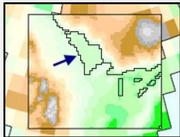




About this issue

This issue of "Climate Matters" focuses on USGS research designed to improve understanding of patterns of precipitation and drought in the western U.S., impacts of climate variability on the land surface and carbon sequestration, and the use of climate models to understand climate patterns of the past and present.

Science Feature

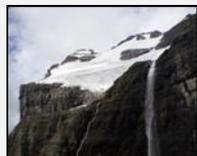


[Climate models: applications to understand past climates and climate change](#)

Science Highlights



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[Glacier-Derived August Runoff in Northwest Montana](#)



[Sand dune mobility at Grand Falls on the Navajo Nation, southwestern United States](#)



[Urbanization can switch floodplain wetland soils from a sink to a source of greenhouse gases](#)



[A 7,600-year record of climate and vegetation change from the northern Ruby Mountains, Nevada, USA](#)

New and Noteworthy



Visit the new [USGS Glacier Studies](#) webpage to learn about the important research that U.S. Geological Survey scientists are conducting on our nation's shrinking glaciers in order to better understand the links to climate change and the potential impacts to society.



[Science Documents Mammoth Climate Findings at Legendary Snowmastodon Ice Age Site, Colorado](#)

By Pete Modreski, Jeff Pigati, Heidi Koontz, Marisa Lubeck, Maura O'Neal

Upcoming Meetings

The [2015 Ecological Society of America Annual Meeting](#) will be held in Baltimore, Maryland from August 9-14, 2015. This meeting marks the centennial of ESA, and its theme is "Ecological Science at the Frontier: Celebrating ESA's Centennial".

The [2015 Annual Meeting of the Geological Society of America](#) will be held in Baltimore, Maryland from November 1-4, 2015.

[More . . .](#)

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About this issue

The current drought in the western United States and extreme weather events that have headlined recent news reports have prompted questions as to whether this represents a “new normal” that policy makers must plan for. Have these events resulted from human alteration of the Earth system, or are they within the bounds of natural climate variability? If the current patterns continue, what are their likely impacts on ecosystems, society, agriculture, and infrastructure? How can we plan to mitigate or adapt to these changes?

Research to address these questions requires a multidisciplinary approach that combines instrumental records and geologically-based reconstructions of past climate and land cover with field measurements and modeling efforts to improve our understanding of the mechanisms and impacts of climate change. This issue of “Climate Matters” highlights several recent studies sponsored by the U.S. Geological Survey [Climate Research & Development Program](#) that focus on patterns of precipitation and hydrologic variability in the western United States, the impacts on the land surface and vegetation, and how the onset of drier conditions affects the capacity of floodplain wetlands to sequester carbon.

The research featured in this newsletter is a sampling of the type of integrated research that the USGS Climate Research & Development Program conducts to improve our understanding of the rates, patterns, and consequences of climate and land use change. We welcome comments and feedback to shape future issues. If you would like to subscribe please click the “Subscribe” button on the [Program Newsletter](#) page.

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Climate Research & Development Program

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Climate models: applications to understand past climates and climate change

Effective climate change research requires a thorough understanding of the characteristics and interactions of the Earth's physical, chemical and biological components as they affect climate on varying temporal and geographic scales. However, many important climate-related variables and processes in the Earth system are sparsely observed (e.g., evapotranspiration and soil moisture) or are unobservable (e.g., aspects of the global atmospheric circulation). Therefore, researchers rely on climate models to simulate climate information. Numerical climate models simulate processes and feedbacks within the Earth systems. While they have limitations, they are a valuable tool for discovering and understanding atmospheric processes and mechanisms, for investigating interactions of the Earth system, and for simulating climates of the past and future.

Climate models range in complexity from conceptual to highly detailed numerical models that are programmed in computer codes and run on supercomputers. Numerical climate models are derived from weather-forecasting models which are built upon the physics of thermodynamics and fluid dynamics. The first numerical weather model was developed in 1904 by Norwegian physicist and meteorologist [Vilhelm Bjerknes](#). Most models include fully coupled land surface components to simulate surface processes and their feedbacks to the atmosphere. Many atmospheric-land surface models also are coupled with atmospheric chemistry models and ocean models that simulate oceanic circulation, sea ice and sea-surface interactions with the atmosphere. With the emerging addition of ice sheet models, future climate models will achieve the full ability to simulate the atmosphere and surface of the Earth.

Two model types that are used widely in climate research are general circulation models (GCMs) and limited area or regional climate models (RCMs). GCMs simulate the global circulation of the atmosphere and oceans and typically have a spatial resolution on the order of 100s of kilometers. They simulate global climate in response to prescribed, global-scale features, or boundary conditions, that include atmospheric greenhouse gas (GHG) concentrations (e.g., carbon dioxide and methane), incoming solar radiation (insolation) based on Earth-Sun geometry, land mass distribution, sea level and continental ice sheet extent. RCMs include physics that are similar to GCMs but are designed to be run over smaller areas (e.g. North America) at much higher resolution (10s of km or less). RCMs are driven with output from GCMs to obtain higher spatial resolution of climate that captures, for example, the effects of mountain ranges, coastlines, vegetation, and lakes (Figure 1).

Climate models are used to reconstruct past climates when the models are run with prescribed global boundary conditions covering the period of interest. These reconstructions are known generally as paleoclimate simulations. For example, many paleoclimate simulations have been run of the Last Glacial Maximum (LGM) which occurred about 21,000 years ago. The boundary conditions for LGM simulations

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Land-Surface Elevation

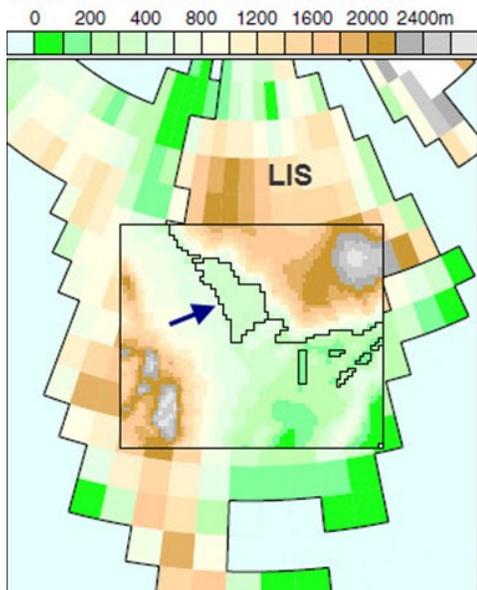


Figure 1. Topography as represented by a GCM and RCM. The larger grid boxes in the map illustrate the topography of North America 11,000 years ago in a GCM that has a resolution of about 300 km × 300 km in latitude and longitude. The inset box, which is the domain of the RCM, illustrates topography on 45 km × 45 km grid boxes. The area within the RCM domain includes the Rocky Mountains in the southwest, the greatest heights of the Laurentide Ice Sheet (LIS) in the northeast and the large proglacial Lake Agassiz (blue arrow) along the southwestern margin of the ice sheet as reconstructed from the geologic record. The Great Lakes are located south of the eastern margin of the ice sheet. From Hostetler et

Paleoclimate simulations are linked with geologic data in several ways. First, the

boundary conditions for the simulations are derived directly from geologic records: GHG levels are known from analyses and dating of ice cores; the extent of the continental ice sheets is known from the geologic evidence left behind after the ice sheet's retreat; and sea level is known through analyses of past shorelines and geophysical models. Insolation, based on Earth-sun geometry, is known precisely from computations developed in the 1920s by [Milutin Milankovitch](#), a Serbian astronomer and mathematician.

include carbon dioxide and other GHG concentrations that were less than half of present levels, insolation that was similar to present, expanded continental ice sheets that covered much of North America and Europe, and sea level that was roughly 120 m lower than present (Figure 2). In response, the models simulate an annual average LGM climate that was globally about 5 °C colder and regionally drier than present. In contrast, simulations of the deglacial period, from 12,000 to 6,000 years ago, include increasing GHG levels, smaller continental ice sheets and Earth-Sun geometry that amplified seasonality of the Northern Hemisphere (increasing summer insolation and decreasing winter insolation), and sea level approaching present conditions. The simulated global climate 6,000 years ago was globally about 1 °C warmer and regionally wetter or drier than present.

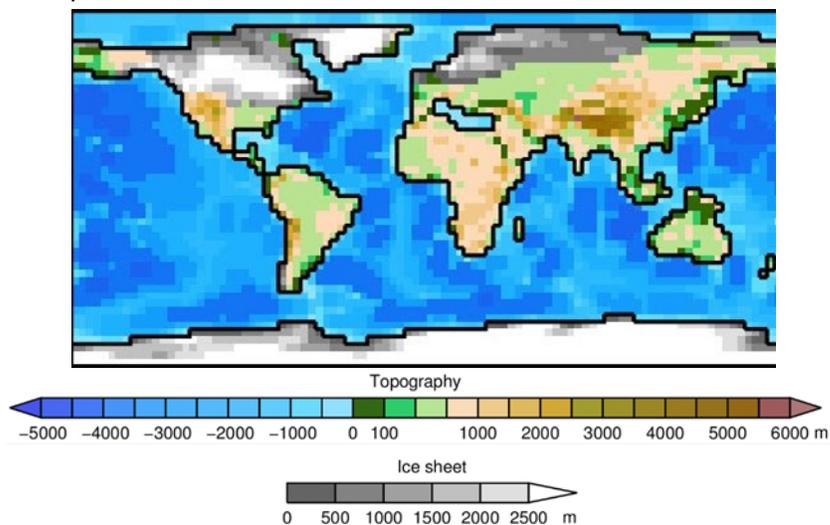


Figure 2. The Earth surface at 21,000 years ago as represented in a GCM. The colors indicate the depth of the oceans, the elevation of the land and the elevation of the continental ice sheets over North America, Europe, Greenland and Antarctica. (From Alder and Hostetler, 2015)



The second way that paleoclimate simulations are linked with geologic data is through comparisons of the simulations with records obtained from lake and marine sediments, ice cores, speleothems, sand dunes, glacial moraines, tree rings, packrat middens, and other natural sources that preserve proxy information about past climate conditions. Such data-model comparisons are a cornerstone of paleoclimate research. They provide a well-established method for quantifying the accuracy of simulations of known past climates and thus improve our confidence in their ability to simulate future climate conditions. Additionally, data-model and model-to-model comparisons are fundamental for studying the mechanisms of climate change and for testing climate hypotheses that lead to an understanding of, for example, the sources of wet and dry cycles over North America during the Holocene (11,700 years ago to present).

Regional climate models are well suited to applications that benefit from higher resolution of climate processes than is typically possible with GCMs. They are particularly useful for exploring feedbacks between the Earth's surface and the atmosphere. The example illustrated in Figure 3 is from the study introduced in Figure 1 that focused on using an RCM to isolate the effect of large proglacial Lake Agassiz on the regional climate over the Laurentide Ice Sheet 11,000 years ago. The extent and depth of Lake Agassiz prescribed in the model was based on reconstructions from geologic records of shorelines, land surface elevation changes associated with the melting of the ice sheet, and the margin of the LIS. The patterns of the simulated winter and summer temperature and annual precipitation climatologies clearly reflect the high resolution of the RCM and the ability of the model to capture the influences and feedbacks associated with the complex paleogeography in the region.

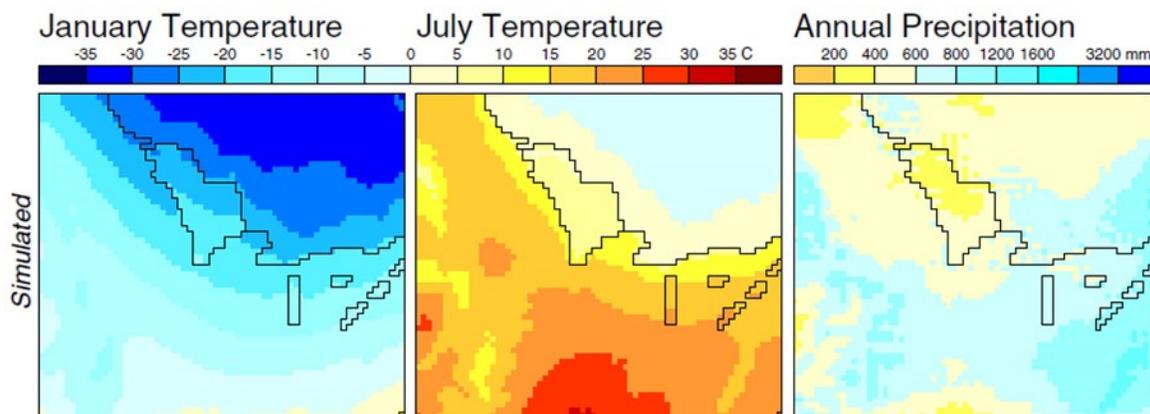


Figure 3. Regional temperature and precipitation climatologies 11,000 years ago as simulated by the RCM (model domain indicated by the inset box in Figure 1). From left to right: a) average January air temperature, b) average July air temperature and c) average annual precipitation. From Hostetler et al. (2000).

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GCMs and RCMs similar to those illustrated here are also applied extensively by international modeling centers to simulate future climates under prescribed changes in GHGs, land use, ice sheets and vegetation. Many of the GCMs that were used to simulate future climate for the current [Fifth Climate Model Intercomparison Project \(CMIP5\)](#) have also been applied to simulate the climates of the LGM and mid-Holocene (6,000 years ago) under the [Paleo Model Intercomparison Project \(PMIP3\)](#).

The broad range of research conducted in the [U.S. Geological Survey's Climate and Land Use Research and Development program \(R&D\)](#) focuses on understanding local to global interactions of the hydrosphere, cryosphere, geosphere, biosphere and atmosphere over time periods ranging from millions of years ago into the future. The paleoclimate research of the R&D program contributes to our understanding of the rates and magnitudes of past climate change which provides a context within which to view present and potential future climates. Combining climate models with data-based climate reconstructions provides a way of discovering and understanding the mechanisms of climate change and explicitly tests the ability of the models to capture known changes in climate. In turn, this approach leads to model improvements and heightened confidence in the ability of the models to simulate future climates.

For more information, please contact [Steve Hostetler](#).

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Alder, J. and S. Hostetler (2015). Global climate simulations at 3,000-year intervals for the last 21,000 years with the GENMOM coupled atmosphere-ocean model. *Climate of the Past* 11, 449-471 doi: 10.5194/cp-11-449-2015.

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Tracing long-term changes in Rocky Mountain climate, water, and ecosystems

Annual runoff from Rocky Mountain snowpack replenishes the essential water resources that supply the semi-arid regions of the west, many of which are faced with increasing water demand. An understanding of the climate controls on seasonal precipitation facilitates effective planning for future water availability. Since observations began in the early 20th century, Rocky Mountain precipitation has been dominated by winter snow. The amount of snowpack varies from year to year, and these variations are related to Pacific ocean-atmosphere processes such as El Niño/Southern Oscillation (ENSO). However, the century-long instrumental records are not sufficiently long to characterize natural snowpack variability.



Scientist works on a frozen lake in early spring to collect sediment cores for regional climate and snowpack reconstructions.

Examining Rocky Mountain precipitation over the last 10,000 years can show how snowpack has changed in response to natural variations in the global energy balance and whether recent trends are attributable to natural variability. New research by USGS scientists is yielding insights on snow and water variability by examining geochemical information contained within snowpack and sediments from lakes located within the Rocky Mountain snowpack accumulation zone. These data provide a detailed record of natural snowpack variability, including long-term averages and extremes. They also provide a context to evaluate recent trends and help understand how the region may respond to future climate change.

In a study carried out over the entire U.S. Rocky Mountain region, scientists from the USGS and the University of Illinois Chicago examined oxygen and hydrogen isotope tracers within the snowpack from ~60 locations over the 21 year period since 1993. The isotopic tracers provide quantitative information about precipitation and temperature in the region at the time of deposition. Results of this research

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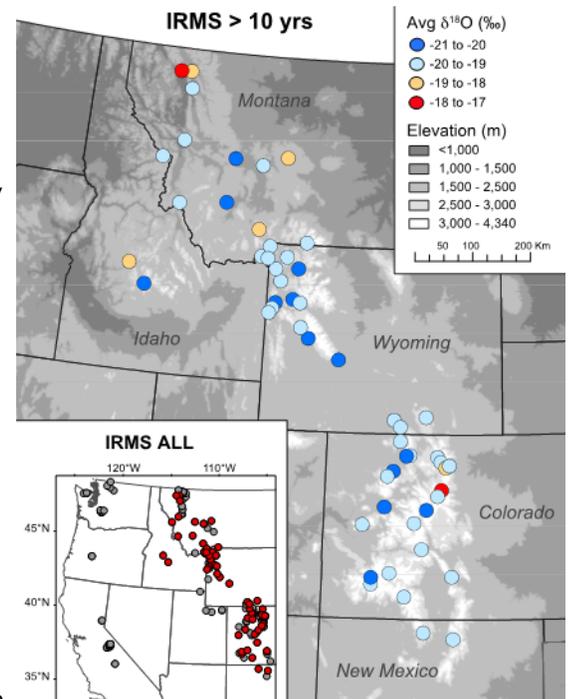
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indicated that snowpack isotopes in some locations are strongly correlated with regional climate. The scientists then applied these relationships to an ~10,000 year lake sediment isotope record from northwest Colorado to make estimates of past climate conditions. This effort showed that regional 20th century snowpack trends are within the range of natural variability.

A related study involving scientists from the USGS and the University of Utah evaluated the relative importance of recent human land use and natural climate change on an alpine landscape. Scientists examined biological and chemical information from a lake sediment record to distinguish changes in vegetation distribution, fire and other natural disturbances. The combined results indicate that vegetation and fire regimes changed dramatically in response to climate and hydrologic change of the last two thousand years. Although post-settlement (circa last 150 years) disturbances were significant, they had relatively less impact suggesting that alpine forests are resilient to the combined impacts of recent human and natural agents of change.



Maps showing locations where snowpack has been collected (inset) for isotope analyses. The colored symbol indicate average oxygen isotope composition from locations that have more than 10 years of measurements since 1993.

The papers are published in *Quaternary Science Reviews* <http://authors.elsevier.com/sd/article/S0277379115001304> and *The Holocene* <http://hol.sagepub.com/cgi/reprint/25/6/932.pdf?ijkey=eGc2n8HkmunYfnv&keytype=finite>.

For more information, please contact [Lesleigh Anderson](#).



Glacier-Derived August Runoff in Northwest Montana

The second largest concentration of glaciers in the U.S. Rocky Mountains is located inside and immediately west of Glacier National Park (GNP), Montana. Here, mountain glaciers are water reservoirs that store winter precipitation as snow and ice and then release meltwater during the summer months. Late summer is typically hot and dry in this region. It is also a time when much of the previous winter's snowmelt has melted and run off. By August, glacier meltwater can help maintain base flows in streams and keep water temperatures cool during seasonal droughts.



Outlet streams below Old Sun Glacier, Glacier National Park. Continued glacier loss in the park will likely lead to significantly reduced stream flow in the future.

The total glacier-covered area in GNP has decreased by ~35% over the past 50 years, a trend that epitomizes the impacts

of a warming climate on the landscape. Since cold water sourced from melting glaciers is considered a vital natural resource, the shrinkage and potential loss of glaciers has raised substantial concerns about declining stream flows, warming water temperatures, and the associated ecological impacts.

The loss of glaciers in GNP has been well documented, and there is plentiful previous work describing the possible consequences of diminishing glaciers here and elsewhere. However, until now no study had quantified glacier melt characteristics explicitly across GNP, leaving important scientific uncertainties associated with the hydrological and ecological processes of these glaciers. In a recent study, researchers from both the University of Montana's Geosciences Department and U.S. Geological Survey worked in a partnership to address these uncertainties for GNP. Together they developed a regional glacier melt model that was calibrated with weather and glacier melt measurements on five remote glaciers in the park. Because the glaciers can only be reached on foot, the scientists used an innovative weather station design, which allowed the stations to be broken down and carried in backpacks across rugged mountainous terrain.

Results from the model, which was run for the months July, August, and September during years 2009

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and 2010, produced robust estimates of the summer meltwater production by glaciers. The researchers found that during the month of August, glaciers in the region produce approximately 25×10^6 m³ of potential runoff. They then estimated the glacier runoff component in five gaged streams sourced from GNP basins containing glaciers. Glacier-melt contributions ranged from 5% of runoff in a basin where glaciers only covered 0.12% of the watershed catchment to more than 90% in a basin where glaciers covered 28.5% of the catchment. The model results indicated that glacier loss will likely lead to lower discharges and warmer temperatures in streams draining basins greater than 20% glacier-covered. Lower flows could be expected in streams draining basins with as little as 1.4% glacier cover if glaciers continue to shrink.

The paper, published in *Arctic, Antarctic, and Alpine Research* is available at: <http://aarjournal.org/doi/pdf/10.1657/AAAR0014-033>.

For more information, please contact [Adam Clark](#).

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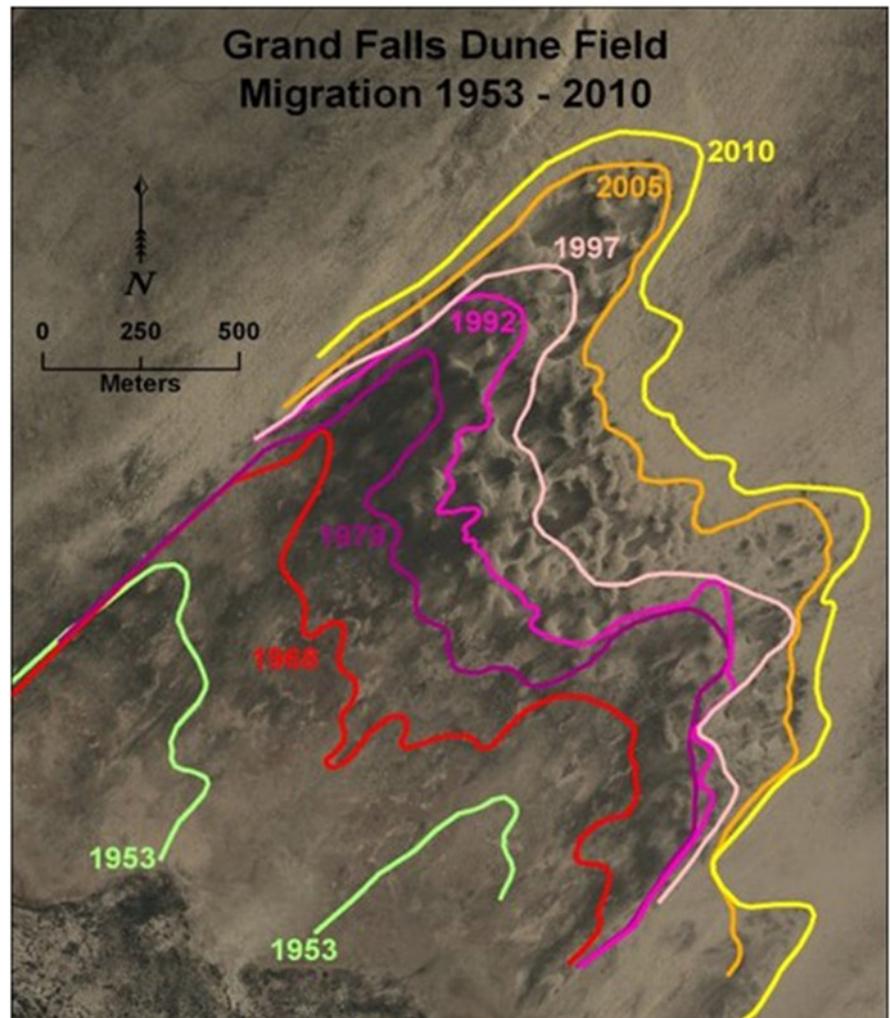


Sand dune mobility at Grand Falls on the Navajo Nation, southwestern United States

Nearly a third of the Navajo Nation, in the southwestern USA, is covered with sand dunes and sand sheets that have been variably active during droughts of recent geologic history. The sand mobility of these dunes, as with dune deposits worldwide, is a function of wind, sand supply, and vegetation cover. Thus, sand dune deposits are highly sensitive to changes in climate.

Increased aridity due to higher temperatures and a prolonged drought that began in the late 1990s is producing significant changes in dune mobility on the Navajo Nation. However, developing models that can directly link the state of dune activity to changing climatic conditions has been a challenge. Sand and dust movement in the region is closely linked to regional aridity, flood events, and wind circulation and energy. Related sand and dust storms can damage rangeland and cause dangerous travel conditions. These storms can also generate economic, cultural, and health consequences for the Navajo people.

To understand and document the current and future potential for dune mobility on the Navajo Nation, U.S. Geological Survey scientists recently carried out a study that focused on a field of sand dunes located downwind of the Little Colorado River at Grand Falls, Arizona. These dunes formed in the early 1950s. The areal extent of the dunefield has increased rapidly during recent



Location of the migrating front of Grand Falls Dune Field showing the extent of dune cover from 1953 to 2010, superimposed on 2005 aerial photo. Historic positions of the dune field front were derived from archival imagery. The dune front and extent of dunes has changed rapidly in recent decades, with an approximately 70% increase in dune cover from 1992 to 2010 (modified from [USGS Fact Sheet 2011-3085](#)).

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drought years. Seasonally repeated surveys were used to track the location of migrating sand dunes. The field survey information on dune migration rates was compared to in-situ meteorological data on wind speed and direction, temperature, precipitation, soil moisture, and vegetation to examine climatic parameters and seasonal variations that affect dune mobility.

Three years of data on migration rates and weather information were collected (2009-2012), providing a detailed snapshot of the seasonal and annual variability of active sand dune movement in the Grand Falls Dune Field. Using GPS field surveys and meteorological data, the study showed that these dunes, under the current arid and sparsely vegetated conditions, are not stable. The sand dunes migrated at rates directly proportional to local wind energy.

During the period of observation, the lowest annual precipitation rate was less than 50% of the local historical average of 160 mm, and the peak precipitation for all three years was only 75% of the long-term average. These low precipitation amounts, combined with increasing average, minimum, and maximum temperatures, result in less effective moisture needed for plant growth and dune stabilization. Additionally, the annual windy season occurs during the spring at the driest part of the year, before much of the plant growth is established. Because plant growth is at a minimum when wind storms are common, the seasonality of the climate of the Grand Falls Dune Field on the southern Colorado Plateau leaves dune deposits more susceptible to wind erosion and impacts from drought.

Average dune migration rates, calculated for wind years beginning in 2009, 2010, and 2011, ranged from 25 m/yr to 43 m/yr within the dune field; rates changed by as much as 48% annually, depending on annual variations in wind energy. The current increase in aridity, coupled with active dune movement in the western Navajo Nation, may hinder the recruitment and establishment of plants needed to stabilize mobile dunes in this region.

This paper, published in the journal *Geomorphology*, is available at <http://www.sciencedirect.com/science/article/pii/S0169555X14004504>.

Please contact [Margaret Hiza Redsteer](#) for additional information.

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Urbanization can switch floodplain wetland soils from a sink to a source of greenhouse gases

Carbon cycling and sequestration in ecosystems helps regulate climate and offset anthropogenic carbon emissions. Soils store a large proportion of the Earth's carbon, and disturbances can switch soils from a carbon sink (where inputs are greater than emissions) to a carbon source (where emissions are greater than inputs). Wetland soils, in particular, hold very large amounts of carbon. Wetland soils are often large sinks of atmospheric carbon dioxide (CO₂), reducing greenhouse gas effects on climate because of inputs from plant growth and slow release from decomposition in waterlogged soils. However, some wetlands also release the potent greenhouse gases methane (CH₄) and nitrous oxide (N₂O), possibly offsetting the climate benefits of CO₂ uptake.

The role of floodplain soils in carbon cycling and sequestration are less well understood compared to other wetlands. Floodplains are widespread along streams and rivers and could potentially intercept carbon eroded from watersheds. Prior studies suggested that floodplain soils in the U.S. could have very large rates of carbon sequestration through sedimentation inputs, but great uncertainty exists on the magnitude, sources, and fate of that carbon. Greater inputs of carbon from sedimentation could be offset by increased rates of greenhouse gas release from floodplain soils. The balance of carbon inputs and



Floodplain soils in Difficult Run, Virginia are losing soil carbon through emissions of carbon dioxide to the atmosphere in this urbanizing watershed. The floodplain is dry most of the year (top photo) with occasional and brief flooding (bottom photo).

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outputs from floodplain soils could also be disrupted by changing land use in watersheds, including urbanization.

U. S. Geological Survey researchers recently published results of a new study that aimed to measure the potential for carbon sequestration in floodplain soils and to contrast carbon inputs from sedimentation and vegetation with losses from greenhouse gas release and bank erosion. Carbon inputs, outputs, and storage from floodplain soils were measured throughout Difficult Run, a suburban watershed in the Washington, DC metro region that is part of the Piedmont region of the Chesapeake Bay watershed. Annual rates of vegetative litterfall production, sedimentation, bank erosion, soil CO₂, CH₄, and N₂O gas emissions, and soil carbon pool size were measured from the headwaters to the mouth of the watershed.

The researchers found that soil CO₂, CH₄, and N₂O emissions did not increase in proportion to carbon input from sedimentation, suggesting that floodplains with greater sedimentation are capable of sequestering more carbon. However, soil CO₂ releases were greater than soil carbon inputs from sedimentation and vegetation, indicating that this floodplain is losing soil carbon regardless of the sedimentation rate. On average, the floodplain is releasing 2% of stored soil carbon to the atmosphere per year. The loss of floodplain soil carbon is likely due to long-term drying from watershed urbanization as indicated by decreased stream water levels during low-flow periods over the past 80 years. This research highlights the potential impact of watershed urbanization on floodplain soil carbon cycling that can cause a reversal from carbon sequestration to a carbon source to the atmosphere.

This paper, published in *Journal of Geophysical Research: Biogeosciences*, is available at <http://onlinelibrary.wiley.com/doi/10.1002/2014JG002817/full>.

For more information, please contact [Gregory Noe](#).

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A 7,600-year record of climate and vegetation change from the northern Ruby Mountains, Nevada, USA

Recent drought episodes in the western United States highlight the need to understand their frequency, duration, and spatial extent. The characteristics of precipitation, including amount, type (snow vs. rain), and seasonality (winter vs. summer) have significant socioeconomic consequences. Winter precipitation across the western United States typically shows a pattern of wetter conditions in the Pacific Northwest and drier conditions in the Southwest. Historical and geological evidence indicates that this pattern can be enhanced during the cool phase of the El Niño-Southern Oscillation (ENSO), which is a major component of interannual and decadal climate variability. Warm ENSO events often result in a reversal of the precipitation pattern, with a wetter Southwest and a drier Pacific Northwest.



Favre Lake, a subalpine lake located in the northern Great Basin, contains a sedimentary record that documents patterns of precipitation and vegetation over at least the last 7,600 years.

The northern Great Basin is located in the transition zone between these two regions. Continuous records of vegetation and climate change over the last 11,700 years (Holocene) are relatively rare in the northern Great Basin, particularly from high elevations where ecosystems are more sensitive to changes in temperature than lower elevations. As a result, past changes in precipitation patterns and vegetation in the northern Great Basin currently are not well understood.

Subalpine lakes in the Ruby Mountains, Nevada, preserve evidence of vegetation and climate change in their lake bottom sediments, and thus have the potential to produce much-needed high-elevation

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Holocene paleoenvironmental records for the northern Great Basin. In a recent study, U.S. Geological Survey scientists analyzed a 4.2 meter sediment core taken from Favre Lake, a small lake in the northern Ruby Mountains situated approximately 2,900 meters above sea level. The goal of this research was to assess changes in vegetation, fire history, lake level, and water conditions in order to better characterize regional climate during the Holocene. Scientists analyzed fossil pollen, charcoal, and diatoms, as well as the physical properties of the sediment. Ages in the core were determined using radiocarbon (^{14}C) analysis. Additional age control came from the chemical analysis of a volcanic ash layer at the base of the core, which showed that it originated from Mount Mazama (Crater Lake) approximately 7,660 years ago.

Results from analysis of the Favre Lake sediment core show that for the past $\sim 7,600$ years climate conditions in the northern Great Basin have been quite variable with respect to temperature and precipitation. The data suggest that the primary controls on this variability are orbital forcing (relative strength of the sun in summer vs. winter) and, for the last few thousand years, changes in surface temperatures of the Pacific Ocean that are tied to ENSO activity. Additionally, the Favre Lake results indicate that, within the precipitation pattern, the Ruby Mountains have a climate affinity with the drier Southwest region as opposed to the wetter Pacific Northwest. The data from this study help to constrain where the transition zone between these two regions is located in the northern Great Basin and improve our understanding of ENSO dynamics in the area.

The timing of major changes in the Favre Lake data is similar to those recorded in other paleoclimate studies from the Great Basin. Taken together, these findings suggest that regional climatic controls in the western United States play an important role on local conditions. The conclusions drawn from these studies have the added benefit of providing long-term baseline information that can help resource managers to better plan for future change.

This paper, published in *Quaternary International*, can be found at <http://www.sciencedirect.com/science/article/pii/S1040618215002116>.

For more information, please contact [David Wahl \(dwahl@usgs.gov\)](mailto:dwahl@usgs.gov).

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Upcoming Meetings

USGS scientists are presenting results from Climate R&D research and/or convening the following ESA sessions:

- [OOS 5](#) Ecological Controls over Soil Organic Carbon Cycling: An Emerging Frontier in Ecology
- [OOS 24](#) Collaborative Ecological Research Networks: Sociology, Successes, and Future Opportunities
- [OOS 36](#) Coastal Plant Range Shifts: Causes and Consequences
- [OOS 45](#) The Emergence, Rise, and Future of Urban Ecology in the United States
- [OOS 86](#) Coastal Wetlands in a Changing World: Drivers of Carbon Storage and Loss
- [OOS 88](#) Extreme Disturbance Events Leading to Forest Ecosystem Change
- [COS 21](#) Biogeochemistry: Aboveground – Belowground Interactions I
- [COS 29](#) Environmental Impact and Risk Assessment
- [COS 31](#) Invasion I
- [COS 43](#) Climate Change: Communities I
- [COS 94](#) Wetlands
- [PS 18](#) Climate Change
- [PS 45](#) Arid and Semi-Arid Systems
- [SS 26](#) Using Science-Policy Integration to Improve Ecosystem Science and Inform Decision-Making; Lessons from U.S. LTERs

USGS scientists will convene the following GSA sessions. The complete program will be available in August - September, 2015.

- T124 Hot or Cold, Wet or Dry: The Diachroneity of Late Pleistocene and Holocene Lacustrine Climate Events
- T140 Late Paleocene and Early Eocene Hyperthermal Events in Terrestrial and Marine Systems
- T190 Paleocological Patterns, Ecological Processes, Modeled Scenarios: Crossing Temporal Scales to Understand an Uncertain Future

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