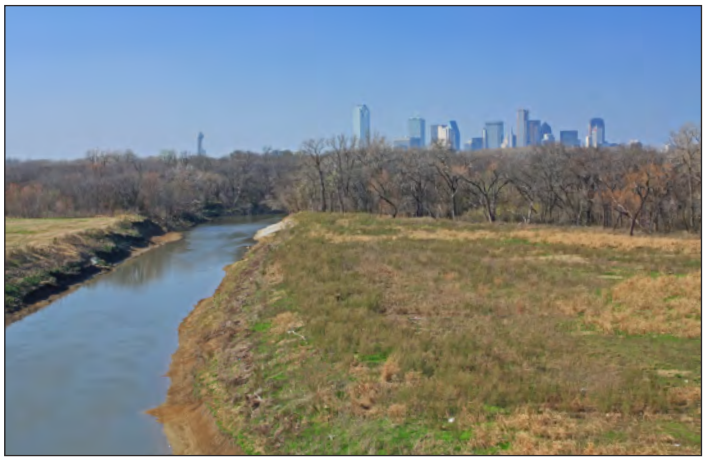
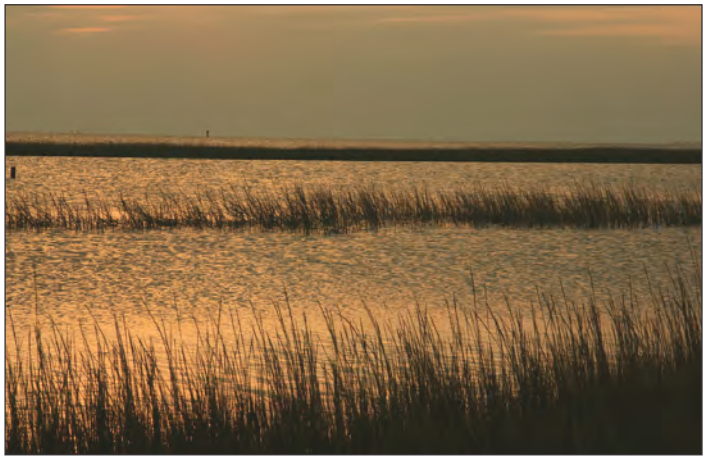
USGS
science for a changing world

U.S. Department of the Interior
South Central Climate Science Center
Strategic Science Plan, 2013–18


Open-File Report 2013–1143

U.S. Department of the Interior
U.S. Geological Survey

Cover photographs. By Alan M. Cressler, U.S. Geological Survey

Front cover:

Top left: Carlsbad Caverns, Carlsbad Caverns National Park, Eddy County, New Mexico

Top right: Trinity River and Dallas skyline, from south Interstate 45 bridge, Dallas, Dallas County, Texas

Bottom left: Butterowe Bayou, Galveston Island State Park, Galveston County, Texas

Bottom right: El Capitan, Guadalupe Mountains National Park, Culberson County, Texas

Back cover:

Top: Strix occidentalis lucida, Big Canyon, Guadalupe Mountains, Lincoln National Forest, Eddy County, New Mexico

Bottom: Prehistoric pictographs, Cave Kiva, Hueco Tanks State Historic Park, El Paso County, Texas

U.S. Department of the Interior
South Central Climate Science Center
Strategic Science Plan, 2013–18

Compiled by Kim T. Winton, Melinda S. Dalton, and Allison A. Shipp

Open-File Report 2013–1143

U.S. Department of the Interior
U.S. Geological Survey
National Climate Change and Wildlife Science Center
South Central Climate Science Center

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013

Suggested citation:
Winton, K.T., Dalton, M.S., and Shipp, A.A., comps., 2013, U.S. Department of the Interior South Central Climate Science Center Strategic Science Plan, 2013–18: U.S. Geological Survey Open-File Report 2013–1143, 24 p., available online at http://pubs.usgs.gov/of/2013/1143/.

Executive Summary

In the South Central United States, climate changes are already impacting natural and cultural resources, from increased maximum summer temperatures and extended droughts across the region to the effects of sea-level rise and coastal erosion. Resource managers and conservation planners are having to consider climate impacts now, as well as plan for future impacts. Additionally, climate change challenges many of the basic assumptions routinely used by conservation planners and managers, including the identification and prioritization of areas for conservation based on current environmental conditions and the assumption those conditions could be controlled by management actions. Climate change alters (and will likely continue to alter) important ecosystem drivers (temperature; precipitation intensity and seasonality; soil moisture; carbon, nitrogen, and phosphorus cycling; and sea-level rise) and makes it difficult, if not impossible, to maintain current ecosystems and environmental conditions into the future. Additionally, the potential for future conservation of non-managed lands may be affected by climate change, which further complicates resource planning. Probable changes to ecosystem drivers, as a result of climate change, highlight the need to develop and adapt effective conservation strategies to cope with the effects of climate and landscape change.

The U.S. Congress recognized the potential effects of climate change and authorized the creation of the U.S. Geological Survey (USGS) National Climate Change and Wildlife Science Center (NCCWSC) in 2008. The directive of the NCCWSC is to produce science that supports resource-management agencies as they anticipate and adapt to the effects of climate change on fish, wildlife, and their habitats. On September 14, 2009, Department of the Interior (DOI) Secretary Ken Salazar signed Secretarial Order 3289 (amended February 22, 2010), which expanded the mandate of the NCCWSC to address climate-change-related impacts on all DOI resources. Secretarial Order 3289, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources," established the foundation of two partner-based conservation science entities: Climate Science Centers (CSC) and their primary partners, Landscape Conservation Cooperatives (LCC). CSCs and LCCs are the Department-wide approach for applying scientific tools to understand the response of ecosystems to climate change, and to coordinate an effective response to its impacts on tribes and the land, water, ocean, fish and wildlife, and cultural-heritage resources that DOI manages.

The CSCs will deliver basic climate-change impact science to LCCs within their respective regions, including physical and biological research, ecological forecasting, and multi-scale modeling. These CSCs will prioritize fundamental science, data, and decision-support activities based principally on the needs of the LCCs, including climate change impacts on natural and cultural resources and adaptive management and other decision support tools for managers. By way of example, the regional CSCs will work with (and sometimes generate) downscaled climate models, providing derivative models and tools that link physical forcing factors with biological, hydrological, physical, ecological, and cultural resource response variables. CSCs will also develop response models and projections for priority ecosystems, species, habitats, and other natural and cultural resources; this development will generally be done at regional levels and then collaboratively with LCCs for specific applications.

LCCs are self-directed partnerships. They provide a structure to define objectives, develop spatially-explicit strategies, and provide scientific and technical decision support to inform natural and cultural resource management across terrestrial, aquatic, and coastal and marine ecosystems. The core of an LCC will be a scientific and technical staff with an applied resource management focus. That staff and capacity will be directed by a Steering Committee, consisting of resource management representatives from government entities (Federal, State, tribal, and local) and non-governmental organizations who are prepared to contribute to the joint effort.

The NCCWSC has established a network of eight DOI CSCs (Alaska, North Central, Northeast, Northwest, Pacific Islands, South Central, Southeast, and Southwest) that will work with a variety of partners and stakeholders to provide resource managers with the tools and information they need to help them anticipate and adapt conservation planning and design for projected climate change. Established in 2012, the South Central CSC is a federally led research collaboration that involves a consortium of partners led by The University of Oklahoma and includes Texas Tech University, Louisiana State University, The Chickasaw Nation, The Choctaw Nation of Oklahoma, Oklahoma State University, and the National Oceanic and Atmospheric Administration's (NOAA) Geophysical Fluid Dynamics Laboratory. The South Central CSC brings together the expertise of Federal, university, and tribal researchers and educators to address climate-change priority needs of Federal, State, non-governmental, and tribal resource managers.

This document is the first Strategic Science Plan for the South Central CSC. The document describes operational considerations, provides the context for climate-change impacts in the south central United States, and establishes science priorities that the South Central CSC will address in collaboration with its partners. This document is intended to be reevaluated and modified as partner needs change or at least once every 5 years.

The South Central CSC receives guidance for regional science priorities from the Stakeholder Advisory Council that is composed of senior-level Federal and State executives, and tribal leaders from the region. Additionally, the South Central CSC will establish a Science Implementation Panel (SIP), which will be responsible for peer review of all proposed projects, and will identify scientific assets of the CSCs and LCCs that may also help address regional science priorities. Key staff from LCCs and other partners associated with the South Central CSC will serve on the SIP, as will impartial subject experts from around the region.

The science priorities described in this plan were established by partners in the south-central natural resources conservation community to address information gaps that can inform the conservation science and resource-management needs of ecoregion conservation partnerships, such as the LCCs. The Strategic Science Plan seeks to identify research that achieves the following objectives:

- 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;
- provide scientifically valid information and tools that can be used to adapt natural resource management strategies to changing environmental conditions; and,
- 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.

This plan identifies the priority science issues that frame the activities needed to achieve the objectives for stakeholders of the South Central CSC. The science products developed will provide models of future conditions, assessments of potential impacts, and tools that can be used to inform the decisions and actions of LCCs and other partners. This information will be critical as managers anticipate and adapt to climate change. The South Central CSC will support integration of science information into conservation, adaptation, and mitigation planning by the natural resources community, by working with, and building the capacity of, resource managers to interpret the science in order to integrate it into their management and decisionmaking processes.

Contents

Executive Summary iii
Introduction 1
Climate Science Center (CSC), Landscape Conservation Cooperative (LCC), and Partner Coordination 3
South Central CSC Consortium 3
South Central CSC Landscape Conservation Cooperative Partners 4
Regional Context 5
Climate and Land-Use Change 6
Observed Climate Change 7
Projected Climate Change 8
Land-Use and Land-Cover Change 11
South Central CSC Science Planning 12
South Central CSC Science Priorities 12
Monitoring Priorities 15
Information Management and Data Sharing 16
Science Resources and Skills 17
Cooperative Research and Decision Support 17
Education and Training 17
Outreach and Community Involvement 17
Selected References 18
Appendix 1. Bibliography 19
Published Material 22
Other Material and Compilations 23
Relevant Web Sites 24

Figures

1. Boundaries of Climate Science Centers and Landscape Conservation Cooperatives....2
2. Physiographic divisions within the boundary of the South Central Climate Science Center....5
3. Observed changes in temperature from baseline conditions (1961–1979) to present (1993–2008) and near-term conditions (2010–2029)....7
4. Observed changes in average annual precipitation, 1958–2008....7
5. Projected changes in temperature from current records to projections in 2099....8
6. Projected change in North American precipitation by 2080–2099 as simulated by an ensemble of 15 climate models under the Intergovernmental Panel on Climate Change A2 emission scenario....9
7. Projected land areas in the southern United States that would be affected by a sea-level rise of 3 feet and 10 feet....10
8. Summary of trends in U.S. land cover change, 1973–2000....11

Appendix Table

1–1. Priority science needs and issues for South Central Climate Science Center partners....21

Abbreviations Used in This Report

CN	Chickasaw Nation
CNO	Choctaw Nation of Oklahoma
CSC	Climate Science Center
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency
GCP	Gulf Coast Prairie
GCPO	Gulf Coastal Plains and Ozarks
GFDL	Geophysical Fluid Dynamics Lab
IPA	Interagency Personnel Agreement
IPCC	Intergovernmental Panel on Climate Change
LCC	Landscape Conservation Cooperative
LiDAR	Light Detection and Ranging
LSU	Louisiana State University
NCCWSC	National Climate Change and Wildlife Science Center
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OSU	Oklahoma State University
OU	University of Oklahoma
SAC	Stakeholder Advisory Council
SARP	Southeast Aquatic Resources Partnership
SCIPP	Southern Climate Impacts Planning Program
SECC	Southeast Climate Consortium
SERPPAS	Southeast Regional Partnership for Planning and Sustainability
SIP	Science Implementation Panel
SRCC	Southern Regional Climate Center
SWAP	State Wildlife Action Plan
TTU	Texas Tech University
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

U.S. Department of the Interior South Central Climate Science Center Strategic Science Plan, 2013–18

Compiled by Kim T. Winton, Melinda S. Dalton, and Allison A. Shipp

Introduction

The Department of the Interior (DOI) recognizes and embraces the unprecedented challenges of maintaining our Nation's rich natural and cultural resources in the 21st century. The magnitude of these challenges demands that the conservation community work together to develop integrated adaptation and mitigation strategies that collectively address the impacts of climate change and other landscape-scale stressors. On September 14, 2009, DOI Secretary Ken Salazar signed Secretarial Order 3289 (amended February 22, 2010) entitled, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources." The Order establishes the foundation for two partner-based conservation science entities to address these unprecedented challenges: Climate Science Centers (CSCs and Landscape Conservation Cooperatives (LCCs). CSCs and LCCs are the Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and the land, water, ocean, fish and wildlife, and cultural-heritage resources that DOI manages. Eight CSCs have been established and are managed through the U.S. Geological Survey (USGS) National Climate Change and Wildlife Science Center (NCCWSC); each CSC works in close collaboration with their neighboring CSCs, as well as those across the Nation, to ensure the best and most efficient science is produced. This close collaboration is necessary, because the role of the CSCs is to provide partners with the tools necessary to respond to climate change, which requires the sharing of resources and information across boundaries.

In the January 2011 DOI draft guidance for both CSCs and LCCs, the following excerpt outlines the relationship between CSCs and LCCs:

> *"Much of the information and tools provided by the CSCs, including physical and biological research, ecological forecasting, and multi-scale modeling, will be in response to the priority needs identified by the LCCs. Working closely with the LCCs, the CSCs will help develop statistically sound sampling programs and processes to monitor climate change effects and help develop adaptive management approaches. The CSCs will be partnership-based regional entities functioning with LCCs, as well as, the regional management community, scientific entities, and other stakeholders."*

DOI recognizes that climate change is, and will be, a serious challenge for resource stewards. Managing by past experience will not be adequate; insight into the possible changes in climate will be necessary and how these changes will exacerbate existing stressors is critical. Through a competitive process, the South Central CSC (fig. 1) was established in 2012 through a cooperative agreement with the University of Oklahoma (OU), Texas Tech University (TTU), Louisiana State University (LSU), the Chickasaw Nation (CN), the Choctaw Nation of Oklahoma (CNO), Oklahoma State University (OSU), and the National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Lab (GFDL); hereafter termed the "Consortium" of the South Central CSC. The Consortium has a broad expertise in the physical, biological, natural, and social sciences to address impacts of climate change on land, water, fish and wildlife, ocean, coastal, and cultural resources. There are 30 departments in 13 colleges and 4 universities working collectively through the Consortium. In cooperation with DOI colleagues and other targeted experts, the Consortium will provide relevant science, tools, and information for the LCCs to develop and execute strategies for successfully adapting to climate change and mitigating its impacts. Unlike a traditional cooperative agreement, the current effort is a determined endeavor to build an enterprise that can achieve more in partnership than any individual government or university entity can realize alone to support the science and research required for land-management decisions. This consortium also provides the CSC the opportunity to strengthen its role regionally and nationally through other collaborations, networks, and funding sources.

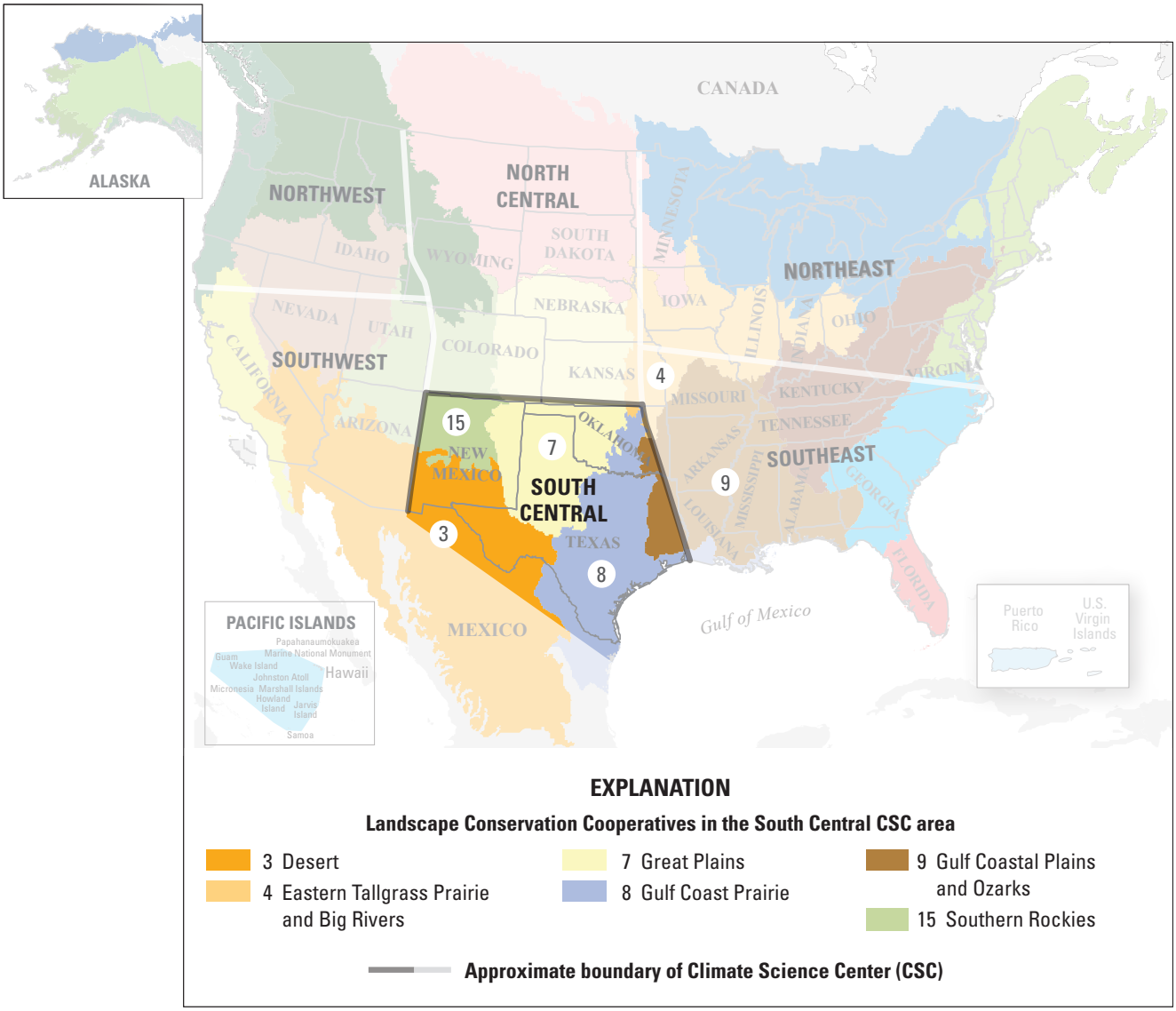


Figure 1. Boundaries of Climate Science Centers and Landscape Conservation Cooperatives.

The purpose of the South Central CSC is to provide scientific information, tools, and techniques that managers and other parties interested in land, water, wildlife, and cultural resources can use to anticipate, monitor, and adapt to climate change, actively engaging LCCs and other partners in translating science into management decisions. The fuzzy boundaries of the CSC were developed to ensure that each CSC may work beyond the general extent of their boundary as the science and research dictates. These fuzzy boundaries are intended to ensure a seamless science network across the CSCs, LCCs, and Nation.

This document is the first Strategic Science Plan for the South Central CSC (2013–18). Using the January 2011 DOI guidance as a model, this document (1) describes the role and interactions of the South Central CSC among partners and stakeholders including Federal, State, and non-governmental organizations throughout the region; (2) describes a concept of what the center will provide to its partners; (3) defines a context for climate impacts in the south-central United States; and (4) establishes the science priorities the center will address through research. Science priorities are currently organized as immediate or future research needs; however, this document is intended to be reevaluated and modified as partner needs change and as scientific work progresses.

Climate Science Center (CSC), Landscape Conservation Cooperative (LCC), and Partner Coordination

The South Central CSC receives funding from the NCCWSC located at the USGS National Center in Reston, Virginia. The NCCWSC provides guidance for national science priorities as part of the USGS Climate and Land-Use Change Mission Area. Although the NCCWSC manages South Central CSC operations, the South Central CSC receives guidance for regional science priorities from the Stakeholder Advisory Council (SAC), which is composed of Federal and State senior-level executives, and tribal leaders throughout the region. The SAC determines the regional science agenda and reviews and approves the annual project plan. Both are critical steps in the development and implementation of the South Central CSC science strategy. The USGS Regional Director for the Southwest will chair the SAC and invitations are currently being drafted and executed; members will consist of representatives from Federal and State partners as well each LCC within the South Central CSC footprint.

The South Central CSC will also convene a Science Implementation Panel (SIP) annually, which will be responsible for peer and technical review of all proposed projects, and will recommend how to utilize available scientific assets of the CSCs and LCCs to address regional science priorities. Key staff from LCCs and other partners (for example, LCC Science Coordinators or other appropriate staff) associated with the South Central CSC will serve on the SIP. Close collaboration between the South Central CSC and the six associated LCCs enhances the functional capacities of both groups to develop meaningful and effective conservation adaptation strategies for the south central landscape. The following list of LCCs have part or all of their geography within the boundaries of the South Central CSC: Desert, Eastern Tallgrass Prairie and Big Rivers, Great Plains, Gulf Coastal Plains and Ozarks, Gulf Coast Prairie, and Southern Rockies (fig. 1).

South Central CSC Consortium

The South Central CSC is composed of seven member institutions: OU, TTU, LSU, CN, CNO, OSU, and NOAA GFDL. The South Central CSC is hosted by OU with furnished space for university, tribal, and Federal employees. The Consortium has broad expertise in the physical, biological, natural, and social sciences to address impacts of climate change on land, water, fish and wildlife, ocean, coastal, and cultural resources.

OU serves as the host institution to the South Central CSC. Located in Norman, Oklahoma, OU is known internationally for its expertise in atmospheric sciences and its 50-year partnership with NOAA. The Oklahoma Climatological, Biological, Geological, Archeological, and Water Surveys are integrated into OU and provide research, service, and outreach to the State. OU biologists, geographers, and ecologists have helped develop the Natural Heritage Program, National Vegetation Classification, and National Ecological Observation Network. The OU Biological Station is one of the largest field stations in the Nation and OU's herbarium includes more than 210,000 specimens. The Center for Applied Social Research at OU applies innovative concepts and methods in social sciences to advance complex, multifaceted organizational, policy, and public health research, including their relation to climate variability and change. OU leads the Southern Climate Impacts Planning Program in partnership with LSU, providing products and education on hazardous climatological events to stakeholders across a seven-state region.

TTU research focuses on the impacts of climate variability and long-term trends on the ecosystems and human systems of semiarid regions. This research has resulted in critical understanding of how climate change will alter ecosystem dynamics and services across important landscapes such as the South Central Region. TTU also has longstanding expertise in high-resolution climate projections, producing the dataset of statistically downscaled projections used by the U.S. Global Change Research Program's 2009 national assessment and contributing to the upcoming 2013 assessment.

The LSU School of the Coast and Environment and Department of Geography and Anthropology provide knowledge, technology, and human resources to successfully manage natural resources and resolve environmental issues important to Louisiana, the Gulf of Mexico region, and comparable areas throughout the Nation and world. LSU scientists contribute significant research in climate and environmental impacts related to wetlands, coastal processes, fisheries, pollution, toxicology and environmental policy and management to address the risks in Gulf of Mexico coastal habitats. LSU hosts the USGS National Wetlands Research Center Coastal Restoration Field Station, Louisiana Cooperative Fish and Wildlife Research Unit, the Water Resources Research Institute, the Southern Regional Climate Center (working with the National Climatic Data Center), and in partnership with OU, the Southern Climate Impacts Planning Program.

CN's jurisdictional territory includes 7,648 square miles (mi^2) of south-central Oklahoma and encompasses all of six and parts of seven different counties. CN is particularly interested in protection of water resources in the face of future climate change and variability. The award winning Chickasaw Cultural Center includes several water features that demonstrate the importance of water resources to the heritage and cultural traditions of the tribe.

CNO's jurisdictional territory includes 10,864 mi^2 of southeast Oklahoma and encompasses all of eight and parts of five different counties. With over 200,000 enrolled members, it is the third most populous tribe in the United States. CNO is particularly interested in protection of water resources in the face of future climate change and variability. CNO has hosted students from OU's Applied Climatology class in order to communicate the cultural and economic importance of water resources to the tribe. CN and CNO now collaborate on long-term water planning that examines the future of water quality

and quantity within south-central and southeast Oklahoma and includes both consumptive and nonconsumptive uses of water.

OSU is a leader in conducting research in agricultural and natural resource science that enriches and improves the lives of Oklahomans, communicating this research to the public and conducting adaptive training for both individuals and professionals. Recent funded research at OSU focuses on ecological costs of biofuels, carbon sequestration in prairies and forests, invasive plants and animals, and biodiversity. An ongoing project integrates research, education, and extension to enhance southern pine mitigation and adaptation under projected climate change.

The NOAA GFDL has been a world leader in the field of global climate model research, building and interpreting computer-based models relevant for society. GFDL's extensive research portfolio aims to improve current understanding and prediction of the behavior of the interconnected climate system—the atmosphere, ocean, ice, and land surface—as well as aspects of terrestrial and marine ecosystems. GFDL has contributed state-of-the-art global climate model projections and expertise to several U.S. and international climate assessment reports, including those of the Intergovernmental Panel on Climate Change (IPCC). GFDL hosts USGS's Continental Water, Climate, and Earth-System Dynamics project, co-locating USGS experts studying climate-water-ecosystem interactions with members of GFDL's climate modeling community.

South Central CSC Landscape Conservation Cooperative Partners

The South Central CSC was established in 2012 to address the regional challenges presented by climate change and variability in the south-central United States. As such, the center focuses on fulfilling science needs that apply across the entire south-central United States and providing regional-scale science products that can inform the local needs of the LCCs and other partners. The South Central CSC will provide scientific information, tools, and techniques that managers and other parties interested in land, water, wildlife, and cultural resources can use to anticipate, monitor, and adapt to climate change, actively engaging LCCs and other partners in translating science into management decisions. The following list of LCCs have part or all of their geography within the boundaries of the South Central CSC: Desert, Eastern Tallgrass Prairie and Big Rivers, Great Plains, Gulf Coastal Plains and Ozarks, Gulf Coast Prairie, and Southern Rockies LCCs (fig. 1). Each LCC encompasses a variety of landscapes and represents resources that are important both economically and culturally.

The Desert LCC covers parts of five States: California, Nevada, Arizona, New Mexico, and Texas, as well as part of northern Mexico. The area is topographically complex, including three deserts (Mojave, Sonoran, and Chihuahuan), grasslands and valley bottoms, and isolated mountain ranges. Hydrologically, the Desert LCC encompasses several important river systems, including those of the lower Colorado, Gila, Rio Grande, San Pedro, and Verde Rivers. The Colorado River and its tributaries alone provide water for almost 30 million people, irrigate nearly 4 million acres of land, provide hydropower across the southwest, and are also a vital resource for many Native American tribes.

The Eastern Tallgrass Prairie and Big Rivers LCC covers portions of 11 States, and extends from southwestern Ohio westward across to parts of eastern Kansas, Oklahoma, and Nebraska, and northward to parts of Iowa, South Dakota, and Minnesota. Historically millions of acres of forest and prairie were cleared for agriculture. Even though most of the LCC is in agricultural lands, there are many State or federally managed lands that provide habitat for a variety of terrestrial and aquatic species.

The Great Plains LCC encompasses parts of seven States, including Colorado, Kansas, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. Many of the most endangered habitats and species in the United States are found in this LCC, including temperate grasslands and the more than 2,000 associated native species of flora and fauna. Playas wetlands are found throughout the LCC, and serve as important habitat for up to 200 species. Additionally, the Great Plains LCC is underlain by the world's largest aquifer—the High Plains (Ogallala) aquifer. The High Plains aquifer is the most important water source in the Great Plains and is vital to the health and economy of the region.

The Gulf Coastal Plains and Ozarks (GCPO) LCC encompasses all of Arkansas and Mississippi and parts of 10 additional States, including Missouri, eastern Texas, and the Florida panhandle. The GCPO LCC is defined by the diversity of its geography and hydrology, containing mountain ranges (Ozark, Boston, and Ouachita), the alluvial valley of the lower Mississippi River, as well as hundreds of miles of Gulf coastline. Additionally, estuaries and wetlands in the region provide essential nursery habitat that supports economically important freshwater and marine fisheries. These landscapes and their variety contribute to the diversity of flora and fauna in the region, including many endemic aquatic species, plants, crayfish, freshwater mussels, and snails.

The Gulf Coast Prairie (GCP) LCC encompasses parts of five States: Kansas, Louisiana, Mississippi, Oklahoma, and Texas, as well as parts of the northeastern Mexico coastline. The region spans several large river systems, including those of the lower Rio Grande, Guadalupe, Brazos, Trinity, Nueces, Arkansas, Red, San Antonio, and Mississippi Rivers. The GCP LCC includes coastal Texas, Louisiana, portions of Mississippi and coastal Mexico, containing fresh, intermediate, and salt marshes; bays and lagoons, which support extensive seagrass beds, tidal flats, and reef complexes; and barrier islands. The coastal area also contains the Laguna Madre, which is the second largest hypersaline lagoon in the world and a wintering habitat to millions of North American migratory waterfowl. Grasslands were the dominant ecosystem in the GCP LCC region but have been mostly lost to urban and agricultural development. The GCP LCC region still supports abundant

wildlife, however, including endangered species such as the ocelot (*Leopardus pardalis*); Attwater's prairie chicken (*Tympanuchus cupido attwateri*); over 300 butterfly species; more than 500 bird species, including the interior least tern (*Sternula antillarum)*, aplomado falcon *(Falco femoralis),* and black-capped vireo *(Vireo atricapilla)*; and a number of native plant species, including the endangered Texas ayenia (*Ayenia limitaris),* South Texas ambrosia *(Ambrosia cheiranthifolia)*, star cactus *(Astrophytum asterias),* Walker's manioc *(Manihot walkerae),* ashy dogweed *(Thymophylla tephroleuca),* and Zapata bladderpod *(Lesquerella thamnophila)*.

The Southern Rockies LCC encompasses part of seven States, including Arizona, Colorado, Idaho, New Mexico, Nevada, Utah, and Wyoming. The region is geographically diverse, having a wide-range in topography that spans many mountain ranges, the Grand Canyon, desert basins, and the headwaters of the Colorado River and Rio Grande. Within the Southern Rockies LCC are several important ecosystems, including alpine tundra, subalpine and montane forests, pinyon-juniper woodlands, desert shrublands, and grasslands that support a number of sensitive species, including Uinta Basin hookless cactus *(Sclerocactus wetlandicus),* greater sage grouse (*Centrocercus urophasianus)*, several fishes, Gunnison prairie dog (*Cynomys gunnisoni*), bighorn sheep (*Ovis canadensis*), aspens, and yellow-billed cuckoo (*Coccyzus americanus)*.

Regional Context

The South Central CSC region represents all or part of six States and northeast Mexico (fig. 1) and covers five major physiographic divisions—the Atlantic Plain, Interior Plains, Interior Highlands, Intermontane Plateaus (Colorado and Basin and Range), and to some extent, the Rocky Mountain System (fig. 2; Vigil and others, 2000). The footprint of the South Central CSC represents a crossroads of ecosystem diversity, containing the Ouachita Mountains to the east and the Rocky Mountain foothills to the west, as well as the area in between, containing varied ecosystems that represent the desert, Great Plains, tallgrass prairies, and hardwood forests.

The Atlantic Plain is a broad expanse of low-relief landscape along the Gulf of Mexico and south Atlantic coasts, extending from Virginia to the Texas coast. Important ecologically in the region, it contains parts of the Mississippi River and the associated delta, as well as bays, estuaries, and the barrier islands associated with the Gulf Coast of Louisiana and Texas. Within the Gulf of Mexico, bays are large, open, and include extensive tidal flats, seagrass meadows, mangroves, and oyster reefs. The Gulf of Mexico is bordered by five U.S. States to the north (Florida, Alabama, Mississippi, Louisiana, Texas), give Mexican states to the west (Tamaulipas, Veracruz, Tabasco, Campeche, Yucatan), and the island of Cuba to the southeast.

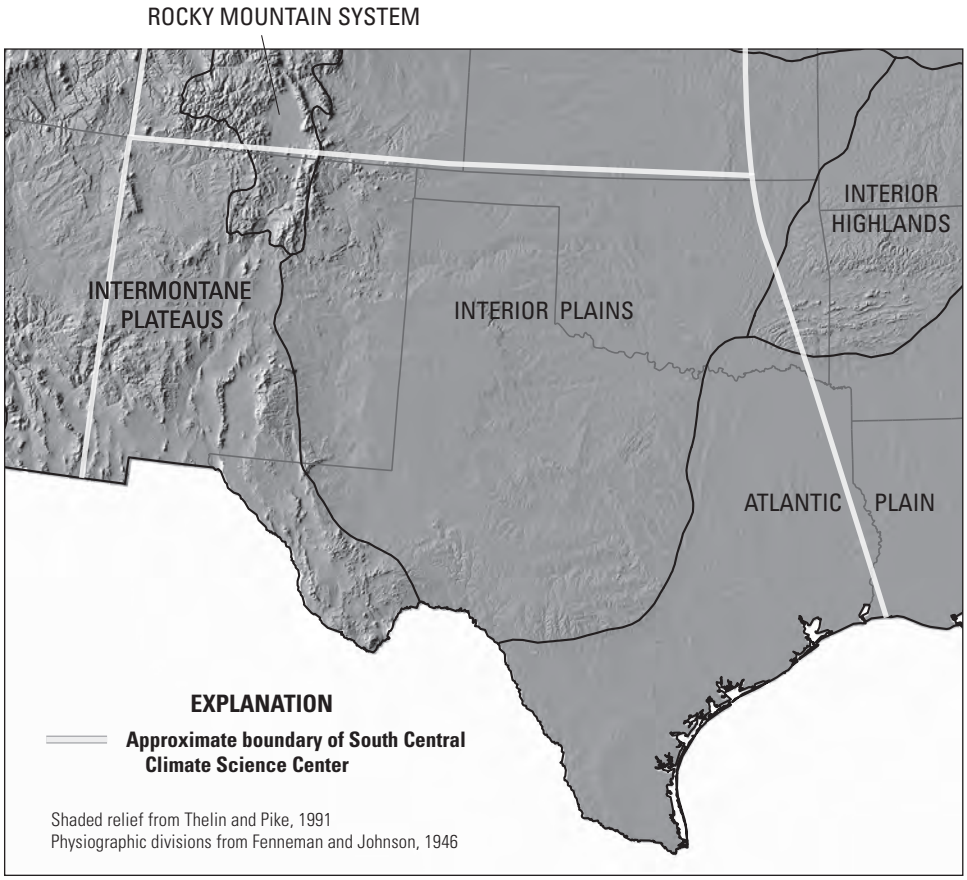


Figure 2. Physiographic divisions within the boundary of the South Central Climate Science Center.

The Interior Plains extend from central Texas into Oklahoma, and parts of New Mexico and Colorado. The Interior Plains were formed by deposition from shallow inland seas and sediments (from the Rockies to the north and the Ozark and Ouachita Mountains to the east) that were compressed into sedimentary rocks. The flatness of the Interior Plains is a function of the mostly marine and stream sediment deposition.

The Interior Highlands includes the inland mountain region of the south-central United States, from eastern Oklahoma into western Arkansas, and parts of Missouri and Kansas, including the Ozark and Ouachita Mountains (Fenneman and Johnson, 1946; Thelin and Pike, 1991; Vigil and others, 2000). The Intermontane Plateaus in the South Central CSC region—specifically, the Colorado Plateau and Basin and Range Province—extend from southern Colorado through New Mexico into west Texas. The Basin and Range province is characterized by shifts in topography that alternate between narrow mountain chains and flat arid valleys. The Colorado Plateau, centered on the four corners area of Colorado, New Mexico, Utah, and Arizona, consists mostly of deserts and isolated forests and contains the greatest number of national parks in the United States.

The humid subtropical climate of the southeastern part of the region, in combination with diverse landscapes, vegetation, and hydrology, contribute to produce a region rich in aquatic and terrestrial flora and fauna. The central and western parts of the region were historically dominated by arid deserts, temperate grasslands, savannas, and shrublands, most of which have since been converted to agricultural lands.

Prior to European settlement, the region's landscape was dominated by upland forests, grasslands, and wetlands to the east and prairies, deserts, and arid forest to the west—all bounded by mountains to the east and west. Longleaf pine was the dominant forest species of the eastern part of the region, although by 1980, less than 2 million of the original estimated 90 million acres of longleaf pine remained (U.S. Fish and Wildlife Service, 2010). Forests of oak, gum, and cypress are still common, although most of the bottomland forests have been converted to agriculture. Roughly half of the wetlands in the region have been converted to other land uses (Hefner, 1994); even with these losses, much of the remaining wetlands in the United States are located in the region and nearby coastal areas (U.S. Geological Survey, 1996).

Populations in Gulf of Mexico coastal counties increased 150 percent between 1960 and 2008, adding approximately 8.4 million people (U.S. Census Bureau, 2010). Between 1980 and 2003, coastal counties in the region showed the largest rate of population increase (58 percent) of any coastal region in the conterminous United States (Laporte and others, 2010). Future projections indicate that populations along coastal counties in the south-central United States will increase another 15 percent by 2030 (National Oceanic and Atmospheric Administration, 2011).

The South Central CSC region also has a very rich tribal presence and culture that has already been, and will continue to be, affected by climate change. Oklahoma is home to 39 Federally Recognized Native American Tribes, most of whom were forcibly relocated from their native homelands to "Indian Territory." New Mexico is home to 18 pueblos and 6 tribes who have occupied the region for thousands of years. Texas has three federally recognized tribes. The hispanic population of Texas settled in the area prior to the 1836 revolution and the Mediterranean-African roots of Louisiana's Creole and Cajun cultures are unique to the South. The diversity of historical populations, many of which are still active, in the south-central United States have left a wealth of archeological resources that may be affected by climate change. Examples of archeological and ethnographical resources in the region that may be affected by climate change include both prehistoric and historic submerged sites and shipwrecks; terrestrial prehistoric and historic encampments, midden dumps, home sites, villages, and ceremonial sites; battlefields; historic homesteads, farms, plantations, and production sites; and historic and prehistoric structures.

Climate and Land-Use Change

The U.S. Global Change Research Program most recent national assessment, Global Climate Change Impacts in the United States (2009), outlined several regional climate and land use change issues that will affect the south-central United States in the future:

- Projected effects of changes in temperature, evaporation, and drought frequency will increase competition for the region's declining water resources.
- Agriculture, ranching, and natural lands, already under pressure due to an increasingly limited water supply, are likely to also be stressed by rising temperatures.
- Climate change is likely to affect native plant and animal species by altering key habitats such as the wetland ecosystems known as prairie potholes or playa lakes.
- Ongoing shifts in the region's population from rural areas to urban centers will interact with a changing climate, resulting in a variety of consequences.
- Water supplies will become increasingly scarce, calling for tradeoffs among competing uses and potentially leading to conflict.
- Increasing temperature, drought, wildfire, and invasive species will accelerate transformation of the landscape.
- Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure.
- Projected increases in air and water temperatures will cause heat-related stresses for people, plants, and animals.
- Sea level will rise and hurricane intensity and associated storm surge are likely to increase.

Observed Climate Change

Long-term temperature records in the south-central United States show that average annual temperatures have not changed significantly during the last century; since 1961 however, average annual temperature has increased by almost 2 degrees Fahrenheit (°F; fig. 3). During this same period, the greatest changes in average annual temperature occurred during the winter months, and the number of freezing days per year decreased.

Although precipitation records for 1958–2008 show a general regional increase in annual rainfall from 5 to 20 percent (fig. 4), precipitation patterns during this period indicate changes in the frequency and intensity of storms and a regional increase in the occurrence and severity of droughts since 1970 (U.S. Global Change Research Program, 2009). Increased sea-surface temperatures since 1970 have been accompanied by the increased destructive potential of hurricanes making landfall in the region, although changes in the frequency of hurricanes making landfall has not been established (U.S. Global Change Research Program, 2009).

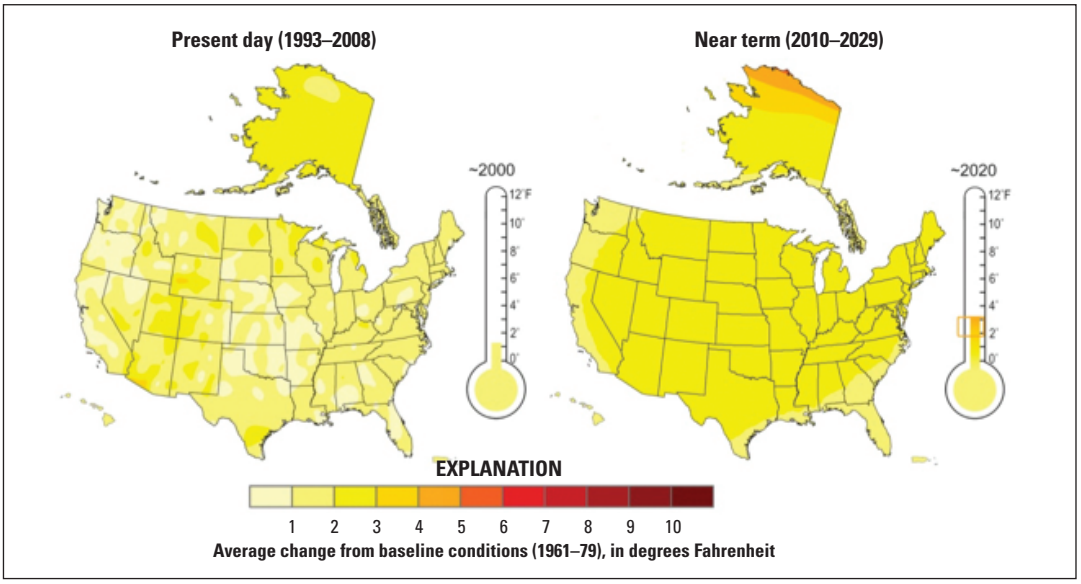


Figure 3. Observed changes in temperature from baseline conditions (1961–1979) to present (1993–2008) and near-term conditions (2010–2029; from U.S. Global Change Research Program, 2009).

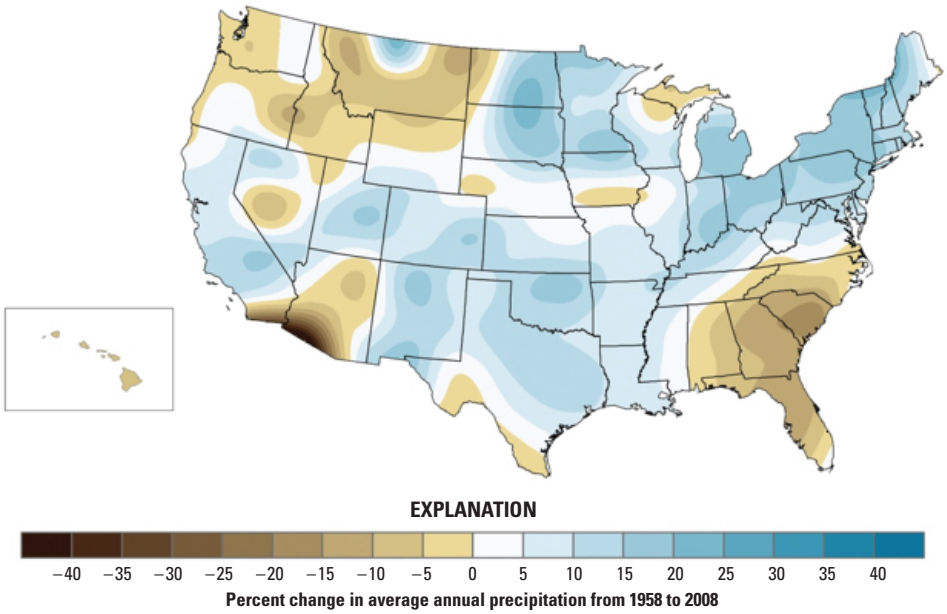


Figure 4. Observed changes in average annual precipitation, 1958–2008 (from U.S. Global Change Research Program, 2009). Although U.S. annual precipitation has increased about 5 percent during the past 50 years, there have been important regional differences as shown above.

Projected Climate Change

Temperature projections from both the IPCC's Fourth Assessment Report (Parry and others, 2007) and the second national assessment (U.S. Global Change Research Program, 2009) indicate continued warming for all seasons across the south-central United States along with increased rates of temperature increases through 2099. Projected rates of warming are twice the rates of temperature increases experienced in the region since 1975, and the greatest temperature increases are projected to occur during the summer months. The number of days with peak temperatures over 90 °F is predicted to increase at a greater rate than average temperature (fig. 5). Temperature projections vary based on emission scenarios; lower emission scenarios project an average temperature increase of about 4.5 °F by 2099, whereas higher emission scenarios project an average annual temperature increase of about 9 °F, including a 10.5 °F increase in summer and a much higher heat index for the southern United States (U.S. Global Change Research Program, 2009). Climate models also project a continuing decline in days below freezing across the entire region during the coming decades.

Climate models provide divergent results for future average annual precipitation for most of the south-central United States; however, the ensemble of models used by the IPCC (Parry and others, 2007) and the U.S. Global Change Research Program (2009) predict that south-central States will tend to have less rainfall overall (fig. 6), with the greatest reductions occurring in winter and spring. Because corresponding predicted temperature increases will lead to increased evapotranspiration, moisture deficits and droughts are likely to continue to increase (U.S. Global Change Research Program, 2009).

Sea-surface temperature is projected to increase globally as the oceans absorb increasing heat energy from corresponding projected annual increases in air temperature. Tropical storm and hurricane intensities are likely to increase in the Atlantic hurricane-formation region as a function of globally observed higher sea-surface temperatures (Parry and others, 2007; U.S. Global Change Research Program, 2009). If the intensity of Atlantic tropical storms increases, ecosystems in the Gulf of Mexico region likely will be exposed to higher peak wind speeds, rainfall intensities, storm surges, and wave heights.

Predicted average annual temperature increases are likely to increase the rate that land ice melts; global average mean sea levels are expected to increase up to 2 feet or more by 2100 (U.S. Global Change Research Program, 2009). A potential increase in the rate and magnitude of sea-level rise has serious implications for low-lying coastal wetlands and barrier islands. Many coastal environments along the Gulf of Mexico have undergone land-surface subsidence due to groundwater withdrawals, changes in sediment delivery by rivers, and the drainage of soils for coastal development. Even if hurricanes do not increase in intensity, an increase in mean sea level will amplify coastal inundation and erosion during hurricane landfall.

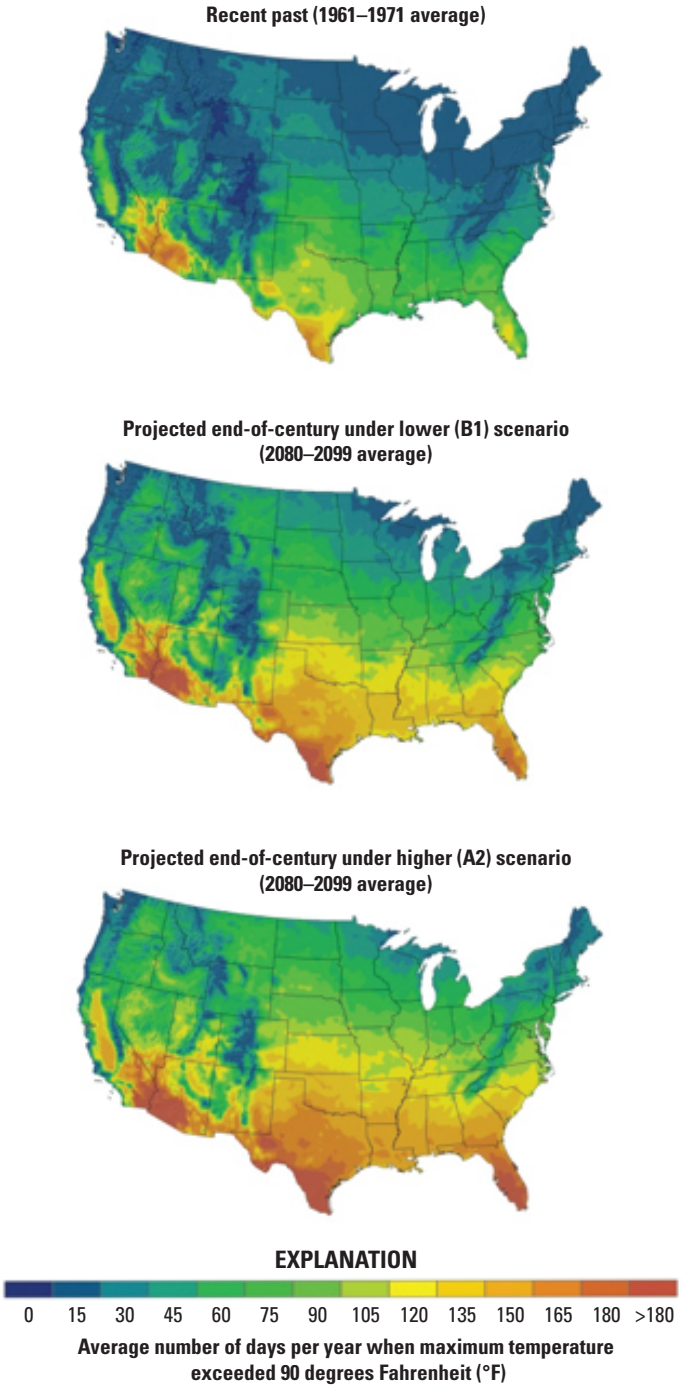


Figure 5. Projected changes in temperature from current records to projections in 2099 (from U.S. Global Change Research Program, 2009). Much of the southern United States is projected to have more than twice as many days per year above 90 °F by the end of this century.

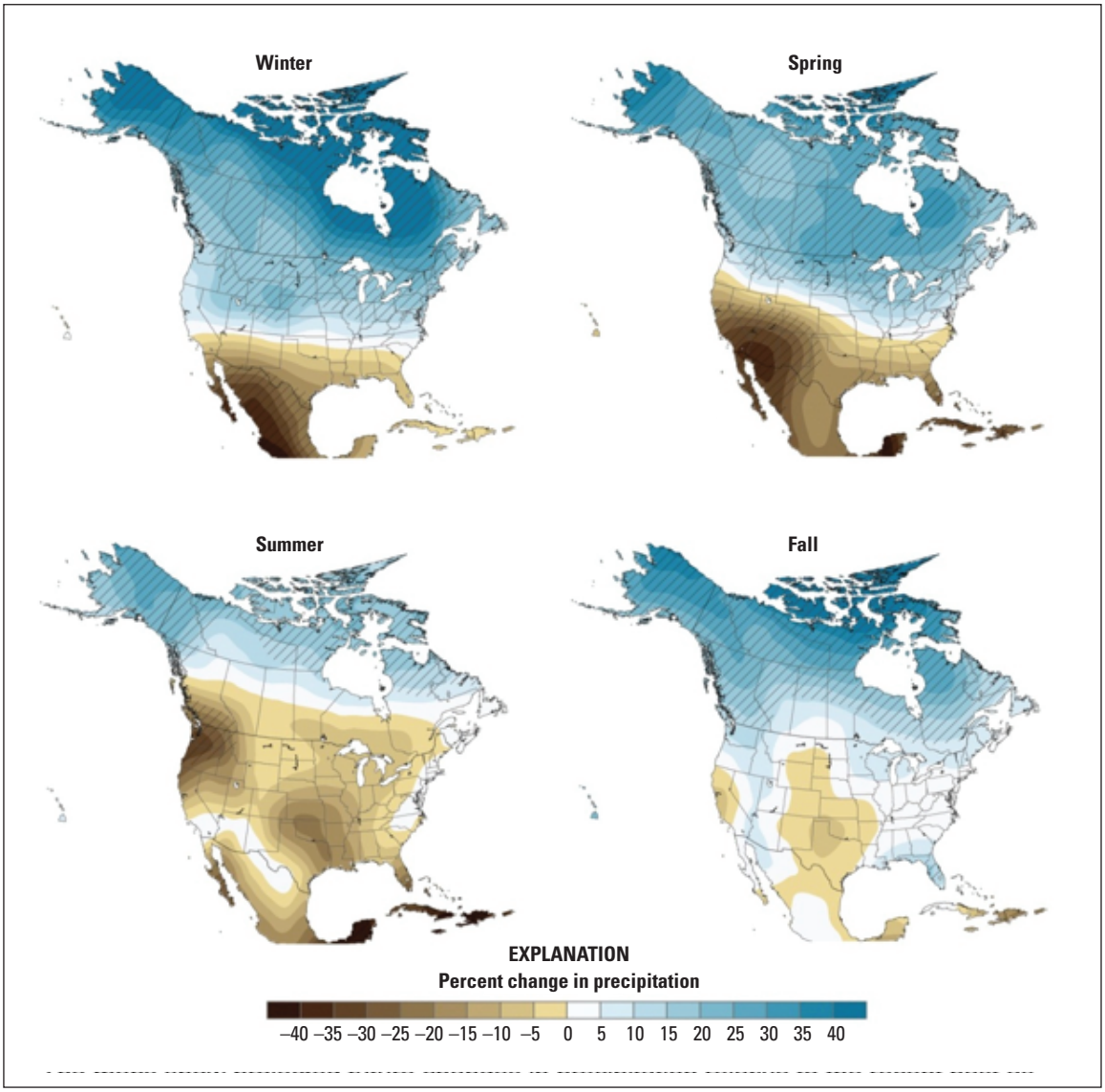


Figure 6. Projected change in North American precipitation by 2080–2099 as simulated by an ensemble of 15 climate models under the Intergovernmental Panel on Climate Change A2 emission scenario (from U.S. Global Change Research Program, 2009). In the spring, climate models agree that northern areas are likely to get wetter, and southern areas drier. There is less confidence in exactly where the transition between wetter and drier areas will occur. Confidence in the projected changes is highest in the hatched areas.

Currently, 5,000 mi² of dry land are within 2 feet of mean sea level in coastal areas of the conterminous United States. Although the majority of this land currently is undeveloped, coastal development in the south-central United States is predicted to increase (National Oceanic and Atmospheric Administration, 2011; U.S. Environmental Protection Agency, 2011; Laporte and others, 2010), and any terrain within a few feet above mean sea level could be inundated (fig. 7; U.S. Environmental Protection Agency, 2011). Currently, sea levels are rising at a rate of 0.07 inch per year. IPCC (Parry and others, 2007) predictions of future sea-level rise through 2100 are between 0.6 and 2 feet. Impacts of rising sea levels include coastal erosion; coastal inundation, including wetlands; increased storm surge; loss of habitat, property, and cultural resources; and degraded surface and groundwater quality. Highly productive coastal wetland ecosystems are particularly vulnerable to sea-level rise (Parry and others, 2007; U.S. Environmental Protection Agency, 2011). These ecosystems provide habitats for many species, act as filters to improve groundwater and surface-water quality, provide an economic base for many coastal communities, offer recreational opportunities, and protect local areas from flooding.

Projected changes in temperature, precipitation patterns, tropical-storm intensity, and sea-level rise over the coming decades have serious implications for human communities and natural resources in the south-central United States. The warming projected during the next 50 to 100 years will create heat-related stress on people, agricultural crops, livestock, trees, transportation and other infrastructure, fish, and wildlife. Seasonal changes in precipitation patterns, coupled with increased temperature and evapotranspiration, could have widespread and significant effects on water resources, ultimately affecting fish and wildlife resources and the people who depend on them. Based on historical and projected patterns of land-cover change in this region, land-use change and other human development impacts are likely to amplify the adverse effects of climate change on habitats and species.

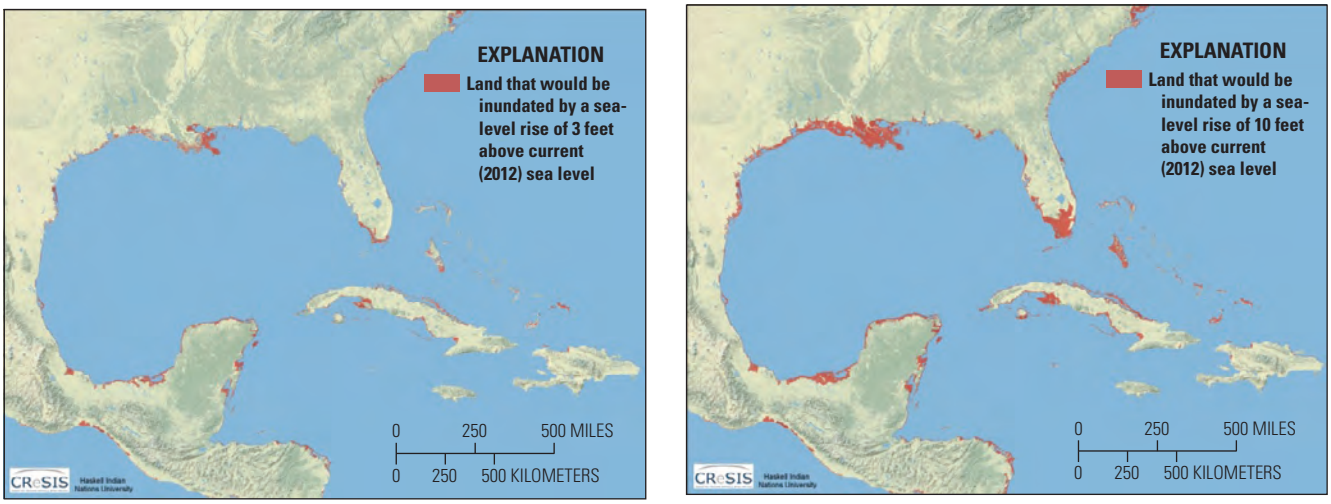


Figure 7. Projected land areas in the southern United States that would be affected by a sea-level rise of *(A)* 3 feet and *(B)* 10 feet (Center for Remote Sensing of Ice Sheets [CReSIS], 2011).

Land-Use and Land-Cover Change

The U.S. Global Change Research Act of 1990 defines global change as "changes in the global environment (including alterations in climate, the land surface and its biological productivity, oceans or other water resources, atmospheric chemistry, and ecological systems) that may alter the Earth's capacity to sustain life" (U.S. Congress, 1990). Understanding how land-use change interacts with other climate-change drivers to influence ecosystems and ecosystem services may prove to be more important in the south-central region of the United States than other regions because of its ecosystem diversity. Most of the region experienced some change in land use during the 1973–2000 period (up to 34 percent; fig. 8), attributable mostly to agricultural, forest-industry practices, and urban growth. In the south-central United States, agricultural lands have recently been lost to urban growth. Development is predicted to accelerate across the region, resulting in the potential conversion of both agricultural and forested lands to urban environments (Loveland and Acevedo, 2010).

Increased temperatures and changes in precipitation patterns are projected, which also may affect land-use patterns in the south-central United States. Predicted climatic changes could reduce the net primary productivity (that is, the net amount of carbon fixed by green plants over the course of a year) of southern pines. Model results indicate that southern hardwoods will be much more productive than southern pines and that forest productivity will shift northward. As a result, agricultural productivity is expected to increase in areas where forest productivity is reduced (U.S. Global Change Research Program, 2009).

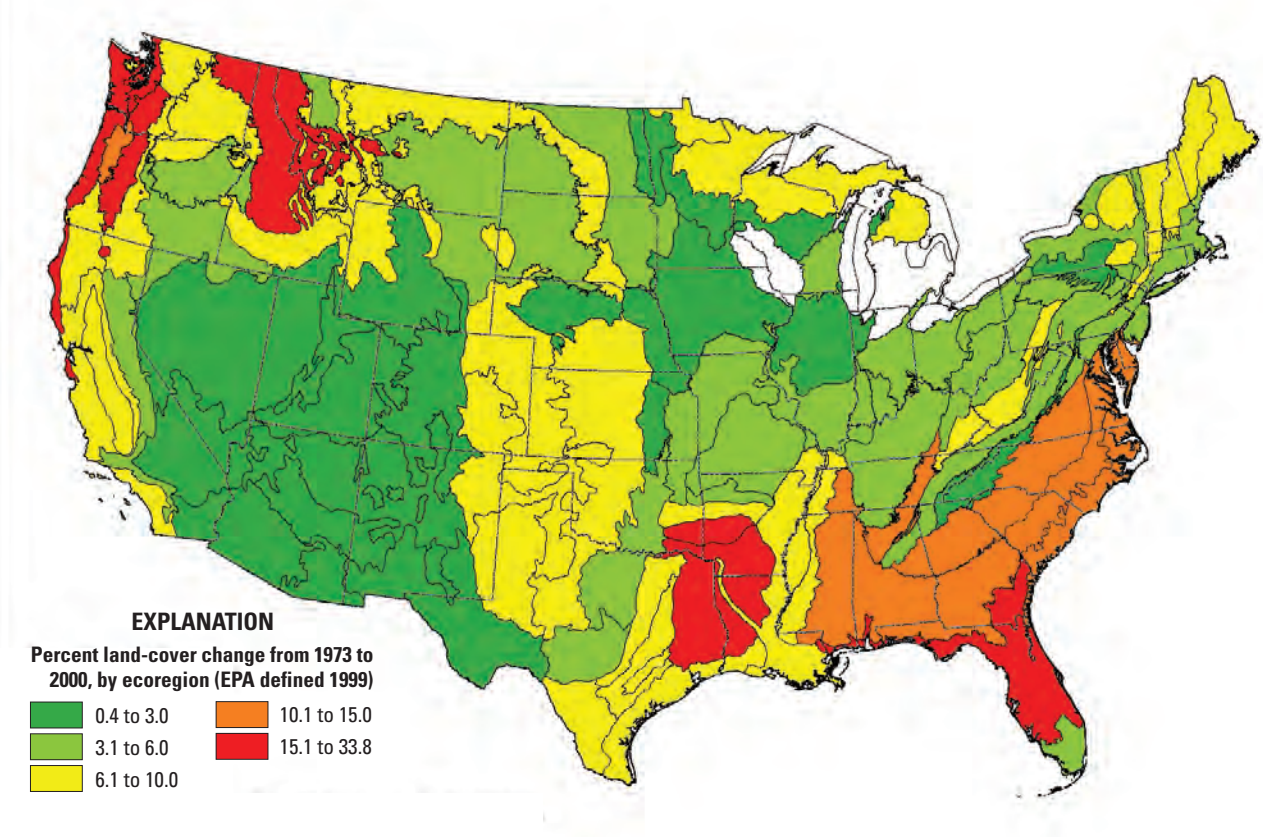


Figure 8. Summary of trends in U.S. land cover change, 1973–2000 (source, USGS Earth Resources and Observations Science Center, 2011; EPA, U.S. Environmental Protection Division).

South Central CSC Science Planning

Spatial and temporal changes in the south-central's climate are linked to changes in biodiversity; key wildlife feeding, breeding, and nesting habitats; water quantity and quality; wetland quality and extent; coastal erosion and inundation; stream sedimentation and flow; range and density of heritage and invasive species; cultural and natural landscapes; pathogen outbreaks; and health of ecosystem services. Changes in the region also result from other stressors, and responses to climate change must be examined in combination with land cover/land-use change, habitat fragmentation, increasing population, pollution, invasive species, increasing demand for natural resources, and other relevant stressors that resource managers must address in adaptation and mitigation planning.

The process used to develop this Strategic Science Plan included an effort to identify the climate-change related management needs that State, Federal, and non-governmental partners of the South Central CSC have previously identified as issues or science products they need now (or in the near future) to develop conservation, adaptation, and mitigation plans. These priorities and their derivation are provided in appendix 1. As a science need and (or) issue was mentioned in a partner publication (for example, agency strategic planning documents, State wildlife action plans, and LCC operational plans) it was tallied and then ranked according to frequency of inclusion in reference materials; the 10 most frequently mentioned science needs or priorities are the framework for this plan (table 1–1). Continued involvement from partners in the science planning process will ensure that the document and its science priorities are more responsive and relevant to the needs of the conservation community into the future. This plan is intended to serve as a 5-year Strategic Science Plan that will be updated and modified to account for evolving partner's needs as they change in response to research developed as part of the South Central CSC annual science planning process.

Annually, the South Central CSC will produce a project plan that outlines the process and development of research goals for each fiscal year. This annual project plan will be developed in cooperation with the SIP and will rely on partner input in the solicitation of research proposals. The annual science planning process will typically address priority issues identified in the 5-year Strategic Science Plan; however, there may be instances in which a new issue or need evolves prior to the 5-year plan update, these instances will be accounted for in the annual planning process.

South Central CSC Science Priorities

The South Central CSC Strategic Science Plan identifies the 10 most frequently identified science priorities already recognized by partners in the region's conservation community. These science priorities will help address information gaps that can be used to inform the conservation science and resource-management needs of ecoregional conservation partnerships, such as the LCCs. The priorities presented here will evolve and be modified through an adaptive management approach that incorporates observed results and management assumptions developed by resource managers at various spatial scales. The South Central CSC will provide the scientifically valid information needed to manage ecosystems and cultural resources, thus maximizing their values in a changing climate. This will be accomplished by providing models of future conditions, assessments of potential impacts, and other products used to inform the decision-support tools developed by LCCs and other partners, allowing resource managers to anticipate and develop adaption strategies to climate change. This Strategic Science Plan is intended to prioritize the basic or applied research required to move data and models from the research environment to the operational environment where they are needed most.

In order to understand the degree to which natural and cultural resources in the region may be affected by climate change, the South Central CSC also will provide support for vulnerability assessments conducted for natural and human systems. Derivative products developed by the CSC, such as numbers of freeze days or fire frequency, provide valuable information for finer-scale conservation planning. The South Central CSC will share derivative products and engage in finer-scale planning efforts related to vulnerability. By comparison, conservation science partnerships, such as LCCs, can use CSC assessments and derivative products in conducting vulnerability assessments for specific natural or cultural resources.

The following is a list of the 10 most frequently recognized science priorities or issues for South Central CSC partners. Within each category is a list of specific projects or research needs given as examples by partners in their documentation. This list is intended to provide the framework for the South Central CSC's annual planning process; however, it does not limit the South Central CSC research agenda to only these items; the Director in consultation with the SAC and SIP, will have final authority to determine the annual science agenda.

1. Climate Change Adaptation, Mitigation, Resiliency, and Vulnerability Assessments

- Identify species, fauna and flora, or ecosystems of immediate concern ("hotspots") for adaptation or mitigation as a result of climate and land-use change.
- Evaluate the specific factors that affect species and (or) ecosystem vulnerability and (or) resiliency to climate change.
- Assess the impact of human populations and development, in response to global change, on priority species and ecosystems.
- Identify changes to species populations in support of vulnerability assessments and adaptation strategies.

2. Climate Change Effects on Ecosystems

- Evaluate the effects of predicted ecosystem changes on community structure and functioning caused by land use and (or) climate change.
- Evaluate current and predicted landscape change and other implications of climate change on priority species and habitats, including imperiled or unique ecosystems.
- Develop species-habitat global-change response models for both terrestrial and aquatic priority species.
- Evaluate impacts of coastal erosion and sea-level rise on shorebird and other priority species and their habitats.
- Evaluate the interactive and cumulative impacts of nonpoint source pollution, human disturbances, and climate variability on ecosystem dynamics and species responses.

3. Hydrologic Response to Climate Change

- Evaluate the effects of climate change on aquatic systems, including stream temperature, water availability, water quality, aquatic health, ecohydrology, and management alternatives.
- Evaluate the effects of climate change on groundwater and surface-water interactions.
- Determine the impact of groundwater development on groundwater-dependent habitats.
- Evaluate the combined (nonlinear) impacts of climate change and land-use change on regional hydrology.

4. Climate Change Effect on Human Populations, Socioeconomics, Urbanization, Cultural Resources, and Agricultural Issues

- Evaluate future water availability and distribution for use by the competing needs of native species and human populations, including uses for agriculture and natural resources.
- Determine the extent to which climate change may impact traditional cultural uses of resources such as recreation, hunting, fishing, ceremonies, sacred sites, and so forth.
- Evaluate the extent to which climate change will impact Native American Communities, including associated populations of plant and animal species and water resources.
- Evaluate impacts of new energy development intended to mitigate the effect of climate change on the environment; in particular, wind, solar, and geothermal-energy development on native lands and develop models of future nontraditional energy development.
- Evaluate the types of information policy-makers in the region utilize in making decisions concerning potential climate impacts.
- Evaluate the impacts of climate variability on patterns of biodiversity associated with green space in urban areas.
- Initiate science education opportunities that address issues concerning climate variability and human adaptation and response in the south-central region.

5. Improved Monitoring Networks for Resources Affected by Climate Change and Management Actions

- In cooperation with partners, work to increase monitoring of species distribution and abundance in support of vulnerability assessments.
- Update, expand, and improve the application of existing land-cover classification systems for priority habitats.
- Improve inventories of endemic species of imperiled habitats.
- Determine the extent, connectivity, and health of ecosystems across the region as focal landscapes for understanding current and future responses to climate.
- Develop and coordinate long-term monitoring stations to detect changes in physical and biological indicators of climate change and sea-level rise.

6. Improved Management and Sharing of Climate Change and Geospatial Data

- Improve the functionality and compatibility of datasets across geographic areas.
- Create user-friendly databases and simplify access to data.
- Develop consistent geospatial datasets for assessing habitat characteristics.
- Develop life-history databases for priority species across the region.
- Determine effective processes for the communication of climate information to enhance policy decisions.
- Evaluate the linkages between available climate data across the region and the ability of the data to be extrapolated to a larger context.

7. Imperiled and Rare Communities and Invasive Species

- Evaluate the impacts of projected climate change on future distributions of invasive species.
- Evaluate the potential impacts of invasive species response to climate change on vulnerable plant and wildlife communities.
- Determine the effect of climate change on the movement of invasive species.
- Evaluate the vulnerability of imperiled or rare habitats to climatic changes using population and habitat models and decision-support tools.
- Evaluate the impacts of climate change on imperiled or unique ecosystems.

8. Coastal Response to Sea-Level Rise and Changing Geomorphology

- Develop consistent models of sea-level rise and inundation across the Gulf coastal region.
- Refine existing sea-level-rise models to incorporate local variables affecting outcomes of sea-level rise such as inundation, erosion, and subsidence.
- Improve sea-level rise and inundation predictions by incorporating seamless LiDAR.
- Evaluate the impact of mangrove migration on sea-level rise and coastal erosion.
- Develop decision-support tools (for example, mapping products) to project changes in marsh, oyster reef, and SAV locations; to predict wetland stability; to identify ideal restoration locations for marsh and oyster habitats; and to predict coastal-erosion rates for shorelines.
- Determine and predict the physical impacts of climate change on coastal and upland areas in terms of (1) sea-level change, (2) rate of elevation change, (3) shoreline change, (4) loss of barrier islands, (5) the role of coastal development in preventing migration of marshes and other habitats, and (6) inland, coastal, and ocean hydrology, and apply this knowledge to habitat-restoration efforts.
- Develop an understanding of coastal and marine natural processes, such as sediment transport, currents, and shoreline retreat, and the spatial variability of future sea-level rise.

9. Biological Response to Climate Change and Disturbance, Conservation Design and Delivery

- Develop species-response models for priority and focal aquatic and terrestrial species that predict occurrence and persistence.
- Develop effective techniques to restore impacted ecosystems or populations.
- Develop decision-support tools for resource managers to use in developing management plans for species or habitats.
- Develop conservation strategies for landscape impacts by disturbance.
- Evaluate the economics of conservation design and delivery projects required to adapt to current and predicted global changes.
- Develop a conservation design prioritization tool for ecosystems, corridors, and watersheds.

10. Land-Use and Land-Cover Change

- Develop land-use and land-cover-change models that predict spatial and temporal changes to ecosystems.
- Evaluate the effect of changing land use and land cover on the connectivity and fragmentation of habitats.
- Evaluate the effects of disturbance on ecosystems.
- Incorporate the potential of communities to develop smart-growth initiatives into future planning into urban-growth models.
- Identify ecosystems that will, or currently do, require restoration efforts.

Although not identified by partners in the South Central CSC as one of their top 10 science priorities, CSCs nationwide have recognized the importance of improving our understanding of climate-model limitations, as well as improving and communicating the uncertainty associated not only with climate science but modeling in general. The South Central CSC will work to expand research into better understanding the uncertainties surrounding climate science, reduce those uncertainties, and factor uncertainty into climate tools. Additional priorities for this task include:

- Studies to reduce the large uncertainty in precipitation projections for the region, especially on convective and nocturnal precipitation.
- Understanding seasonal and interannual variability of climate and how to develop projections for this large signal (compared to smaller mean annual trends).
- Quantifying and communicating scientific uncertainties.
- Compiling a comprehensive paleohydroclimatic study that describes how the region has changed historically under climatic impacts beyond the range of changes seen during the instrumental period.

The complexity and magnitude of these priorities and challenges demands that the conservation community work together to develop integrated adaptation and mitigation strategies that collectively address the impacts of climate change and other landscape-scale stressors. The research and science are necessary to understand how climate change will affect the basic assumptions routinely used by conservation planners and managers, how it will alter important ecosystem drivers, and how it will change management strategies. By actively engaging the LCCs and other partners, the South Central CSC can provide scientific information, tools, and techniques so that managers and other parties can translate science into management decisions. Working together, the South Central CSC, the Consortium of Universities and Partners, and the land-management community can address these priorities to understand the south-central United States within the context of a changing environment.

Monitoring Priorities

Data from monitoring networks are a critical resource for the South Central CSC and LCC partners; scientific research, management decisions, and the evaluation of management outcomes all depend on data collected at the appropriate scale and frequency. Historical and contemporary observations and future predictions of climatic and biophysical factors, ecosystem conditions, and species distributions and diversity across the range of terrestrial and aquatic ecosystems in the region are critical for improving downscaling model performance; evaluating and refining models; detecting changes in physical conditions, ecosystems, and populations; and monitoring the outcomes of management and restoration activities. Although the CSCs are not tasked with maintaining monitoring programs, they will assist LCCs and other partners by helping to identify monitoring priorities and strategies for the regions that build upon the current monitoring and assessment activities and create an awareness of the current and future information needs associated with science, management decisions, and evaluation needs. The South Central CSC will work with partners to ensure that data-management strategies, resources, and systems associated with data collected as part of CSC-funded science activities are compliant with DOI-wide information standards.

Information Management and Data Sharing

The South Central CSC will be involved in generating, integrating, and disseminating data that will help resource managers develop adaptation strategies in response to changes that are induced or exacerbated by climate. The South Central CSC's science program must be of the highest quality, with results viewed as unbiased, based on sound science, and useful to resource managers. To maintain high-quality research, the South Central CSC will implement strict procedures for reviewing proposals, avoiding conflicts of interest, and protecting confidential information.

Serving and archiving data and research outputs are critical aspects of CSC activities. South Central CSC data-management activities will comply with the guidance, policies, and standards identified in the national NCCWSC/CSC Data-Management Policy and the NCCWSC/CSC Data-Sharing Policy (*https://nccwsc.usgs.gov/content/data-policies-and-guidance*), both of which build on DOI and other government-wide policies. A national data-management strategy is needed to ensure that appropriate standards, consistent guidelines, and strategies are used to allow links to (and consistency with) other systems, which will foster a true national CSC network. Maximum efforts will be made to ensure the utility of the systems and data to LCCs in the region as well.

In implementing the NCCWSC/CSC information-management and data-sharing policies, the South Central CSC will leverage current resources of the Consortium, its partners, and the overall CSC network to the maximum extent possible. This includes computing assets, storage capabilities, and specialized analysis and visualization resources. In addition, as the South Central CSC identifies regionally-specific data or information needs, these needs will be aggregated with those of the other CSCs to identify important national priorities.

Some specifics of the data requirements include the following:

- All data associated with the CSC will be fully accessible.
- Data must be provided by all researchers funded by the CSC in regular, defined intervals and not simply at the end of respective projects.
- When research is completed, the South Central CSC expects significant findings to be promptly submitted for publication, with authorship accurately reflecting the contributions of those involved.
- Publications will be targeted toward outlets having maximum impact and visibility.
- Investigators will be required to share with other researchers, within a reasonable time, the data, samples, physical collections, and other supporting materials created or gathered.
- For continuing observations or long-term (multiyear) projects, data should be released to the public at routine intervals.
- Data for ongoing projects (particularly those of students) can be password protected, but must be provided.
- Annual reports will be required for all projects. These reports will address progress on the sharing of data and research findings.
- The South Central CSC will comply with Federal requirements for the protection of intellectual property, including patents, inventions, and copyrights.
- The South Central CSC will comply with all Federal, State, and tribal requirements to protect sensitive data against unintended public release in accordance with current data-protection policies.
- The South Central CSC, as feasible and appropriate, will expedite access to, and sharing of, its facilities and equipment to reduce costs, increase efficiency, and avoid duplication of effort.

Data management and integration will be greatly facilitated by infrastructure investments previously made by NCCWSC and DOI. The GeoData portal (*http://cida.usgs.gov/gdp/*) is a Web-delivered computer application for identification, selection, extraction, processing, quality control, and formatting of spatio-temporal data for modeling applications. The purpose is to bring modelers (researchers who require input datasets for their models) and data providers (researchers who process, synthesize, or otherwise provide information that can be used by the modelers) together in a common framework. Although the initial intent of the GeoData portal is to disseminate the high-resolution national climate change dataset, the platform and framework of the portal will support other data-dissemination needs of the South Central CSC.

Science Resources and Skills

The South Central CSC will target science and administrative staff with skills necessary to meet the science priorities outlined in this strategic plan. Scientists will be recruited who have complementary skills to those existing at the Consortium and USGS Science Centers. Other science skill sets that may be available to the South Central CSC from Federal and State agencies, academia, and non-governmental organizations will be considered, and efforts will be made to fully utilize existing science staff. The goal is to have a combination of permanent hires, rotational term appointments, Interagency Personnel Agreements (IPAs), and other administrative options to recruit and maintain a highly skilled science and administrative staff. By using several administrative mechanisms to obtain high-quality staff, the South Central CSC can remain flexible and responsive to partners' needs. The South Central CSC will work with LCCs, the Consortium, and other partners to target science staff hiring to benefit the CSC as well as other partners.

Cooperative Research and Decision Support

The South Central CSC will seek to leverage its investments in science capacity, projects, and data with its partners in the research and resource-management communities to the maximum extent possible through communication and coordination with those groups. It will seek out, at every opportunity, cooperation and collaboration with other institutions doing complementary work so as to minimize redundancies and to integrate their efforts and products into the science needs identified by the South Central CSC SAC. The South Central CSC will seek to bring the collective knowledge of the science community into the decision framework of the agencies involved in the development of climate-change adaptation strategies, including the development and testing of novel ways of framing and presenting information for climate-sensitive decisions. Developing the decision-support tools in cooperation with the LCCs and other resource partners is a critical step in the success of this task

Education and Training

A key resource in dealing with the challenges posed by global change in general, and climate change more specifically, is the need for individuals trained in rigorous approaches to investigating the science of climate change. The South Central CSC will not only support research that is useful to those who live and work in the region but will also work with the Consortium to train undergraduate and graduate students in the skills necessary to research and communicate about climate-change science.

Undergraduate and graduate students will be educated and trained in the science of climate change by the Consortium; the South Central CSC staff will be instrumental in helping to train these students by providing research and mentoring opportunities. The CSC will play a role in mentoring students associated with the Consortium, exposing them to the latest scientific research providing the connections to partners working in applied and basic fields related to climate change. In some cases, the mentoring of students will be formal, whether through classes or co-advising students; in other cases, the mentoring will be more informal, and conveyed through talks and other forms of interaction. South Central CSC scientists will be fully integrated into scientific departments in such a way that these interactions and relationships are most fluid. Students who are trained in association with the South Central CSC will benefit greatly, but they also will be a benefit to the South Central CSC by providing high-quality work, collaborating outside of the CSC's existing connections, and communicating science to others.

Outreach and Community Involvement

The South Central CSC will readily and effectively communicate scientific findings and strategies with the LCCs and other partners. While developing and funding climate-related research in the region, the CSC will work closely with LCCs to ensure that science priorities for partners are being met. At the same time, it is imperative that research findings be communicated in a timely and efficient manner so that resource-management partners and the LCCs can begin synthesizing assessments and plan adaptive-management strategies through the use of the analytical and decision-making tools produced by the CSC.

Additionally, the South Central CSC and the Consortium are aggressively committed to reaching a broad public audience for communicating science news and results. The South Central CSC will use a Consortium developed Web site (*http://southcentralclimate.org/)*, in addition to the DOI site (*http://www.doi.gov/csc/southcentral/index.cfm*) as outreach tools for communicating climate-change science being conducted throughout the region. A key challenge in dealing with climate change is developing a public understanding of the sometimes complicated science of climate, climate change, and biological responses to climate change. The continued success of the South Central CSC and its mission is, at many levels, contingent on public understanding and support.

The South Central CSC is committed to providing scientific information in the most understandable and accessible form. All products of the South Central CSC will be disseminated to a wide audience, whether through the media, seminars, or symposiums. In addition, the South Central CSC will take advantage of current capabilities of their Web sites for science communication and outreach. The sites will feature profiles of climate-change scientists, highlights of current research in the region, and information about upcoming meetings, symposiums, and research opportunities. As part of the effort to train students and reach out to the public, the Web sites will serve as a hub for serving news about climate-change research to the public and as a tool to forge new relationships that facilitate communication of science across the south-central United States.

Selected References

Center for Remote Sensing of Ice Sheets (CReSIS), 2011, Sea-level rise maps for the Southeastern U.S.: Lawrence, Kan., The University of Kansas data products, accessed June 20, 2011, at *https://www.cresis.ku.edu/data/sea-level-rise-maps?quicktabs_3=3#quicktabs-3*.

Fenneman, N.M., and Johnson, D.W., 1946, Physiographic divisions of the conterminous United States: Washington, D.C., U.S. Geological Survey, scale 1:7,000,000, 1 pl.

Hefner, J.M., 1994, Southeast wetlands—Status and trends, mid-1970s to mid-1980s: Atlanta, Ga., U.S. Fish & Wildlife Service, 32 p.

Karl, T.R., Melillo, J.M., and Peterson, T.C., eds., 2009, Global climate change impacts in the United States: New York, Cambridge University Press, 189 p., accessed December 2010 at *http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf*.

Laporte, C., Alber, M., Bryant, D., DeVoe, M.R., Havens, K., Hopkinson, C., Rebach, S., Sanger, D., Spranger, M., and Voiland, M., 2010, South Atlantic regional research plan: Athens, Ga., Georgia Coastal Research Council, University of Georgia, 29 p. (Revised 2011), available online at *http://www.gcrc.uga.edu/SARRP/Documents/SARRP_ResearchPlan_2010.pdf*.

Loveland, T.R., and Acevedo, W., 2010, Land cover change in the Eastern United States: U.S. Geological Survey Land Cover Trends Project: Accessed April 27, 2011, at *http://landcovertrends.usgs.gov/east/regionalSummary.html*.

National Oceanic and Atmospheric Administration [NOAA], 2011, Communities—The U.S. population living in coastal watershed counties: NOAA's state of the coast: Accessed June 29, 2011, at *http://stateofthecoast.noaa.gov/population/welcome.html*.

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., and Hanson, C.E., eds., 2007, Climate change 2007—Impacts, adaptation and vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge, U.K., Cambridge University Press, 976 p.

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., and Miller, H.L., eds., 2007, Climate change 2007—The physical science basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge, U.K., Cambridge University Press, 996 p.

Thelin, G.P., and Pike, R.J., 1991, Landforms of the conterminous United States—A digital shaded-relief portrayal: U.S. Geological Survey Miscellaneous Investigations Series Map I-2206, scale 1:3,500,000, 1 pl.

U.S. Census Bureau, 2010, Population estimates, datasets for all geographies: U.S. Census Bureau, Population Division, available online at *http://www.census.gov/popest/datasets.html*.

U.S. Climate Change Science Program, 2009, Coastal sensitivity to sea-level rise—A focus on the Mid-Atlantic region: Washington, D.C., U.S. Environmental Protection Agency, a report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, 320 p.

U.S. Congress, 1990, U.S. Global Change Research Act of 1990: Public Law 101-606 (11/16/90) 104 Stat. 3096-3104: Available online at *http://www.gcrio.org/gcact1990.html*.

U.S. Environmental Protection Agency, 2011, Climate change—Health and environmental effects: Coastal zones and sea level rise: Accessed April 27, 2011, at *http://www.epa.gov/climatechange/effects/coastal/index.html*.

U.S. Fish & Wildlife Service, 2010, Carolina Sandhills National Wildlife Refuge—The longleaf pine/wiregrass ecosystem: Accessed April 26, 2011, at *http://www.fws.gov/carolinasandhills/longleaf.html#demise*.

U.S. Geological Survey, 1996, National water summary on wetland resources: U.S. Geological Survey Water-Supply Paper 2425, 431 p.

Vigil, J.F., Pike, R.J., and Howell, D.G., 2000, A tapestry of time and terrain: U.S. Geological Survey Geologic Investigations Series I–2720, 1 plate, scale 1:2,500,000, 1 pamphlet, available at *http://pubs.usgs.gov/imap/i2720/*.

Appendix 1. Bibliography

The following materials were used to develop the list of science themes and tasks. The information was collected from climate change or conservation and management plans developed by agencies and organizations that will potentially be or are already partners of the South Central CSC. These materials include peer-reviewed publications, unpublished drafts, and relevant Web sites that contain information about priority issues or areas of scientific concern related to the effects of climate change. These priority issues were ranked according to frequency of inclusion in the reference materials; those items most often listed as an area of concern, or a priority issue, were evaluated for inclusion in the Science Priorities section of the South Central CSC Strategic Science Plan (table 1–1).

Table 1–1 was constructed after completing a literature review of publications that focused on climate change and resulting needs by Federal, state, and local partners. The focus of publications ranged from a national to local scales, but the focus of the South Central CSC is on priority science needs or issues in the region. Publications of Federal and State agencies were considered during this exercise; however, in order to ensure an equal weighting of priority issues among agencies and other partners, some publications were consolidated to account for only one record. For example, each of the six states within the boundaries of the South Central CSC produces a State Wildlife Action Plan (SWAP); the priority issues for the SWAPs were consolidated and recorded just once during ranking. This is also the case for the individual National Park Service (NPS) Inventory and Monitoring Networks within the boundary of the South Central CSC (five in total). In order to ensure that the priorities of these programs were not weighted higher than any others, they were consolidated into one record.

Each mention of a priority science need or issue was recorded and then aggregated to develop a list of the most “important” science needs or issues in the region. Although this list was compiled by doing a literature review, the list is incomplete and the review should be considered an ongoing exercise.

Table 1–1. Priority science needs and issues for South Central Climate Science Center partners.

[Blue denotes priority issues addressed by the South Central Climate Science Center Strategic Science Plan; LCC, Landscape Conservation Cooperative; USFWS, U.S. Fish and Wildlife Service; USGS, U.S. Geological Survey; SSPT, Science Strategy Planning Team, NPS, National Park Service; NOAA, National Oceanic and Atmospheric Administration; USGCRP, United States Global Change Research Program; CCSP, Climate Change Science Program]

Publication by partner	Priority issue										
	Adaptation, mitigation, resiliency, and vulnerability assessments	Healthy ecosystems/vegetation communities	Hydrologic models (inc. temperature, water availability, quality, health, ecohydrology, management)	Human populations, socioeconomic, urban Issues, cultural resources, agricultural Issues	Improved Data Mgmt and Sharing of Climate Change Data (incl. geospatial data)	Imperiled and rare communities/invasive species	Improved monitoring networks of resources affected by climate change/management actions	Coastal response to sea-level rise and climate change/coastal geomorphology	Biological response to climate change and disturbance (inc. species-response models)	Land-use and land-cover change	Biological planning, conservation design, conservation delivery
Gulf Coastal Plains and Ozarks LCC	1	1	1	1	1	1	1		1	1	1
Gulf Coast Prairies LCC	1	1	1	1	1	1		1	1	1	1
Southern Rockies LCC	1	1	1	1	1	1	1		1	1	1
Desert LCC	1	1	1	1	1	1	1		1	1	
East Coast Tall Grass Prairies LCC											
Great Plains LCC	1	1	1	1	1	1	1		1	1	1
Governor's Gulf of Mexico Alliance											
USFWS Strategic Habitat Conservation	1										1
USGS Global Change SSPT								1	1	1	
NPS Inventory and Monitoring Networks[1]	1	1	1		1	1	1	1	1	1	
NOAA Climate Services		1	1					1			
USGCRP,Potential Consequences of Climate Variability, Southeast Region Chapter				1				1			
CCSP, Thresholds of Climate Change in Ecosystems											
USGCRP, 2009, Global Climate Change Impacts in US, State of Knowledge Report											
USGCRP, 2000, Conclusions and Research Pathways Section		1	1					1	1	1	
USFWS Strategic Plan	1				1		1				1
NPS Climate Climate Change Response Strategy	1			1	1		1				1
U.S. Forest Service Climate Change Resource Program		1	1	1		1					
National Research Council: Americas Climate Choices	1	1	1	1	1	1	1	1			
CCSP, Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources	1										1
State Wildlife Action Plans[2]	1	1	1	1	1	1	1	1			
Cumulative mention of Science Priority	**12**	**11**	**11**	**10**	**10**	**9**	**8**	**8**	**8**	**8**	**8**

[1] Compilation of all five Inventory and Monitoring Networks (Gulf Coast, Southern Plains, Chihuahuan Desert, Sonoran Desert, and Southern Colorado Plateau)

[2] Compilation of all six State priority issues (Texas, Oklahoma, New Mexico, Colorado, Kansas, and Louisiana)

Table 1–1. Priority science needs and issues for South Central Climate Science Center partners.—Continued

[Blue denotes priority issues addressed by the South Central Climate Science Center Strategic Science Plan; LCC, Landscape Conservation Cooperative; USFWS, U.S. Fish and Wildlife Service; USGS, U.S. Geological Survey; SSPT, Science Strategy Planning Team, NPS, National Park Service; NOAA, National Oceanic and Atmospheric Administration; USGCRP, United States Global Change Research Program; CCSP, Climate Change Science Program]

Priority issue																				
Clean coastal and ocean waters/water quality for healthy beaches/seafood	Global carbon cycle understanding and prediction	Climate model limitations/uncertainty	Habitat connectivity (aquatic and upland)	Decision-support tools for habitat, connectivity, and management (aquatic and terrestrial)	Species abundance/habitat-population models	Forest health/productivity (inc. by type as habitat)	Environmental education/communication	Identify priority species for conservation	Identify focal aquatic species	Understanding past climate change and sea-level rise	Crop yields and economic impacts	Changes in extremes of weather and climate; climate policy	Classification and evaluation of water resources	Impacts of renewable energy on species	Wildlife disease	Public participation in developing a solution to climate change impacts	Outcome based monitoring and adaptive management	Assumption-based research	Marine benthic communites/coral reefs	Amphibians and reptile communities	Soils issues
			1	1	1	1		1	1				1								
		1	1	1	1	1		1	1					1							
			1	1	1	1	1	1	1		1	1		1	1						
			1	1	1			1	1		1	1	1	1	1						1
			1	1	1								1		1						
1							1														
																	1	1			
	1									1											
1																			1	1	
1												1									
1		1				1					1										
1																			1		
	1															1	1	1			
	1	1																			
	1					1															
	1	1					1			1						1					
		1																			
1							1			1											
6	**5**	**5**	**5**	**5**	**5**	**5**	**4**	**4**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**

Published Material

Beller-Simms, Nancy, Ingram, H., Feldman, D., Mantua, N. Jacobs, K.L., and Waple, A.M., 2008, Decision support experiments and evaluations using seasonal to interannual forecasts and observational data—Final report: Asheville, N.C., National Oceanic and Atmospheric Administration, National Climatic Data Center, U.S. Climate Change Science Program Synthesis and Assessment Product 5.3, 192 p.

Brekke, L.D., Kiang, J.E., Olsen, J.R., Pulwarty, R.S., Raff, D.A., Turnipseed, D.P., Webb, R.S., and White, K.D., 2009, Climate change and water resource management—A Federal perspective: U.S. Geological Survey Circular 1331, 65 p., available online at *http://pubs.usgs.gov/circ/1331/*.

Burkett, V.R., Taylor, I.L., Belnap, J., Cronin, T.M., Dettinger, M.D., Frazier, E.L., Haines, J.W., Kirtland, D.A., Loveland, T.R., Milly, P.C.D., O'Malley, R., and Thompson, R.S., 2011, Public review draft—USGS global change science strategy: A framework for understanding and responding to climate and land-use change: U.S. Geological Survey Open-File Report 2011–1033, 32 p., available online at *http://pubs.usgs.gov/of/2011/1033*.

Dietz, Thomas, and Stern, P.C., eds., 2008, Public participation in environmental assessment and decision making: Washington, D.C., National Academies Press, 322 p.

Fagre, D.B., Charles, C.W., Allen, C.D., and others, 2009, Thresholds of climate change in ecosystems—Final report: U.S. Geological Survey, U.S. Climate Change Science Program Synthesis and Assessment Product 4.2, 156 p.

Jacob, J.S., and Showalter, S., 2008, The resilient coast—Policy frameworks for adapting the wetlands to climate change and growth in coastal areas of the U.S. Gulf of Mexico: National Oceanic and Atmospheric Administration, National Sea Grant Office, 40 p., available online at *http://tcwp.tamu.edu/files/2012/06/ResilientCoastWetlands-sm2.pdf*.

Jacobs, K.L., 2002, Connecting science, policy and decision-making—A handbook for researchers and science agencies: Silver Spring, Md., National Oceanic and Atmospheric Administration, Office of Global Programs.

Johnson, Genevieve, 2012, Desert Landscape Conservation Cooperative: Identifying Science Needs for 2012, 4 p., available online at *http://www.usbr.gov/WaterSMART/lcc/docs/dlcc/FY12DesertLCCScienceNeeds.pdf*.

Julius, S.H., and West, J.M., eds., Baron, J.S., Joyce, L.A., Kareiva, P., Keller, B.D., Palmer, M.A., Peterson, C.H., and Scott, J.M., 2008, Preliminary review of adaptation options for climate-sensitive ecosystems and resources—Final report: Washington, D.C., U.S. Environmental Protection Agency, U.S. Climate Change Science Program Synthesis and Assessment Product 4.4, 873 p.

Karl, T.R., Melillo, J.M., and Peterson, T.C., eds., 2009, Global climate change impacts in the United States: New York, Cambridge University Press, 189 p., accessed December 2010 at *http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf*.

Lester, G.D., Sorenson, S.G., Faulkner, P.L., Reid, C.S., and Maxit, I.E., 2005, Louisiana Comprehensive Wildlife Conservation Strategy: Baton Rouge, La., Louisiana Department of Wildlife & Fisheries, 455 p. available online at *http://www.wlf.louisiana.gov/sites/default/files/pdf/page_wildlife/33691-Wildlife Action Plan Details/la_wap_pdf.pdf*.

Melillo, J.M., Janetos, A.C., Karl, T.R., Corell, R.C., Barron, E.J., Burkett, V.R., Cecich, T.F., Jacobs, K., Joyce, L., Miller, B., Morgan, M.G., Parson, E.A., Richels, R.G., and Schimel, D.S., 2000, Climate change impacts on the United States: The potential consequences of climate variability and change—Overview: Cambridge, U.K., Cambridge University Press, 154 p.

National Park Service, 2011, Climate change science in the national parks: Climate Change Response Program Science Brief, 1 p., available online at *http://www.nature.nps.gov/climatechange/*.

National Park Service, 2010, Gulf Coast Network: Southeast Region Inventory & Monitoring Program Climate Change Resource Brief, 2 p., available online at *http://www.nature.nps.gov/climatechange/docs/GULN_CC.pdf*.

National Research Council, 2006, Completing the forecast: Characterizing and communicating uncertainty for better decisions using weather and climate forecasts: Washington, D.C., National Academies Press, 124 p.

National Research Council, 2007, Evaluating progress of the U.S. Climate Change Science Program: Methods and preliminary results: Washington, D.C., National Academies Press, 178 p.

National Research Council, 2009a, Informing decisions in a changing climate: Washington, D.C., National Academies Press, 200 p.

National Research Council, 2009b, Observing weather and climate from the ground up—A nationwide network of networks: Washington, D.C., National Academies Press, 250 p.

National Research Council, 2009c, Restructuring federal climate research to meet the challenges of climate change: Washington, D.C., National Academies Press, 266 p.

National Research Council, 2010a, Adapting to the impacts of climate change: Washington, D.C., National Academies Press, 292 p.

National Research Council, 2010b, Advancing the science of climate change: Washington, D.C., National Academies Press, 528 p.

National Research Council, 2010c, Informing an effective response to climate change: Washington, D.C., National Academies Press, 348 p.

National Research Council, 2010d, Limiting the magnitude of future climate change: Washington, D.C., National Academies Press, 276 p.

NIDIS Implementation Team, 2007, The National Integrated Drought Information System Implementation Plan: Available online at *http://www.drought.gov/media/imageserver/NIDIS/content/whatisnidis/NIDIS-IPFinal-June07.pdf*

National Oceanic and Atmospheric Administration, 2011, Sector Applications Research Program (SARP): Climate Program Office Information Sheet, 1 p., accessible online at *http://www.cpo.noaa.gov/cpo_pa/sarp/*.

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., and Hanson, C.E., eds., 2007, Climate change 2007—Impacts, adaptation and vulnerability: Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change: Cambridge, U.K., Cambridge University Press, 976 p.

Rice, John, 2012, Southern Rockies Landscape Conservation Cooperative: Science needs for 2012, 2 p, available online at *http://southernrockieslcc.org/southrock/wp-content/uploads/2013/01/Science_Needs_2012.pdf*.

Segura, M., Woodman, R., Meiman, J., Granger, W., and Bracewell, J., 2007, Gulf Coast Network vital signs monitoring plan: Fort Collins, Colo., National Park Service Natural Resource Report NPS/GULN/NRR–2007/015.

Society for Ecological Restoration International, 2009, Policy Position Statement: Ecological restoration and rare species management in response to climate change: Tucson, Ariz., Society for Ecological Restoration International, 7 p., available online at *http://www.ser.org/docs/default-document-library/pps_on_rare_species_final2.pdf*.

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., and Miller, H.L., eds., 2007, Climate change 2007—The physical science basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge, U.K., Cambridge University Press, 996 p.

Stern, P.C., and Easterling, W.E., eds., 1999, Making climate forecasts matter: Washington, D.C., National Academies Press, 192 p.

U.S. Fish & Wildlife Service, 2009, Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative Development and Operations Plan: Accessed June 29, 2011, at *http://www.fws.gov/southeast/LCC/GulfPlains/pdf/GCPOLCCDevOpPlanFinal12112009.pdf*.

U.S. Fish and Wildlife Service National Wildlife Refuge System, 2010, Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change: U.S. Fish & Wildlife Service, 36 p., available online at *http://www.fws.gov/home/climatechange/pdf/ccstrategicplan.pdf*.

U.S. Global Change Research Program, 2009, Global climate change impacts in the U.S.: Available online at *http://nca2009.globalchange.gov/*.

Other Material and Compilations

Alaska Climate Science Center Draft Science Plan, January 2011.

Compilation of responses to Department of Interior HPPG data call on vulnerability assessment activities FY2011.

CSC/LCC Implementation Guidance Document (Draft—January 2011).

National Climate Change and Wildlife Science Center, 2009, Proposed 5-year strategy: Unpublished draft, 7/17/09, 22 p., available online at *https://nccwsc.usgs.gov/sites/default/files/documents/NCCWSC_5_year_strategy_ver_7-13-09b.pdf*.

U.S. Department of the Interior Southeast Climate Science Center Science and Operational Plan: U.S. Geological Survey Open-File Report 2012–1034, 48 p., available online at *http://pubs.usgs.gov/of/2012/1034/*.

Relevant Web Sites

Desert Landscape Conservation Cooperative: *http://www.usbr.gov/WaterSMART/lcc/desert.html*

Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative: *http://www.tallgrassprairielcc.org/*

Environmental Protection Agency (EPA) Climate Change Program: *http://www.epa.gov/climatechange/index.html*

Great Plains Landscape Conservation Cooperative: *http://www.greatplainslcc.org/*

Gulf Coast Prarie Landscape Conservation Cooperative: *http://gulfcoastprairielcc.org/*

Gulf Coastal Plains and Ozarks LCC: *http://gcpolcc.ning.com*

Gulf of Mexico Alliance: *http://gulfofmexicoalliance.org/welcome.html*

National Integrated Drought Information System (NIDIS): *http://www.drought.gov/*

National Oceanic and Atmospheric Administration (NOAA) Climate Services: *http://www.climate.gov*

National Park Service (NPS) Climate Response Program: *http://www.nature.nps.gov/climatechange/*

Southeast Aquatic Resources Partnership (SARP): *http://southeastaquatics.net/*

Southeast Climate Consortium (SECC): *http://seclimate.org/*

Southeast Regional Partnership for Planning and Sustainability (SERPPAS): *http://serppas.org/*

Southern Climate Impacts Planning Program (SCIPP): *http://www.southernclimate.org/*

Southern Regional Climate Center (SRCC): *http://www.srcc.lsu.edu/*

Southern Rockies Landscape Conservation Cooperative: *http://southernrockieslcc.org/*

U.S. Climate Change Science Program: *http://www.climatescience.gov/default.php*

U.S. Fish & Wildlife Service (USFWS) Climate Change, Southeast Region: *http://www.fws.gov/southeast/climate/*

U.S. Forest Service Climate Change Resource Center: *http://www.fs.fed.us/ccrc/*

Manuscript approved on May 31, 2013

Layout by Caryl J. Wipperfurth
Science Publishing Network, Raleigh PSC

For more information about this publication, contact:

Kim T. Winton, Ph.D.
Director, South Central Climate Science Center
U.S. Geological Survey
Suite 1100
David L. Boren Blvd (temporary address)
Norman, OK 73072
Phone: 405-833-5091
kwinton@usgs.gov

University Consortium Contacts:

Dr. Berrien Moore III
Principal Investigator, South Central Climate Science Center
Vice President, Weather and Climate Programs
Dean, College of Atmospheric and Geographic Sciences,
The University of Oklahoma
Chesapeake Energy Corporation Chair in Climate Studies
Director, National Weather Center

Dr. Renee A. McPherson
Director of Research, South Central Climate Science Center
Associate Professor of Geography and Environmental Sustainability
The University of Oklahoma
120 David L. Boren Blvd., Suite 2900
Norman, OK 73072-7305
renee@ou.edu