rise and Coastal Development

PI: Mike Osland (USGS Wetland and Aquatic Research Center)

In a previous study titled “Establishing a Foundation for Understanding Climate Change Impacts on Coastal Wetland Ecosystems,” also funded by the USGS RFP process, Dr. Osland and his team advanced the understanding of how temperature and precipitation influence coastal wetland ecosystems. The researchers identified critical ecological thresholds and demonstrated that ***transformative ecological changes due to climatic shifts are probable throughout the Gulf of Mexico within this century***. In certain areas, small changes in temperature or rainfall are expected to trigger large ecological changes and affect certain ecosystem services.

Coastal wetlands provide a suite of valuable benefits to people and wildlife, including important habitat, improved water quality, reduced flooding impacts, and protected coastlines. Sea-level rise and coastal development often negatively impact coastal wetlands, and both are expected to greatly alter coastal landscapes across the globe. One strategy to prepare for such changes is to ensure that there is space available for coastal wetlands to adapt through migration. As part of this second study (funded with the four LCCs whose regions include the Gulf Coast), the ***researchers produced customized landscape conservation-design products focused on identifying landward migration routes for coastal wetlands***. Building on work completed by the LCCs, the researchers then identified where future urban development and future tidal saline wetland migration are expected to occur under five different potential sea-level rise scenarios. The resulting products provide environmental managers with decision information to enhance the adaptive capacity of coastal wetlands, protecting these ecosystems and the critical economic and ecological benefits that they provide.

Identifying Best Agricultural Management Practices for Maintaining Soil Health and Sustainability Under Changing Climate Conditions

PI: John Zak (Texas Tech University)

The role of soil temperature in agricultural health is largely understudied, but recent research suggests that it can affect soil health in important ways. Smaller daily temperature ranges of soil in the Southern High Plains are associated with higher levels of soil microbes and decreased nitrogen availability. Such information suggests that ***climate variability may have implications for soil health and microbial content***. A more developed understanding of how management practices, climate variability, and soil health interact is essential for sound agricultural decision making.

This project implemented demonstration fields where various sustainable management practices were tested and their impacts on soil temperature and health were monitored. The demonstration fields focused on cotton production and tested management practices related to water use efficiency, carbon storage, and soil health. Results from this ongoing project will contribute substantially to our collective understanding of the interactions between climate variability, soil health, and agricultural productivity in the Southern High Plains. Additionally, ***information gained from this project will equip stakeholders with the knowledge they need to make appropriate management decisions for optimal agro-ecosystem health***.



All USGS RFP-Funded Projects:

The priorities developed by the Stakeholder Advisory Committee were *categorized as follows for the review process* for the USGS Request for Proposals. Each proposal was assigned to the category that best fit its focus.

- 1) **Hydrology:** Studies of the impacts of climate change on the hydrology (not biology) of natural systems
- 2) **Priority Ecosystems:** Studies of the impacts of climate change on high value ecosystems
- 3) **Priority Habitats:** Studies of the impacts of climate change on high value habitats
- 4) **Gulf Coast:** Studies of the impact of climate change and the resulting sea-level rise on coastal geomorphology and processes
- 5) **Priority Species:** Studies of the impacts of climate change on high value species
- 6) **Human Systems:** Studies of the impacts of climate change on human systems, such as, agriculture, economies, governance, transportation, education, planning, recreation, energy, and information
- 7) **Cultural Artifacts & Sites:** Studies of the impacts of climate change on items, building, and places of cultural significance to the peoples of the South Central U.S.
- 8) **Improved Data Management & Sharing:** Development (or evaluation) of techniques for improved climate change data management and compatibility across geographies, computing devices, models, scientific disciplines, and levels of expertise
- 9) **Improved Monitoring Networks:** Basic monitoring of biological and cultural resources to determine impacts of climate change and efficacy of management actions
- 10) **Decision-Support Systems:** Tools that are intended to assist in decision-making by providing relevant information
- 11) **Restoration Techniques:** Techniques for restoring (or moving) ecosystems or populations impacted by climate change
- 12) **Tribal Nations:** Outreach and/or trainings regarding climate change on topics relevant to Tribes
- 13) **Resource Managers:** Outreach and/or trainings regarding climate change on topics relevant to cultural and natural resource management
- 14) **General Public:** Outreach and/or trainings regarding climate change in a manner that is easily understood by the public using appropriate media

FY12 funding:

Evaluating the impacts of climate extremes on karst hydrology and species vulnerability (priority #1)

Barbara Mahler (USGS), PI – 15 months, \$40,000

Terrestrial connectivity across the South-Central U.S.: Implications for sustainability of wildlife populations & communities (priority #3)

Kristen Baum (OSU), PI – 2 years & 6 months, \$250,592 (additional funding: \$91,202)

Building capacity within the CSC Network to effectively deliver and communicate science to resource managers and planners (priority #8)

Dennis Patterson (TTU), PI – 12 months, \$50,000

Comparing and evaluating different models to simulate current and future temperature and precipitation (priority #8)

Katharine Hayhoe (TTU), PI – 2 years, \$33,216

Assessing the potential impact of sea-level rise on submersed aquatic vegetation and waterfowl in the northern Gulf of Mexico (priority #9)

Megan La Peyre (USGS, LA CFWRU), PI – 3 years & 1 months, \$267,209

Mapping fresh, intermediate, brackish and saline marshes in the North Central Gulf of Mexico Coast to inform future projections (priority #9)

Steve Hartley (USGS, WARC), PI – 2 years & 4 months, \$150,000

Analyzing and communicating the ability of data and models to simulate streamflow and answer resource management questions (priority #10)

Shannon Brewer (USGS, OK CFWRU), PI – 3 years, \$50,000

Inter-Tribal workshops on climate change in the Central U.S. (priority #12)

Laurel Smith (OU), PI – 2 years, \$55,407

FY13 funding:

Impacts of climate change on flows in the Red River Basin (priority #1)

Wayne Kellogg (Chickasaw Nation), PI – 2 years, \$366,099

Assessing the drivers of water availability for historic and future conditions in the South Central U.S. (priority #1)

Lauren Hay (USGS, NRP), PI – 12 months, \$223,400

Understanding the nexus between climate, streamflow, water quality, and ecology in the Arkansas-Red River Basin (priority #2)

William Andres, Christopher Harich (USGS, OK WSC), PIs – 3 years, \$49,800

Predicting Sky Island forest vulnerability to climate change: fine scale climate variability, drought tolerance, and fire response (priority #2)

Dylan Schwilk (TTU), PI – 2 years, \$99,937

Modeling the effects of climate and land use change on crucial wildlife habitat (priority #3)

Colleen Caldwell (USGS, NMSU), PI – 3 years & 4 months, \$237,704

Improving representation of extreme precipitation events in regional climate models (priority #8)

Ming Xue (OU), PI – 12 months, \$23,938

Testing downscaled climate projections: is past performance an indicator of future accuracy? (priority #8)

John Lanzante (GFDL), PI – 12 months, \$67,650

Establishing a foundation for understanding climate change impacts on coastal wetland ecosystems (priority #9)

Michael Osland (USGS, WARC), PI – 2 years, \$148,704

Regional graduate student, post-doc, and early career researcher workshop (priority #14)

Renee McPherson (OU), PI – 12 months, \$50,959

FY14 funding:

Understanding future fire frequency and impacts on species distribution in the South Central U.S. (priority #5)

Ester Stroh (OU), PI – 12 months, \$162,529

Community resilience to drought hazard: an analysis of drought exposure, impacts, and adaptation in the south-central United States (priority #6)

Nina Lam (LSU), PI – 2 years, \$254,485

Developing effective tools for communicating drought information (priority #8)

Mark Shafer (OU), PI – 2 years, \$184,945

Examining soil and drought dynamics to improve fire forecasting in the southern Great Plains (priority #10)

John Zak (TTU), PI – 2 years, \$154,078

Ecosystem modeling in the South Central US: a synthesis of current models toward the developments of coupled models (priority #10)

Yiqi Lou (USGS, CERC), PI – 12 months, \$60,277

Identifying Tribal vulnerabilities and supporting planning for extreme weather events (priority #12)

Dawn Jourdan (OU), PI – 12 months, \$21,456

FY15 funding:

Changing fire regimes and management strategies (priority #2)

Mark Shafer (OU), PI – 12 months, \$112,558

Developing and analyzing statistically downscaled climate projections for the South Central U.S. (priority #8)

Carlos Gaitan (OU) & Keith Dixon (NOAA–GFDL), PIs – 12 months, \$85,000

Soil moisture-based drought monitoring for the South Central Region (priority #9)

Tyson Ochsner (OSU), PI – 3 years, \$45,857

Quantifying future precipitation in the South Central U.S. for water resources planning (priority #10)

Jung-Hee Ryu (TTU) & Barry Keim (LSU), PIs – 2 years, \$140,429

Informing hydrologic planning in the Red River Valley through improved regional climate projections (priority #10)

Ming Xue (OU), PI – 2 years, \$127,099

Climate training for Native Tribes of Louisiana and New Mexico (priority #12)

Kristine DeLong (LSU), PI – 2 years, \$86,180

Online climate change impacts course to inform managers about planning for the future (priority #14)

Aparna Bamzai (OU), PI – 2 years & 5 months, \$144,132

Regional graduate student and early career researcher training II (priority #14)

Derek Rosendahl (OU), PI – 12 months, \$58,997

FY15 funding (targeted request for supplementary drought funding):

Informing the management and coordination of water resources in the Rio Grande Basin (priority #6)

Jack Friedman, Jennifer Koch, Jadwiga Ziolkowska (OU), PIs – 12 months, \$303,476 (additional funding: \$558,762)

Assessing the state of water resource knowledge and tools for future planning in the Rio Grande-Rio Bravo Basin (priority #6)

Phaedra Budy (USU), PI – 18 months, \$131,725

Assessing the state of water resource knowledge and tools for future planning in the Rio Grande-Rio Bravo Basin (priority #6)

Samuel Solis (UC Davis), PI – 15 months, \$72,622

Improving predictions of water supply in the Rio Grande under changing climate conditions (priority #10)

David Gutzler (UNM), PI – 12 months, \$92,915 (additional funding: \$170,198)

FY16 funding:

Enhancing the capacity of coastal wetlands to adapt to sea-level rise and coastal development (priority #4)

Mike Osland (USGS, WARC), PI – 14 months, \$35,000

Characterizing uncertainties in climate projections to support regional decision-making (priority #8)

Renee McPherson (OU), PI – 18 months, \$94,380

Identifying best agricultural management practices for maintaining soil health and sustainability under changing climate conditions (priority #10)

John Zak (TTU), PI – 12 months, \$12,000

Developing tools for improved water supply forecasting in the Rio Grande headwaters (priority #10)

David Clow (USGS, CO WSC), PI – 14 months, \$50,000

Building a decision-support tool for assessing the impacts of climate and land use change on ecological processes (priority #10)

Terry Sohl (USGS, EROS), PI – 14 months, \$60,000

Tribal capacity building (priority #12)

Renee McPherson (OU) – 12 months, \$86,704

Translational science support (priority #14)

Renee McPherson (OU), PI – 12 months, \$74,521

Proposals Selected for FY17 funding:

The effects of wildfire on snow water resources under multiple climate conditions (priority #1)

C. David Moeser (USGS, NM WSC), PI – 2 years, \$299,999

Evaluation of sustainable water availability in drought prone watersheds in southeastern Oklahoma (priority #1)

Wayne Kellogg (Chickasaw Nation), PI – 2 years, \$251,926

Balancing water usage and ecosystem outcomes under drought and climate change: enhancing an optimization model for the Red River (priority #1)

Thomas Neeson (OU), PI – 2 years, \$212,732

Wildfire probability mapping based on regional soil moisture models (priority #10)

Tyson Ochsner (OSU), PI – 2 years, \$298,086

Cultivating a climate science learning community amongst Tribal water managers (priority #12)

Molly Yunker (OU), PI – 2 years, \$113,907

Regional graduate student, post-doc, and early career researcher training III (priority #14)

Derek Rosendahl (OU), PI – 12 months, \$61,783

Summary of the USGS Request for Proposal-funded Grants

RFP	Submission Period	SOI Due	Proposal Invites Sent	Proposals Due	Notice of Award	Reviewers	Total SOIs	Invited Proposals	Accepted	Funded
2012							57	20	7	8
2013	Jan 9, 2013 - Mar 25, 2013	Feb 1, 2013	Feb 25, 2013	Mar 25, 2013		FWS, USBR, USGS	76	20	8	9
2014	Jul 23, 2013 - Aug 24, 2013	Jun 25, 2013	Jul 23, 2013	Aug 21, 2013	Oct 15, 2013	FWS, USBR, USGS	48	12	4	5
Directed Funding 2014	Jun 21, 2014 - Sep 30, 2014						3	1	1	1
2015	Apr 28, 2014 Jun 20, 2014	Jun 20, 2014	Aug 1, 2014	Oct 1, 2014	Dec 15, 2014		44	22	8	8
Two Basin Project 2015	May 13, 2015 Jul 31, 2015					FWS, USBR, USGS, SR LCC	6	6	2	4
Directed Funding 2015	Jul 1, 2016 - Jan 31, 2017						7	7	7	7
2015	Dec 1, 2016 - Jan 18, 2017	Jan 18, 2017	Feb 3, 2017	Mar 30, 2017	May 15, 2017	FWS, BOR, Fort Collins USGS Science Center LCCs (GP, Desert, GCP), BIA, USGS, TX PWS, USACE, USDA	65	16	6	6

Consortium Base Funding

South Central CSC Base Funding Per Year:

Across the first five grant years, the non-Federal members of the South Central CSC *consortium expended \$3,521,681 of the budgeted \$3,527,473 (85.9%) in our hosting agreement*. The total budget expenditure amounts are itemized by year (Years 1-5) in the tables below for all non-Federal consortium members.

Year 1:	Received	Carryover	Expended	Percent Expended
University of Oklahoma	\$351,592	\$0	\$229,963	65.4%
Texas Tech University	\$96,710	\$0	\$68,083	70.4%
Louisiana State University	\$75,033	\$0	\$24,540	32.7%
Chickasaw Nation	\$108,061	\$0	\$58,598	54.2%
Oklahoma State University	\$74,657	\$0	\$31,102	41.7%
Total	\$706,053	\$0	\$412,286	58.4%

Year 2:	Received	Carryover	Expended	Percent Expended
University of Oklahoma	\$276,153	\$121,629	\$352,460	88.6%
Texas Tech University	\$98,525	\$28,627	\$127,152	100.0%
Louisiana State University	\$78,265	\$50,493	\$81,071	63.0%
Chickasaw Nation	\$109,550	\$49,463	\$95,476	60.0%
Oklahoma State University	\$74,812	\$43,555	\$44,112	37.3%
Total	\$637,305	\$293,767	\$700,271	75.2%

**Includes carryover from Year 1. Carryover resulted from the time it took to staff up the Center.*

Year 3:	Received	Carryover	Expended	Percent Expended
University of Oklahoma	\$247,699	\$45,322	\$302,077	103.1%
Texas Tech University	\$150,910	\$0	\$143,530	95.1%
Louisiana State University	\$108,780	\$47,687	\$156,467	100.0%
Chickasaw Nation	\$111,069	\$63,538	\$172,911	99.0%
Oklahoma State University	\$91,163	\$74,255	\$163,048	98.6%
Total	\$709,621	\$230,802	\$938,033	99.7%

**Includes carryover from Year 2. Carryover resulted from position turnover and hiring process.*

Year 4:	Received	Carryover	Expended	Percent Expended
University of Oklahoma	\$252,244	-\$9,056	\$243,158	100.0%
Texas Tech University	\$154,905	\$7,380	\$132,728	81.8%
Louisiana State University	\$113,701	\$0	\$113,701	100.0%
Chickasaw Nation	\$112,618	\$1,696	\$112,617	98.5%
Oklahoma State University	\$93,640	\$2,370	\$82,083	85.5%
Total	\$727,108	\$2,390	\$684,287	93.8%

**Includes carryover from Year 3. Carryover resulted from position turnover and hiring process.*

Year 5:	Received	Carryover	Expended	Percent Expended
University of Oklahoma	\$256,883	\$30	\$255,431	99.4%
Texas Tech University	\$161,241	\$29,557	\$190,798	100.0%
Louisiana State University	\$118,868	\$0	\$118,665	99.8%
Chickasaw Nation	\$114,200	\$1,697	\$114,194	98.5%
Oklahoma State University	\$96,194	\$13,927	\$107,716	97.8%
Total	\$747,386	\$45,211	\$786,804	99.3%

**Includes carryover from Year 4. Carryover resulted from position turnover and hiring process.*

Consortium Leveraged Funding

South Central CSC Funding from Non-USGS Grants:

The total funding listed above from USGS was *leveraged to obtain \$218,045,935 in additional funding* for CSC-related research and outreach that align with the goals of USGS. Below is the total dollar amount received by the consortium from non-USGS grants.

Year 1:	Received	Funding Agencies
University of Oklahoma	\$413,903	U.S. Army Corps; NCAR; NOAA
Texas Tech University	\$267,327	DOE; NSF; USDA
Choctaw Nation of Oklahoma	\$50,000	BIA
Oklahoma State University	\$12,428,898	USDA; ODWC
Total	\$13,160,128	

Year 2:	Received	Funding Agencies
University of Oklahoma	\$2,104,405	BIA, NOAA
Oklahoma State University & University of Oklahoma	\$24,000,000	NSF EPSCoR, Oklahoma State Regents
Texas Tech University	\$34,000	USDA; Cotton Inc.
Louisiana State University	\$10,000	LA EPSCoR
Oklahoma State University	\$2,325,446	USDA; ODWC
Total	\$28,473,851	

Year 3:	Received	Funding Agencies
University of Oklahoma	\$199,944	Oklahoma EPSCoR; NP-OUORA; FWS
Texas Tech University	\$4,654,013	USDA; NSF; NOAA; Cotton Inc.
Louisiana State University	\$200,000	Coypiu Foundation; Global Green; NSF
Choctaw Nation of Oklahoma	\$146,992	BIA
Oklahoma State University	\$913,014	OWRRI; NSF; ODWC
Total	\$6,113,963	

Year 4:	Received	Funding Agencies
Texas Tech University	\$171,257	NSF; Cotton Inc.
Louisiana State University	\$101,227	Louisiana Board of Regents
Chickasaw Nation	\$265,607	BIA, BoR WaterSmart
Total	\$538,091	

Year 5:	Received	Funding Agencies
University of Oklahoma	\$167,935,175	NSF, NASA
Texas Tech University	\$44,644	NOAA; Cotton Inc.
Louisiana State University	\$1,500,000	NASA EPSCoR; Louisiana Board of Regents
Oklahoma State University	\$280,083	ODWC; USDA; Pheasants Forever, Inc.
Total	\$169,759,902	

Consortium Research Projects

Here, we highlight several projects that were funded either through the USGS Hosting Agreement or through leveraged funds from non-USGS grants. For more information on all of the projects associated with the South Central CSC, please visit our website (<http://southcentralclimate.org>).

Adapting Socio-Ecological Systems to Increased Climate Variability

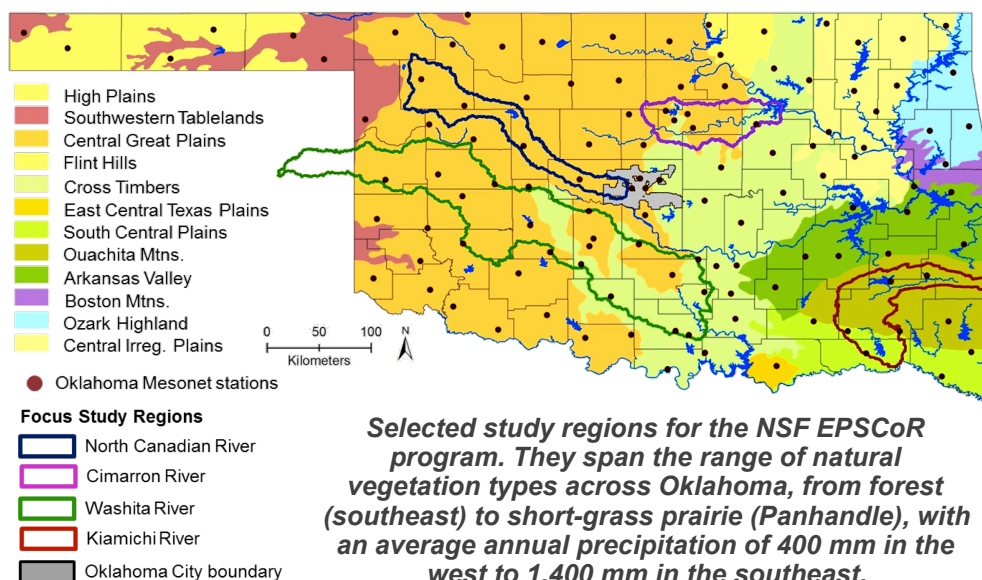
Science Leads: Renee McPherson (OU) and Duncan Wilson (OSU), funded by the National Science Foundation

South Central CSC personnel drove this multi-institutional, collaborative project. Researchers at OU, Oklahoma State University, the University of Tulsa, and the Samuel Roberts Noble Foundation proposed an unique, coupled human-natural systems research project for the National Science Foundation's (NSF) Experimental Program to Stimulate Competitive Research program. They were awarded the five-year, \$20 million project in June 2013. The goal has been to study **how human and environmental systems interact in a highly variable climate**, providing knowledge that will empower resource managers to effectively adapt to a changing climate.

As part of the project, the researchers sought to accomplish three main goals: (1) establish a unique, statewide, socio-ecological observatory network designed to provide a new understanding of the coupled human and natural systems; (3) develop a fully integrated modeling and prediction system based on the data collected from the established observatory that will be used to project future scenarios for decision-makers; and (3) create decision-support products and services that would provide researchers, educators, and practitioners with the information needed to explore and understand the social and ecological impacts from climate change. In particular, five study areas were identified to examine differences across ecological systems: the North Canadian, Cimarron, Washita, and Kiamichi river watersheds and the Oklahoma City metropolitan area.

Researchers developed a panel survey (address-based, random sample of Oklahoma households) that integrates household-level social science data with climate data to better understand environmental perceptions, behaviors, and decision making under different weather conditions. Other teams developed GIS-based tools for integrated, scenario-based planning that managers could use to examine alternate futures in water and other natural resource planning. Still other researchers brought to light the inequities in Tribal farmer and small farmer disbursements of Federal funding in response to climate-related disasters, leading to discussions to provide data-driven support for these growers in times of need.

For the South Central CSC in particular, **this project provided cyberinfrastructure to support GCM, downscaling, and other climate datasets; created a framework for developing scenario planning tools for the Rio Grande basin; co-funded Tribal college climate conferences and Tribal grants workshops; and provided better understanding of socio-ecological systems within our region.**



Effects of Climate Change on the Lesser Prairie-Chicken Geographic Distribution

Graduate student at Oklahoma State University funded through the CSC Hosting Agreement

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 these distinct populations have likely adapted to different climatic conditions. Jacob Peterson (CSC-funded graduate student) at Oklahoma State University is running species distribution models for the whole species and for the two separate populations. The 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 already have shown interest in using the results of this research to help improve long-term conservation outcomes of this species.

Dendrochronology Reveals Response of Coastal Pine Trees to Climate Parameters

Graduate student at Louisiana State University funded through the CSC Hosting Agreement

Tree rings can provide a window into past climates. 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 Louisiana State University 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 dendrochronologists 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*.

Competitive Interactions of Two Pelagic Broadcast Spawning Cyprinids of the Great Plains

Graduate student at Oklahoma State University funded through the CSC Hosting Agreement

Daniel Logue, a South Central CSC-funded masters student at Oklahoma State University, is studying if the non-native Red River Shiner *Notropis bairdi* has the potential to spread throughout the Arkansas River drainage basin. Its presence could adversely impact the Arkansas River Shiner (*Notropis girardi*), a Federally threatened native fish. Daniel seined 10 Cimarron River and 10 South Canadian River reaches and collected microhabitat information. Using occupancy models, he is ***examining the associations between species presence/absence and environmental characteristics typical of prairie streams including fluctuation of temperature, salinity, and discharge***. Daniel works with Dr. Shannon Brewer, a research fisheries biologist and assistant unit leader of the Oklahoma Cooperative Fish and Wildlife Research Unit and an Associate Professor in the Department of Natural Resources Ecology and Management at Oklahoma State University.

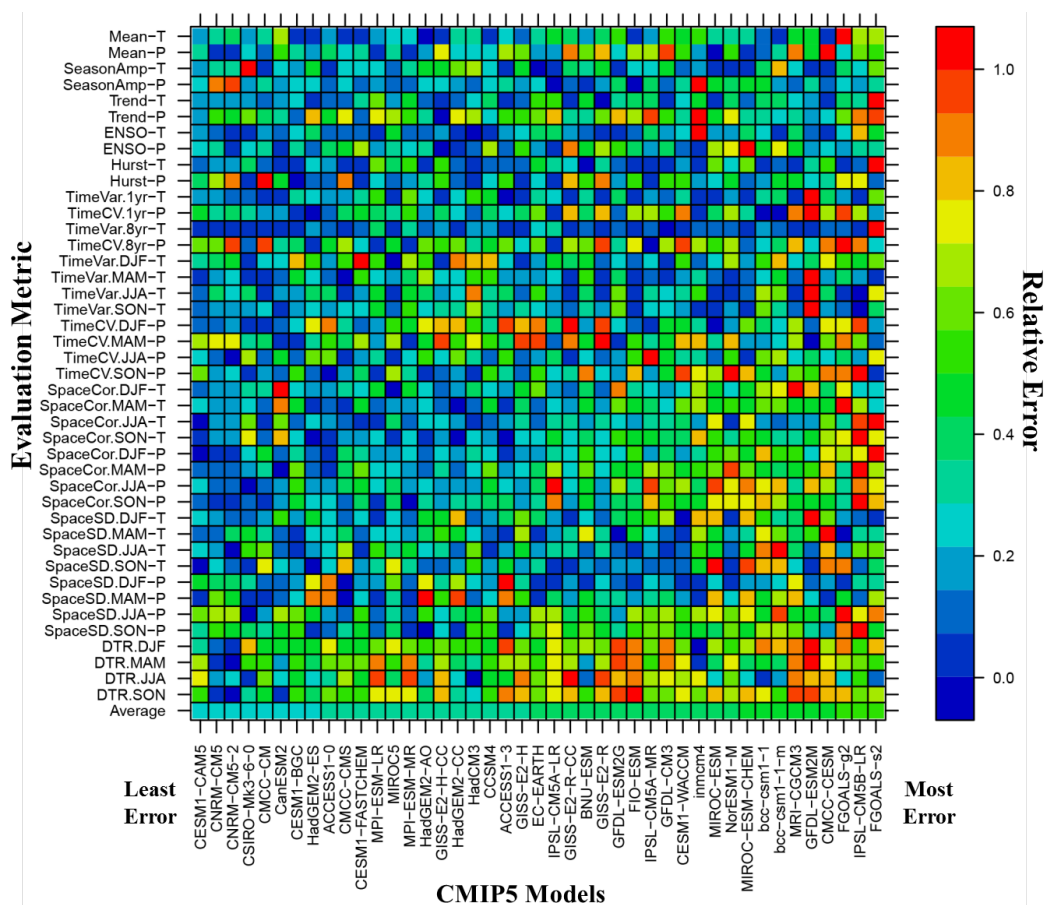
Evaluating the Historical Performance of Global Climate Models Over the South-Central United States

Science Lead: Derek Rosendahl, funded by the University of Oklahoma (VPR's University Strategic Organization)

Today's environmental decision makers are requesting local and regional projections of climate change and its impacts for their planning purposes. Climate research and services communities have responded by providing downscaled projections that are forced by global climate models (GCM). However, **many times the choice of GCMs and resulting downscaled datasets is not made with an understanding of the strengths and weaknesses of the output for the user's region or need.** Thus, to analyze the suitability of models within the area served by the South Central Climate Science Center, Drs. Derek Rosendahl and Renee McPherson (OU), in collaboration with Dr. David Rupp (Oregon Climate Change Research Institute), compared monthly temperature- and precipitation-based metrics from 43 GCMs (from the Coupled Model Intercomparison Project Phase 5; CMIP5) to 20th Century historical observations over the south-central United States and the surrounding region. **The metrics included measures of the climatological mean and variability, seasonal cycles, diurnal temperature range, correlation and variance of mean seasonal spatial patterns, long-term persistence, and regional teleconnections to El Niño-Southern Oscillation.** They documented the performance of all models for each individual metric and ranked them according to their overall performance.

Results indicated that no one model performed "best" in all metrics. **Model performance varied from one metric to another**, and even those models that ranked highest overall still had individual metrics with greater relative bias than lower-ranked models. Additionally, **model performance over the south-central United States was found to differ from that found for other regions of the country.**

Therefore, the researchers advise that users choose a subset of GCMs with caution and based on those performance metrics that are most relevant to their region and application.



Evaluation of global climate models across the south-central U.S. for various metrics. The colors represent the total relative error (better = blue, worse = red). Courtesy Derek Rosendahl.

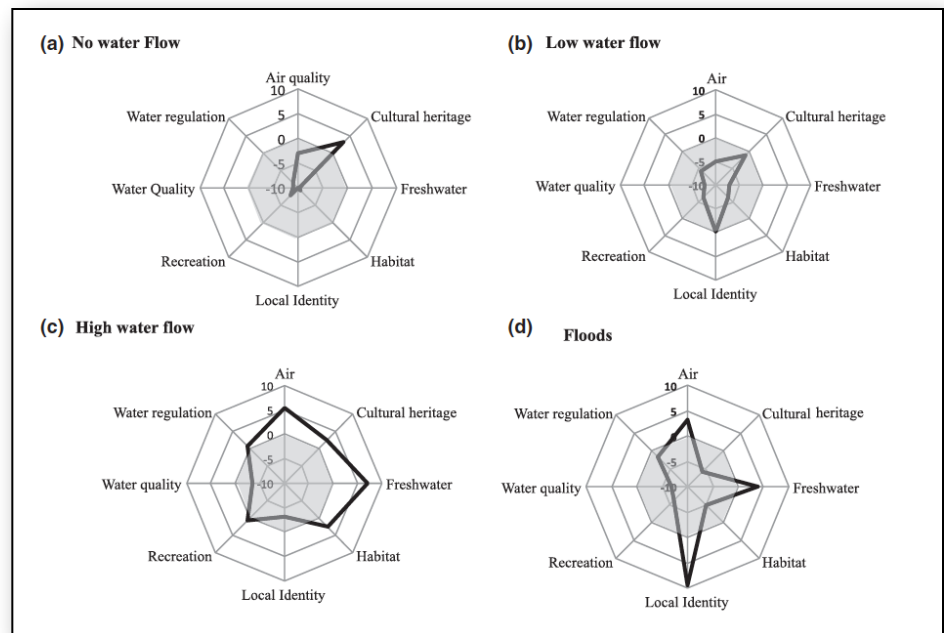
On the figure shown, the models are ordered from least (left) to most (right) total relative error, summarizing their performance in the south-central United States.

Socio-ecological Assessment of Ecosystem Services

PI: Caryn Vaughn, funded by the University of Oklahoma (VPR's University Strategic Organization)

Freshwater is vital for humans and wildlife (aquatic and terrestrial). Unfortunately, humans are using freshwater more rapidly than it can be replenished in many areas across our region. The Kiamichi River watershed in southeastern Oklahoma has recently been at the center of intense conflict over water ownership and use.

Missing from these disputes were the needs of the watershed's rich animal and plant life, including three Federally endangered freshwater mussels. Dr. Caryn Vaughn (OU) and colleagues used an ecosystem services framework to examine how different water management/environmental flow scenarios in the watershed affect the delivery of ecosystem services, and thus contribute to the wellbeing of people living both in and outside of the watershed. In doing so, they gave a voice to the watershed's rich animal and plant life that provide many of the valued ecosystem services in the region (e.g., water regulation, species habitat). **Their research showed that indeed it is possible (and useful for decision-making) to capture society's value of local ecosystem services.**



Perceived tradeoffs in ecosystem services for four different flow scenarios. Figure courtesy of the Journal of the American Water Resources Association (DOI: 10.1111/1752-1688.12379).

In the figure shown, the perceived tradeoffs are outlined based on four different flow scenarios (no flow, low flow, high flow, and flood). The gray shaded area corresponds to a perceived negative impact, while the white areas corresponds to a perceived positive impact. The solid black line represents the population's perceived impact on the ecosystem services.

Derived Downscaled Climate Projection Portal

PIs: Katharine Hayhoe and Anne Stoner, funded through the CSC Hosting Agreement

Drs. Katharine Hayhoe and Anne Stoner of Texas Tech University created a **web portal that allows visualization and downloading of future climate projections from a group of statistically downscaled global climate models** in collaboration with USGS' Center for Integrated Data Analytics. The team used temperature and precipitation projections from these GCMs to calculate derivative climate indicators that measure the number of days that exceed certain thresholds. All derivative climate indicators in the portal were derived from a suite of atmospheric-oceanic GCM simulations from the Coupled Model Intercomparison Project Phase 3 (CMIP3) archive using four scenarios from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. **The user can control what is shown on the map** and the plot window using an interactive toolbar. The portal for Eighth degree-CONUS Statistical Asynchronous Regional Regression Daily Downscaled Climate Projections can be accessed at <https://cida.usgs.gov/gdp/>.

All Consortium-Funded Research Projects:

The following list shows the research projects that were *funded through non-Federal consortium members* as part of the broader work conducted by the South Central Climate Science Center. *These leveraged funds added research capacity through graduate students, post-doctoral associates, cyberinfrastructure, networks of stakeholders, and other benefits.* Acronyms are as follows: OU = University of Oklahoma, TTU = Texas Tech University, LSU = Louisiana State University, OSU = Oklahoma State University, and PI = principal investigator.

Year 1 (March 1, 2012 – February 28, 2013)

Climate change impacts at Department of Defense installations

Katharine Hayhoe (TTU), PI – 3 years, \$187,227, U.S. Department of Energy & Argonne National Laboratory

Evaluation of Northern Bobwhite in western Oklahoma

David Leslie, Craig Davis, Dwayne Elmore, Sam Fuhlendorf (OSU), PIs – 6 years, \$2,433,568, Oklahoma Department of Wildlife Conservation

Tornado warning response

Renee McPherson (OU), PI – 3 years, \$75,110, National Oceanic and Atmospheric Administration

Soil microbial communities: key indicators of soil carbon transformation when Conservation Reserve Program land is converted to cropland

John Zak (TTU), PI – 4 years, \$48,000, U.S. Department of Agriculture

Impacts of fragmentation and heterogeneity resource selection, survival, and recruitments of Lesser-Prairie Chickens in Oklahoma

Dwayne Elmore, Sam Fuhlendorf, Craig Davis (OSU), PIs – 4 years, \$428,000, Oklahoma Department of Wildlife Conservation

Water decisions for sustainability in the Arbuckle-Simpson aquifer

Renee McPherson (OU), PI – 2 years, \$295,429, National Center for Atmospheric Research & National Oceanic and Atmospheric Administration

RCN-SEES: engineering research collaboratory for sustainable infrastructure in a changing climate

Katharine Hayhoe (TTU), PI – 5 years, \$32,100, National Science Foundation through University of New Hampshire

Resilience and vulnerability of beef cattle production in the Southern Great Plains under changing climate, land use, and markets

Dave Engle (OSU), PI – 5 years, \$9,567,330, U.S. Department of Agriculture – Agriculture and Food Research Initiative & National Institute of Food and Agriculture

Choctaw Drought Contingency Plan

Choctaw Nation of Oklahoma, PI - 12 months, \$50,000, Department of Interior – Bureau of Indian Affairs

Utilization of regional climate science programs in reservoir and watershed impact assessments

Renee McPherson (OU), PI - 12 months, \$43,364, U.S. Army Corps of Engineers

Year 2 (March 1, 2013 – February 28, 2014)

Derived downscaled climate projection portal

Anne Stoner (TTU – Postdoc) – CSC Hosting Agreement

Investigating drivers of land cover change in the Oklahoma Cross Timbers

Emma Kuster (OU – Graduate Student) – CSC Hosting Agreement

NSF EPSCoR RII: Enhancing the resilience of socio-economic systems to climate variability in Oklahoma

Renee McPherson (OU) and Duncan Wilson (OSU), Science Leads; Jim Wicksted, PI – 5 years, \$20,000,000, National Science Foundation - Experimental Program to Stimulate Competitive Research

NSF EPSCoR RII: Enhancing the resilience of socio-economic systems to climate variability in Oklahoma

Renee McPherson (OU) and Duncan Wilson (OSU), Science Leads; Jim Wicksted, PI – 5 years, \$4,000,000, Oklahoma State Regents for Higher Education

Southern Climate Impacts Planning Program (SCIPP) phase II

Mark Shafer, Renee McPherson (OU), PIs – \$2,104,405, National Oceanic and Atmospheric Administration

Quantifying the characteristics of upper-air dynamics associated with ice storms

Katharine Hayhoe (TTU), PI – 1 month, \$10,000, U.S. Department of Agriculture - Forest Service

Understanding the impacts of surface groundwater conditions on stream fishes under altered base flow conditions

Shannon Brewer (OSU), PI – 2 years, \$381,560, Oklahoma Department of Wildlife Conservation

Development of coral microatolls for environmental reconstructions

Kristine DeLong (LSU), PI – 16 months, \$10,000, Pilot Funding for New Research & Louisiana Experimental Program to Stimulate Competitive Research

Reevaluation of the status and distributions of Black Bears in southeastern Oklahoma

Sue Fairbanks, Chip Leslie (OSU), PIs – 4 years, \$1,177,867, Oklahoma Department of Wildlife Conservation

Altering DTR soil through changes in bed design: practical approaches for enhancing the potential benefits of reduced DTR soil to drylands cotton production

John Zak (TTU), PI – 1 year, \$24,000, Cotton Incorporated

Plant and soil responses to prescribed burning of WRP wetlands

Craig Davis, Sam Fuhlendorf, John Weir (OSU), PIs – 4 years, \$217,190, U.S. Department of Agriculture - Natural Resources Conservation Service

Increasing water yield and quality through an integrated woody and herbaceous biofuel feedstock producing system

Rod Will, Chris Zou, Dave Engle, Ray Huhnke (OSU), PIs – 5 years, \$548,829, U.S. Department of Agriculture – National Institute of Food and Agriculture

Year 3 (March 1, 2014 – February 28, 2015)

Competitive interactions of two pelagic broadcast spawning Cyprinids of the Great Plains

Daniel Logue (OSU – Graduate Student) – CSC Hosting Agreement

Reconstructing regional climate from American forts' documents

Jordan Pino (LSU – Graduate Student), Jacob Warner (LSU - Graduate Students) – CSC Hosting Agreement

Evaluating the historical performance of Global Climate Models over the South-Central United States

Derek Rosendahl (OU – Postdoc) – CSC Hosting Agreement

Trends in cold temperature extremes and winter-weather for the SPTC region

Renee McPherson, Esther Mullens, Mark Shafer, Derek Rosendahl, Michael Richman (OU), PIs – 3 years, \$132,240, Department of Transportation – Southern Plains Transportation Center

Assessing the spacing movement and habitat needs of Riverine Neosho Smallmouth Bass

Shannon Brewer (OSU), PI – 4 years, \$367,915, Oklahoma Department of Wildlife Conservation

Cooperative agreement for office space

Renee McPherson (OU), PI – 5 years, \$32,004, Department of Interior – Fish and Wildlife Service

CORE: Evaluations of DTR soil dynamics across cotton growing regions in the United States and implications or managing hail avoidance

John Zak (TTU), PI – 12 months, \$8,794, Cotton Incorporated

CORE: Practical approaches for enhancing the potential benefits of reduced DTR soil to drylands cotton production through alteration of bed design

John Zak (TTU), PI – 12 months, \$23,057, Cotton Incorporated

CORE: Understanding the potential of Sorghum residues for improving soil moisture, soil heat load and daily temperature variability in a cotton rotation system

John Zak (TTU), PI – 12 months, \$51,560, Cotton Incorporated

Cyber-infrastructure improvement for Oklahoma EPSCoR Track 1

Renee McPherson (OU), PI – 4 years, \$35,700, Oklahoma Experimental Program to Stimulate Competitive Research

Increasing water yield and quality through Red Cedar removal and establishment of herbaceous biofuel feedstock production systems - effect of vegetation on groundwater recharge in upland

Chris Zou, Rod Will, Garey Fox (OSU), PIs – 12 months, \$25,000, Oklahoma Water Resource Research Institute

Climate projections in support of USDA analyses

Katharine Hayhoe (TTU), PI – 3 years, \$129,485, U.S. Department of Agriculture

Slowing the expansion of woodlands and increasing the resilience of grasslands in the Southern Great Plains

Chris Zou, Sam Fuhlendorf (OSU), PIs – 3 years, \$249,757, National Science Foundation through Texas A&M University

Mangrove structural and functional properties in oligotrophic systems

Victor Rivera-Monroy, Robert Twilley (LSU), PIs – 3 years, \$150,000, National Science Foundation through Florida International University

Carbon stocks in South Louisiana coastal wetlands

Victor Rivera-Monroy, Jeffrey Supak, Edward Castañeda-Moya (LSU), PIs – 19 months, \$50,000, Coypiu Foundation/Global Green

Interactions of drought and precipitation variability on soil temperatures

John Zak (TTU), PI – 12 months, \$8,000, Cotton Incorporated

Interactions of drought and precipitation variability on soil temperatures: assessing impacts using field manipulations and the West Texas Mesonet Network

John Zak (TTU), PI – 12 months, \$13,671, Cotton Incorporated

SEES Fellows: Sustainable infrastructure in a changing climate: dismantling the knowledge barrier between infrastructure engineering and climate science

Ann Stoner (TTU), PI – 4 years, \$4,419,446, National Science Foundation

Evaluating the effectiveness of stream restoration projects based in natural channel design concepts using process-based investigations

Shannon Brewer, Garey Fox (OSU), PIs – 3 years, \$270,342, National Science Foundation – Division of Earth Sciences

Tribal climate change adaptation learning project

Choctaw Nation of Oklahoma, PI – 1 year, \$146,992, Department of Interior – Bureau of Indian Affairs

Year 4 (March 1, 2015 – February 29, 2016)

Examining the effects of climate on animal populations and movement

Julia Earl (OSU – Postdoc) – CSC Hosting Agreement

Black Bear range expansion in altered habitats

Emily Artz (OSU – Graduate Student) – CSC Hosting Agreement

Dendrotempestology: understanding hurricanes and tree growth

Clay Tucker (OSU – Graduate Student) – CSC Hosting Agreement

Collaborative research: understanding the impacts of storms on forest ecosystems of the northeastern U.S.

Katharine Hayhoe (TTU), PI – 3 years, \$91,257, National Science Foundation

Inductively coupled plasma mass spectrometer for research in geography and anthropology

Kristine DeLong (LSU), PI – 2 years, \$101,227, Louisiana State Board of Regents

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 dryland and irrigated cotton rotation systems

John Zak (TTU), PI – 12 months, \$80,000, Cotton Incorporated

Tribal planning for drought vulnerability assessments project

Wayne Kellogg (CN), PI – 2.5 years, \$78,526, Department of Interior – Bureau of Indian Affairs

Research internship Pprogram

Wayne Kellogg (CN), PI – 2 years, \$74,917, Department of Interior – Bureau of Indian Affairs

Regional drought contingency plan for the Arbuckle Simpson Aquifer Region

Wayne Kellogg (CN), PI – 2 years, \$43,364, Department of Interior – Bureau of Reclamation

Year 5 (March 1, 2016 – February 28, 2017)

Climate change and the Lesser Prairie-Chicken: relative importance of climate variable to Lesser Prairie-Chicken vital rates

Julia Earl (OSU – Postdoc) – CSC Hosting Agreement

Effects of climate change on the Lesser Prairie-Chicken Geographic Distribution

Jacob Peterson (OSU – Graduate Student) – CSC Hosting Agreement

Predicting water temperature extremes and variability in depressional wetlands

Julia Earl (OSU – Postdoc) – CSC Hosting Agreement

Hot playgrounds and children's health

Jenny Vanos (TTU) – CSC Hosting Agreement

Microbial control of Golden Alga outbreaks: climate interactions

Tirhas Hailue (TTU – Postdoc) – CSC Hosting Agreement

Variability of bias in gridded sea-surface temperature data products

Gil Ouellette (LSU – Graduate Student) – CSC Hosting Agreement

Dendrochronology reveals response of coastal pine trees to various climate parameters

Clay Tucker (LSU – Graduate Student) – CSC Hosting Agreement

Climate Science Center support for Tribal resilience planning

Renee McPherson (OU), PI – 15 months, \$77,772, Department of Interior – Bureau of Indian Affairs

Citizen science network: growers helping growers to farm sustainably & improve soil health

Natasja van Gestel, John Zak (TTU), PIs – 12 months, \$18,750, Cotton Incorporated

Thermal ecology and impacts of fragmentation and prescribed fire of Rio Grande Wild Turkey in Oklahoma

Dwayne Elmore, Craig Davis, Matt Carroll (OSU), PIs – 12 months, \$212,211, Oklahoma Department of Wildlife Conservation

The GeoCarb Mission

Berrien Moore (OU), PI – 5 years, \$166,000,000, National Aeronautics and Space Administration - Earth' System Science Pathfinder Program

Understanding and quantifying carbon export to coastal oceans through deltaic systems

George Zue, Victor Rivera-Monroy, Kanchan Maiti, Eurico D'Sa, Zhu Ning (LSU), PIs – 3 years, \$1,500,000, Coypiu Foundation/Global Green

Effects of the CRP and anthropogenic features on the long distance movements and mortality risk of Lesser Prairie-Chickens

Sam Fuhlendorf, Julia Earl (OSU), PIs – 3 years, \$67,872, U.S. Department of Agriculture & Pheasants Forever, Inc.

U.S. - India partnership for climate resilience (PCR) workshop support

Katharine Hayhoe (TTU), PI – 12 months, \$25,894, National Oceanic and Atmospheric Administration & North Carolina State University

Tribal college conference series on climate change

Renee McPherson (OU), PI – 1 month, \$14,841, Oklahoma Experimental Program to Stimulate Competitive Research

Collaborative research: developing a framework for seamless predication of sub-seasonal to seasonal extreme precipitation events in the United States

Elinor Martin, Jason Furtado, Michael Richman, Cameron Homeyer, Renee McPherson (OU), PIs – \$1,842,562, National Science Foundation

Key Products

An outcome for several of the research projects that are completed or underway is datasets, tools, or other products that can be used by decision makers. In this section, we *overview a few examples of key products that have been produced through USGS or consortium funding.*

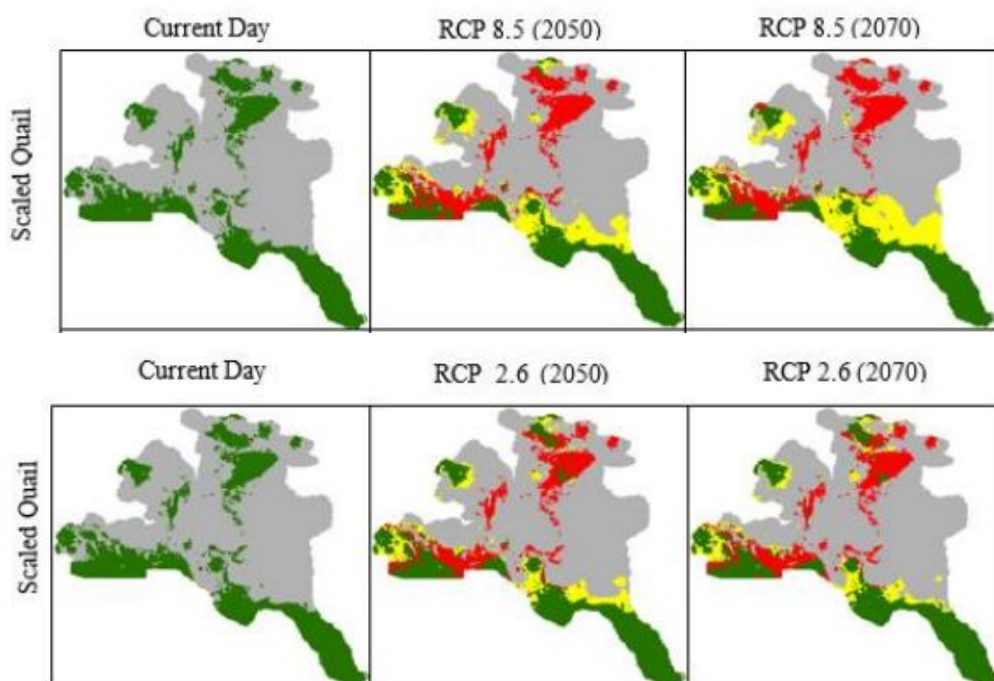
Modeling the Effects of Climate and Land Use Change on Crucial Wildlife Habitat

PIs: Colleen Caldwell (New Mexico Cooperative Fish and Wildlife Research Unit), Kenneth Boykin (New Mexico State University), and Keith Dixon (National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory)

Changing temperature and precipitation patterns in the south-central U.S. are already having an impact on wildlife. Hotter and drier conditions are prompting some species to move in search of cooler conditions, while other species are moving into warmer areas that were once unsuitable for them. These ***changes in the distribution of wildlife populations present challenges for wildlife managers, hunters, Tribal communities, and others who are making decisions about wildlife stewardship.***

As part of this project, the researchers examined the effects of shifting climate conditions on 20 species of conservation concern in the south-central U.S. The current geographical range for each species was examined to better understand the environmental conditions, especially climate, necessary for their survival. Climate and land use change projections for 2050 and 2070 were applied to assess the potential future distributions of conditions suitable for these species.

The researchers ***developed maps that evaluate the patterns of suitable conditions gained or lost for the species.*** These maps were incorporated into the ***publicly accessible Crucial Habitat Assessment Tool (CHAT) for New Mexico.*** CHATs are used by states across the western U.S. to facilitate conservation and project planning. Therefore, including information about the potential impacts of climate and land use changes on species distributions into this tool will ensure that this important information is accessible to managers.



Example of changes to the distribution of scaled quail under two climate change scenarios (RCP2.6 and RCP8.5) and two future time periods.

Three-to-the-Fifth (3⁵) Project Results

PIs: Adrienne Wootten and Renee McPherson (OU) and Keith Dixon (NOAA's GFDL)

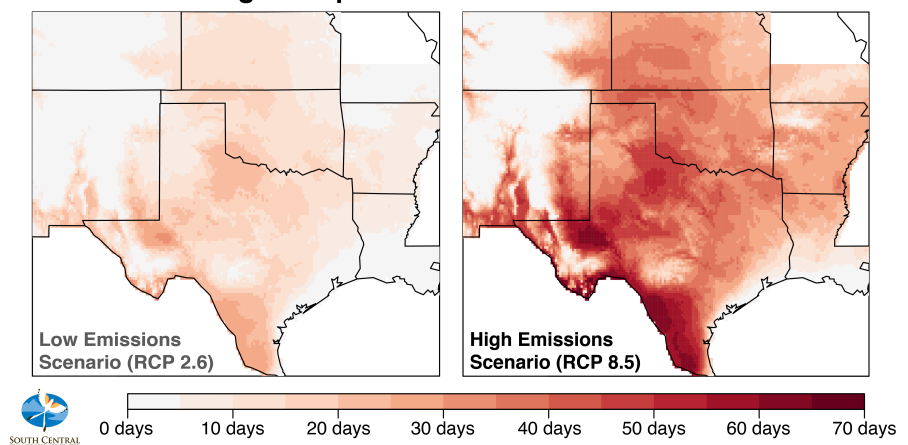
Downscaling techniques are often used to generate finer-scale projections of climate variables and capture small-scale features that meet the needs of stakeholders for adaptation planning. Different sources of uncertainty can affect the downscaled projections, however. Hence, the goal of this project is to create ***an ensemble of downscaled climate projections that incorporates multiple sources of uncertainty***. This ensemble will allow our stakeholders in the south-central U.S. to become aware of the range of risk in their planning processes. This project is the result of collaboration between the University of Oklahoma and NOAA's Geophysical Fluid Dynamics Laboratory.

The resulting set of projections will incorporate ***three statistical downscaling techniques, three observation datasets*** (used to train each downscaling technique), ***three global climate models, and three emissions scenarios***. At the conclusion of this project, the researchers will have generated 81 downscaled datasets for each of ***three climate variables: daily maximum temperature, daily minimum temperature, and daily total precipitation***. By late 2016, this

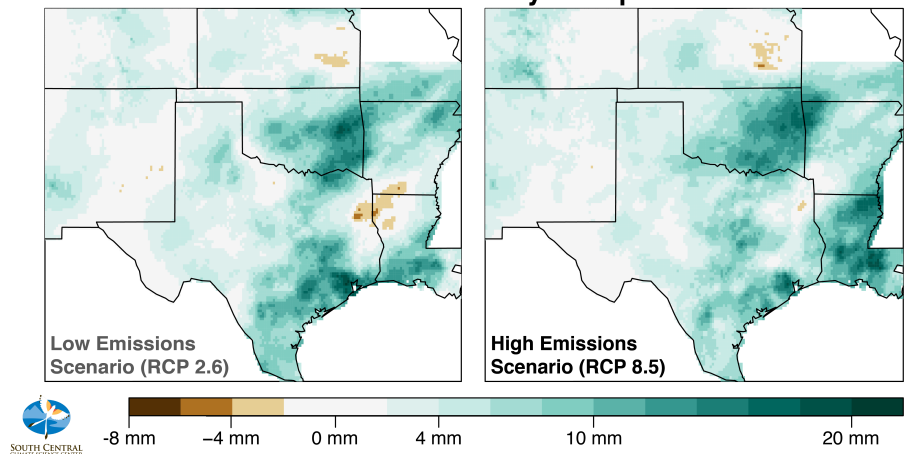
project had produced projections using one statistical downscaling technique for all three GCMs, emissions scenarios, observation datasets, and variables for Oklahoma, Texas, New Mexico, Louisiana, Arkansas, southern Kansas, southern Missouri, and southern Colorado.

The resulting projections will not only be used to address stakeholder needs, but also to address critical research questions regarding the sensitivity of downscaling techniques for climate projections. ***The first set of projections is currently being distributed as images (right) to stakeholders.*** While the remaining projections are being produced, this engagement will help us produce useful guidance documents to share with the completed datasets. Stakeholder groups involved in these discussions include Tribal Nations, Landscape Conservation Cooperatives, municipalities, and State and Federal agencies. The resulting projections and guidance documents produced will inform users involved in impact assessments and adaptation planning across the South Central CSC domain.

Projected Change (2041-2070) of the Average Annual Number of Days the High Temperature is Greater than 100°F



Projected Change (2041-2070) of the Average Annual Maximum 1-Day Precipitation



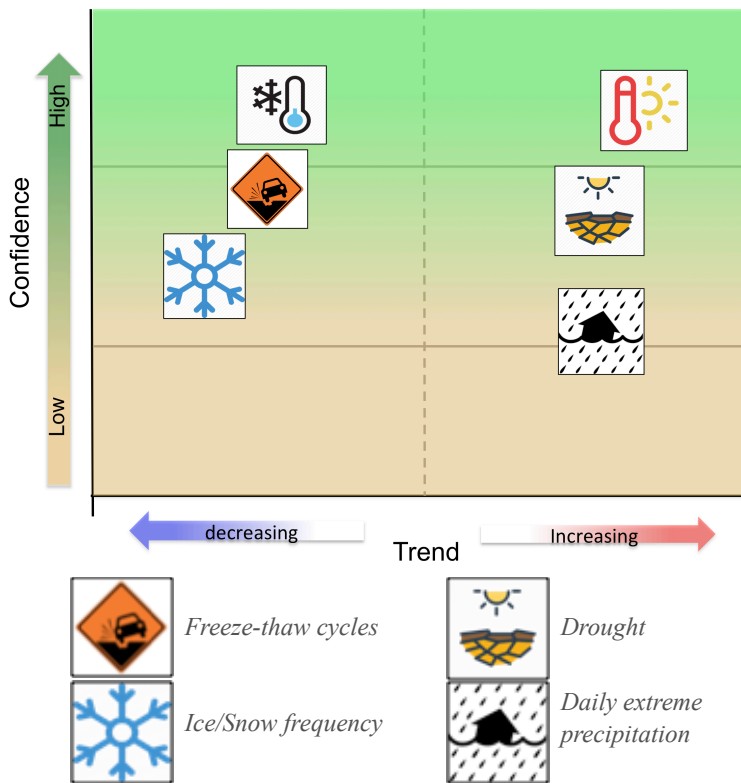
Ensemble mean projected change of average annual number of days the high temperature is greater than 100°F (top) and annual maximum 1-day precipitation amount (bottom) by emissions scenario for 2041-2070. Courtesy Adrienne Wootten.

Winter Weather Datasets

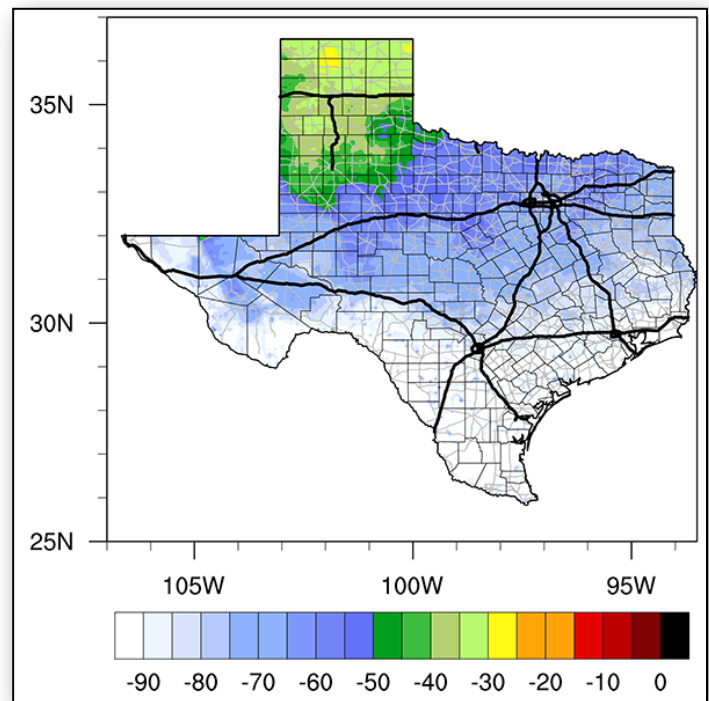
PIs: Esther Mullens, Renee McPherson, Mark Shafer, Derek Rosendahl, and Michael Richman (OU)

Dr. Esther Mullens, OU postdoc at the CSC, examining historical trends and future climate scenarios of winter weather for the south-central U.S. This project was funded by the U.S. Department of Transportation through the Southern Plains Transportation Center (SPTC). As part of the project, *she derived a 36-year spatial dataset for freezing precipitation, constructed freeze-thaw cycle maps, and developed future scenarios for each transportation-relevant variable.* Value-added data and graphics were generated for the entire SPTC region, and individual state summaries are currently under development. Once completed, these summaries will be shared on our CSC website and with individual state transportation agencies.

Climate trends for each state were outlined in a two-page summary document. In a concise and impactful



Weather type, expected trend based on climate projections, and the confidence in the trend for winter weather events in Oklahoma. Courtesy Esther Mullens.



Projected changes in the number of days with snow or ice by mid-century (2021-50) for RCP8.5. Courtesy Esther Mullens.

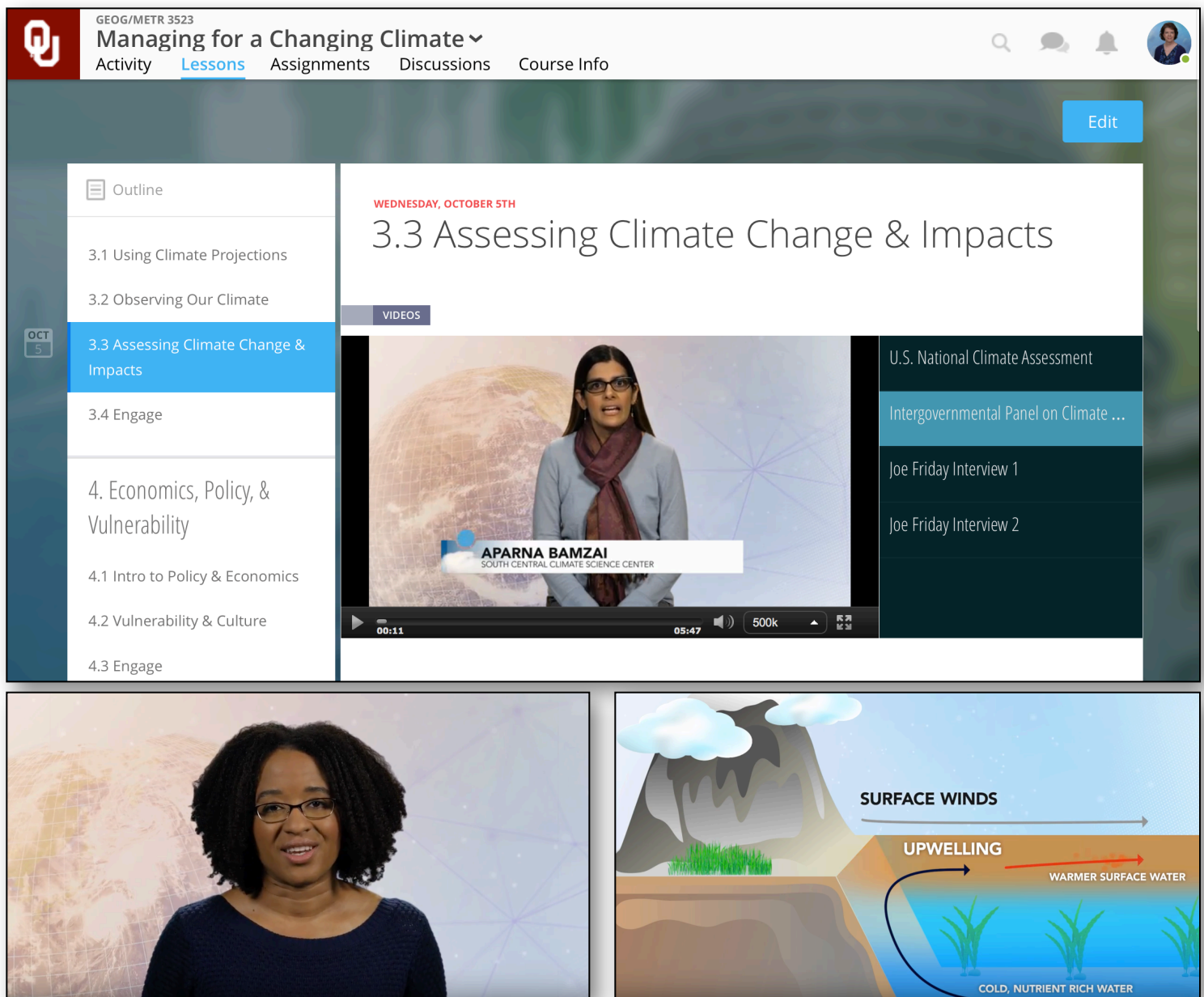
manner, these documents show decision-makers the projected trends in freeze-thaw cycles, ice/snow frequency, frequency of 100°F days, extreme daily precipitation, and drought. With each trend, Dr. Mullens also lists the implications that these trends would have on the transportation sector for that state.

Although developed originally for transportation managers, the winter weather summaries and associated datasets and graphics are important for natural resource managers too. For example, in eastern Oklahoma and Texas, larger and more intense forest fires result during years when the dead-fuel load is high. Typically, these years occur after an ice storm severely damages trees, breaking branches and creating enhanced fuel in the understory after heat, low relative humidities, or drought conditions. Projections indicate that the number of these severe ice storms will slowly decline out to the end of the century. This information is useful in fire management and planning.

Managing for a Changing Climate

PIs: Elinor Martin, Emma Kuster, and Renee McPherson (OU) and Aparna Bamzai (USGS NC CSC)

In Fall 2017, the South Central CSC hosted the first online version of “Managing for a Changing Climate.” The course is open to the public and can be completed at one’s own pace. **Over 500 participants around the world took part in the course**, along with approximately 25 students who were taking the course for credit at OU. Now in its second year, the online course continues to provide participants with an overview of the climate system and its impacts on natural and cultural resources. **Over 50 short videos were created for this course**, each accessible for free through the janux.ou.edu platform and our South Central CSC Youtube Channel. For each week during the semester, participants in the class watch 4-6 short educational videos, read additional material such as book chapters, and conduct online discussions. All participants are evaluated through regular online quizzes. Upon completion of the course, each participant receives a personalized certificate.



The screenshot displays the course interface for 'Managing for a Changing Climate' (GEOG/METR 3523). The top navigation bar includes links for Activity, Lessons (selected), Assignments, Discussions, and Course Info. The sidebar on the left shows the course outline, with '3.3 Assessing Climate Change & Impacts' highlighted. The main content area features a video player showing a woman, Aparna Bamzai, speaking. To the right of the video player is a list of related resources, including 'U.S. National Climate Assessment', 'Intergovernmental Panel on Climate ...', 'Joe Friday Interview 1', and 'Joe Friday Interview 2'. Below the main video player, there are two smaller video thumbnails: one showing a woman speaking and another showing a diagram of ocean circulation.

WEDNESDAY, OCTOBER 5TH

3.3 Assessing Climate Change & Impacts

VIDEOS

APARNA BAMZAI
SOUTH CENTRAL CLIMATE SCIENCE CENTER

U.S. National Climate Assessment

Intergovernmental Panel on Climate ...

Joe Friday Interview 1

Joe Friday Interview 2

Outline

- 3.1 Using Climate Projections
- 3.2 Observing Our Climate
- 3.3 Assessing Climate Change & Impacts**
- 3.4 Engage
- 4. Economics, Policy, & Vulnerability
 - 4.1 Intro to Policy & Economics
 - 4.2 Vulnerability & Culture
 - 4.3 Engage

Diagram: The diagram illustrates ocean circulation. It shows a cross-section of the ocean with a mountain on the left. Surface winds are shown blowing from left to right. This causes water to move to the right, where it is labeled 'UPWELLING'. The upwelling process shows 'WARMER SURFACE WATER' moving up and 'COLD, NUTRIENT RICH WATER' moving down. The diagram also shows a cross-section of the ocean floor with a mountain on the left.

Examples of online video screenshots for Managing for a Changing Climate. Courtesy University of Oklahoma.

Capacity Building

Because of the unique position of the South Central Climate Science Center among university, Tribal, and Federal researchers and educators as well as their stakeholders across the south-central U.S., ***the CSC has a grand opportunity to educate the next generation of researchers and resource managers to work together in developing science-informed decisions.*** The research facilities, including cyberinfrastructure, experiment stations, and lab and field equipment, at the consortium institutions is cutting edge. In addition, the faculty at the consortium universities are well practiced at teaching to a diverse group of students and early-career professionals. Hence, we highlight several of our key capacity-building programs.

Internship for Under-represented Undergraduates:

Funded through the CSC Hosting Agreement, with leveraged fund from the consortium universities

Our summer undergraduate internship for students of underrepresented minorities interested in science, technology, engineering, and mathematics takes place during the summer each year. We select 10 undergraduate students to participate in this three-week internship. Interns are involved in hands-on activities related to climate research that allow 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 travel across the south-central United States to visit university campuses and field locations and interact with researchers conducting cutting-edge research. They have the opportunity to learn how to collect and analyze field data, as well as gain an understanding of the breadth of climate science work being done throughout the region. Additionally, student interns are 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 learn about opportunities to work with the USGS and other Federal agencies or how to successfully apply to and complete graduate school. ***Many of the graduates of the program during the summers of 2014-2017 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.***

“I learned more than I thought I possibly could in the short three weeks of this internship, and have even decided to pursue grad school. I can’t express how grateful I am to have had this opportunity where I gained hands-on experience, new insights, great connections, and lifelong friends.” – Intern’17



Early-Career Professional Development:

Funded through the USGS directed funding

Investigating the complex natural and cultural resource management challenges we face today requires building diverse, interdisciplinary research teams. Robust stakeholder engagement also is critical for ensuring that publicly funded science answers questions that are relevant to these management decisions. ***Early-career scientists who learn how to engage with multi-disciplinary research teams and stakeholders during the early stages of their career have a competitive advantage in the workforce.***

Additionally, these skills may help individuals develop actionable science that addresses critical management questions. With funding provided through USGS, the South Central CSC has developed a biennial, week-long training for graduate students, postdocs, and early-career environmental professionals to help them develop these essential skills.



The primary objectives of the trainings are to: (1) introduce participants to the goals, structure, and unique research-related challenges of the South Central CSC and its place within the U.S. Department of the Interior and the larger CSC network (offering participants an insight into how their research fits into the broader research priority goals and its eventual applicability to end-user needs across the region); (2) provide an opportunity for participants to present their research to fellow peers; (3) facilitate interdisciplinary interactions between participants within the South Central CSC purview in an effort to foster collaboration opportunities; and (4) generate curricular materials that can be used by others conducting similar workshops in the future.

Participants are selected through a competitive application process with the requirement that their research focus be associated with the south-central U.S. or northern Mexico, and that it corresponds with at least one of the defined science priorities of the South Central CSC. Our 2014 training consisted of 28 participants representing 17 different disciplines at various career stages – Masters (7), Ph.D. (8), Postdoc (10), and early-career researchers/environmental professionals (3). Our 2016 training had 23 participants from 20 different disciplines from Masters (5), Ph.D. (9), Postdoc (5), and early-career researchers/environmental professionals (4). Participants in both trainings were ethnically, culturally, and geographically diverse.

The one-week trainings consist of a series of instructional presentations from top researchers from the South Central CSC. We cover a wide range of research topics (including specific sessions on science communication to both multidisciplinary technical audiences and non-technical audiences), small group interdisciplinary activities, a real-world case study, and in-person meetings/discussions with stakeholders and decision-makers from the region. To optimize the participants' experiences, we included both classroom presentations and field trips to showcase how scientific results are used in the decision-making process.

The long-term goal is for the trainings to provide early-career professionals with a foundation for working in today's interdisciplinary, stakeholder-driven research contexts and remove institutional barriers, or 'silos,' at an influential time of professional development for these individuals. We also are building a cohort who can network through their careers and who eventually will lead outcome-oriented, interdisciplinary research.

"What a fantastic week of training, learning, and genuine enthusiasm and support for our group. I came away inspired, and with new skills and tips and knowledge that have already been useful." – Participant

Research Experiences for Undergraduates:

Funded by the National Science Foundation

The South Central CSC has partnered with the National Weather Center at OU in the Research Experiences for Undergraduates (REU) program over the past four years, and plans to continue this partnership in the future. This 10-week intensive program offers undergraduates the opportunity to conduct scientific research under the guidance of top research mentors. ***Six students from five different universities across the nation have been paired with mentors at the South Central CSC.*** The participating students were from a variety of disciplines, including meteorology, physics, agriculture, and geology. Upon completion of the program, the students were provided funding to attend a professional conference to present their research.

The research projects conducted by these six students were climate-based and related to the mission and goals of the South Central CSC. Our students conducted research on optimizing wind turbine layout on a wind farm, assessing how tornadic activity may be impacted by soil moisture in the region leading up to tornado season, and assessing future projections of a variety of indices important to stakeholders across the South Central U.S.

A highlight of the experience these undergraduates received while being mentored at the South Central CSC was their immersion into end-user focused research. ***They were able to directly see the stakeholders and decision-makers who would make use of their research results.*** In some cases, the students had direct discussions with those potential end-users who helped in guiding the research goals of the project to best meet the current needs.

Tribal Engagement:

Funded through the CSC Hosting Agreement, University of Oklahoma (VPR's University Strategic Organization), USGS annual CSC grants, and the Bureau of Indian Affairs

At the creation of the consortium to host the South Central Climate Science Center, a purposeful effort was planned and initiated to ensure full representation of Tribal Nations and Native voices within the development of our strategic plans, research activities, and education and outreach. ***Our consortium includes two Tribes — the only CSC with sovereign nations in its organizational leadership — and two full-time Tribal liaisons to serve almost 70 Tribes and Pueblos across our region.*** In 2014, we published *USGS Circular 1396: Tribal Engagement Strategy of the South Central Climate Science Center* (<https://pubs.usgs.gov/circ/1396/pdf/circ1396.pdf>) to guide our work across the south-central U.S. This guidance recognizes that some of the Native peoples within our jurisdiction have been on their lands for thousands of years and others were forcibly removed from their homelands to their current locations (and thus experience an unique but relevant “climate change”). All have experiences with climate adaptation that can help the rest of the U.S. cope with climate variability and change.

In our Tribal engagement plan, ***we focus on the following strategies to partner with Tribes and Pueblos: (1) leveraging climate-change funds for Tribes and studies related to Tribal lands; (2) assisting development of projects and adaptation strategies, (3) inclusion of Indigenous knowledge where appropriate and acceptable, and (4) education and outreach for Tribal staffs, educators, and students.*** An example of the first strategy is the co-production of future streamflow projections for the Red River Basin using funding from USGS, Chickasaw Nation, and the University of Oklahoma and resulting drought planning using funding from the Bureau of Reclamation and Chickasaw Nation.

For the second strategy, CSC Tribal liaisons and post-doctoral associates have aided in proposal development and award implementation for Tribes and Tribal organizations across the region, especially as related to obtaining and

interpreting climate data, projections, and other products, connecting decision makers with relevant consortium researchers, and translating science to planning decisions. In addition, the CSC worked with the OU Office of the Vice President for Research to develop and host two grant-writing workshops focused on building capacity in the Tribes for the peculiarities of writing climate change-related proposals. We also hosted a climate adaptation training session for the DOI Tribal liaisons supported by the Bureau of Indian Affairs to work with the network of regional CSCs.

Less seemingly has been completed in the third strategy — the inclusion of Indigenous knowledge, or traditional ecological knowledge (TEK). During the first five years of the CSC, however, we were focused on building the relationships of trust that are needed for discussions of TEK. Building relationships cannot be fast-tracked. Still, several of our Native undergraduates have engaged in research into ecological changes in plants of cultural significance to the Chickasaw or Choctaw Nations.

Finally, the South Central CSC has developed and led a significant number of education and outreach activities since its inception, most prominently focused on increasing capacity within the Tribes and Pueblos to lead their own research and conduct their own vulnerability assessments, climate adaptation planning, or climate-related decision activities. Over 20 Native students have served as interns in the South Central CSC main office over the years, with up to 10 working in our office at a single time and funded by the Chickasaw Nation or Bureau of Indian Affairs.

Our efforts have been noticed by the Department of the Interior. ***In 2015, we were honored by the Secretary of the Interior with her Environmental Achievement Award for Climate Science and Partnerships for increasing Tribal capacity for climate change adaptation.***

Communications and Outreach Activities

Effective communication is essential to the South Central CSC's mission of providing actionable science. The South Central CSC uses a combination of digital, print, and in-person communications channels for sharing research outcomes, engaging stakeholders in the research process, and leveraging regional partnerships. ***Some of the channels most frequently used to communicate with end-users about our science are highlighted below.*** For more information about how we communicate with the broader CSC community and USGS, please consult the communications plan.

Communications Plan and Channels:

As the South Central CSC concluded its fifth year, stakeholders and staff asked how they could better use communications resources to share science and build relationships with end-users. To answer this question, the South Central CSC worked with Gregg Elliott to survey partner communications preferences and develop a strategic plan. ***The resulting Communications Plan presents three overarching goals and accompanying communications objectives, identifies critical audiences, and suggests messaging tactics for reaching these audiences to accomplish goals.*** Communications staff revisit the Plan every six months to assess progress against metrics, make adjustments to refocus on goals and objectives, choose new tactics as appropriate, and develop metrics for these new tactics on a six-month timeline. The Plan is very much a living document.

In addition, communications staff are working with selected principal investigators to develop their own communications plans for individual research projects that could benefit from communications support.

Website

The South Central CSC website is located at <http://southcentralclimate.org>, is hosted by the Oklahoma Climate Survey, and is maintained by CSC communications staff. ***The website is home to project descriptions, news, staff profiles and contact information, resources, and an event calendar.*** The newsletter and social media accounts (below) are used to drive this website, serving as a hub for all South Central CSC information.

Monthly Newsletter

Communications staff deliver a monthly MailChimp newsletter to a list serve of 580 subscribers. This newsletter is intended for partners of diverse institutional affiliations and serves as a one-stop-shop for keeping partners informed. ***The average open rate for this list serve is 36.8%, exceeding the average open rate across all industries by at least 10 percentage points*** (as reported by MailChimp). Each newsletter has five component parts, including photographs and links to complementary sections of the South Central CSC website:

- ***Feature Story*** – Usually contains a story about the impact of South Central CSC science or events. Past examples include the South Central CSC Undergraduate Internship and highlights from stakeholder meetings.
- ***Research Highlight*** – Showcases recently completed South Central CSC products, tools, and publications.
- ***Opportunities and Resources*** – Provides links to South Central CSC-relevant webinars, educational resources, job postings, funding opportunities, regional events, etc.
- ***Staff and Student Highlights*** – A space for introducing new staff, saying farewell to staff leaving the team, or highlighting staff and student accomplishments.
- ***Partner's Corner*** – A space for cross-posting events and announcements from our close partners, specifically our region's LCCs, NOAA Regional Integrated Sciences and Assessments (RISA) program, and USDA Climate Hub.

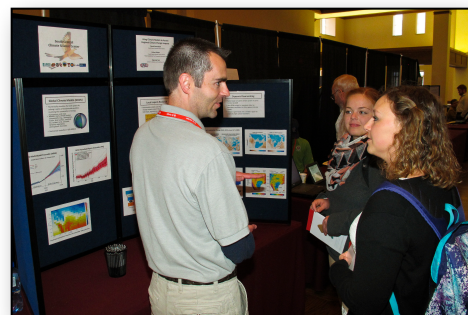
Social Media

The South Central CSC maintains a consistent and cross-platform social media presence. Communications staff post to a South Central CSC Facebook and Twitter account multiple times per week. Although maintaining the pages does take time, it is one of the most effective methods we have for engaging our early-career audiences.

- *Facebook: 647 likes (as of 9/1/2017), <https://www.facebook.com/SouthCentralCSC/>*
 - Facebook is a great place for paragraph-length descriptions of our activities that can be paired with an interesting photograph or flyer. The reach of any given post on our page often exceeds 500 Facebook users. Our Facebook posts highlight:
 - Information about staff/student activities and accomplishments (this kind of post historically gets the most likes, shares, and comments);
 - Links to new CSC reports, results, tools, and publications;
 - Stories involving collaboration in which multiple partners can be tagged to increase post reach and shares;
 - Registration information for events open to the public; and
 - Job announcements and career-development opportunities relevant to South Central CSC work.
- *Twitter: 200 Followers (as of 9/1/2017), <https://twitter.com/southcentralcsc>*
 - South Central CSC twitter posts are usually shortened versions of our Facebook posts. We take advantage of the retweet feature often to spread the word about news and events taking place across the South Central CSC consortium. We also live tweet at national and international conferences to engage with our audiences as well as fellow attendees.
- *YouTube: 45 Subscribers (as of 9/1/2017), <https://www.youtube.com/channel/UCUT91zTJxrfxts-ktVkn8w>*
 - The South Central CSC's YouTube channel serves as a platform for recorded events, webinars, and trainings.

Outreach Activities:

The South Central CSC participates in different outreach activities throughout the year to engage with youth, land managers, decision-makers, researchers, and the general public about our role in the south-central region. Some of the programs that we have been a part of include: American Indian Math and Science Camp, EPSCoR Women in Science Conference, Chickasaw Children's Fair, Annual Conference of the Society of Environmental Journalists, Chickasaw Osto (Pumpkin) Festival, GIS Day at OU, National Weather Festival, Choctaw Nation of Oklahoma STEM Camp, Oklahoma Water Festival, and Choctaw Labor Day Festival.





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

Contact Information

201 Stephenson Parkway
Suite 2100
Norman, OK 73019
Phone: 405-325-1272
Fax: 405-325-1122

Mike Langston, Ph.D.
Acting USGS Director
U.S. Geological Survey
mlangston@usgs.gov

Renee A. McPherson, Ph.D.
University Director
The University of Oklahoma
renee@ou.edu

Elizabeth (Betsy) Glenn, Ph.D.
USGS Research Coordinator
U.S. Geological Survey
eglenn@usgs.gov

Emma Kuster, M.A.
Program Coordinator
The University of Oklahoma
emmakuster@ou.edu

April Taylor, M.E.E.R.M., G.I.S.P.
Sustainability Scientist
The Chickasaw Nation
april.taylor@chickasaw.net

Atherton Phleger
Asst. Sustainability Scientist
The University of Oklahoma
aphleger@ou.edu

Jessica Blackband
Communications Specialist
The University of Oklahoma
jblackband@ou.edu

Terri Sarsycki
Financial Administrator
The University of Oklahoma
tsarsycki@ou.edu