2012 Annual Report

Southwest Climate Science Center

Photo: David Graff

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Introduction




Photo: Ashwin Naidu

On October 10, 2010, the Secretary of the Interior announced the selection of a consortium of six institutions as the hosts for the Department of the Interior's Southwest Regional Climate Science Center (SWCSC): The University of Arizona, Tucson; University of California, Davis; University of California, Los Angeles; Desert Research Institute, Reno; University of Colorado, Boulder; and the Scripps Institution of Oceanography at the University of California, San Diego. The University of Arizona serves as the central location and administrative center for the SWCSC.

The mission of the SWCSC is to be a national model for effective collaboration with land, water, wildlife, cultural resource, and civic managers to provide scientific research, tools, and techniques needed to anticipate, monitor, and adapt to climate variability and change. The SWCSC was officially launched in spring 2011.

The activities of the SWCSC are guided by its science agenda, which is a broad review of science needs and priorities within Department of the Interior agencies and resource managers in the southwest region. Each year, the SWCSC draws from the long-term agenda to identify project plans that help guide decisions about research funding. Both of these guiding documents are written in close consultation with the SWCSC's Stakeholder Advisory Committee, which includes representatives of federal, tribal, state, and local resource management agencies and Landscape Conservation Cooperatives (LCCs) within the Southwest.

Key Personnel

Interim Director

David E. Busch has served as the Interim Director of the SWCSC since November 2010 (through July 30, 2012). He is based at the Pacific Southwest Area Office of the U.S. Geological Survey (USGS) in Sacramento, California. Dr. Busch was previously the USGS research liaison to the Regional Ecosystem Office in Portland, Oregon where he helped develop the interagency research and monitoring program in support of the Northwest Forest Plan. Formerly, he led the U.S. National Park Service Inventory and Monitoring program in the Florida Everglades, and has held leadership positions with federal agencies responsible for research and monitoring of the lower Colorado River from the Grand Canyon to Mexico. Dr. Busch also maintains a scientific interest in the functional ecology of riparian and wetland plant communities, and has been active in research and monitoring issues associated with invasive species in these and other systems. He has undergraduate and graduate degrees from the University of Nebraska, and completed his Ph.D. at the University of Nevada, Las Vegas. Having taught a graduate seminar on early indications of global change over 20 years ago, he now comes full circle in helping to coordinate USGS climate program implementation in the southwestern United States.

Principal Investigators

Jonathan Overpeck at the University of Arizona serves as the University Director of the SWCSC. He brings research expertise in climate dynamics, paleoclimate, climate-ecosystem dynamics, and stakeholder-driven science. Dr. Overpeck is an international leader in climate change research, and served as a coordinating lead author of the Nobel-prize winning Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC); he is also contributing as a lead author to the Fifth Assessment of the IPCC. Additionally, he was the lead author of the Southwest chapter of the 2009 National Climate Assessment report, "Global Climate Change Impacts in the United States."

Dr. Overpeck has served for eight years (to present) as lead principal investigator of the stakeholder-driven, National Oceanic and Atmospheric Administration (NOAA)-funded Climate Assessment for the Southwest (CLIMAS), was founding director of the World Data Center for Paleoclimatology and was a Guggenheim Fellowship award winner. Dr. Overpeck is also currently co-director of the University of Arizona Institute of the Environment, professor of geosciences, and professor of atmospheric sciences.

Alexander (Sasha) Gershunov is an associate research meteorologist at Scripps Institution of Oceanography at the University of California, San Diego. His research focuses on interrelated aspects of weather, climate, and society. His research interests include understanding the links between regional weather extremes and large-scale climate variability and change, long-range climate prediction, paleoclimate reconstruction, the atmospheric water cycle, water resources, heat waves, cold snaps, climate and wildfire, energy, health and agriculture, climate influence on society and human influence on climate. Dr. Gershunov holds a B.S. in mathematics from University of California, Irvine, an M.S. in applied probability and statistics, and Ph.D. in geography, both from University of California, Santa Barbara.

Dr. Gershunov has received the NASA Global Change Research Fellowship and a Rotary Foundation International Teaching Grant. He has served extended terms as visiting researcher at the Laboratoire de Météorologie Dynamique (LMD) of the French National Scientific Research Center (CNRS), and at the Centre National de Recherches Météorologiques (CNRM), Meteo-France, the French meteorological service. Gershunov has also served as a visiting professor at the Departamento de Fisica, Universidad de Alcalá de Henares, Spain. He is also involved in a local NSF-funded climate education effort—the Climate Education Partners—devoted to understanding and communicating the causes of climate change, its regional impacts and their mitigation in San Diego County.

Glen MacDonald is a professor of geography and of ecology and evolutionary biology and director of the multidisciplinary University of California, Los Angeles Institute of the Environment and Sustainability. Dr. MacDonald leads the Institute in educating the next generation of professional and scientific leadership committed to the health of the planet, driving interdisciplinary environmental and sustainability research, and creating outreach opportunities with businesses, non-profit organizations, policy makers, and the community.

His areas of interest are paleoclimatology, environmental reconstruction, water resources, global change issues, climate change and societal impact, and biogeography. Dr. MacDonald has researched environmental change across the globe in places such as the southwestern United States, Canada, Mexico, Egypt, Syria, India, West Africa, Russian Eurasia, and the Arctic. He is a fellow of the American Association for the Advancement of Science, a Guggenheim Fellowship award winner, recipient of the UCLA Distinguished Teaching Award, and University of California Presidential Chair.

Kelly T. Redmond is the regional climatologist and deputy director at the Western Regional Climate Center, located at the Desert Research Institute in Reno, Nevada. He was born in Wausau, Wisconsin, raised in southwest Montana, received a B.S. in physics from the Massachusetts Institute of Technology and an M.S. and Ph.D. in meteorology from the University of Wisconsin in Madison. He worked in the Atmospheric Sciences Department at Oregon State University from 1982-1989, the last six years of which he was state climatologist for Oregon, and served as president of the American Association of State Climatologists in 1989-1990. In 2008 Dr. Redmond received the Applied Climatology Award from the American Meteorological Society, and was also elected a fellow of that society. His research and professional interests span every facet of climate and climate behavior, its physical causes and variability, how climate interacts with other human and natural processes, and how such information is acquired, used, communicated, and perceived.

Mark Schwartz is a professor in the Department of Environmental Science and Policy and the director of the John Muir Institute of the Environment at the University of California, Davis. He conducts research focused on plant ecology, biogeography, and conservation biology under climate change. His current research projects include: fire management adaptation strategies for climate change in the Sierra Nevada, embedding social and ethical concerns into management decisions on managed relocation and endangered species translocation, and assessing climate change impacts on the vulnerability of rare plants. Collaborating with colleagues from federal agencies, international and local conservation agencies, Dr. Schwartz currently focuses on support tools for decision making for conservation. Dr. Schwartz earned a B.A. in biology from the University of St. Thomas, an M.S. in ecology from the University of Minnesota, and a Ph.D. in biology from Florida State University. Dr. Schwartz was editor of *Biological Conservation* (1998 – 2004), served as National Science Foundation program officer (2001-2002), was the chair of the graduate group in ecology (2004-2009), currently serves on the publications committee of the Society for Conservation Biology (2008-), and is the chair of the Conservation Management degree certificate program at University of California, Davis.

Brad Udall is the director of the University of Colorado Western Water Assessment, one of eleven NOAA-funded Regional Integrated Sciences and Assessments (RISA) programs designed to connect climate science with decision-making. He serves as co-principal investigator for both the Southwest and North Central Climate Science Centers.

As a member of the research faculty at the University of Colorado, Mr.Udall's expertise includes hydrology and related policy issues of the American West. He has written extensively on the impacts of climate change on water resources including U.S. Global Change Research Program reports, Bureau of Reclamation documents and state of Colorado assessments. His current focus is on how humans should adapt to the unavoidable impacts of climate change, including proper use of climate model outputs.

Mr. Udall has provided testimony for the U.S. Congress. He has received the Climate Science Service Award from the California Department of Water Resources for his work in facilitating interactions between water managers and scientists and the Partner in Conservation Award from the Department of Interior. He served on the Water Research Foundation expert panel on climate change and serves on the advisory boards of the Colorado Water Institute, the Union of Concerned Scientists' Energy and Water in a Warming World Initiative and the Research Applications Laboratory at the National Center for Atmospheric Research. He recently spent four months as a visiting scholar at the Department for Water in South Australia. He is currently writing a book on how Australian water reforms might be applied to the United States.

Other Affiliated Researchers

Daniel R. Cayan is based at Scripps Institution of Oceanography, University of California, San Diego and the U.S. Geological Survey. Dr. Cayan's work is aimed at understanding climate variability and changes over the Pacific Ocean and North America. His research concerns how climate affects water resources, including precipitation, snowpack, and streamflow in western North America as well as the impacts upon ecosystems, agriculture, and human health. Dr. Cayan has specific interests in the California region, and has played a leading role in the NOAA-funded California Nevada Applications Program and the California Climate Change Center, sponsored by the California Energy Commission.

Michael Dettinger is a research hydrologist for the U.S. Geological Survey, Western Region Branch of Regional Research, and a research associate of the Climate, Atmospheric Sciences and Physical Oceanography Division at Scripps Institution of Oceanography. Dr. Dettinger has monitored and researched the hydrology, climates, and water resources of the West for over 30 years, focusing on regional surface water and groundwater resources, watershed modeling, causes of hydroclimatic variability, and climatic-change influences. He has authored over 90 scientific articles in scholarly journals and books, 20 government reports, and another 70 articles in less formal outlets. He was the physical-sciences team leader for Department of the Interior-Department of Defense ecosystem planning in the Mojave Desert, a founding member of the Consortium for Integrated Climate Research in Western Mountains, climate advisor to the CALFED Bay-Delta Restoration Program, member of the Science Steering Group for the federal Global Water Cycle Program, research advisor for USGS Surface-Water Discipline, member of the USGS Global Change Science Strategic Planning Team, and lead author of the Water Resources chapter of the 2013 National Climate Assessment. He has degrees from the University of California, San Diego, Massachusetts Institute of Technology, and a Ph.D. in Atmospheric Sciences from the University of California, Los Angeles.

Erica Fleishman is a researcher at the John Muir Institute of the Environment, University of California, Davis. She holds a B.S. and M.S. from Stanford University and a Ph.D. from the University of Nevada, Reno. Dr. Fleishman's work focuses on integration of conservation science with management and policy, especially in the intermountain western United States. She collaborates extensively with academic and agency researchers and practitioners. Predictive modeling of occupancy, land-cover and land-use change, and connectivity is central to her work. Dr. Fleishman also has coauthored curricula on applications of remote sensing to environmental sciences and ecological modeling. She has been involved with the science process for multiple Habitat Conservation Plans and Natural Community Conservation Plans in California.

Staff

Alison Meadow, based at the University of Arizona, was hired in January 2012 as the program manager for the SWCSC host universities. She has a Ph.D. from University of Alaska Fairbanks in environmental anthropology. She also has an M.A. in American Indian studies and an M.S. in planning, both from University of Arizona. Dr. Meadow brings to the SWCSC experience in the use of social science in scientific needs assessments, experience working in American Indian and Alaska Native communities, and a background in program planning and evaluation. In addition to her management responsibilities, Dr. Meadow is actively engaged in use-inspired research through the SWCSC and through University of Arizona's CLIMAS program.

Postdoctoral and Research Associates

Christine Albano is a research associate at University of California, Davis. She has a B.S. in biology from Westminster College and an M.S. in ecology from Colorado State University. She has worked as a biologist for the USGS Utah Water Science Center and more recently served as a program manager for a regional non-profit organization, where she developed and implemented research initiatives intended to provide perspectives and guidance for management and conservation of federal rangelands in the southwestern United States. Her research interests include stream ecology, ecology and conservation of western rangelands, and effects of climate change on species' distributions.

Ruth Cerezo-Mota is a postdoctoral researcher at University of California, Los Angeles. She has a background in oceanography but began to focus on the atmosphere during her graduate work. She received a B.S. from the University Autonomous of Baja California, an M.S. in physical oceanography from the Center of Scientific Research and High Education of Ensenada, and a Ph.D. from Oxford University. She has been working with regional climate models for almost a decade, mainly to study mechanisms controlling precipitation over different regions (southern Africa, the North American monsoon region, and more recently Los Angeles). She is currently working on the Los Angeles Regional Collaborative for Climate Action and Sustainability project analyzing simulations for current and future time over the region of Los Angeles. Her particular interest is future changes in precipitation intensity and frequency.

Britta Daudert is an assistant research scientist at the Desert Research Institute. She obtained her undergraduate degree in mathematics and mathematical physics at the National University of Ireland, Maynooth. She continued her studies at University of California, Riverside where she focused on fractal geometry, in particular vibrational properties of fractal drums, the subject of her Ph.D. in mathematics. Her work for the SWCSC involves developing mechanisms to provide easy access to climate data and data products by means of user-friendly and intuitive web interfaces. She will work closely with researchers and managers within the CSC network, with representatives of the Landscape Conservation Cooperatives, and with researchers and managers throughout the Department of the Interior to act as a bridge between NOAA Regional Climate Centers and the CSC program.

Kristen Guirguis is a postdoctoral scholar at Scripps Institution of Oceanography. She received her Ph.D. in 2008 from the Department of Civil and Environmental Engineering at Duke University studying the hydrometeorology of the western United States. At Scripps, her research has focused on extreme weather. She received the Postdocs Applying Climate Expertise (PACE) Fellowship in 2010 from the University Corporation for Atmospheric Research (UCAR) to study extreme heat characterization and relationships with human health with host partners Scripps Institution of Oceanography and the California Environmental Protection Agency. She is also involved in extreme weather predictability for energy applications.

Suraj Devidasrao Polade is a postdoctoral researcher in the Climate Research and the Physical Oceanography Research divisions at Scripps Institution of Oceanography. His research focuses on regional climate change, including downscaling climate projections at regional scales to better understand the climate change impacts on a focus region. He is also interested in understanding the links between regional weather extremes and large-scale climate variability and change, the atmospheric water cycle, climate influence on society, and human influence on climate. He received a B.Sc. in industrial chemistry at Amravati University, India, an M.Sc. in space sciences and an M.Tech. in atmospheric sciences, both at University of Pune, India, and a Ph.D. from the University of Hamburg for research diagnosing the deficiencies of regional mesoscale models in the prediction of the atmospheric water cycle.

Partner Institutions

In addition to the six host institutions, the SWCSC has partner institutions throughout the region that add to its scientific capacity and stakeholder-outreach capabilities.

Arizona State University

Northern Arizona University

UC Merced

UNLV

NASA

U.S. Institute for Environmental Conflict Resolution
Udall Foundation

Outreach




Stakeholder Outreach

Stakeholder Advisory Committee

Outreach to build a Stakeholder Advisory Committee (SAC) began in autumn 2011. Letters were sent to all federal and state agencies and tribes in the SWCSC region inviting representatives to participate in the SAC. In December 2011, the first SAC meeting was held in Sacramento. Details about the meeting, including a list of attendees, can be found at www.doi.gov/csc/southwest/news/Southwest-Climate-Science-Center-Convenes-Its-First-Stakeholder-Meeting.cfm. A list of the twenty-two current SAC members can be found at www.swcsc.arizona.edu/content/about/swcsc-advisory-groups.

Following the December 2011 meeting, the SAC members met via teleconference to compile a list of science needs for their agencies in the Southwest. The ten topics identified by the SAC (not necessarily in order of priority) as the most important for science research include:

1. *What are the effects of climate change on disturbance agents (e.g., fire, flood, drought, insects, invasive species, etc.), the interaction between them and impacts on ecosystem function, resilience and ecosystem services?*
2. *How can we determine landscape resiliency to climate change and the methods for restoring landscapes that have been impacted by climate change?*
3. *What are the anticipated changes in hydrologic processes and how will they impact species and riparian habitats?*
4. *Standardize metrics of change.*
5. *What are possible changes to vegetation/cover type based on temperature and water quantity that impact habitat and cover type?*
6. *What are current conditions (habitat) and how are they going to change due to climate change; for example, succession and invasive species?*
7. *Better understand demographic responses to climate change including dispersal survival and productivity.*
8. *Interplay of surface and ground water models and climate models.*
9. *What downscaled models are useful to managers in certain areas? And how can it help conservation efforts?*
10. *What are the anticipated impacts of ocean acidification and sea-level rise on marine ecosystems and species, commercial fishing, inundation and increased salinity of wetlands, and contamination of fresh water resources?*

These priorities were communicated to the SWCSC principal investigators by Dave Busch shortly after the SAC meeting and were used, along with other needs assessments (see below), as the basis for the SWCSC's call for research proposals in spring 2012.

Other Needs Assessment Activities

In order to bolster the science priorities identified by the SAC, Christine Albano and Alison Meadow conducted a rapid regional needs assessment by reviewing existing science needs assessment documents pertinent to the region and the mission of the SWCSC. They identified 397 science needs from 56 different sources including reports, websites, white papers, existing requests for proposals, workshops, and individual accounts. A full summary of the needs assessment, including a list of all sources consulted, can be found at www.swcsc.arizona.edu.

While the sample of assessment documents was quite good, Albano and Meadow identified some gaps in representation, particularly from California, the Southern Rockies, and tribal communities. They hope to continually add to their sample, eventually creating a searchable database that can be used as a resource for SWCSC leadership scientists, and stakeholders.

The categories of science needs identified through this process largely matched those developed by the SAC.

Science Need	Number of Times Mentioned in 56 Sources
Climate change effects on habitats	38
Climate effects on species demography	31
Climate effects on disturbance agents	31
Model downscaling[1]	24
Climate and water model interplay	18
Changes to hydrologic processes and aquatic/riparian ecosystems	23
Resiliency and restoration methods	19
Sea level rise and ocean acidification	13
Vegetation, land cover, or soil changes	15
Standardize change metrics	6

Several additional climate science needs identified through the rapid assessment process included:

Climate Science Need	Number of Times Mentioned in 56 Sources
Social/economic/human health effects of climate change	22
Climate interaction with non-climate stressors	20
Addressing uncertainty and evaluating existing models[2]	13

Science Implementation Panel

The SAC members were asked to submit nominations to Dave Busch for participation in the SWCSC's Science Implementation Panel (SIP), which helped to craft the 2012 call for proposals. The SIP, consisting of representatives of many DOI agencies and all the LCCs in the region, met in March 2012 in Las Vegas. The SIP used the needs assessments generated by the SAC, LCCs, and CSC to craft a call for proposals that fit the needs and interests of agencies and other stakeholders in the Southwest. The 2012 call for proposals can be found at: www.swcsc.arizona.edu/announcements/funding-proposal-announcements.

Tribal Outreach

Tribes and tribal resource managers are a key group of stakeholders for the SWCSC. One hundred eighty-two tribes fall within the SWCSC's region. Tribal lands account for almost 11% of the land base in the region (approximately 180,000 km^2, or 44.5 million acres).

On behalf of the SWCSC, the Pacific Southwest Area Regional Executive sent letters and emails to all federally recognized tribes in California, Arizona, Utah, and Nevada to introduce them to opportunities to work with the SWCSC on its science program. The letters and emails included information about USGS plans to consult with tribal government leaders during 2012.

Outreach to Native American representatives resulted in participation on the SWCSC SAC by LeRoy Shingoitewa, chair of the Hopi Tribe (Arizona) and Paula Britton, EPA director of the Habematolel Pomo of Upper Lake (California). Both attended the initial SAC meeting in December 2011.

In addition to targeted outreach, Dave Busch made a number of formal presentations and informally discussed participation opportunities with tribal and Bureau of Indian Affairs (BIA) representatives at meetings throughout the Southwest. These included

- Desert LCC meetings in Phoenix, Albuquerque, and San Bernardino
- Southern Rockies LCC meetings in Denver and Salt Lake City
- A special tribal outreach session sponsored by the above LCCs in Albuquerque
- Great Basin LCC meetings in Reno and Salt Lake City
- Western Regional Partnership – Tribal Subcommittee meeting in Sacramento
- U.S.-Mexico Federal Coordinating Committee meeting in El Centro, California
- Joint briefing with Southern Rockies LCC of the Institute for Tribal Environmental Professionals in Flagstaff
- American Indian/Alaska Native Climate Change Working Group meeting in Tucson

Funds were allocated to support travel of tribal representatives to the 2012 Southwest Climate Summit, held in Tucson in June 2012. Twelve people representing eight tribes attended the Summit and substantively contributed to the discussions of climate science needs and priorities in the Southwest.

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1 Note that the original SAC topic was: What downscale models are useful to managers in certain areas? And how can it help conservation efforts? Nine of the 22 needs included in this category were just asking for model downscaling in general and did not indicate how these models could be applied to resource management.

2 Seven of the 13 needs identified came from the water management sector.

Activities




Photo: Catlin Orem

Synthesis

Southwest Climate Assessment

A primary activity of the SWCSC in 2012 has been co-facilitating and executing the Southwest Climate Assessment (SWCA), a component of the ongoing National Climate Assessment (NCA). Experts from around the Southwest compiled a comprehensive report on climate change science and impacts for Arizona, California, Colorado, Nevada, and Utah. The SWCSC principal investigators served as assessment report authors, as did colleagues from several of the SWCSC affiliates.

The report, "Assessment of Climate Change in the Southwest United States," synthesizes scientific knowledge about the physical climate and its impacts on ecosystems and society. It also highlights scientific uncertainties and options for mitigation and adaptation.

The report will contribute to the National Climate Assessment. The NCA will inform the federal government in prioritizing climate science investments. The SWCA report will be published in autumn 2012. The NCA will publish its final report in 2013; subsequent assessments will occur every four years, fulfilling a mandate of the Global Change Research Act of 1990.

Research

Climate Change and its Impacts on Ecological and Social Systems in the Southwest

Evaluation of climate model simulations is an important step in the investigation of trade-offs among potential resource management options. The models can help inform decisions by providing information about projected changes in climate and potential effects on ecological and social systems. The Intergovernmental Panel on Climate Change (IPCC) has orchestrated standardized formats for climate experimental simulations with the latest global climate models (GCMs) according to updated emission scenarios. These updated global projections will become the standard for future impact assessments and projections by the CSC network and others. Assessing this new generation of models in an important step in keeping resource managers and other decision makers in the Southwest apprised of potential climate impacts in the region.

This large project was divided into three sub-projects, each with a specific focus. The first project compares models used in the IPCC Assessment Report 4 (AR4) and Assessment Report 5 (AR5) to determine the extent to which AR5 models represent an improvement in our understanding of climate change in the southwest United States. The second project is working to assess climate change in the region of Los Angeles County, specifically at spatial and temporal scales relevant for municipal planning. The third project focuses on the potential climate change impacts on amphibian and reptile habitat in the southwest United States. Detailed reports for each of the three projects can be found at www.swcsc.arizona.edu/projects-publications.

Comparison of climate models used in the IPCC Assessment Reports Four (AR4) and Five (AR5) for the Southwest U.S.

Principal Investigator:
Dan Cayan, Scripps Institution of Oceanography/UC San Diego and USGS

Collaborators and Partners:
Suraj Polade, Scripps Institution of Oceanography; Mike Dettinger, USGS and Scripps Institution of Oceanography; Alexander Gershunov, Scripps Institution of Oceanography; David Pierce, Scripps Institution of Oceanography; Mary Tyree, Scripps Institution of Oceanography

In this project the research team is comparing the models used in the IPCC Assessment Report 4 (AR4) and Assessment Report 5 (AR5) to determine the extent to which AR5 models represent an improvement in our understanding of climate change in the Southwest United States. They are focused, in particular, on the performance of the climate models in simulating natural modes of variability and their teleconnections between the Pacific Ocean and North America (contiguous United States and northwest Mexico).

Initial results indicate that the AR4 and AR5 models projections are generally similar across the Southwest. However, AR5 models appear to be more effective than AR4 in simulating key short-term Pacific climate modes and their teleconnections to North America, which should provide a better representation of short-term climate variability over the Southwest. AR5 models also appear to better capture the links between winter Pacific sea-surface temperature anomaly patterns and North American precipitation anomalies. This is a useful advance because much of the precipitation in the Southwest occurs in winter and the precipitation variability is dominated by interannual to decadal changes, not long period changes.

Climate change in the Los Angeles region: temperature and precipitation

Principal Investigators:
Glen MacDonald, UCLA; Alex Hall, UCLA

Collaborators and Partners:
Daniel Walton, UCLA; Neil Berg, UCLA; Ruth Cerezo-Mota, UCLA

This project focuses on assessing climate change in the region of Los Angeles County and determining climate change impacts at spatial and temporal scales relevant for municipal planning and policymaking. The project uses a hybrid dynamic-statistical downscaling technique to model the region at a horizontal resolution of 2km over two different periods: baseline (August 1981-August 2000) and future (August 2041-August 2061).

The researchers applied their downscaling techniques to models from the Coupled Model Intercomparison Project 3 (CMIP3) and CMIP5 archives in order to produce an ensemble of possible warming outcomes in the LA region. They found that the mean annual projected warming and the uncertainty (95% confidence interval) is slightly lower in the CMIP3 (2.0 ± 0.8 °C) models than in the CMIP5 models (2.5 ± 1.1 °C) which may be partly due to differences in emissions scenarios used in each ensemble (A1B for the CMIP3 ensemble and RCP8.5 in the CMIP5 ensemble). Perhaps more significantly, when the CMIP5 models are statistically downscaled, they show elevated warming, especially over inland and mountainous parts of the domain.

A linear precipitation model is now being tested to examine mid-20th century precipitation projections over the LA region. Once several more validation exercises are completed, the research team will have the complete framework to efficiently downscale the CMIP5 precipitation projections to the LA region.

Testing emerging tools for species distribution modeling using newly downscaled climate model simulations

Principal Investigator:
Mark W. Schwartz, John Muir Institute of the Environment, University of California, Davis

Collaborators and Partners: Amber Wright, UC Davis; Robert Hijmans, UC Davis; Betsy Bolster, California Fish and Game; H. Bradley Shaffer, UCLA; Alexander Gershunov, Scripps Institution of Oceanography

The effects of climate change on amphibians and reptiles in California have not yet been modeled. Amphibians and reptiles exhibit a high diversity of narrowly and broadly distributed species that range across a wide array of habitats, and a rich record of observational data about species habitat exists on which researchers can draw. This project seeks to use observational data, climate models, and expert opinion to project future amphibian and reptile habitat changes under several climate change scenarios. The project team has developed a suite of species distribution models using over 120,000 observations distributed among 153 species.

The research team used 19 bioclimatic variables at a 1-km spatial resolution, using WorldClim, to model current climate (1950-2000) then used the CCCMA CGCM3.1 general circulation model and the A1B emissions scenario to project future climate. The team then calculated the frequency with which a changing climate may increase or decrease the habitat value for each occupied 1-km cell in order to determine the likely habitat value of each cell, given projected changes in the climate. They also averaged the raw values of occupancy for cells from current to future to assess whether species are, on average, likely to lose or gain habitat through climate change.

The research team is now working to downscale AR5 climate projections, which will allow them to quantify and spatially assess the differences in species distribution projections between AR4 and AR5 climate projections. When the comparison is complete, they will then apply both sets of outcomes to a standard vulnerability assessment tool (NatureServe's CCVI protocol) to assess whether the difference between AR4 and AR5 result in different projections of overall vulnerability. Finally, the team is using expert opinion on non-traditional climatic variables (e.g., mid-winter dry-period frequency and maximum daily heat-load variables) in order to assess the degree to which these attributes affect projections of future species distributions.

Publications

Dettinger, M. D., 2012: Projections and downscaling of 21st century temperatures, precipitation, radiative fluxes and winds for the Southwestern US, with focus on Lake Tahoe. *Climatic Change*. DOI 10.1007/s10584-012-0501-x

Gershunov A. and K. Guirguis, 2012: California heat waves in the present and future. *Geophysical Research Letters*, in press. DOI:10.1029/2012GL052979

Outreach

Southwest Climate Summit

The Southwest Climate Summit, hosted by the SWCSC, was held June 12-13, 2012 in Tucson. Additional small-group meetings were held on June 11 and 14. The goals of the Summit were to present the findings of the Southwest Climate Assessment and collect input from regional stakeholders for the SWCSC's long-term science agenda. Both goals were accomplished through presentations by Southwest Climate Assessment authors, other climate scientists, and resource managers, and ample time for questions and discussion among presenters and audience members.

Breakout sessions allowed for more-detailed discussion of topics raised by the findings of the Southwest Climate Assessment and contribution of ideas for questions or projects to be undertaken by the SWCSC over the next five years.

One hundred twenty people participated in the Summit. About one-third were affiliated with federal agencies, one-third with universities in the Southwest, and the rest with tribes (10 people), nongovernmental organizations (11 people), LCCs (5 people), and state and local agencies and governments, private firms, and water utilities.

A full summary of the Summit, as well as copies of presentations given, is available at www.swcsc.arizona.edu/announcements/southwest-climate-summit-0.

SOUTHWEST
Climate Summit

HOSTED BY THE SOUTHWEST
CLIMATE SCIENCE CENTER

USGS Briefing Forums

Dave Busch and SWCSC PIs Jonathan Overpeck, Sasha Gershunov, Mark Swartz, and affiliate Mike Dettinger participated in several briefings for USGS staff in the region on the scientific capabilities of the SWCSC. These briefings were held:

December 1, 2010 – Flagstaff, AZ
March 22, 2011 – San Diego, CA
May 27, 2011 – Sacramento, CA
August 8, 2012 – Menlo Park, CA

The goal of the briefings was to introduce USGS staff to the PI team, outline the scientific capabilities of the SWCSC, and look for opportunities for future collaboration between USGS scientists and resource managers and researchers with the SWCSC host institutions.

Professional Development

Alaska Climate Science Center Summer School

Part of the mission of the SWCSC is to provide professional development opportunities to early career scientists who are interested in collaborating with resource managers to answer climate change adaptation questions. To further that objective, the SWCSC sent research associate Christine Albano to participate in a two-week summer school course, developed and hosted by the Alaska CSC. Twenty graduate students and early-career scientists from the eight CSCs participated in the course. Topics included evaluation of model downscaling techniques, applications of downscaled models to models of hydrology, sea ice, glaciers, permafrost, and ecosystems, communicating uncertainty, and the effects of climate change on indigenous cultures.

Introduction

Photo: Larry Hogan

2012 Research Projects

The SWCSC has selected seven projects to fund in FY 2012. These projects will support both the long-term and short-term goals of the SWCSC by providing needed scientific research in areas of particular concern to regional stakeholders. Research topics address downscaled climate model development and assessment, effects of sea-level rise, vulnerabilities to and adaptation strategies for extreme events, modeling hydrologic systems, and vulnerabilities of Native American communities to climate change in the Southwest.

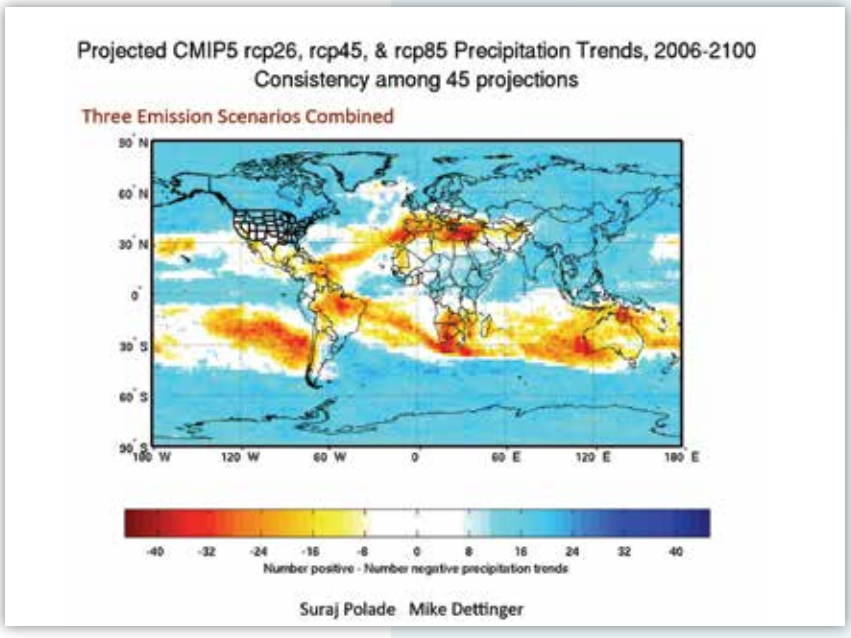
These projects were selected from a total of 93 statements of interest and 15 full proposals by a panel of science experts assembled and led by Dave Busch. Summaries of the selected projects follow.

Comparative analysis of downscaled climate simulations: Providing guidance to end users

Principal Investigator:
Daniel Cayan, Scripps Institution of Oceanography

Cooperators and Partners:
Bridget Thrasher, Climate Analytics Group; Alex Hall, University of California Los Angeles; Michael Dettinger, USGS

In this project, the researchers will develop guidance for potential users of a large set of statistical downscaled simulations. The foundation for this guidance will be a set of comparative analyses to better understand the accuracy and properties of statistical downscaled climate simulations and climate-change projections.



Climate change vulnerability of Native Americans in the Southwest

Principal Investigator:
Karletta Chief, University of Arizona

Cooperators and Partners:
Aleix Serrat-Capdevila, University of Arizona; William J. Smith, University of Nevada, Las Vegas; David Busch, USGS; Alison Meadow, University of Arizona

Native Americans in the Southwest are vulnerable to climate change because of their intimate relationship with the environment upon which their culture, tradition, and livelihood depend. Climate change may overwhelm tribes already stressed by economic and development challenges. A primary example is Nevada's largest tribe, the Pyramid Lake Paiute Tribe, located at the terminal end of the Truckee-Carson River, who are deeply connected—culturally, physically, and spiritually—to Pyramid Lake and its ecosystem. The four objectives of this project are to:
1) determine the potential of the Pyramid Lake Paiute Tribe to adapt to climate change;
2) develop collaborative tribal water management and adaptive strategies; 3) produce a framework for a decision support system model of a coupled climate-biophysical-social system; and 4) determine approaches that lead to effective tribal partnerships and collaborations. The unique and complex links between cultural and human values and the natural environment are strong but difficult to model with conventional modeling approaches. For each party to understand their role in the system, the system must be viewed holistically and collaborative decision-making process that are considerate of both parties must be used.

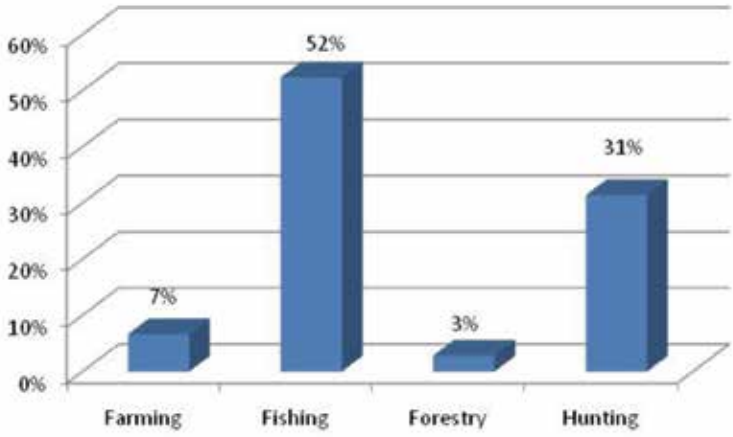
Lahontan Cutthroat Trout (LCT)

Fishermen sitting on ladders while fishing for LCT

Tribal Economy

Mostly centered around fishing and recreational activities at Pyramid Lake

- permit fees for fishing
- day use and overnight camping



Multi-criteria sensitivity analysis of the vulnerability of hydrologic systems to climate variability and change in the southwestern United States

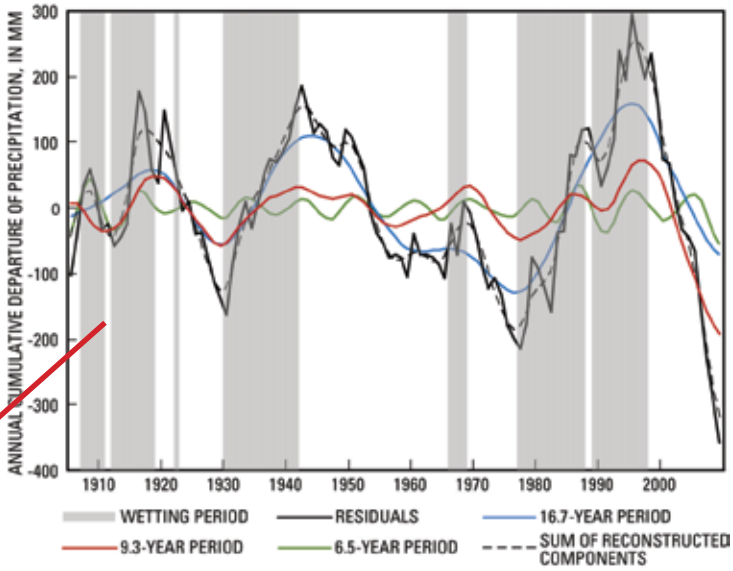
Principal Investigator:
P.A. Ty Ferre, University of Arizona

Cooperators and Partners:
Jesse Dickinson, USGS; Christopher Castro, University of Arizona; Peter Troch, University of Arizona; Stan Leake, USGS; Hoshin Gupta, University of Arizona; Randy Hanson, USGS; Pamela Nagler, USGS; Rafael Rosolem, University of Arizona

The potential consequences of climate variability and climate change have been identified as major challenges to the sustainability and availability of the water resources of the United States. Long-term decreases in precipitation will result in reduced recharge, lowered regional groundwater levels, loss of groundwater storage, stream baseflow depletion, and loss of riparian vegetation. We will examine how hydrologic systems filter climate signals and how this filtering depends on the frequency of the signal and the properties of the hydrologic system. An improved understanding of the vulnerability of hydrologic and riparian areas to future climate will inform water and riparian managers about which systems may be most sensitive to trends and periodic variations in climate.

Identify periodic and long-term variations in climate data

Periodic components of precipitation near Tombstone



Downscaled climate and hydrologic response for California and the Great Basin

Principal Investigator:
Lorraine Flint, USGS

Cooperators and Partners:
Alan Flint, USGS Water Resources Division; Michael Moran, USGS Water Resources Division; John Dingman, University of California, Santa Barbara; James Thorne, University of California, Davis; Lisa Micheli, Dwight Center for Conservation Science at Pepperwood; Healy Hamilton, University of California, Berkeley; Stuart Weiss, Bay Area Open Space Council; Bridget Thrasher and Claudia Tebaldi, Climate Analytics Group; Deanne DiPietro, Sonoma Ecology Center and California Climate Commons; Grant Ballard and Sam Veloz, PRBO Conservation Science

Climate change is causing rising temperatures and increased extremes in precipitation across the West. Snowmelt is earlier and droughts are longer, impacting the ability of water-supply managers to anticipate how to maintain water for drinking, agriculture, and fisheries. These changes also affect the landscape, stressing vegetation, increasing the number and size of forest fires, and challenging the survival of species, and are likely to become more pronounced. To adapt, natural resource managers need up-to-date, scientifically sound, and accessible information.

The study will provide state-of-the-art climate and hydrology data for California and the Great Basin, and provide interpretations that may inform the planning and decisions of natural resource managers. These analyses will help managers understand where the landscape effects of climate change are likely to be the most profound, how the environment is likely to change, and how certain the scientific community is about these changes.

The results of this study will be available to managers and the public on a user-friendly website that explains the results and provides interactive data and maps. The website will provide answers to questions about climate change and the tools and science used to explore how Earth is changing.

Approach

- Develop for California and the Great Basin region at 270-m spatial resolution
- Historical monthly climate and hydrology: 1900-2010
- Ensemble projections of monthly climate and hydrology
- Climate: AR4 and AR5: 23 models, 7 emissions scenarios
- Hydrology: PET, AET, snow, recharge, runoff, climatic water deficit
- Analyze hydrologic results to assess ensemble hydrologic outcomes for selected variables
- Analyze ~300 basins to calculate current and future discharge, changes in seasonal timing and frequency of extremes
- Format and post in California Climate Commons

Trans-specific drivers of climate-driven variation in forecasted distributional changes of Southwest birds and reptiles

Principal Investigator:
David J Mattson, USGS

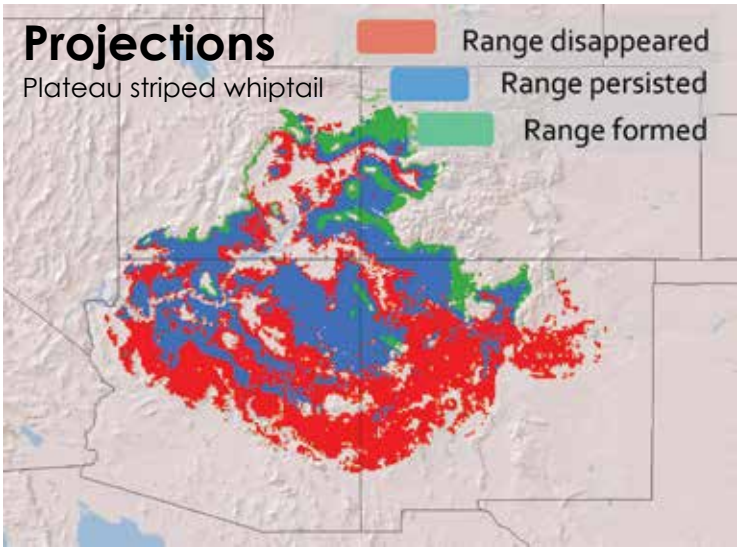
Cooperators and Partners:
Matthew J. Johnson, Northern Arizona University; Charles van Riper III, USGS; James R Hatten, USGS; J. Tomas Giermakowski, University of New Mexico; Erika Nowak, Northern Arizona University; Jennifer Holmes, Northern Arizona University; Michael Peters, Northern Arizona University; Paul Heinrich, Northern Arizona University

Current – 2099

Species are declining worldwide in ways that are consistent with the predicted effects of climate change. Managers are faced with identifying where, when, and how to allocate their limited resources with maximal effect relative to emerging and evolving societal concerns. Forecasts can provide managers with the prospective identities and locations of species that are likely to be at future risk because of climate change.

This research will address three main questions of relevance to the use of species distribution models in forecasting the extent and locations of species' vulnerability to climate change. 1) What explains differences in forecasts of species distributions, and how do these explanations relate to species characteristics? 2) What are the relations of our forecasts based on species distribution models to the results of assessments of species' vulnerability that are based on common vulnerability assessment methods? What bird and reptile species, currently common or not of conservation concern, will be at risk under the forecasted climate change in the southwestern United States, and why?

To address these questions we will model the distributions of 14 to 20 bird and reptile species that occur in the Southwest and couple the resulting species distribution models with forecasts of six different climate models to project future distributions of each species at three future times (2039, 2069, and 2099). The results will be combined with 13 existing species forecasts (for a total of 27–33 species forecasts) to analyze how differences among forecasts can be explained by species' characteristics. We then will relate the forecasts for each of our focal species to two different vulnerability assessments, one for birds, produced by the North American Bird Conservation Initiation, and one for birds and reptiles, produced by NatureServe. This research will build on the results of a three-year project with a similar focus that was funded by the National Climate Change and Wildlife Science Center and concluded during 2012.

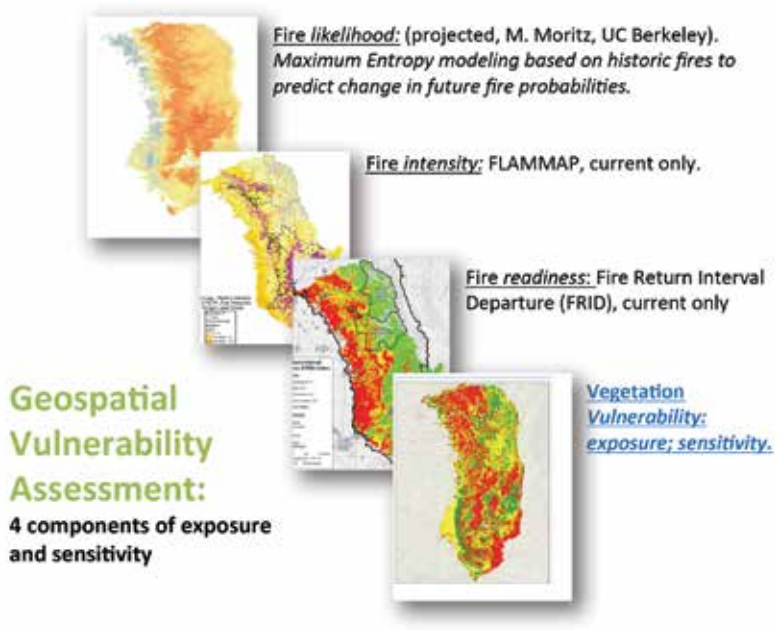


Climate change vulnerabilities and adaptation strategies to wildfire in the southwestern United States

Principal Investigator:
Mark W. Schwartz, University of California, Davis

Cooperators and Partners:
Mark Lubell, University of California, Davis; Jim Thorne, University of California, Davis; Patrick Gonzalez, National Park Service; Nate Stephenson, USGS; Max Moritz, University of California, Santa Barbara; Tim Brown, Desert Research Institute; Gregg Garfin, University of Arizona

Climate change is driving stress in plant communities and these stressed communities have differing, often negative, responses to wildfire. Forest wildfire is a growing problem in the southwestern United States, with millions of dollars spent each year in fire control. We are identifying where and when forest and woodland ecosystems of the southwestern United States will become vulnerable to change as a consequence of fire. The Southwest has begun to lose forested ecosystems through fire and drought; this will likely increase with increasing heat and drought. The research will assess where and when plant communities are projected to exhibit stress as a consequence of falling outside the bioclimatic window for that vegetation type. Stressed ecosystems are vulnerable to increased mortality and higher fire severity. Together, understanding fire probabilities and forest vulnerabilities will provide decision support for how fuels management (prescribed fire and mechanical fuels reduction) is deployed as well as appropriate management responses to wildfire events. An understanding of how vegetation is likely to change with climate will allow proactive land management decisions to guide forested ecosystems toward stable, functioning future states.



Effects of sea-level rise and extreme events on California coastal habitats

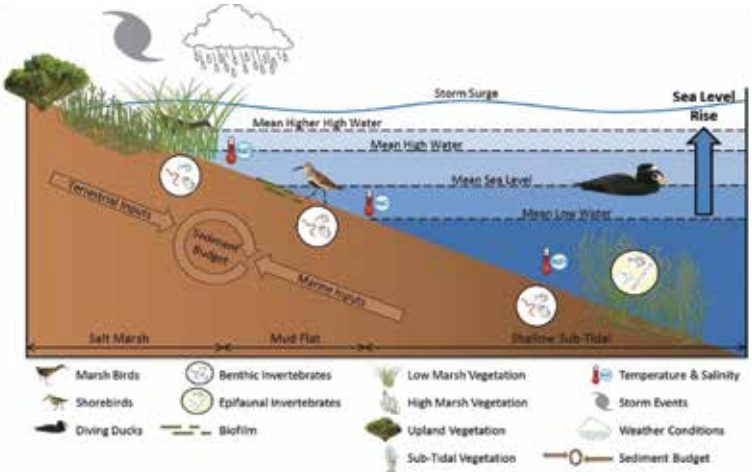
Principal Investigator:
John Y. Takekawa, USGS

Cooperators and Partners:
Rich Ambrose, University of California, Los Angeles; Patrick Barnard, USGS; Michael Casazza, USGS; Susan De La Cruz, USGS; Glenn Guntenspergen, USGS; Alex Hall, University of California, Los Angeles; Bruce Jaffe, USGS; Glen MacDonald, University of California, Los Angeles; Cory Overton, University of California, Davis; Karen Thorne, University of California, Davis; Susan Ustin, University of California, Davis; Brian Collins, Fish and Wildlife Service; Kenneth Griggs, Fish and Wildlife Service; Eric Nelson, Fish and Wildlife Service; Steven Schwarzbach, USGS; Andy Yuen, San Diego Refuge Complex

Photo: tidal marsh gradient fieldwork (courtesy of USGS; biologist and PhD candidate Kevin Buffington measuring the elevation of a staff gage, photo credit: USGS

In California, the nearshore area where the ocean meets the land is a highly productive region that supports a wealth of wildlife, including several native bird species. The salt marshes, mudflats, and shallow bays of this boundary region are connected habitats critical to wildlife, local people, and communities. Climate change effects such as sea-level rise are altering these habitats, but we don't know how they are being affected or will change in the future. This study will examine the links among these habitats and expected future changes at several sites along the California coast. It will review the current weather patterns, elevations, tidal range, and sediment of these connected habitats to see how they affect plants and animals, and to project how climate change may alter that balance. The goal of the project is to provide scientific information to support future planning and conservation of nearshore natural resources as climate changes.

Downscaling climate change models to local site conditions: effects of sea-level rise and extreme events to California coastal habitats



Next Steps




Photo: Alexis Vargas

Next Steps

Permanent Director

A permanent federal director for the SWCSC began his new role on September 10, 2012. Dr. Stephen Jackson comes to the SWCSC from the University of Wyoming, where he was a professor of botany and founding director of the doctoral program in ecology.

Before joining the University of Wyoming in 1995, Dr. Jackson held faculty positions at Indiana University, Idaho State University, and Northern Arizona University. He is past president of the American Quaternary Association and is on the governing board of the Ecological Society of America and the editorial boards of *Ecosystems*, *Frontiers in Ecology & Environment*, and *Trends in Ecology and Evolution*. He is a Fellow of the Aldo Leopold Leadership Program (2006) and of the American Association for the Advancement of Science (2009). His own research employs tree rings, fossil rodent middens, and sediments from lakes and bogs to investigate how past climatic changes and human activities have affected species distributions, biodiversity, and ecosystem properties.

Dr. Jackson received his Ph.D. in ecology and evolutionary biology from Indiana University and his B.A. and M.S. in botany and geology from Southern Illinois University at Carbondale.

In addition to his SWCSC directorship position through USGS, Dr. Jackson also will hold two appointments at the University of Arizona: adjunct professor in the Department of Geosciences and adjunct research professor in the School of Natural Resources and the Environment.

The principal investigators, staff, and research associates of the SWCSC thank Dave Busch for his extraordinary efforts as Interim Director to establish a solid base for the SWCSC.

Science Planning Process

In late 2012 the SWCSC will develop a five-year science agenda to guide future research and funding decisions both within the SWCSC and within the larger network of regional climate science centers.

The SWCSC science agenda will draw from the needs identified by constituent agencies within the Department of the Interior, the guidance provided by the Stakeholder Advisory Committee, and the scientific expertise of the principal investigators, partner investigators, and affiliate researchers.

On the basis of needs assessment activities conducted in 2012, a general list of priorities for the SWCSC includes:

- Scale climate models to the spatial and temporal scales at which resource management decisions are made.
- Develop effective links between groundwater/surface-water models and ecosystem models and metrics.
- Link climate models to hydrologic and ecosystem models to give resource managers a better idea of how changes in climate will affect their management area and resources.
- Improve information on the nature and impacts of extreme climate events (storms and floods, for example), including their frequency, duration, and spatial scale.
- Investigate the effects of sea-level rise and ocean acidification on ecosystems and physical systems.
- Investigate ecosystem and species resiliency and develop effective restoration or adaptation strategies.
- Develop monitoring strategies to collect multidisciplinary baseline data that can be used to observe multiple facets of future climate change.
- Develop and implement strategies to improve communication with stakeholders about climate change risk, uncertainty, and the state of the science.

We will submit the five-year science plan to the National Climate Change and Wildlife Science Center by January 2013.

Research Priorities for 2013 and 2014

Requests for research proposals from the SWCSC for fiscal years 2013 and 2014 will be coordinated with the seven other regional climate science centers. We anticipate that the call will be distributed in early January 2013. Approximately three weeks later, statements of interest will be due to the individual CSCs. Each CSC will ask for input on the statements of interest from its Science Implementation Panel and other key partners. The statements of interest will also be reviewed at the national level by the National Climate Change and Wildlife Science Center. We anticipate that full proposals will be invited by mid-February and due to the SWCSC in mid-March. Investigators of selected projects will be notified in mid-April 2013.

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