Issued: February 25, 2009

Southwest Climate Outlook

THE UNIVERSITY OF ARIZONA®
Arizona's First University.

Source: Zack Guido

Photo Description: The mountains near Snowbird ski area in Utah received about two feet of snow in the 24 hours prior to this photo, taken on February 10. Many of the Utah SNOTEL locations, where snow-water conditions are measured, currently have near-average snow water content (SWC). In the Colorado mountains, which supply the majority of water to the Colorado River, SWC is slightly higher (see page 13).

Would you like to have your favorite photograph featured on the cover of the *Southwest Climate Outlook*? For consideration send a photo representing Southwest climate and a detailed caption to: knelson7@email.arizona.edu

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OFFICE OF THE STATE CLIMATOLOGIST

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February Climate Summary

Temperature – Western Arizona has recently been cooler than average, while New Mexico is 2 to 4 degrees warmer than average over the last 30 days.

Precipitation – Winter storms that brought significant precipitation to western Arizona bypassed New Mexico, leaving extremely dry conditions.

Drought – Two cold and wet storms moved across Arizona in December, improving short-term drought status in the Little Colorado River and the Aguafria watersheds. In southern New Mexico, drought conditions worsened between January and February.

ENSO – Weak La Niña conditions were present again this month across the equatorial Pacific Ocean, but the current La Niña conditions may be short lived.

Snow – Above-average snowpack persisted into mid-February across much of the high country in Arizona and New Mexico. Many SNOTEL locations are reporting above-average snow water content (SWE) in Colorado and below average SWC in Utah.

Climate Forecasts – Temperature forecasts extending into the summer indicate most of the West has increased chances of above-average temperatures. Precipitation forecasts through May call for increased chances of below-average precipitation in the Southwest, with less predictable conditions for the summer forecasts.

The Bottom Line – While winter conditions in eastern New Mexico resemble a La Niña, year most of Arizona and northwest New Mexico have experienced numerous storms. As a result, the Colorado River and Rio Grande watersheds have received more precipitation than average—snow accumulation in the higher elevations of these areas are above average. Streamflow forecasts suggest that these watersheds will have slightly above-average spring and summer flows.

Note from the Editor

CLIMAS launched the *Southwest Climate Outlook* (SWCO) in 2003 in response to a need for more accessible and understandable Southwest-specific climate information. Since then, readers have played a vital role in shaping how and what information is presented. That collaboration continues. In September 2008, CLIMAS issued an online survey and received 118 responses that provided valuable comments and suggestions.

Responses revealed that the SWCO is useful, and illuminated several ways to improve the publication. Among these were concerns that the summaries for the Colorado Plateau region in northern Arizona and New Mexico can be misleading. Other comments highlighted ways to improve the verification pages and the feature article.

While the bulk of the monthly outlook will remain the same, we will attempt to address readers' comments. To begin, the feature article will be slightly shorter and the style will vary, at times providing literature reviews, roundtable interviews, and news articles. We will communicate each change and encourage your feedback.

– Zack Guido

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Past and present climate

What prehistoric and modern records say about future climes

By Zack Guido

How would you know your heating bills were high this winter if you did not have records of past bills? The same logic applies to climatology. To understand if the observed warming of the last 100 years and the rise in greenhouse gases is unusual, scientists have mined data from ice and sediment cores, tree rings, and other sources to piece together detailed paleoclimate records for much of the past two million years and as far back as 65 million years.

From these records, scientists now know that atmospheric concentrations of greenhouse gases such as carbon dioxide (CO_2) are more elevated today than at any period in the past 650,000 years; temperature often has changed by more than 10 degrees Fahrenheit in a matter of decades; the current global temperature is warmer than it has been during at least the last 500 years; and the climate during this modern instrumental age of the last 100 years or so has been less variable than in the more distant past.

The paleodata has revealed something else: if warming continues unabated, as climate models suggest, the resulting climate change within this century would be extremely unusual in geological terms, according to the International Panel on Climate Change (IPCC).

Unearthing Pre-historic Climate

We need examples in the past to understand present climate and anticipate future changes, said Connie Woodhouse, associate professor of geography and regional development at The University of Arizona and a CLIMAS affiliate. The examples are often found in proxies, natural phenomena that leave clues about past climate and are used when direct measurements are not available. Gases trapped in ice and the shells of tiny ocean organisms buried in ocean floor sediments, for instance, provide reliable and valuable climate information.

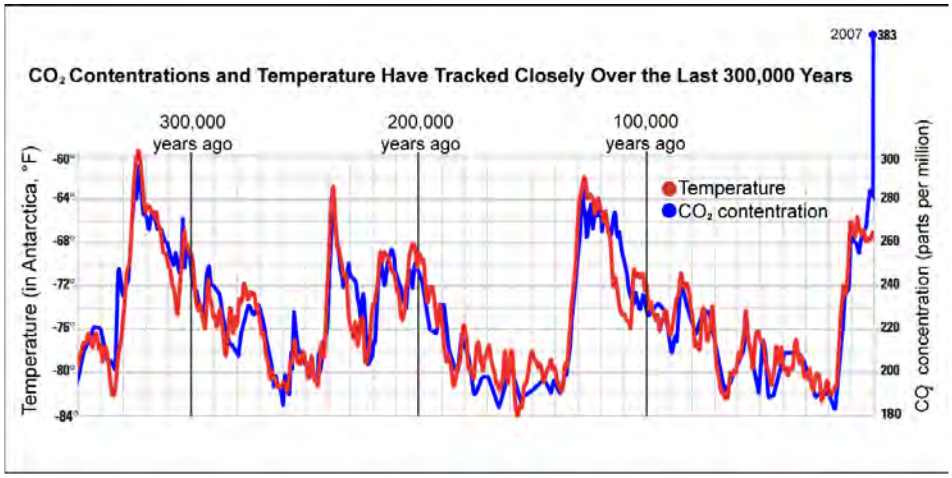

Figure 1: Ice core records from Vostok, Antarctica, show temperature near the South Pole has varied during the past 350,000 years in a regular pattern that constitutes the ice age/interglacial cycles. Changes in carbon dioxide concentrations track closely with changes in temperature during these cycles. *Credit: Image is modified and courtesy of the Marian Koshland Science Museum of the National Academy of Sciences.*

Many oceanographers have drilled the sea floor and analyzed diatom and foraminifera shells because their chemical make-up can be altered by changes in ocean water, revealing a historical record of shifts in ocean temperatures. Climate records derived from shells dive deepest into the past, providing insight into climate as far back as 65 million years, roughly when dinosaurs inhabited the Earth. The most detailed records from shells, however, span about the past two million years.

While sea-faring scientists have found climate clues at ocean depths, polar and high altitude expeditions have recovered miles of ice cores that contain preserved atmospheric gases in the frozen water. Captured in these cores, oxygen, CO_2, and other gases such as methane have illuminated in detail atmospheric and climate conditions of the past 650,000 years.

The climate records from these ancient sources have contributed immeasurably to climatology, revealing numerous glacial-interglacial cycles during the past three million years in which average global temperatures have oscillated by about 10 degrees F and regional temperatures have shifted even more. The records also have shown the intervals between the glacial maximums were similar at times during this period. For the past 400,000 years, for example, the area covered by the continental ice sheets was greatest about every 100,000 years. Prior to this period, the intervals between glacial maximums were longer, but they still occurred regularly.

This rhythm begged for an explanation—what caused glaciations and the warmer intervals to be periodic? The widely accepted theory is that glacial periods are instigated by changes in solar energy striking the Earth's surface. These cycles are known as Milankovitch cycles, named after the man who first proposed the idea that ice ages were triggered by variations in the Earth's astronomical position. Scientists believe changes in the Earth's tilt, axis of rotation, and the ellipticity of its orbit around the Sun slightly altered

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the amount of solar energy striking the Northern Hemisphere.

The solar energy changes, however, are relatively small and do not explain the degree of temperature change. Many scientists believe that while solar energy variations likely kicked off the transitions between warmer and cooler times, changes in the concentration of greenhouse gases in the atmosphere instigated by the warming or cooling are most likely responsible for amplifying the change.

These ideas are again rooted in ice. Cores drilled in Antarctica show that temperature and CO_2, a powerful greenhouse gas that has an intensifying effect on temperature, have been nearly in lockstep (Figure 1). The cores also show that changes in temperatures generally precede changes in CO_2 by several centuries. In its latest assessment report published in 2007, the IPCC stated the probability is greater than 90 percent that CO_2 variations strongly amplified climate but did not trigger the end of glacial periods. In other words, solar energy changes set in motion warming that in turn sparked other changes, such as increases in greenhouse gases that caused temperatures to rise by about 10 degrees F.

The ice cores also contained atmospheric gases that showed CO_2 varied between 180 and 300 parts per million (ppm) during the past 650,000 years, and concentrations of methane, another greenhouse gas, ranged from 320 to 790 parts per billion (ppb). To put this in perspective, the IPCC reported that CO_2 concentrations in 2007 topped 383 ppm, while methane reached 1,775 ppb in 2005. Since the beginning of the Industrial Revolution, the burning of fossil fuels, deforestation, and other human activities have contributed to these increased atmospheric concentrations. In the mid-eighteenth century, before the height of the modern industrial era, the estimated atmospheric concentration of CO_2 was 280 ppm.

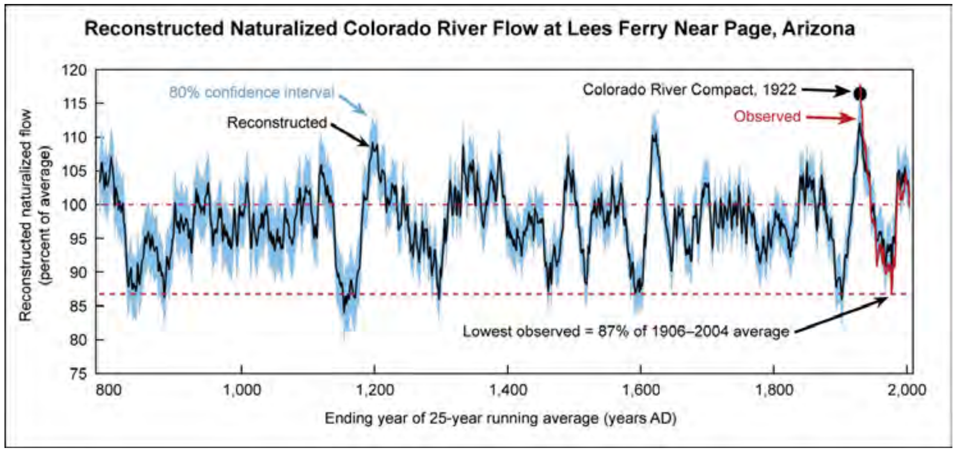

Figure 2: Colorado River flows reconstructed from tree-rings that spans the period 792–2005. The black line is the 25-year running average. Flows are plotted as a percentage of the 1906–2004 average, which incorporates most of the years in which instruments measured the flows (average is equal to 15.0 million acre-feet). *Credit: Figure modified from Meko et al., 2007.*

The use of past climate to better understand current conditions is vital, said Jonathan Overpeck, director of the Institute for Environment and Society and a geosciences professor at the UA, because knowledge of past climate provides a long context for better understanding recent climate change and the full range of natural variability.

Abrupt Climate Changes

While recurring cold and warm periods characterize past climates, so, too, do punctuated, large climate changes. Transitions into and out of the warmer and colder periods, for example, were not always gradual.

Researchers are trying to understand the "pop" in the system—the reasons why past temperatures have increased and decreased rapidly, said Joellen Russell, assistant professor of geosciences at the UA whose research includes using state-of-the-art climate models to simulate past climates.

Abrupt climate change occurs when the climate system crosses a threshold, triggering a rapid transition to a new climate state. A climate system with thresholds behaves similarly to a tipping bucket balanced over a pivot—the bucket remains upright until one too many water droplets topples it. The paleorecord is full of rapid climate changes and suggests that gradual changes, such as an increase in solar radiation striking the Earth or the melting of polar ice, may cause a large and rapid jump in temperature.

In the paleoclimate record, an intensely studied rapid climate change occurred approximately 12,800 years ago, marking the beginning of the Younger Dryas, a 1,200-year cool period observed most notably in the North Atlantic region. Ice core analyses indicate the period began with a few, decade-long cooling intervals and ended with a jump in regional temperature of about 15 degrees F in 10 years.

Another rapid climate change occurred about 8,200 years ago when temperatures around the north Atlantic Ocean fell by as much as 18 degrees F and Europe cooled by around 4 degrees F. Many scientists believe that this cooling was instigated by the catastrophic draining of mammoth lakes that formed from glacial melt-water at the toe of the

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continental ice sheet. Scientists hypothesize that as the ice sheet retreated in response to warming temperatures, seven times the amount of water contained in all five of the Great Lakes flushed into the north Atlantic Ocean. The influx of fresh water seemingly disrupted oceanic circulation; the current that delivered tropical heat to Europe weakened, and air temperatures plummeted.

Scientists believe that rapid climate change is a relatively common occurrence. By some estimates, more than 24 events of similar duration, degree of temperature change, and global extent as the Younger Dryas occurred in the last 110,000 years.

While some of the rapid climate changes have solid explanations, others, like the sudden warming at the end of the last glacial period, about 20,000 years ago, are still a mystery.

Researchers know, for instance, that for a small increase in solar radiation, a disproportionally large temperature change occurs, Russell said, referring to the jump in global temperature at the end of the last glaciation. "But there are 28 different theories about how feedbacks amplify the sun cycles," she said.

The past is the key to the future

Closer to home, reconstructions of tree growth in the western United States. have been particularly helpful in revealing climate for the past 8,000 years. By analyzing the width of tree-rings, which are altered by precipitation in some species and temperature in others, scientists have discovered that the past has been riddled with droughts. A detailed record of Colorado River flows spanning the last 1,200 years, for example, shows numerous periods when flows were lower than the current 100-year average (Figure 2).

"During the medieval period between 800 and 1300 AD, the West experienced persistent and frequent droughts," Woodhouse said. However, dry periods were common even after the medieval period. The longest and most severe occurred in the late 1500s. During this megadrought, the Colorado River had low flows for about six consecutive decades.

In fact, the paleorecord reveals that the average flow over the past 1,200 years is less than the amount allocated for use in 1922 by the Colorado River Compact, an agreement signed by seven western states—including Arizona and New Mexico—and Mexico that governs the water rights of the Colorado River. This information is vital for future water supply management. The U.S. Bureau of Reclamation recently incorporated tree-ring reconstructions into new river operating guidelines designed to prevent the depletion of water from Lakes Mead and Powell.

Records from tree-rings, ice and sediment cores, and other paleoclimate proxies have articulated valuable lessons for planning for the future: climate variability is greater and climate change is faster than they have been in modern times.

While the present has opened the door to the past, the past now provides insight to apply to the future.

"Since the paleorecord shows that there have been megadroughts in the past, it is important that the Southwest become resilient to this degree of change," Overpeck said.

For questions or comments, please contact Zack Guido, CLIMAS Associate Staff Scientist, at zguido@email.arizona.edu or (520) 882-0879.

Related Links

Records of past climate span the globe and describe climatic conditions as far back as 65 millions years. They provide a rich context to understand current climate and to anticipate future changes. More information on paleoclimate and past climate reconstructions can be found at the following Web sites.

Data for the Western United States spanning about the last 100 years based on instrumental measurements:
http://www.cefa.dri.edu/Westmap/

Global and regional temperature data from various sources that span numerous periods:
http://www.ncdc.noaa.gov/paleo/recons.html

Paleoclimate information derived from tree-rings:
http://www.ncdc.noaa.gov/paleo/treering.html

Paleoclimate information derived from ice-cores:
http://www.ncdc.noaa.gov/paleo/icecore.html

IPCC 4th assessment report (chapter 6 focuses on paleoclimate:
http://www.ipcc.ch/ipccreports/assessments-reports.htm

On-line book about abrupt climate change issued by the National Academy of the Sciences:
http://www.nap.edu/openbook.php?isbn=0309074347

Temperature (through 2/18/09)

Source: High Plains Regional Climate Center

Temperatures since the beginning of the 2009 water year on October 1 have averaged between 35 and 45 degrees Fahrenheit across northeastern Arizona and the northern half of New Mexico (Figure 1a). In the highest elevations, temperatures have been between 25 and 35 degrees F. Southern and much of eastern New Mexico has been between 45 and 55 degrees, while average temperatures across southern and southwestern Arizona have ranged from 50 to 65 degrees. These temperatures generally have been 1 to 3 degrees above average for the water year across both states (Figure 1b). New Mexico has had some areas with temperatures 1 to more than 5 degrees above average near Silver City in the southwest and in the northeast corner of the state. Arizona has a small area with temperatures as much as 3 degrees F colder than average in the west-central counties.

The past 30 days have brought colder-than-average temperatures to western Arizona and warmer-than-average temperatures to eastern New Mexico (Figures 1c–d). Western Arizona has been as much as 4 degrees colder than average, while eastern New Mexico has been 2 to 4 degrees warmer than average. Eastern Arizona and western New Mexico have been about 2 degrees warmer than average. The east-west temperature gradient during the past 30 days is due to the location of a persistent high pressure system over New Mexico that has steered the winter storms around New Mexico and eastern Arizona.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. Water year is more commonly used in association with precipitation; water year temperature can be used to measure the temperatures associated with the hydrological activity during the water year.

Average refers to the arithmetic mean of annual data from 1971–2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

The continuous color maps (Figures 1a, 1b, 1c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. The dots in Figure 1d show data values for individual stations. Interpolation procedures can cause aberrant values in data-sparse regions.

These are experimental products from the High Plains Regional Climate Center.

On the Web:

For these and other temperature maps, visit:
http://www.hprcc.unl.edu/maps/current/

For information on temperature and precipitation trends, visit:
http://www.cpc.ncep.noaa.gov/trndtext.shtml

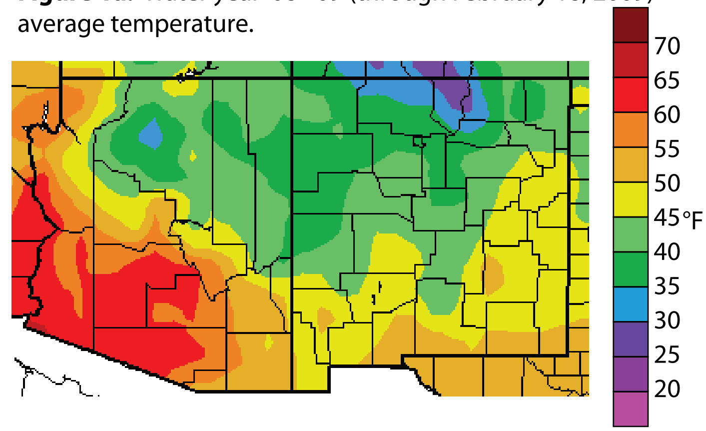


Figure 1a. Water year '08–'09 (through February 18, 2009) average temperature.

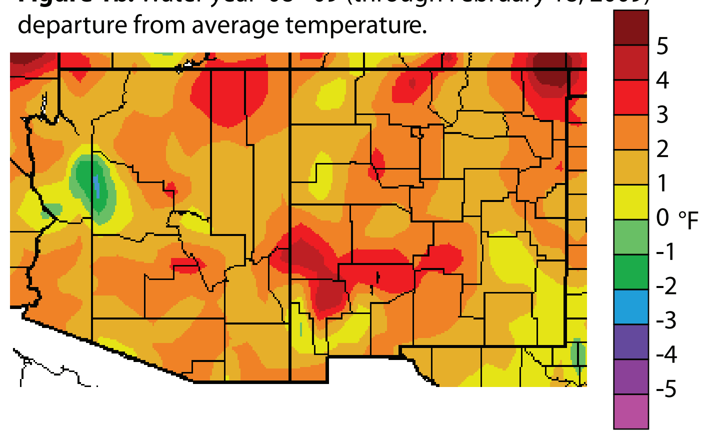


Figure 1b. Water year '08–'09 (through February 18, 2009) departure from average temperature.

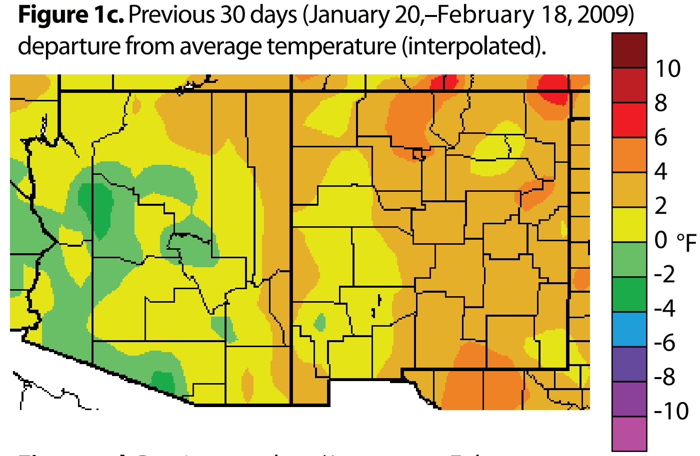


Figure 1c. Previous 30 days (January 20,–February 18, 2009) departure from average temperature (interpolated).

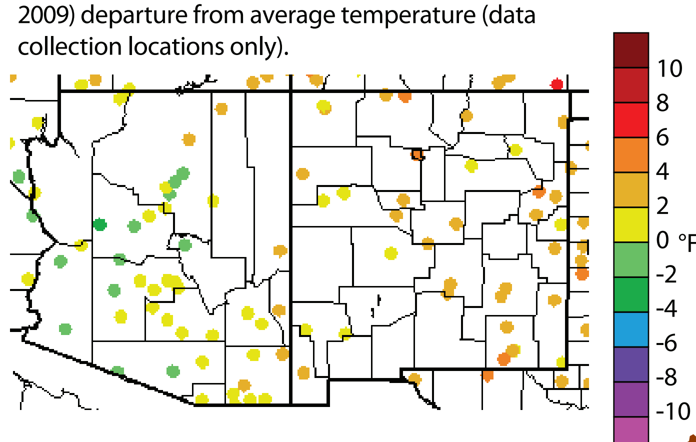


Figure 1d. Previous 30 days (January 20–February 18, 2009) departure from average temperature (data collection locations only).

Precipitation (through 2/18/09)

Source: High Plains Regional Climate Center

Most of Arizona and northern New Mexico have received 50 to 90 percent of average precipitation for the water year beginning on October 1 (Figures 2a–b). The driest areas are north-central and southeastern Arizona and most of southern New Mexico, which have had less than 50 percent of average precipitation during the water year. Above-normal precipitation (between 110 to 130 percent of average) has fallen along the lower Colorado River in western Arizona, in small areas in the central and eastern mountains of Arizona, and around the northwestern mountains of New Mexico. The highest elevations of central and northeastern New Mexico have received 130 to 200 percent of average precipitation.

The persistent high pressure ridge over southern Arizona and New Mexico this winter has moved eastward in the last month, allowing storm systems to enter western and central Arizona. During the past 30 days, three winter storms have moved across Arizona, bringing rain to the western and central deserts and snow to northern Arizona and the higher elevations. These recent storms have bypassed New Mexico, leaving almost the entire state at less than 50 percent of average precipitation for this period (Figures 2c–d). Northeastern New Mexico, however, has received 110 to 300 percent of average precipitation, in part due to the confluence of moisture moving westward through Texas and arctic air moving south across the central plains.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2008, we are in the 2009 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions.

The dots in Figures 2b and 2d show data values for individual meteorological stations.

On the Web:

For these and other precipitation maps, visit:
http://www.hprcc.unl.edu/maps/current/

For National Climatic Data Center monthly precipitation and drought reports for Arizona, New Mexico, and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2003/perspectives.html#monthly

Figure 2a. Water year '08–'09 (through February 18, 2009) percent of average precipitation (interpolated).

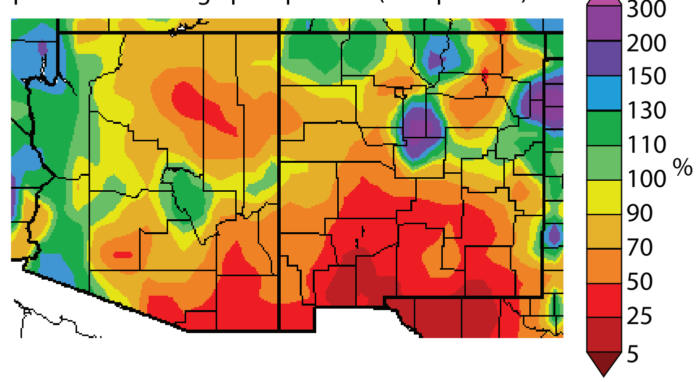


Figure 2b. Water year '08–'09 (through February 18, 2009) percent of average precipitation (data collection locations only).

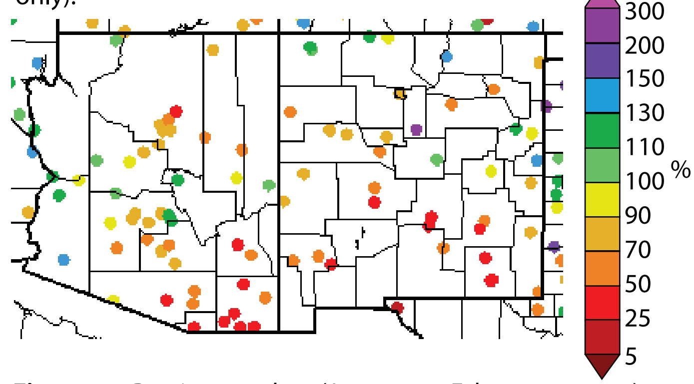


Figure 2c. Previous 30 days (January 20–February 18, 2009) percent of average precipitation (interpolated).

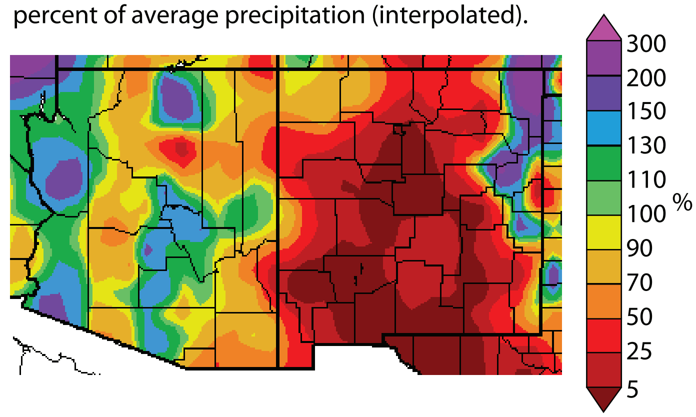
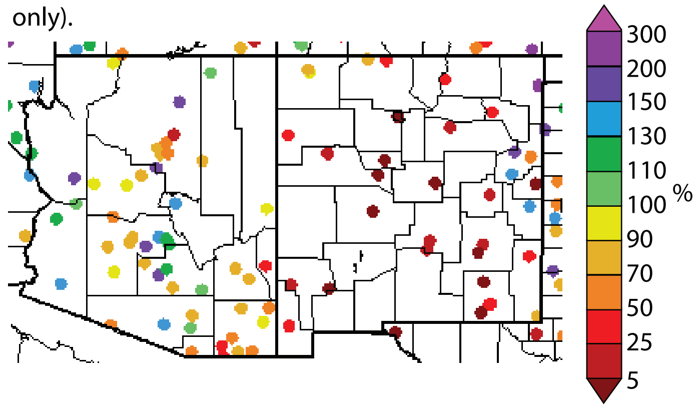


Figure 2d. Previous 30 days (January 20–February 18, 2009) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 2/19/09)

Sources: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

The U.S. Drought Monitor reports improvements to drought conditions for parts of Arizona and worsening conditions for parts of New Mexico (Figure 3). Improvements in Arizona are mostly due to winter storms, which tracked southwest to northeast across the state. However, this precipitation mostly bypassed southeastern Arizona, where rainfall since October has been less than 50 percent of average (see Figures 2a–b). In eastern and southern New Mexico, abnormally dry conditions have expanded and are causing agricultural impacts. Elsewhere, large portions of Texas are experiencing severe, extreme, and exceptional drought intensities. In northern California, nearly 2 and one half years of below-average precipitation has contributed to the extreme drought intensity.

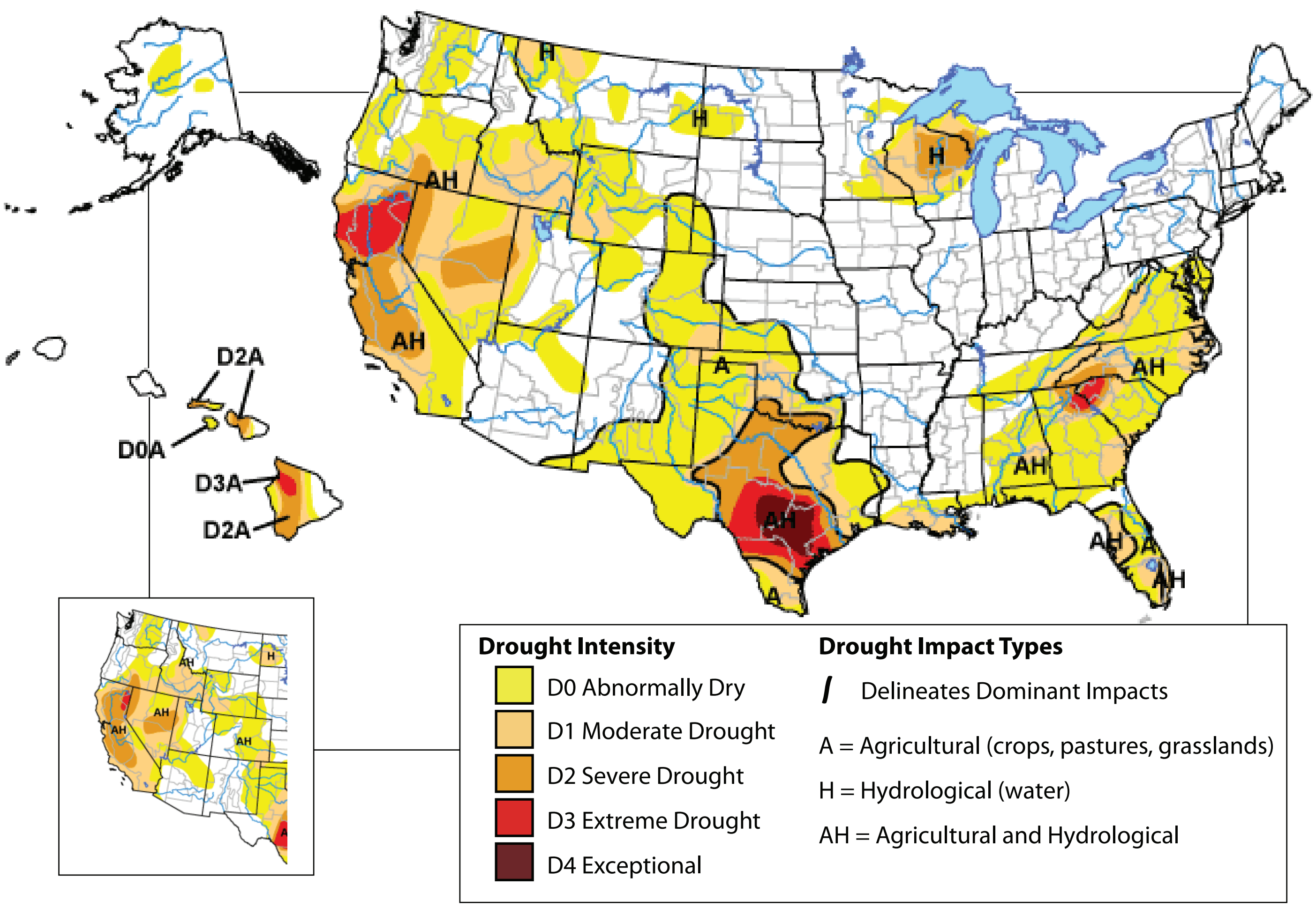
On February 17, approximately 79 percent of Arizona had no drought classification, while about 21 percent was abnormally dry. In the past month, the total area in Arizona with a drought intensity decreased from about 35 percent to 21 percent. In New Mexico, about 50 percent of the state had no drought status on February 17. About 49 percent was abnormally dry and the remainder had moderate drought intensity. In the past month, the total area in New Mexico classified with a drought intensity increased by about 20 percent.

Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous month's map.

The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of the several agencies; the author of this monitor is David Miskus, JAWF/CPC/NOAA.

Figure 3. Drought Monitor released February 19, 2009 (full size), and January 15, 2009 (inset, lower left).



On the Web:

The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website: http://www.drought.unl.edu/dm/monitor.html

Arizona Drought Status

(data through 12/31/08)

Source: Arizona Department of Water Resources

Arizona drought status is for January, with a one-month lag time in accordance with the most recent update of drought conditions by Arizona Department of Water Resources.

A couple of cold and wet storms moved across Arizona in December, bringing widespread rain and snow in higher elevation areas. This helped bring some short-term drought relief to the Little Colorado River and the Aguafria watersheds, which improved from moderate drought to abnormally dry conditions (Figure 4a). Elsewhere, short-term drought conditions remained unchanged, with much of northern and southeastern Arizona experiencing abnormally dry conditions. Several watersheds in southern Arizona also have shown improvements in long-term drought conditions, largely as a result of above-average precipitation over the past 12 months (Figure 4a). The Lower Gila improved from abnormally dry to average conditions, while the Santa Cruz River, San Pedro River, and the Willcox Playa watersheds improved from moderate drought to abnormally dry status.

Long-term drought conditions continue to impact recreational activities along the reservoirs of the Colorado River in northern Arizona. A popular boating shortcut for Lake Powell will be modified to accommodate the lower reservoir levels that have persisted over the past several years (Associated Press, February 14). With higher water levels, the Castle Rock cut allowed boaters to quickly access the main part of Lake Powell from the Wahweap Marina. The modification includes making the passage deeper by removing 15,000 cubic yards of sandstone. Additional modifications will be carried out in the future if water levels continue to fall, according to the National Park Service.

Notes:

The Arizona drought status maps are produced monthly by the Arizona Drought Preparedness Plan Monitoring Technical Committee. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 4a shows short-term or meteorological drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known as hydrological drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfall (e.g., many months to years) on water supplies (i.e., streamflow, reservoir and lake levels, and groundwater). These maps are delineated by river basins (wavy gray lines) and counties (straight black lines).

On the Web:

For the most current Arizona drought status maps, visit:
http://www.azwater.gov/dwr/drought/DroughtStatus.html

Figure 4a. Arizona short-term drought status for January 2009.

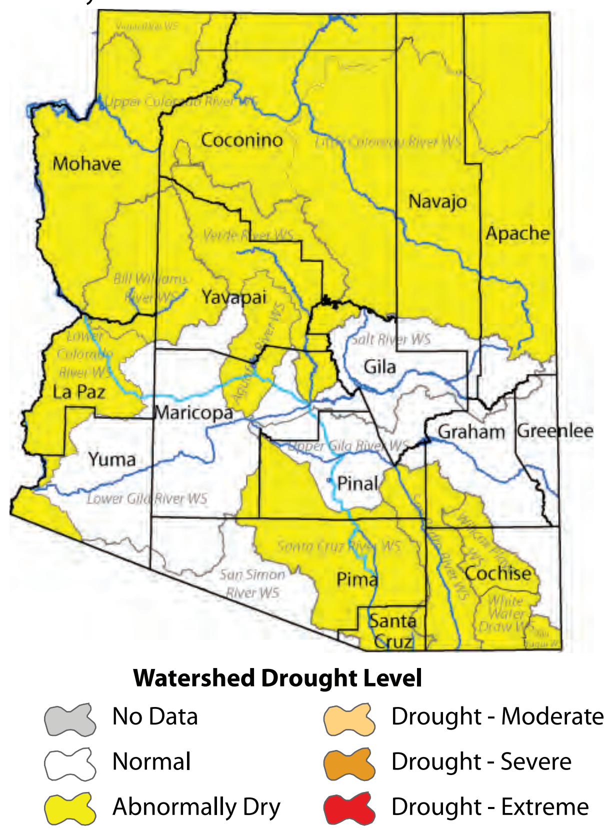
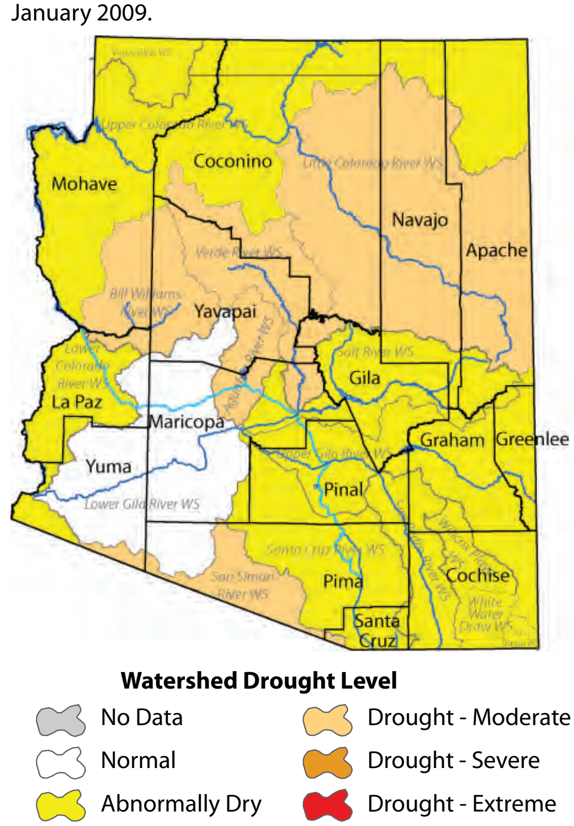


Figure 4b. Arizona long-term drought status for January 2009.



New Mexico Drought Status

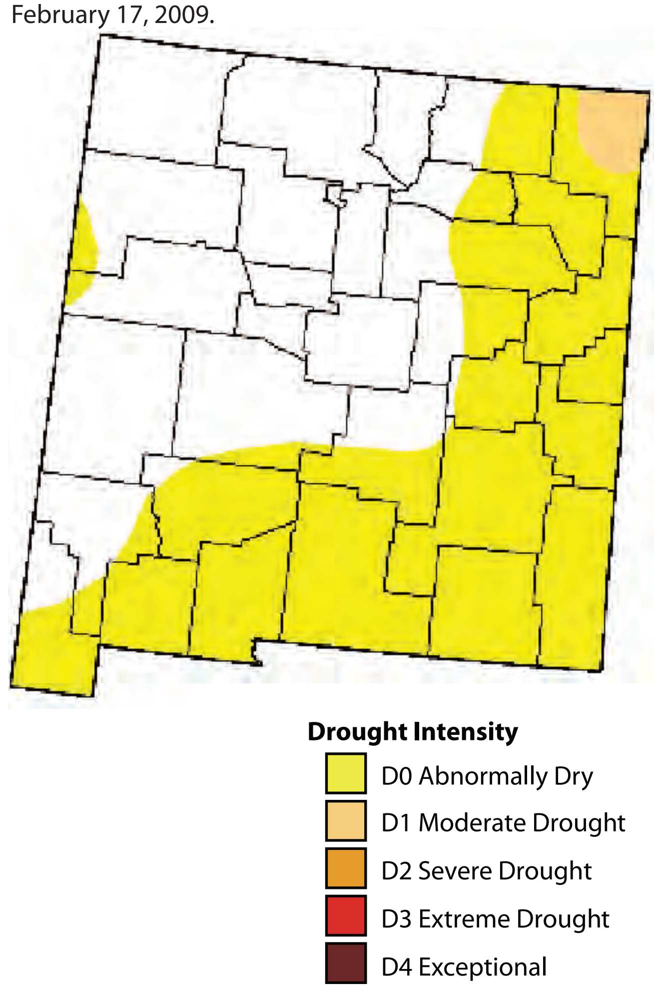
(released 2/19/09)

Source: New Mexico State Drought Monitoring Committee

Drought conditions worsened slightly over much of southern New Mexico between January and February, with abnormally dry conditions expanding across that part of the state (Figure 5). Abnormally dry conditions also continue to persist across the eastern third of the state and a small area in the west-central mountains. Moderate drought conditions are only felt in the northeastern corner of Union County. Most of New Mexico observed less than 50 percent of average precipitation over the past 30 days (see Figures 2c–d). Very dry conditions in the past month limited the improvement of and helped expand drought conditions—a little more than 50 percent of the state is experiencing some sort of drought, up from 30 percent in January.

Farmers in southern New Mexico are paying close attention to water levels in Elephant Butte Reservoir. Although snowpack is above average in the upper Rio Grande basin and streamflow levels are expected to be near average in the early spring, the Elephant Butte Irrigation District announced that the initial water allotment for farmers will be two acre-feet per irrigable acre from the reservoir, one acre-foot less than the full allotment (*Las Cruces Sun-News*, February 15). Irrigation District officials report that levels in the Elephant Butte and Caballo reservoirs are not high enough to support their full share.

Figure 5. New Mexico drought map based on data through February 17, 2009.



Notes:

The New Mexico section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of the several agencies.

This summary contains substantial contributions from the New Mexico Drought Working Group.

On the Web:

For the most current drought status map, visit:
http://www.drought.unl.edu/dm/DM_state.htm?NM,W

For the most current Drought Status Reports, visit:
http://www.nmdrought.state.nm.us/MonitoringWorkGroup/wk-monitoring.html

Arizona Reservoir Levels

(through 1/31/09)

Source: National Water and Climate Center

Combined reservoir storage in Lakes Powell and Mead declined by 333,000 acre-feet during January (Figure 6). Nevertheless, the combined Powell and Mead storage is more than 1.8 million acre-feet greater than at this time last year, thanks to above-average spring 2008 runoff. During January, storage in the Salt River watershed increased by about 3 percent, while storage in the Verde River watershed increased by about 10 percent. The combined storage in the Salt-Verde reservoir system increased by approximately 74,300 acre-feet.

In water-related news, the Salt River Project, operator of Roosevelt Lake Reservoir, released water from the reservoir in February because rapidly melting snow and winter storms threatened to send lake levels above their maximum allowable limit (*Arizona Republic*, February 10). Also, Arizona will receive from the new economic stimulus package about $39 million for projects dealing with water quality and flood control (*Arizona Daily Sun*, February 15).

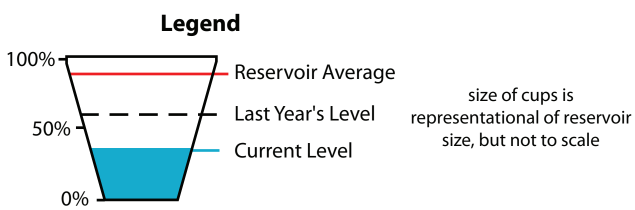
Notes:

The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of 4 people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

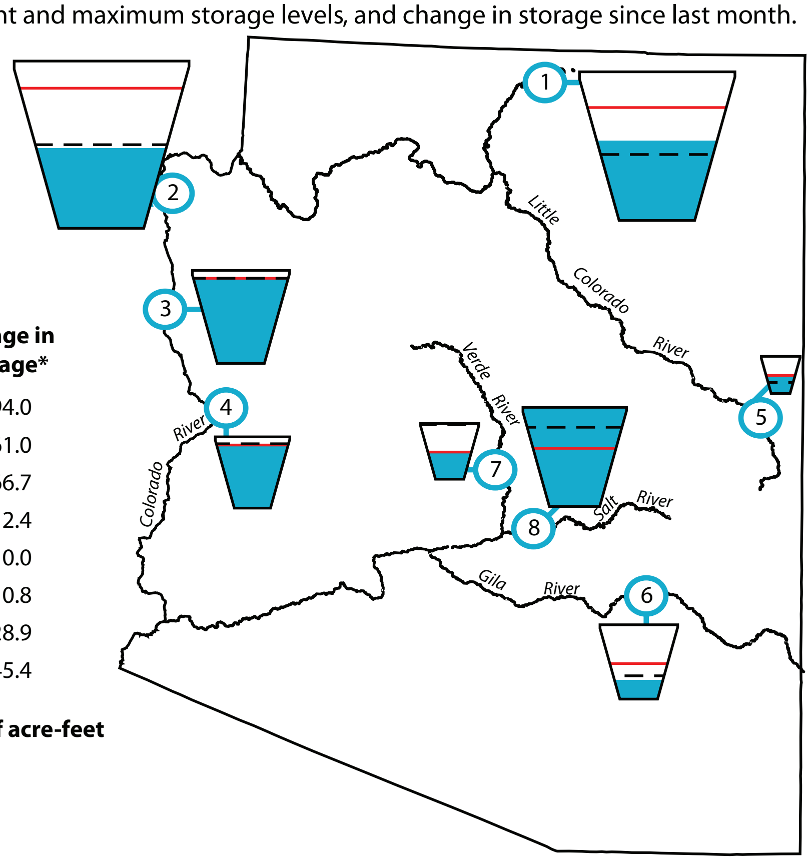
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Dino DeSimone, Dino.DeSimone@az.usda.gov.

Figure 6. Arizona reservoir levels for January 2009 as a percent of capacity. The map depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Lake Powell	54%	13,147.0	24,322.0	-394.0
2. Lake Mead	48%	12,573.0	26,159.0	61.0
3. Lake Mohave	91%	1,647.4	1,810.0	66.7
4. Lake Havasu	90%	559.3	619.0	2.4
5. Lyman Reservoir	47%	14.2	30.0	0.0
6. San Carlos	26%	227.5	875.0	10.8
7. Verde River System	51%	146.9	287.4	28.9
8. Salt River System	99%	1,999.4	2,025.8	45.4

*** thousands of acre-feet**



On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

New Mexico Reservoir Levels

(through 1/31/09)

Source: National Water and Climate Center

The total reservoir storage in New Mexico increased by 52,300 acre-feet during January (Figure 7). Notably, storage in Elephant Butte Reservoir rose by approximately 42,100 acre-feet, and Pecos River reservoirs experienced slight storage increases.

In water news, U.S. Representative B.R. Luján introduced several water resource bills in Congress (*New Mexico Independent*, February 12). The bills would provide funds for New Mexico Indian tribes to improve irrigation infrastructure to conserve water; authorize the secretary of the interior to provide funds for the development of an Eastern New Mexico Rural Water System; hasten settlement of the Navajo-San Juan Indian water-rights dispute; and fund a statewide assessment of groundwater resources.

Notes:

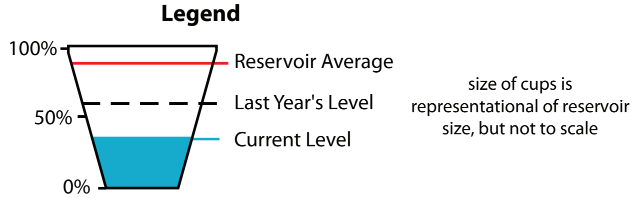
The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of 4 people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

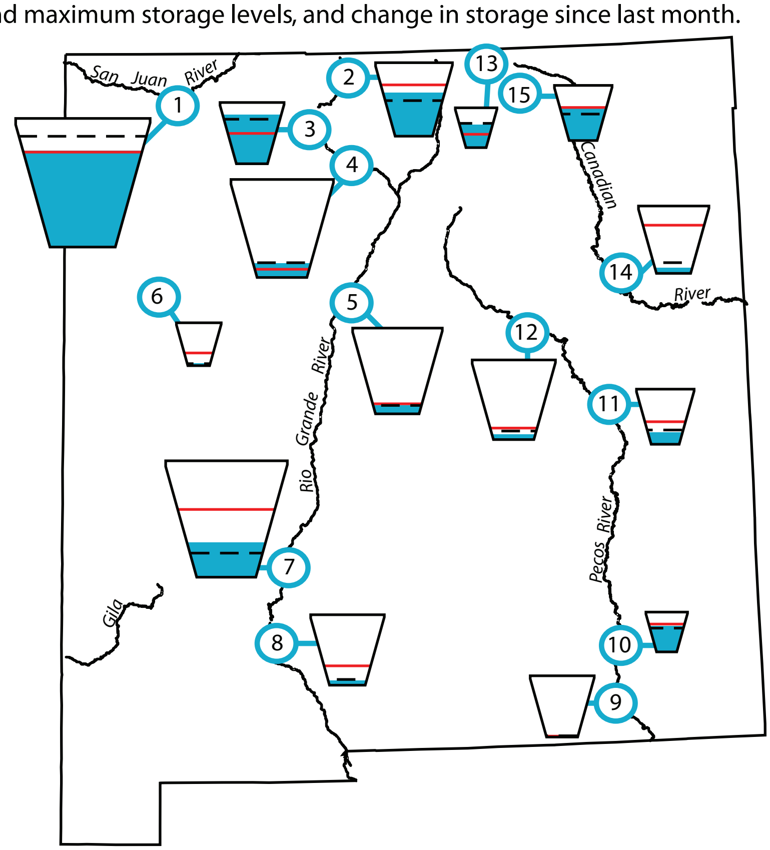
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Richard Armijo, Richard.Armijo@nm.usda.gov.

Figure 7. New Mexico reservoir levels for January 2009 as a percent of capacity. The map depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.

Legend



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	75%	1,264.7	1,696.0	-13.2
2. Heron	61%	242.3	400.0	0.4
3. El Vado	80%	155.9	195.0	11.0
4. Abiquiu	15%	184.0	554.5	2.0
5. Cochiti	10%	50.9	491.0	-0.1
6. Bluewater	6%	2.4	38.5	0.5
7. Elephant Butte	30%	659.3	2,195.0	42.1
8. Caballo	7%	23.5	332.0	2.1
9. Brantley	2%	20.6	1008.2	2.1
10. Lake Avalon	65%	2.6	4.0	0.4
11. Sumner	22%	22.0	102.0	3.2
12. Santa Rosa	7%	31.4	438.3	0.3
13. Costilla	59%	9.4	16.0	0.5
14. Conchas	9%	21.9	254.2	0.3
15. Eagle Nest	59%	46.8	79.0	0.7



On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

Southwest Snowpack

(updated 2/18/09)

Sources: National Water and Climate Center, Western Regional Climate Center

The above-average snowpack that began accumulating in December persisted into mid-February across much of the high country in Arizona and New Mexico (Figure 8). Several cold and wet storms moved across the region in early February, producing significant snowfall and providing a short-term boost to snowpack levels. Many basins in Arizona are reporting average snow water content (SWC) values in excess of 125 percent of average. However, snowpack levels in the Upper Gila River watershed are comparatively low, with less than 12 inches of snow reported at a key SNOTEL site. This has led to a basin average SWC value estimate of 50–75 percent of the historic average. Snowpack conditions in northern New Mexico are quite favorable, with most basin average SWC estimated at 90–125 percent of average. As in Arizona, stations further south in the Gila River watershed are reporting below-average snowpack conditions. The Gila River basin estimate is at 74 percent of average, while the Mimbres River basin stands at only 45 percent of average for mid-February. This is due to a more northerly storm track for the past several storms that favored heavy snowfall over the northern White Mountains in Arizona and southern Rocky Mountains in New Mexico.

In Colorado, many SNOTEL locations are experiencing above-average SWC, while many SNOTEL site locations in Utah are below average. The Colorado River receives about 70 percent of its annual flow from winter precipitation.

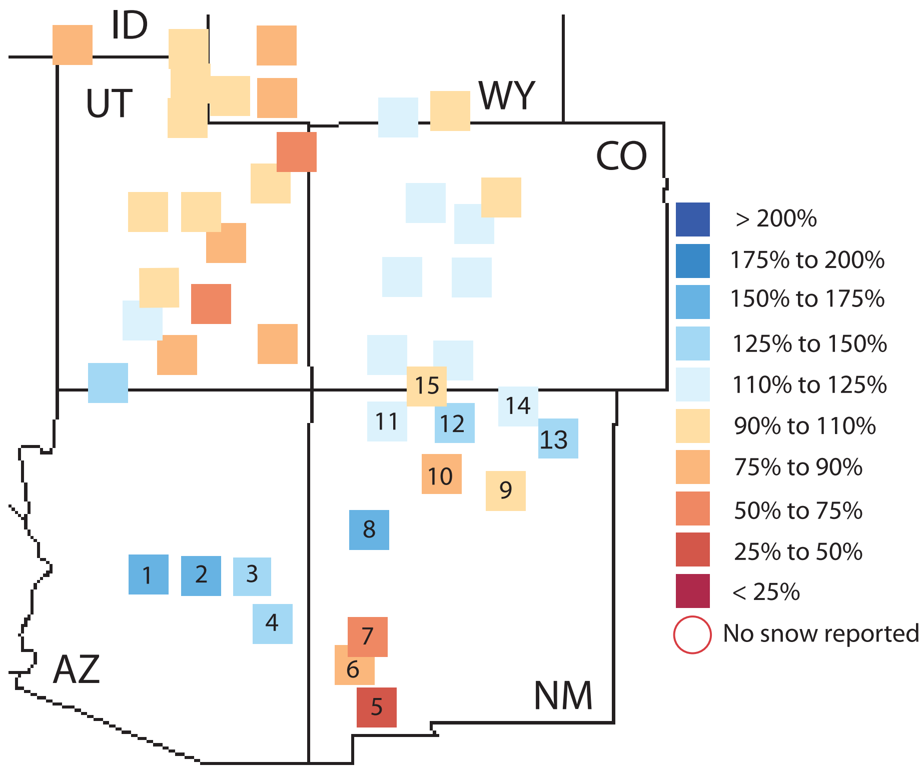


Figure 8. Average snow water content (SWC) in percent of average for available monitoring sites as of February 18, 2009.

Arizona Basins
1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins
5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

On the Web:

For color maps of SNOTEL basin snow water content, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html

For NRCS source data, visit: http://www.wcc.nrcs.usda.gov/snow/

For a list of river basin snow water content and precipitation, visit: http://www.wrcc.dri.edu/snotelanom/snotelbasin

Notes:

Snowpack telemetry (SNOTEL) sites are automated stations that measure snowpack depth, temperature, precipitation, soil moisture content, and soil saturation. A parameter called snow water content (SWC) or snow water equivalent (SWE) is calculated from this information. SWC refers to the depth of water that would result by melting the snowpack at the SNOTEL site and is important in estimating runoff and streamflow. It depends mainly on the density of the snow. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWC than light, powdery snow.

Figure 8 shows the SWC for selected river basins, based on SNOTEL sites in or near the basins, compared to the 1971–2000 average values. The number of SNOTEL sites varies by basin. Basins with more than one site are represented as an average of the sites. Individual sites do not always report data due to lack of snow or instrument error. CLIMAS generates this figure using daily SWC measurements made by the Natural Resource Conservation Service.

Temperature Outlook
(March–August 2009)
Source: NOAA Climate Prediction Center (CPC)

The NOAA-Climate Prediction Center (CPC) long-lead temperature forecasts for the continental U.S. show increasing chances of above-average temperatures for much of the Southwest through the spring and into summer (Figures 9a–d). The forecast predicts Arizona will have up to a 60 percent chance of seeing temperatures that are above the climatological average through August. The two-week lead forecast for March–May relies on both the La Niña conditions that formed in late 2008 as well as long-term trends. However, the La Niña conditions do not factor into the forecasts for April–June or beyond, which instead rely on statistical and dynamical forecast tools. The CPC forecast discussion indicates that dry soil moisture conditions across portions of Texas and Oklahoma also are expected to contribute to above-average temperatures throughout the southern Plains.

Notes:
These outlooks predict the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC temperature outlook, areas with light brown shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average temperature. A shade darker brown indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average temperature, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 9a. Long-lead national temperature forecast for March–May 2009.

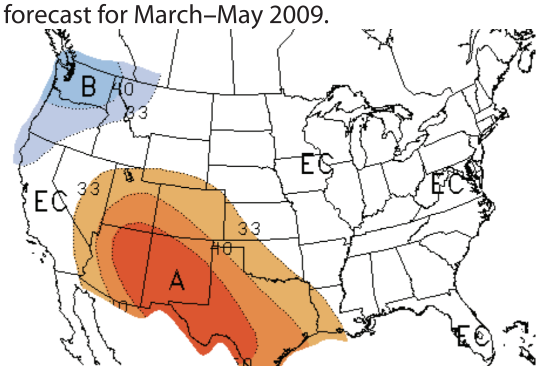
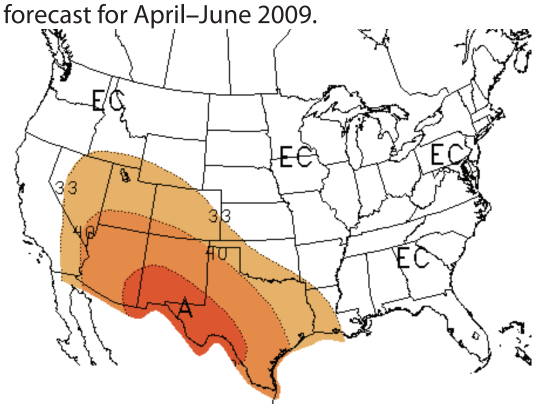


Figure 9b. Long-lead national temperature forecast for April–June 2009.



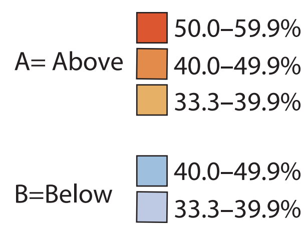


Figure 9c. Long-lead national temperature forecast for May–July 2009.

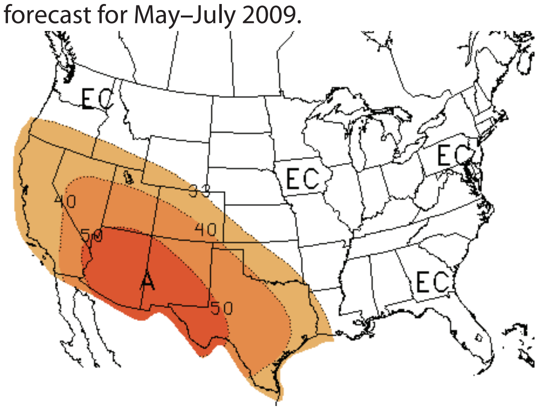
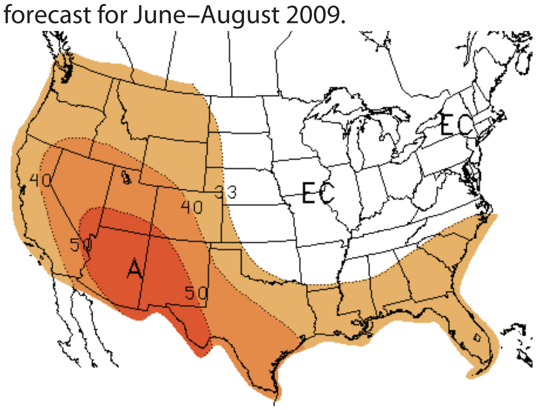


Figure 9d. Long-lead national temperature forecast for June–August 2009.



EC= Equal chances. No forecasted anomalies.

On the Web:
For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions//multi_season/13_seasonal_outlooks/color/churchill.php
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Precipitation Outlook

(March–August 2009)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-Climate Prediction Center (CPC) long-lead precipitation forecasts for the Southwest show increased chances of below-average precipitation for Arizona and New Mexico (up to a 50 percent chance of below-average precipitation for most of both states) and in much of the Southeast U.S. through May (Figure 10a). The March–May forecast reflects both the existing La Niña conditions and recent trends, while the remaining forecasts through August generally indicate equal chances of above-, below-, and near-average precipitation throughout the Southwest (Figures 10b–d). The La Niña signal is much less useful for predicting summer precipitation through most of the Southwest due to complexities associated with the North American Monsoon.

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC precipitation outlook, areas with light green shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. A shade darker green indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average precipitation, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 10a. Long-lead national precipitation forecast for March–May 2009.

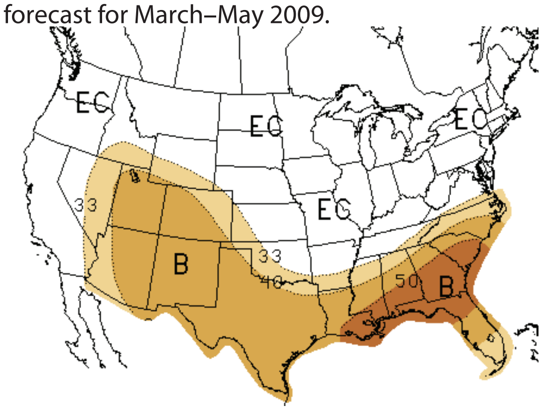


Figure 10b. Long-lead national precipitation forecast for April–June 2009.

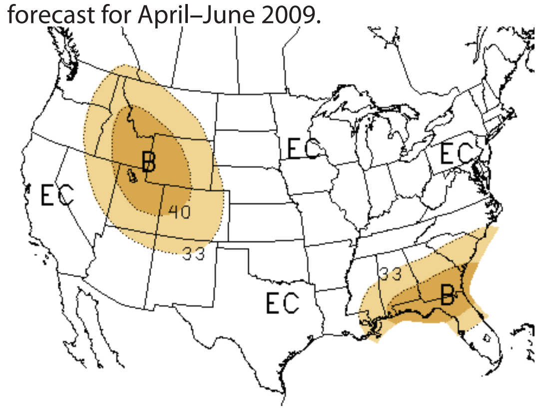


Figure 10c. Long-lead national precipitation forecast for May–July 2009.

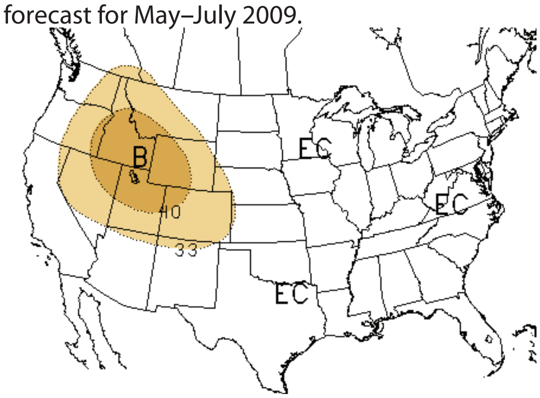
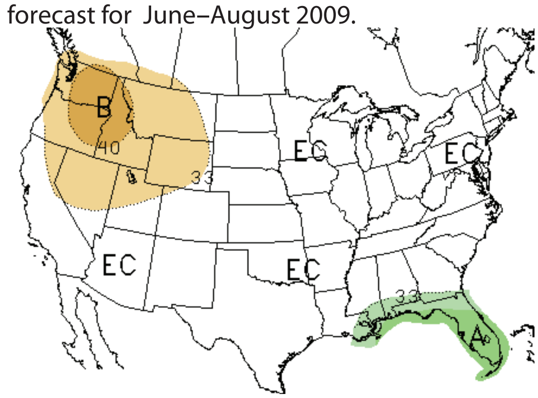
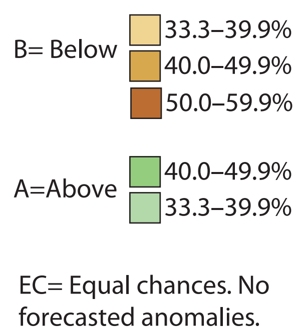


Figure 10d. Long-lead national precipitation forecast for June–August 2009.





On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions//multi_season/13_seasonal_outlooks/color/churchill.php
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Seasonal Drought Outlook
(through May 2009)

Source: NOAA Climate Prediction Center (CPC)

The National Oceanic and Atmospheric Administration's Climate Prediction Center (NOAA-CPC) reports that drought conditions for February 19 through May 2009 will generally persist or intensify in Southern California, much of Nevada, central Texas, and parts of Florida (Figure 11). Drought will likely develop in southeastern New Mexico, western Texas and Florida. Drought improvements likely will occur in northern California, Hawaii, and parts of the Great Lakes region.

There are no short-term drought conditions in Arizona, and the NOAA-CPC forecast does not call for drought conditions to develop. This forecast is in part due to the historical occurrence of winter storms during this time period. However, drought will likely develop in southeastern New Mexico due to the forecast of below-average rainfall for March through May. In southeast Colorado, drought will likely persist because the forecasts are dry for all time periods from five days to three months.

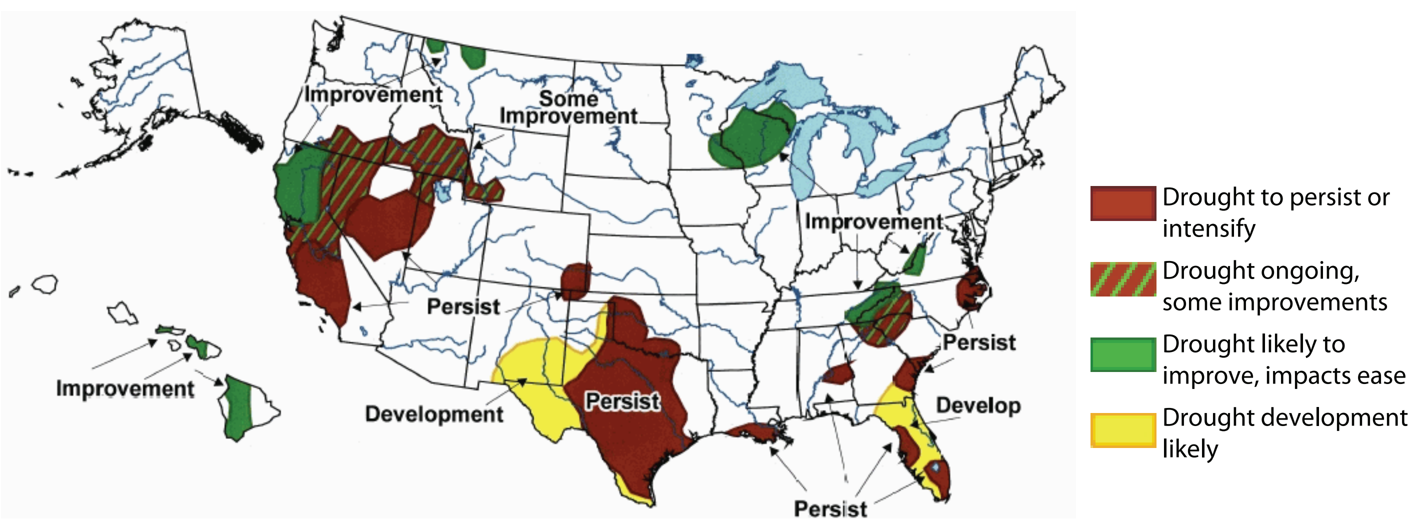
In California, heavy rain and snow during mid-February raised river levels and boosted snowpack in some drought-affected areas, but major reservoirs remained well below average. Improved conditions for northern and central parts of the state are expected, as forecasts call for above-average rain and snow into early March. However, as a result of long-term deficits accumulated over nearly three years, it is highly unlikely that water shortages in California will end before the dry season begins.

In the southern Plains, moderate to exceptional drought is expected to continue in Texas and parts of Oklahoma due to forecasts for below-average rainfall from March through May. In Florida, medium-range, monthly, and seasonal forecasts all indicate below-average rainfall. The Seasonal Drought Outlook reflects this, depicting persistant and expanding drought across the Florida peninsula and into southeastern Georgia. Wildfire danger could become a major concern before the onset of the wet season if these forecasts are correct.

Notes:

The delineated areas in the Seasonal Drought Outlook (Figure 11) are defined subjectively and are based on expert assessment of numerous indicators,including the official precipitation outlooks, various medium- and short-range forecasts , models such as the 6-10 day and 8-14 day forecasts, soil moisture tools, and climatology.

Figure 11. Seasonal drought outlook through May 2009 (released February 19, 2009).



On the Web:

For more information, visit:
http://www.drought.gov/portal/server.pt

For medium- and short-range forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/forecasts/

For soil moisture tools, visit:
http://www.cpc.ncep.noaa.gov/soilmst/forecasts.shtml

Streamflow Forecast
(for spring and summer)

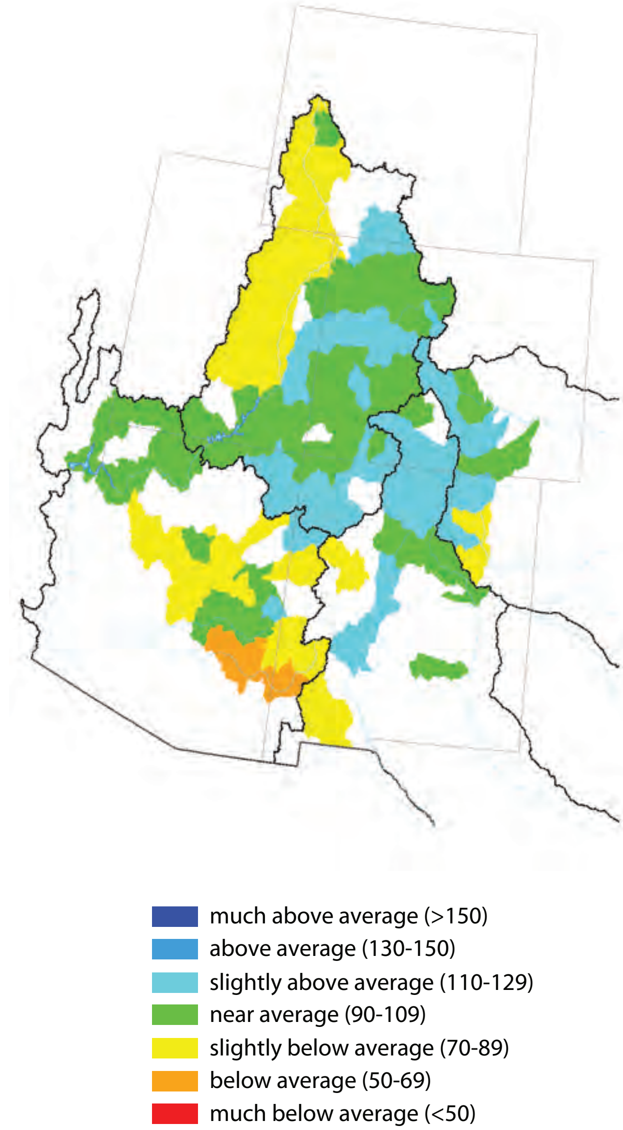
Source: National Water and Climate Center

The February 1 streamflow forecast for the Southwest shows a wide range of projected flows for basins in Arizona and New Mexico (Figure 12). There is at least a 50 percent chance that inflow to Lake Powell will be 101 percent of the 30-year average for April–July. For streams south of Arizona's Mogollon Rim, such as the Gila, San Francisco, and San Pedro, predictions are for well below-average flows. Forecasts for other streams in the Colorado River basin indicate most probable flows of 111, 113, and 115 percent of average, respectively, for the San Juan River (near Farmington, New Mexico), the little Colorado River (at Lyman Lake, Arizona), and Chevelon Creek (near Winslow, Arizona).

In the Rio Grande Basin, forecasts indicate above-average spring-summer flows for virtually all streams. Forecasts indicate most probable March through July total flows of 118 percent of average (Rio Grande at Otowi Bridge), 123 percent of average (Costilla Creek near Costilla Reservoir), and 124 percent of average (Rio Hondo near Valdez). On the Pecos River, the forecast for Santa Rosa Lake inflow is 106 percent of average.

In water news, to plug Tucson Water's $6.5 million fiscal year budget deficit, the Tucson City Council voted unanimously to sell more than one-third of its Central Arizona Project (CAP) water share for this fiscal year (*Arizona Daily Star*, February 4). The council also approved Tucson Water's plan to sell 50,000 acre-feet of CAP water to the Arizona Water Banking Authority for next fiscal year, which begins July 1. An acre-foot, about 324,000 gallons, is enough to serve two to three households for one year.

Figure 12. Spring and summer streamflow forecast as of February 1, 2009 (percent of average).



On the Web:

For state river basin streamflow probability charts, visit:
http://www.wcc.nrcs.usda.gov/cgibin/strm_cht.pl

For information on interpreting streamflow forecasts, visit:
http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit:
http://www.wcc.nrcs.usda.gov/water/quantity/westwide.html

Notes:

The forecast information provided in Figure 12 is updated monthly by the National Water and Climate Center, part of the U.S. Department of Agriculture's Natural Resources Conservation Service. Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions. The USDA-NRCS only produces streamflow forecasts for Arizona between January and April, and for New Mexico between January and May.

The NWCC provides a range of forecasts expressed in terms of percent of average streamflow for various statistical exceedance levels. The streamflow forecast presented here is for the 50 percent exceedance level, and is referred to as the most probable streamflow. This means there is at least a 50 percent chance that streamflow will occur at the percent of average shown in Figure 12.

El Niño Status and Forecast

Sources: NOAA Climate Prediction Center (CPC), International Research Institute for Climate and Society (IRI)

Weak La Niña conditions were present again this month across the equatorial Pacific Ocean. Sea surface temperatures (SSTs) were close to 1 degree Celsius below-average across the middle portion of the basin (longitude 170°–120° west, also known as the Niño3.4 region), which is cold enough to meet La Niña conditions as defined by the International Research Institute for Climate and Society (IRI). Above-average easterly winds are helping to maintain these weak La Niña conditions. IRI also notes that the Southern Oscillation Index (SOI) remains positive, indicating an atmospheric response to and reinforcement of cool SSTs across the eastern Pacific Ocean (Figure 13a). The late onset of La Niña in December indicates that La Niña conditions will have trouble strengthening and persisting through the spring. IRI continues to suggest that the current La Niña conditions may be short-lived and not meet their official definition of a La Niña event, which requires five consecutive months of La Niña conditions.

IRI reports that a suite of statistical and dynamical models are split between forecasting the continuation of weak La Niña conditions through the spring (February–April) and a quick return to neutral conditions. Almost all models are forecasting the return of neutral conditions by the April–June period (Figure 13b). Given the model results, the IRI probabilistic forecast indicates a 59 percent chance of La Niña conditions through the February–April period relative to a 40 percent chance of neutral conditions returning and only a 1 percent chance of El Niño conditions developing. The probability of neutral conditions returning rises quickly to 55 percent by late spring (April–June). Official spring season precipitation forecasts produced by the NOAA Climate Prediction Center indicate an increased chance of below-average precipitation across Arizona and New Mexico, consistent with expected impacts during a La Niña event.

Notes:

Figure 13a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through January 2009. The SOI measures the atmospheric response to SST changes across the Pacific Ocean Basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

Figure 13b shows the International Research Institute for Climate and Society (IRI) probabilistic El Niño-Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

On the Web:

For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

For more information about El Niño and to access graphics similar to the figures on this page, visit: http://iri.columbia.edu/climate/ENSO/

Figure 13a. The standardized values of the Southern Oscillation Index from January 1980–January 2009. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).

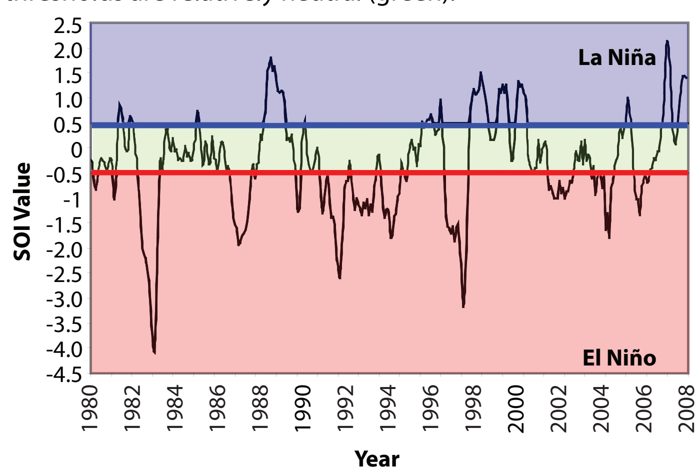
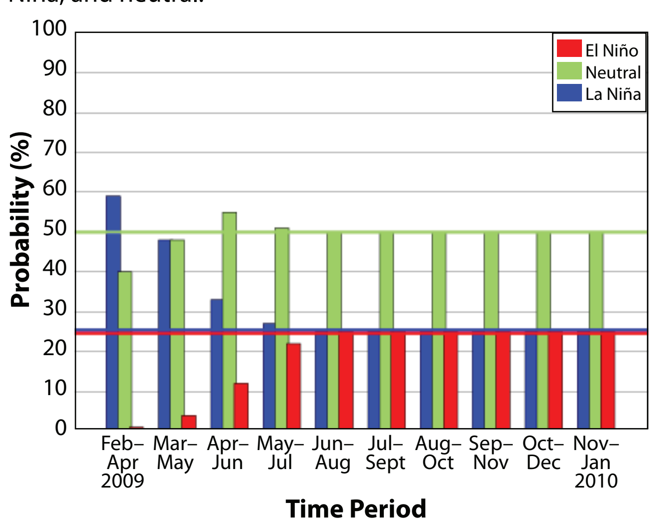


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released February 19, 2009). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification

(November 2008–January 2009)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-Climate Prediction Center (CPC) seasonal temperature outlook for October–December 2008 predicted increased chances of above-average temperatures east of the Continental Divide, including the upper Midwest. The forecast included slight probabilities of above-average temperatures through New Mexico and Texas (Figure 14a), although this forecast assigned Arizona with equal chances of above-, below-, or near-average temperatures based primarily on long-term temperature trends. The overall observed pattern of temperatures from October through December reveals above-average temperatures throughout almost the entire West, but consistently colder-than-average conditions through most of the Midwest (Figure 14b). These conditions were primarily due to a series of cold fronts that swept through the upper Midwest beginning in December and into January. This particular CPC forecast, therefore, was not accurate with regard to the actual conditions observed through much of the country.

Figure 14a. Long-lead U.S. temperature forecast for November 2008–January 2009 (issued October 2008).

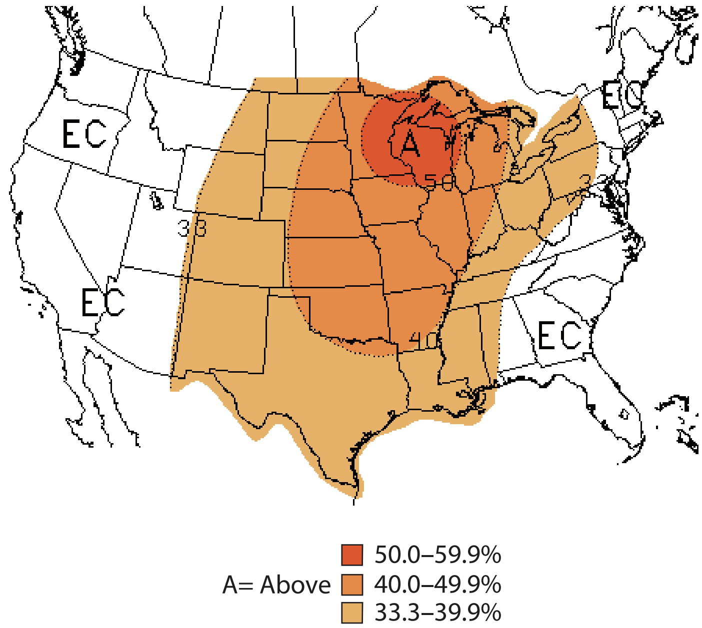
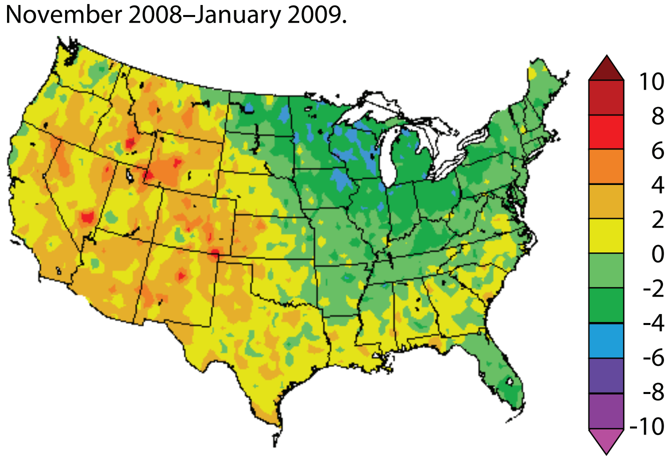


Figure 14b. Average temperature departure (in degrees F) for November 2008–January 2009.



Notes:

Figure 14a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months November 2008–January 2009. This forecast was made in October 2008.

The outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 14b shows the observed departure of temperature (degrees F) from the average for the November 2008–January 2009 period. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps. The temperature departures do not represent probability classes as in the forecast maps, so they are not strictly comparable. They do provide us with some idea of how well the forecast performed. In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions//multi_season/13_seasonal_outlooks/color/churchill.php

Precipitation Verification

(November 2008–January 2009)

Source: NOAA Climate Prediction Center (CPC)

The two-week lead time forecast issued by the NOAA-Climate Prediction Center (CPC) seasonal precipitation outlook for November 2008–January 2009 predicted equal chances of near-, above-, and below-average precipitation through most of the United States and below-average precipitation in much of the southern portion of the country, including Arizona and New Mexico (Figure 15a). Observed precipitation revealed very dry conditions through most of the Southwest, with Texas, Oklahoma, and nearly all of southern New Mexico experiencing dry conditions (Figure 15b). Southeast Arizona was dry as well, but overall conditions in Arizona were more variable, with above-average conditions in the northwestern region of the state. The CPC forecast was generally consistent with the dry conditions in the southern third of the United States.

Figure 15a. Long-lead U.S. precipitation forecast for November 2008–January 2009 (issued October 2008).

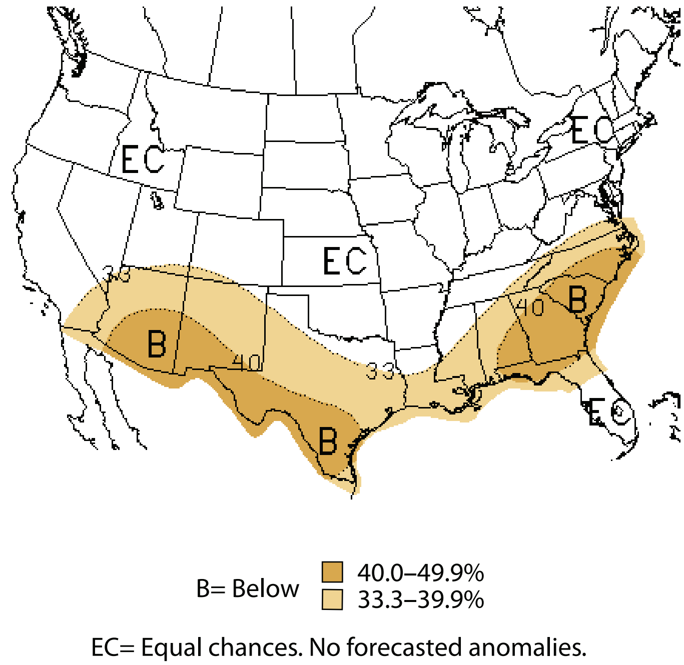
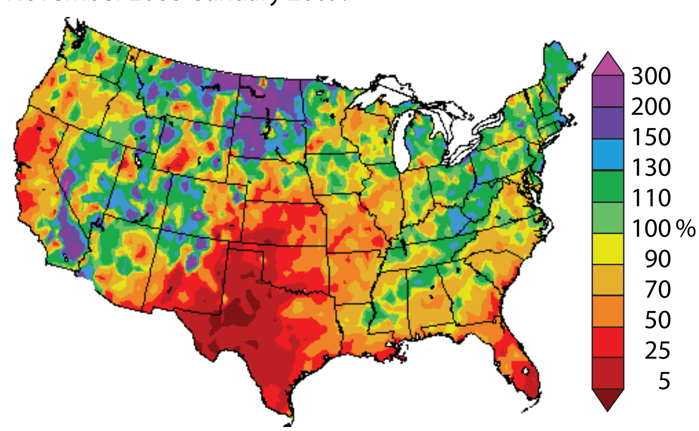


Figure 15b. Percent of average precipitation observed from November 2008–January 2009.



Notes:

Figure 15a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months November 2008–January 2009. This forecast was made in October 2008.

The outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 15b shows the observed percent of average precipitation for November 2008–January 2009. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps. The observed precipitation amounts do not represent probability classes as in the forecast maps, so they are not strictly comparable, but they do provide us with some idea of how well the forecast performed.

In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions//multi_season/13_seasonal_outlooks/color/churchill.php