November 21, 2012

Southwest Climate Outlook

Vol. 11 Issue 11

Sandstone canyon cliffs near Sedona, Arizona are partially hidden by verdant vegetation. Photo taken in November, 2011 by Zack Guido.

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In this issue...

November Climate Summary

Drought: The drought picture remains largely unchanged from one month ago. Moderate to extreme drought covers all of Arizona and New Mexico.

Temperature: Warmer-than-average temperatures continue to be the norm in the Southwest, upholding recent trends toward a warmer fall and early winter.

Precipitation: Dry conditions have prevailed in the last month, which is not uncommon for this time of year.

ENSO: The prospect of an El Niño event faded this past month. ENSO-neutral conditions are now expected to persist through the winter season.

Climate Forecasts: Precipitation outlooks call for increased chances for drier-than-average conditions in January through March, while temperature outlooks suggest warmer-than-average conditions this winter.

The Bottom Line: Drought conditions across the Southwest are widespread, with only about 1 percent of Arizona and New Mexico not experiencing at least moderate drought. These conditions reflect both short-term drought, which accumulates over several months, as well as the persistence of longer-term rain and snow deficits. In the last six years, for example, most of the Southwest has received between 71 and 90 percent of average precipitation. The past two years were especially dry, as back-to-back La Niña events helped divert winter storms north of the region. Water supply is one measure of long-term drought impacts, and currently low storage in the region's reservoirs paints a grim picture. Combined, the 15 reservoirs in New Mexico are only about 19 percent full. In Arizona, reservoirs on the Verde and Salt rivers have decreased 36 percent in the last two years and contain only about half of their 2.3 million acre-feet storage capacity. Lakes Mead and Powell are also storing about half of their capacity. The next several months will go a long way toward determining if water supply and drought conditions improve or deteriorate. While the winter outlook called for above-average precipitation only a few months ago, that forecast has dissipated, along with a once-promising El Niño. Now, ENSO-neutral conditions are expected and historically have had lower odds of bringing above-average precipitation to the Southwest. In fact, an ENSO-neutral event coupled with other current factors contributes to an outlook for increased chances for below-average precipitation and above-average temperatures for most of the winter. If conditions are warmer, more rain may fall instead of snow, especially at mid-elevations, and spring snowmelt may begin earlier in the year, as has been the case in recent years.

Water Shortage Sparks Debate

Irrigation and domestic wells are running dry in Eddy County in New Mexico as a result of ongoing drought and continued groundwater pumping (*Carlsbad Current-Argus*, November 16). Lingering dry conditions have led to very low reservoir levels in Lake Brantley, which supplies irrigation water for farmers cultivating more than 21,000 acres in the Carlsbad Irrigation District. Lake Brantley contains only 3,200 acre-feet out of a possible 1 million acre-feet. To partially mitigate surface water shortages in times of low flow, a settlement was reached in 2010 that allowed the state to pump groundwater. The added water was intended to have three benefits: supplement irrigation; enable New Mexico to meet its obligations to deliver water to Texas, as mandated in the 1948 Pecos River Compact; and prevent water conservation measures from being foisted on junior water right holders during low flow years, which, in turn, would stave off large economic loses. The settlement, however, did not plan for substantial declines in groundwater that would leave the wells of some users high and dry. Local leaders are currently debating how best to proceed.

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SWCO Staff:

Mike Crimmins
UA Extension Specialist

Stephanie Doster
Institute of the Environment Editor

Dan Ferguson
CLIMAS Program Director

Gregg Garfin
Founding Editor and Deputy Director of Outreach, Institute of the Environment

Zack Guido
CLIMAS Associate Staff Scientist

Gigi Owen
CLIMAS Assistant Staff Scientist

Nancy J. Selover
Arizona State Climatologist

Jessica Swetish
CLIMAS Publications Assistant

This work is published by the Climate Assessment for the Southwest (CLIMAS) project, the University of Arizona Cooperative Extension, and the Arizona State Climate Office.

ENSO-Neutral: Another Dry Winter?

By Zack Guido

A once-promising winter forecast for an El Niño—and the wet conditions it often brings to the Southwest—has dissipated. Now, it appears a neutral phase of the El Niño–Southern Oscillation, or ENSO, is moving in, diminishing chances for copious winter rain and snow in the region.

"Our latest forecast for January–March is for below-average precipitation over most of the Southwest," said David Unger, a NOAA-Climate Prediction Center (CPC) meteorologist.

This is particularly bad news for the region's water supply. Irrigation water in the Elephant Butte Reservoir on the Rio Grande—the lifeblood for farmers in New Mexico's most productive agricultural region—is completely exhausted, while the four reservoirs on the Pecos River have dwindled down to only 1 percent of their total capacity. In Arizona, storage on the Salt and Verde rivers, which supply water to the Phoenix metropolitan area, have plummeted about 36 percent in the last two years, containing only about half of their 2.3 million acre-feet capacity.

Contributing to the forecast for below-average precipitation is the combination of a neutral ENSO event with warmer-than-average sea surface temperatures (SSTs) in the northwest Pacific Ocean, which have in the past brought a robust dry signal to the West. With that situation playing out again this year, another winter drought could further jeopardize water supply.

ENSO Briefly Explained

El Niño and La Niña are part of ENSO, a natural seesaw in oceanic SSTs and surface air pressure between the eastern and western tropical Pacific Ocean.

ENSO's inner workings are complex. The rotation of the Earth causes trade winds in low latitudes to blow hard from the east, pushing warm surface water in the tropical Pacific Ocean westward near the northern coast of Australia like a snow plow. As the warm water pools, it works in tandem with intense solar rays to heat the surrounding air.

The hot air then rises like a balloon, creating a zone of low air pressure. As the air ascends, it cools and condenses, forming clouds that burst with rain. That air then travels east, where it descends and piles on the Earth's surface, forming a high pressure zone that acts like a vice.

The pressure difference squeezes air in the east toward the west, where it fills the void created by the hot, rising air. In this way, a large circular and continuous pattern known as the Walker cell is completed, with its vigor tuned by

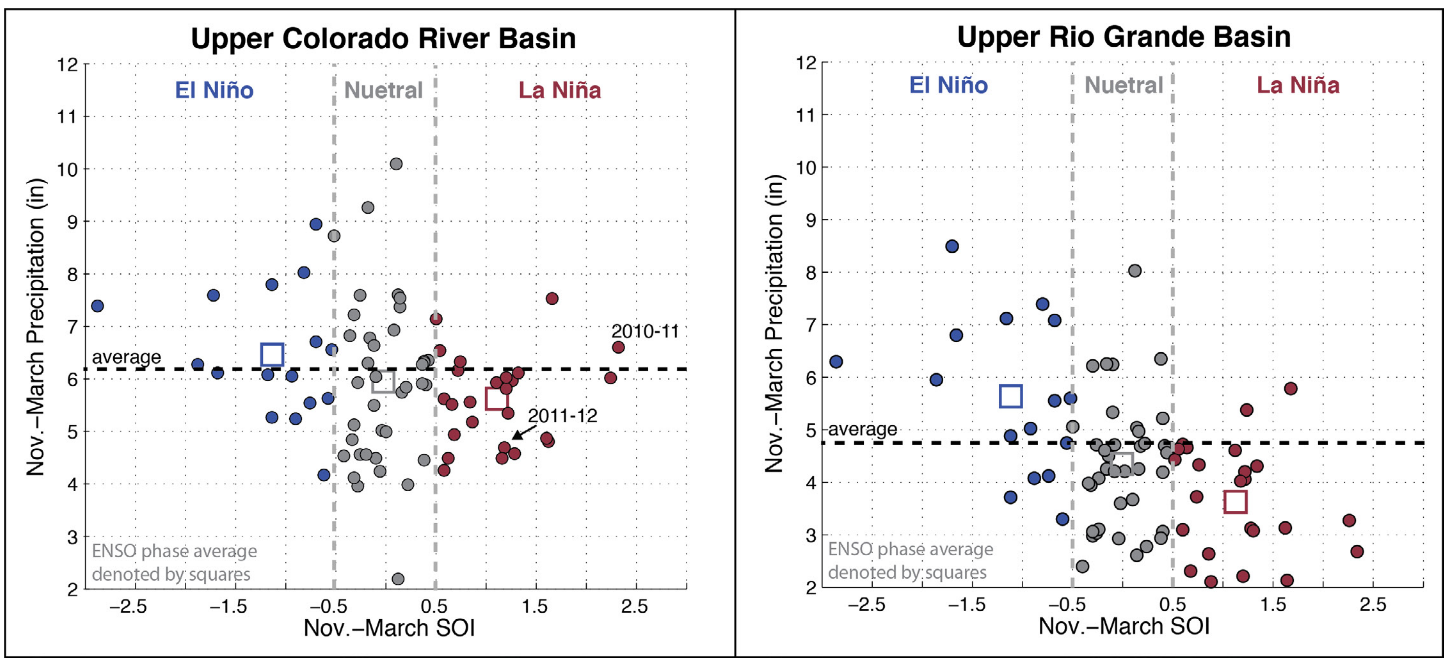

Figure 1. Precipitation during the November–March period in the Upper Colorado and Rio Grande basins during different ENSO phases between 1934 and 2011. The squares denote the average values for each phase. For the Upper Colorado River Basin, monthly PRISM data was averaged over the hydrologic units corresponding to the Upper Green and Lower Green, White-Yampa, Gunnison, San Juan, Lower Dirty Devil, Colorado River Headwaters, and Dolores. For the Rio Grande, precipitation data was averaged over the Rio Grande headwaters and the Upper Rio Grande hydrologic units. PRISM (Parameter-elevation Regressions on Independent Slopes Model) data was obtained from Westmap.

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ENSO-Neutral, continued

ENSO's adjustments of SSTs and wind speed.

Changes in ENSO have far-reaching effects. During El Niño events, for example, surface waters warm and easterly winds weaken, which sends waves through the atmosphere that impact weather around the globe, much like a stone dropped in a placid pool creates ripples. In the U.S., El Niño events often cause more storms to waft over southern regions, generally leaving the Pacific Northwest dry. La Niña events, on the other hand, pull the atmospheric strings to shift storm tracks away from southern regions, often causing winter droughts, while delivering wetter conditions in the Pacific Northwest.

2011–2012 Evolution of ENSO

This year, SSTs began to warm in February, marking the beginning of the end for the existing La Niña. By mid-April, surface water temperatures in the tropical Pacific Ocean were near average and a pool of warm water began to accumulate just below the surface. This was the first hint of the development of an El Niño event.

It usually takes months for an event to fully materialize, and in July and August forecasters at the CPC were still confident that an El Niño would form by early winter. But by September, doubt crept in. The gradual warming of SSTs had slowed and easterly winds maintained strength similar to the historical average. This developing El Niño was sputtering like a cold car, and forecasters suggested that even if an El Niño formed, it would likely be weak and short-lived. In mid-November, CPC called off its El Niño Watch.

"It looks as though ENSO-neutral conditions are the best estimate now," Unger said. "The El Niño event was becoming established, but then it stalled."

Hedging Toward Dry

Of the three ENSO phases—La Niña, neutral, and El Niño—La Niña tips its hand the most in terms of what it will bring to the Southwest. It nearly always ushers in below-average rain and snow to the region, making forecasts more accurate.

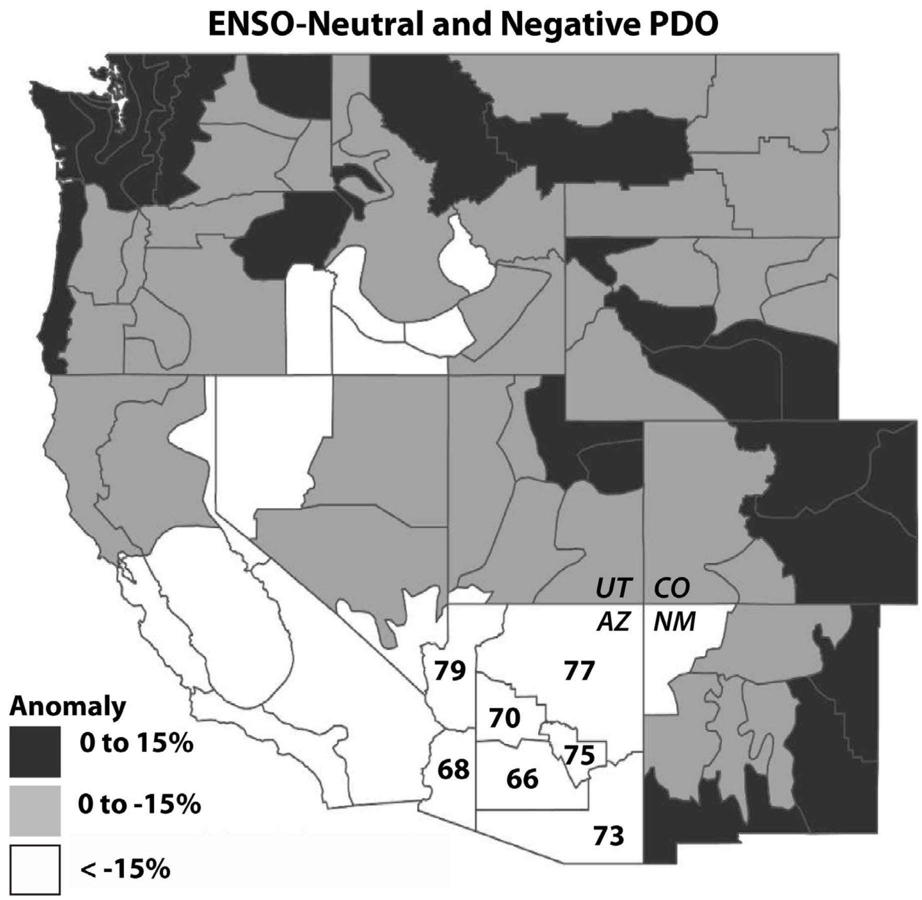

Figure 2. Winter precipitation for all December–March periods for each climate division in the West between 1925 and 1998 in which ENSO was neutral (defined as when the SST average over the Niño 3.4 region falls between -0.5 and 0.5 degrees Celsius) and the PDO was negative. Results from this analysis show that 68 of 84 climate divisions generally experienced below-average precipitation. The map is modified from Goodrich (2007) and the numbers in Arizona correspond to the percent of average winter precipitation calculated for each of the state's climate divisions during the same periods noted above; the numbers were obtained from Goodrich (2004).

"We pretty much know by November if it is going to be a dry winter in a La Niña year," said Gregg Garfin, deputy director for science translation and outreach at the University of Arizona's Institute of the Environment. "The percent we're wrong is in the single digits."

In ENSO-neutral years, however, foresight is harder to come by, in part because the variability is higher. Neutral years have delivered scant rainfall—most recently in 2002, when Arizona and New Mexico together received only about 46 percent of average precipitation—as well as a dousing. In 1995, for example, both states received about 142 percent of average precipitation combined.

"During ENSO-neutral years, we have a tendency to be just below the average in many regions in the Southwest," said Michael Crimmins, an associate professor and extension specialist in the UA's department of soil, water and environmental science. "It's also more variable

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ENSO-Neutral, continued

and we can get really wet years or really dry years."

This also holds true for part of the Rocky Mountains, where most of the water in the region's two most important rivers—the Colorado and Rio Grande—originates (*Figure 1*). About 55 and 73 percent of the ENSO-neutral winters, for example, have delivered below-average rain and snow in the Upper Colorado River and Rio Grande basins, respectively. In neutral years, however, the tug of ENSO isn't as strong, and other forces come into play.

"The ENSO signal is almost the only signal we can hang our hat on in the Southwest," Unger said. "But this year, the forecast is also based on the PDO."

The Pacific Decadal Oscillation, or PDO, is another seesaw in SSTs between the western and eastern Pacific Ocean north of 20 degrees north latitude. The PDO appears to be strongly influenced by ENSO events, according to often-cited research by Newman and others in 2003,[1] and remains in either its positive or negative phase for 20 to 30 years, perhaps sticking there because El Niño and La Niña events tend to cluster. In the last 10 years, for example, there were more La Niña events than El Niño events, and the PDO was generally negative.

"This winter the phase of the PDO is strongly negative, which tends to have La Niña-like atmospheric circulation," Unger said. "Our forecast models are picking up on this pattern."

Consequently, the CPC is hedging the January–March precipitation forecast toward dry conditions in many parts of the West, including nearly all of Arizona and California. Recent observations also support this outlook.

Analysis of data between 1925 and 1998 when winters had both ENSO-neutral conditions and a negative PDO phase—the current situation—revealing that, on average, precipitation in the western U.S. was 8.9 percent below normal, with 68 of 84 climate divisions (geographic divisions within each state) receiving below-average rain and snow.[2] In fact, ENSO-neutral phases during a negative PDO shows the largest precipitation deficits in the western United States.

In the Southwest, the picture is similar. Precipitation in all of Arizona was less than 80 percent of the 1971–2000 average (*Figure 2*), according to another Goodrich publication,[3] while the Upper Colorado and Rio Grande basins also were generally below average. Collectively, this does not bode well for reservoirs with low storage in the Southwest.

The answer to why the PDO exerts an influence, however, has been elusive.

"We know that ENSO forces the atmosphere to respond in different ways," Crimmins said. "We haven't yet found a causal link between the PDO and seasonal climate. Right now, its just statistics."

Without knowing the root cause of the statistics, it's difficult to assess how well they will hold up this year. Nonetheless, the forecast models see PDO-like patterns and call for drier-than-average conditions.

"We don't understand how the PDO teleconnects with other regions," Unger said. "But, because the models are showing a PDO signal, it gives us encouragement that there's something there. I guess the proof in the pudding will be known in a few months."

Further Readings:

1. Newman, Matthew, Gilbert P. Compo, Michael A. Alexander. 2003:. ENSO-forced variability of the pacific decadal oscillation. *Journal of Climate*, 16, 3853–3857. (Abstract)

2. Goodrich, Gregory B., 2007: Influence of the Pacific Decadal Oscillation on Winter Precipitation and Drought during Years of Neutral ENSO in the Western United States. *Weather and Forecasting* 22, 116-124. (Abstract)

3. Goodrich, Gregory B., 2004: Influence of the Pacific Decadal Oscillation on Arizona Winter Precipitation during Years of Neutral ENSO. *Weather and Forecasting* 19, 950-953. (Abstract)

Temperature (through 11/14/12)

Data Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 have averaged between 50 and 60 degrees Fahrenheit on the Colorado Plateau of Arizona and across many parts of New Mexico (*Figure 1a*). The lowest temperatures have been in the higher elevations of both states, while average temperatures in the deserts generally have been in the 70s. Temperatures across the region during October and early November were much warmer than average (*Figure 1b*). The average October temperature for Arizona ranked as the 21st warmest on record for that month, out of 118 years, while the average temperature in New Mexico was the 37th warmest. Because temperatures and precipitation are positively correlated, the lack of recent rain has contributed to the warmer-than-average conditions. Only one winter storm has passed through the Southwest since October 1, and it brought below-average temperatures for only a few days. Otherwise, high pressure has dominated the weather pattern of the Southwest.

During the past 30 days, most of Arizona was 1 to 3 degrees F warmer than average, while northwestern New Mexico experienced temperatures within 1 degree of average (*Figures 1c–d*). Many parts of eastern New Mexico were extremely warm, with temperatures greater than 3 degrees F above average for this time of year. The cold winter storm that moved through Southern California into Arizona in early November exited the state to the northeast, catching the northwest corner of New Mexico but not affecting much of eastern New Mexico.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2012, we are in the 2013 water 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 2013 (October 1 through November 14) average temperature.

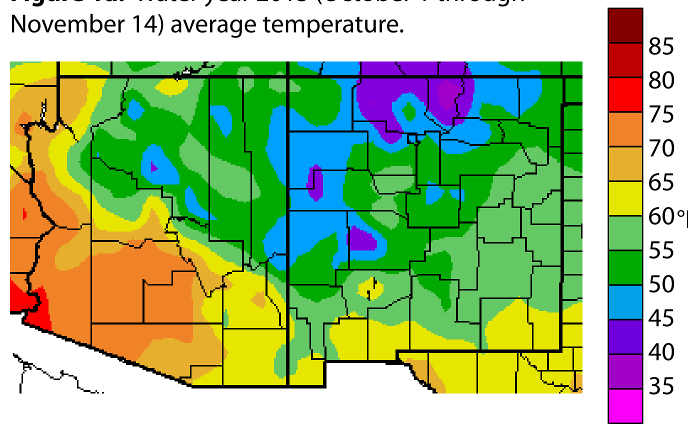


Figure 1b. Water year 2013 (October 1 through November 14) departure from average temperature.

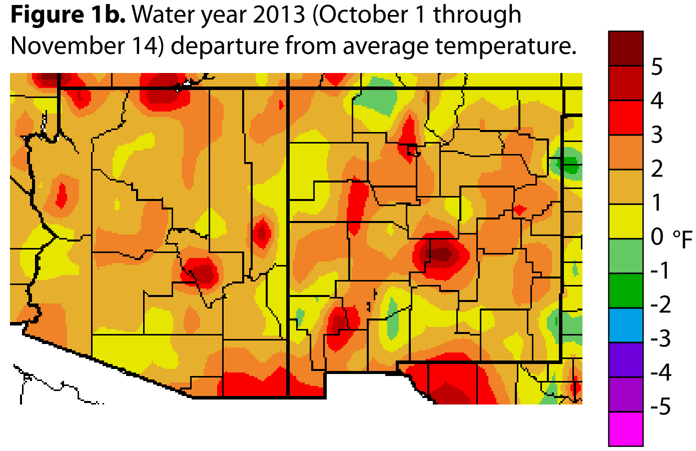


Figure 1c. Previous 30 days (October 16–November 14) departure from average temperature (interpolated).

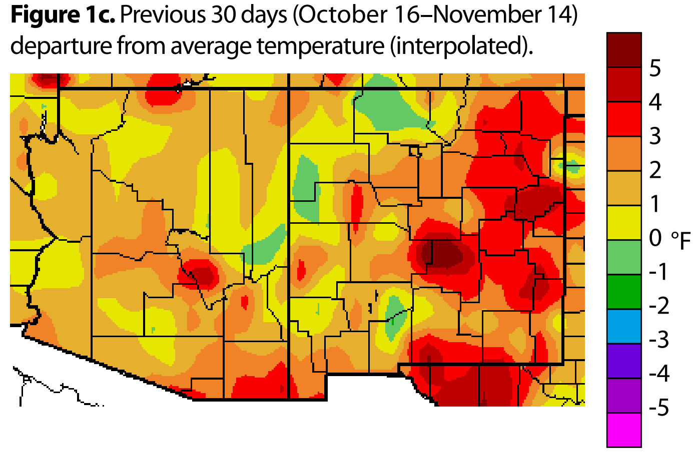
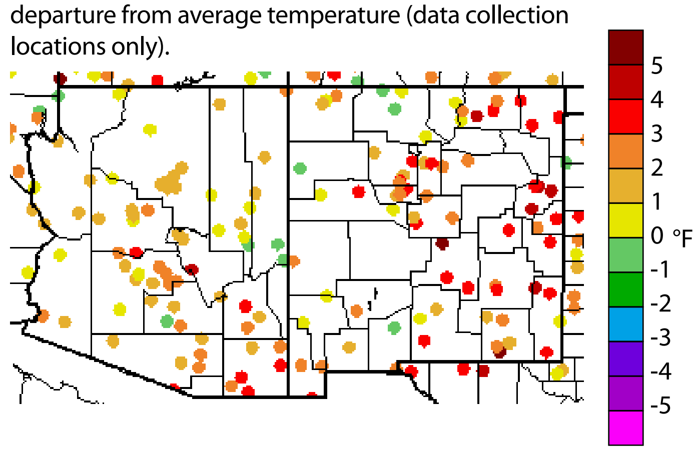


Figure 1d. Previous 30 days (October 16–November 14) departure from average temperature (data collection locations only).



Precipitation (through 11/14/12)

Data Source: High Plains Regional Climate Center

Since the water year began on October 1, conditions across most of the Southwest have been exceptionally dry (*Figures 2a–b*). The one notable exception has been near the Arizona–California border and the far northeastern corner of New Mexico. However, small amounts of precipitation can cause above-average precipitation in these regions due to the historically low precipitation during the time. Outside of these areas, southern Arizona and western and central New Mexico have received less than 25 percent of their average precipitation for this time of year, and most areas have measured less than 50 percent of average. This is not uncommon for this period, especially if tropical storms emanating in the Pacific Ocean do not waft into the region.

The past 30 days also were very dry, particularly in the western third of Arizona and eastern New Mexico, both of which received less than 5 percent of average precipitation (*Figures 2c–d*). Only a small part of Gila County in central Arizona had near-average precipitation. In the last month, only one storm passed through the region, but it did not have much moisture to generate significant rainfall across the region. More low-pressure systems are expected to sweep across the West in the next several weeks. However, after a few months of expecting an El Niño event to develop and deliver wetter-than-average conditions to many parts of the Southwest, the forecast now is for ENSO-neutral conditions to persist through the winter (see page 17). ENSO-neutral events, on average, deliver slightly below-average rain and snow to many parts of the Southwest. They also have brought both very wet and very dry conditions, which makes projecting winter precipitation difficult. La Niña events, on the other hand, almost always bring below-average precipitation to the region.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2012, we are in the 2013 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 2013 (October 1 through November 14) percent of average precipitation (interpolated).

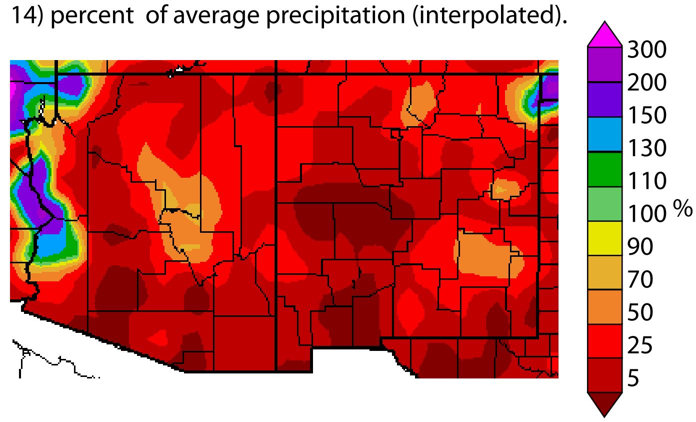


Figure 2b. Water year 2013 (October 1 through November 14) percent of average precipitation (data collection locations only).

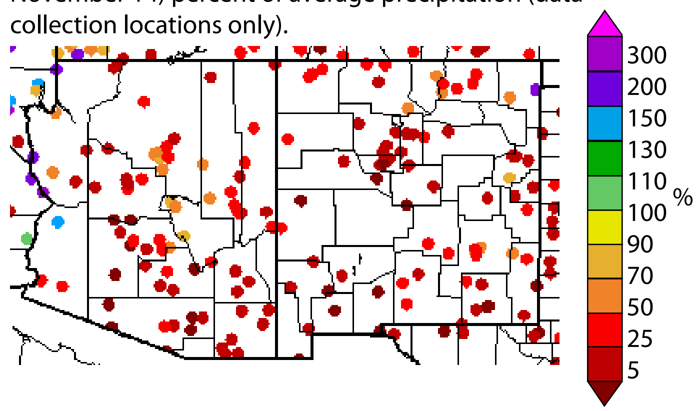


Figure 2c. Previous 30 days (October 16–November 14) percent of average precipitation (interpolated).

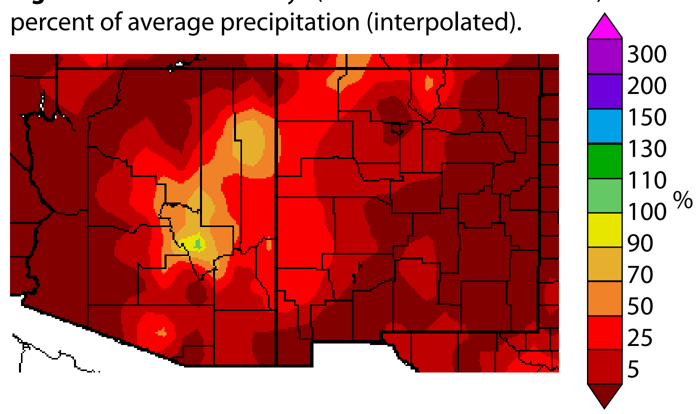
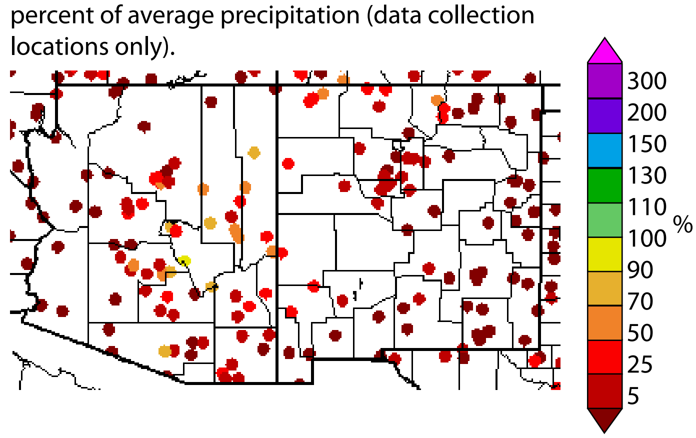


Figure 2d. Previous 30 days (October 16–November 14) percent of average precipitation (data collection locations only).



U.S. Drought Monitor (data through 11/13/12)

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

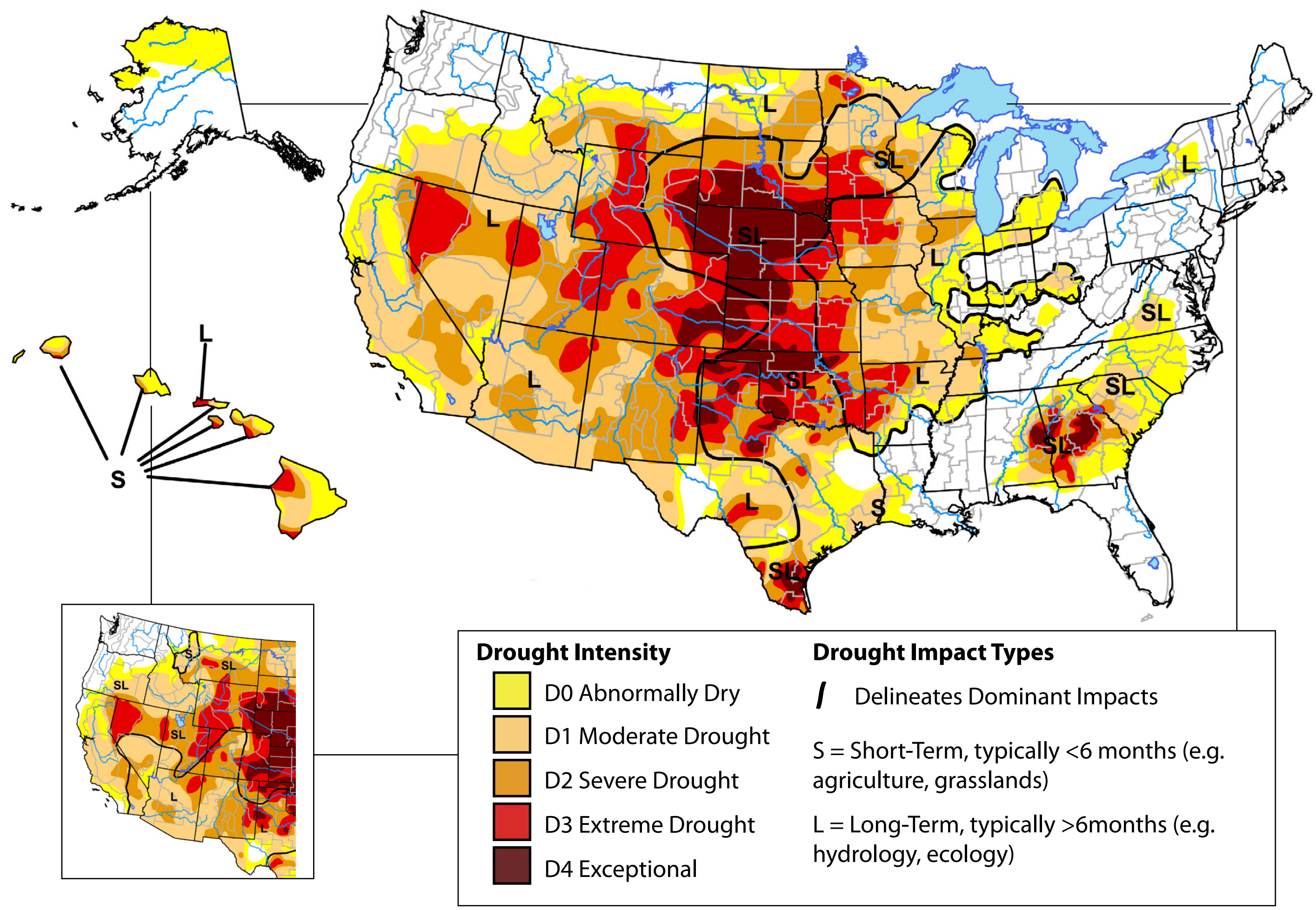
A majority of the western U.S. continues to experience short- and long-term drought conditions, while the Pacific Northwest and parts of the northern Rockies remain free of drought (*Figure 3*). Short-term drought conditions usually refer to conditions that respond quickly to changes in drought, such as range conditions or forest moisture levels. Long-term drought usually reflects conditions with a longer response time, such as reservoir and groundwater storage. While above-average monsoon or winter precipitation will have marked improvements on short-term drought, long-term drought often needs successive seasons with average to above-average conditions.

In the past 30 days, several early winter storms took a northern track across the West, helping to keep drought conditions at bay in Washington, northern Oregon, and Idaho. These storms also helped improve short-term drought conditions that had developed over northern Montana over the past several months. Despite this, some level of drought covers more than 80 percent of the western U.S., with more than 40 percent classified as severeor more intense. These numbers are largely unchanged since last month, because most of the western U.S. has experienced below-average precipitation over the past 30 days.

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 several agencies.

Figure 3. Drought Monitor data through November 13, 2012 (full size), and October 16, 2012 (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.gov/portal/server.pt/community/current_drought/208

Arizona Drought Status

(data through 11/13/12)

Data Source: U.S. Drought Monitor

Dry and warm fall conditions in the past month contributed to the continuation of moderate or more severe short-term drought conditions in most of Arizona, according to the November 13 update of the U.S Drought Monitor (*Figures 4a–b*). About 99 percent of the state is experiencing at least moderate drought, with the most severe conditions occupying a large area in the Four Corners region. Southeastern and central Arizona have less extreme drought conditions than they did one year ago, while the Four Corners region has seen worsening drought.

In the past month, less than 50 percent of average precipitation fell across most of Arizona; consequently, drought coverage and intensity did not improve. November often can be dry, but the winter months can contribute large fractions of the total annual precipitation. One storm that struck the Southwest between November 9 and 11 brought more than an inch of rain to the higher elevations of central and eastern Arizona, but it was too little to compensate for substantial deficits in longer-term precipitation that have accumulated over this area over the past two years.

In other drought indices, the Vegetation Drought Index (VegDRI), which is a measure of the stress on vegetation caused by drought, also shows moderate to severe drought across much of eastern Arizona. Some improvements are noted in eastern Mohave and western Coconino counties, where recent precipitation, as little as it was, may have relieved some short-term drought stress.

Figure 4a. Arizona drought map based on data through November 13.

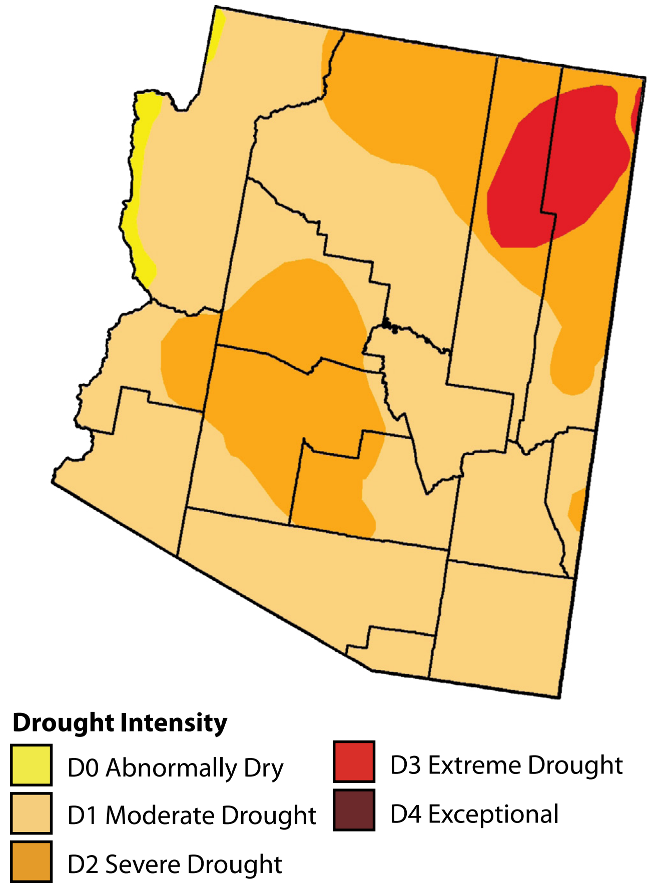


Figure 4b. Percent of Arizona designated with drought conditions based on data through November 13.

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	98.66	34.10	5.67	0.00
Last Week (11/06/2012 map)	0.00	100.00	98.66	35.51	5.67	0.00
3 Months Ago (08/14/2012 map)	0.00	100.00	100.00	93.97	24.95	0.00
Start of Calendar Year (12/27/2011 map)	16.70	83.30	60.34	36.56	2.78	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	31.93	5.67	0.00
One Year Ago (11/08/2011 map)	1.50	98.50	72.03	48.37	29.86	1.24

Notes:

The Arizona 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 several agencies.

On the Web:

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

For monthly short-term and quarterly long-term Arizona drought status maps, visit http://www.azwater.gov/AzDWR/StatewidePlanning/Drought/DroughtStatus.htm

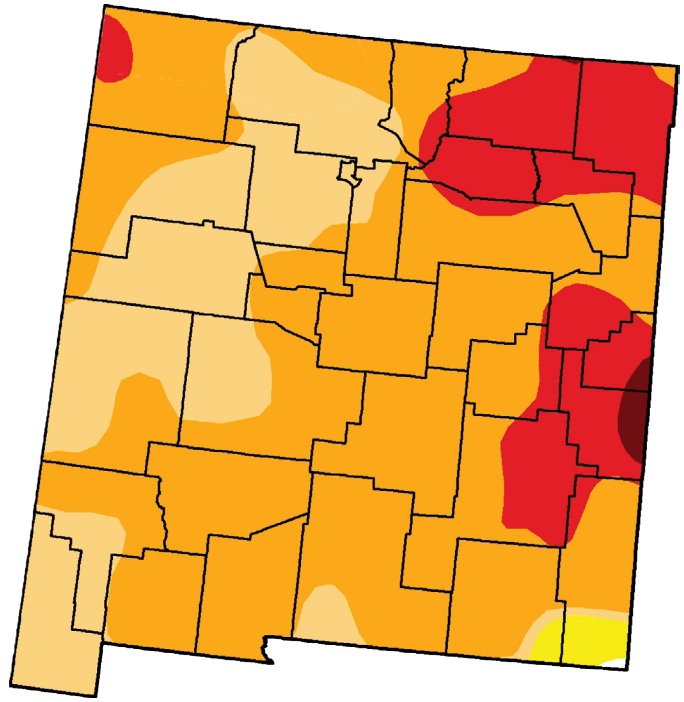
New Mexico Drought Status
(data through 11/13/12)

Data Source: New Mexico State Drought Monitoring Committee, U.S. Drought Monitor

Dry conditions continued to plague much of New Mexico, as above-average temperatures and below-average precipitation in the last 30 days did not provide any relief to short- and long-term drought conditions. Currently, all of the state except a small sliver in the southeast corner is experiencing some level of drought, according to the November 13 update of the U.S. Drought Monitor (*Figures 5a–b*). Severe or more intense drought conditions cover about 75 percent of the state—an increase of about 9 percent from one month ago. Most of this shift from moderate to severe drought occurred in the southwestern corner, where short-term conditions worsened due to the recent lack of precipitation. Drought in New Mexico has largely improved over the past 12 months—only 16 percent of the state is classified with extreme or exceptional drought, compared to about 63 percent one year ago.

In other drought indices, the Vegetation Drought Index (VegDRI), which is a measure of the stress on vegetation due to drought, shows widespread moderate to severe drought impacts to vegetation across all of New Mexico. Areas of extreme drought stress also have emerged over the past 30 days in Grant and Catron counties in the southwest and in Guadalupe and De Baca counties the east. In contrast, drought stress has eased in the far southeastern corner of the state, where conditions are near average or in pre-drought stages.

Figure 5a. New Mexico drought map based on data through November 13.



Drought Intensity

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional

Figure 5b. Percent of New Mexico designated with drought conditions based on data through November 13.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.07	99.93	98.80	74.51	16.30	0.68
Last Week (11/06/2012 map)	0.07	99.93	98.80	74.87	16.28	0.68
3 Months Ago (08/14/2012 map)	0.00	100.00	100.00	85.11	25.88	0.00
Start of Calendar Year (12/27/2011 map)	8.63	91.37	87.60	72.15	23.37	7.57
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	62.56	12.25	0.66
One Year Ago (11/08/2011 map)	6.30	93.70	90.73	85.62	63.05	26.41

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 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 10/31/12)
Data Source: National Water and Climate Center

Combined storage in Lakes Mead and Powell is at 53.4 percent of capacity, a slight decrease from last month (*Figure 6*), and 7.4 percent lower than one year ago. Declines in reservoir storage during the last year were primarily due to a La Niña event, which sent storms north of the Upper Colorado River Basin. San Carlos Reservoir and the Salt River Basin reservoir system continued to decrease, which is normal for this time of year.

In water-related news, the International Boundary and Water Commission confirmed that officials from the United States and Mexico have made a commitment to sign a new agreement on Colorado River water management (Associated Press, November 17). The addendum to the 1944 U.S.-Mexico water treaty would allow Mexico to store water in Lake Mead, provide for a pilot program of water releases to replenish Colorado River wetlands in Mexico, and allow U.S. water agencies to purchase water from Mexico.

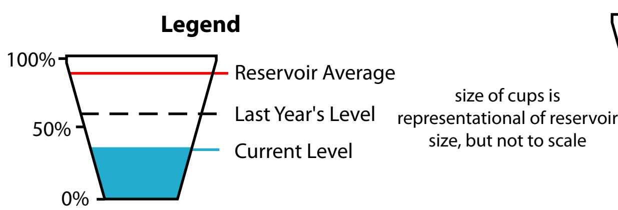
Notes:

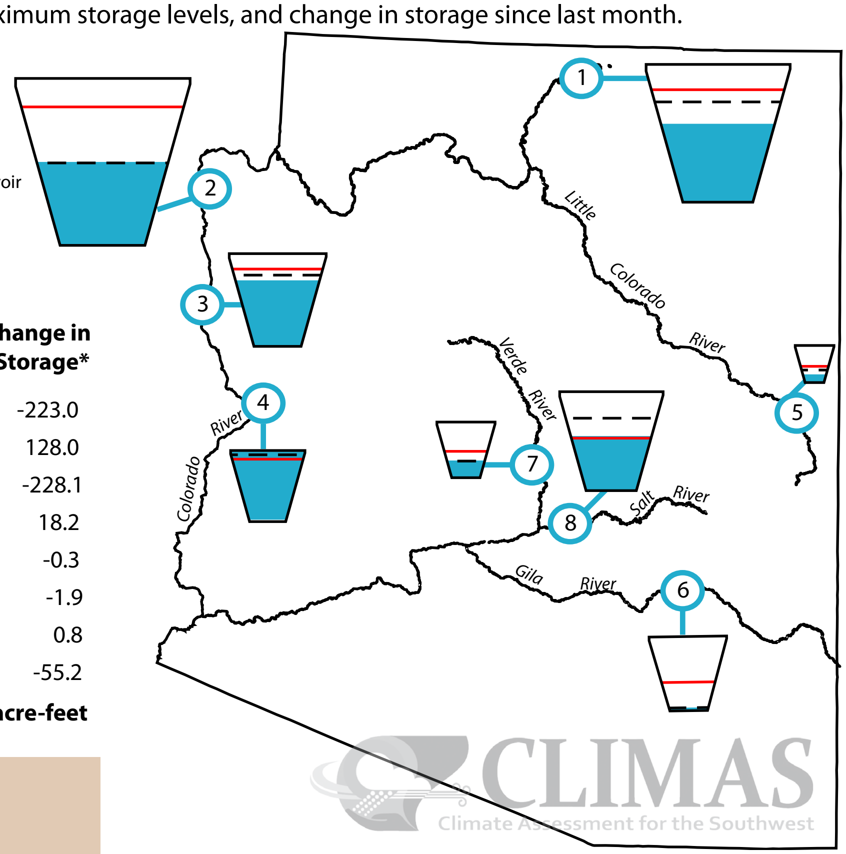
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 Resources Conservation Service (NRCS).

Figure 6. Arizona reservoir levels for October 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	56%	13,706.0	24,322.0	-223.0
2. Lake Mead	51%	13,263.0	26,159.0	128.0
3. Lake Mohave	76%	1,377.4	1,810.0	-228.1
4. Lake Havasu	98%	605.6	619.0	18.2
5. Lyman Reservoir	14%	4.3	30.0	-0.3
6. San Carlos	1%	5.2	875.0	-1.9
7. Verde River System	32%	91.3	287.4	0.8
8. Salt River System	53%	1,063.8	2,025.8	-55.2

*** 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 10/31/12)

Data Source: National Water and Climate Center

Water storage in most New Mexico reservoirs remains well below total capacity and below average (*Figure 7*). Navajo and Heron reservoirs declined by about 48,000 and 15,000 acre-feet, respectively, in the last month. The four reservoirs on the Pecos River are only storing about 1 percent of their total capacity combined. Elephant Butte Reservoir is also extremely low, containing only about 114,000 acre-feet, a reduction of more than 93,000 acre-feet in the last year. Elephant Butte's total capacity is approximately 2.2 million acre-feet. Other New Mexico reservoirs reported in Figure 7 saw small gains or losses in storage, as is typical for this time of year.

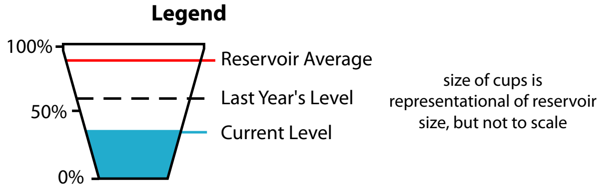
Notes:

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.

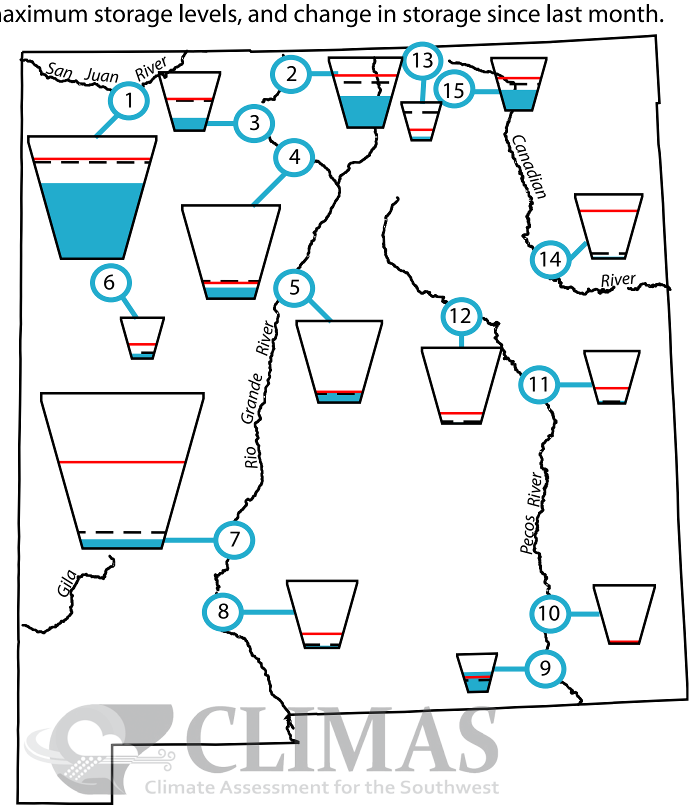
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Figure 7. New Mexico reservoir levels for October 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. Navajo	58%	985.4	1,696.0	-47.7
2. Heron	44%	177.2	400.0	-14.8
3. El Vado	18%	33.8	190.3	0.9
4. Abiquiu	13%	160.9	1,192.8	-2.6
5. Cochiti	11%	52.5	491.0	-0.5
6. Bluewater	9%	3.5	38.5	-0.6
7. Elephant Butte	5%	114.2	2,195.0	1.1
8. Caballo	2%	5.8	332.0	0.6
9. Lake Avalon	45%	1.8	4.0	0.3
10. Brantley	0%	3 .2	1008.2	0.6
11. Sumner	3%	3.4	102.0	-0.5
12. Santa Rosa	1%	4.8	438.3	0.0
13. Costilla	11%	1.7	16.0	0.3
14. Conchas	2%	4.4	254.2	-1.6
15. Eagle Nest	37%	29.3	79.0	-1.0

*** 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

Southwest Snowpack
(updated 11/15/12)

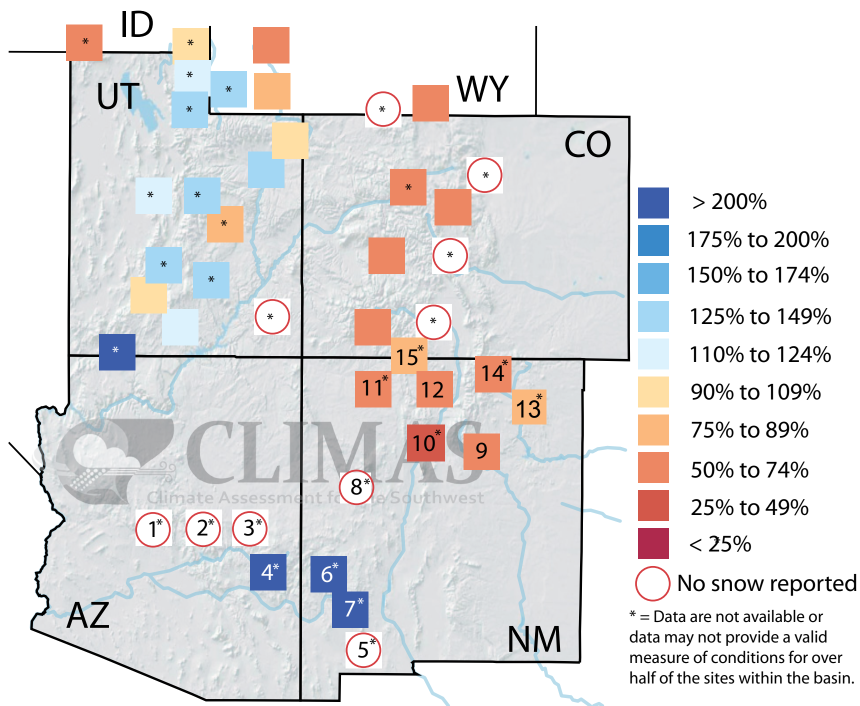
Data Sources: National Water and Climate Center, Western Regional Climate Center

Most basins in Arizona and New Mexico had below-average snow water equivalent (SWE) as of November 15 (*Figure 8*). However, a few basins exhibit above-average conditions as a result of a recent storm. In the Upper Salt River Basin in the White Mountains, for example, SWE now measures 1,350 percent of average. In New Mexico, the San Francisco and the Gila River basins had 600 and 900 percent of average SWE, respectively. These numbers should be viewed cautiously because it is early in the season and as a result even small snow accumulations can cause large deviations from the average.

In the states to the north, which supply most of the water to the Colorado River and the Rio Grande, conditions are mixed. Snowpack levels in Colorado are well below average, ranging from 50 to 64 percent of average SWE, while SWE in Utah ranges from 90 to 263 percent of average. With well below-average storage in many New Mexico reservoirs, it is crucial that precipitation this winter is robust. Combined reservoir storage in New Mexico totals 1.6 million acre-feet and stands at about 19 percent of capacity. A similar picture can be seen in Arizona, where the San Carlos and Salt and Verde reservoirs only contain about 36 percent of their combined 3.2 million acre-feet.

The January–March precipitation outlook recently took a turn toward drier conditions, in part because the once-budding El Niño stalled. The NOAA-Climate Prediction Center (CPC) now calls for increased chances for below-average rain and snow in most of Arizona and New Mexico. However, the forecast for the Upper Colorado and Rio Grande basins calls for equal chances for above- and below-average precipitation (see page 15).

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of November 15, 2012.



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

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 equivalent (SWE) is calculated from this information. SWE 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 SWE than light, powdery snow.

This figure shows the SWE 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 SWE measurements made by the Natural Resources Conservation Service.

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

Temperature Outlook
(December 2012–May 2013)
Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal temperature outlooks issued by the NOAA-Climate Prediction Center (CPC) in November call for increased chances that temperatures will be similar to the warmest 10 years in the 1981–2010 period for the three-month seasons spanning December–May (*Figures 9a–d*). Recent warming trends during these periods influence the forecasts, as do agreement from a suite of dynamical models. The CPC is now more confident that a neutral El Niño-Southern Oscillation (ENSO) event will persist through the winter, which is a recent turn of events because in previous months indications favored the development of an El Niño event. ENSO-neutral conditions coupled with a negative Pacific Decadal Oscillation (PDO)—the current situation—often bring drier conditions to the Southwest. Since precipitation and temperatures are often positively correlated, drier conditions translate to warmer temperatures. The CPC also notes that the state and fate of the Arctic Oscillation (AO) remains a wildcard. If the AO is generally weak, cold Arctic air can spill south and, when entrained in storm tracks, can deliver very cold weather to the Southwest. The AO, however, is hard to forecast more than two weeks in advance.

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 three-category forecast. As a starting point, the 1981–2010 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 no forecast skill has been demonstrated or there is no clear climate signal; 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 December 2012–February 2013.

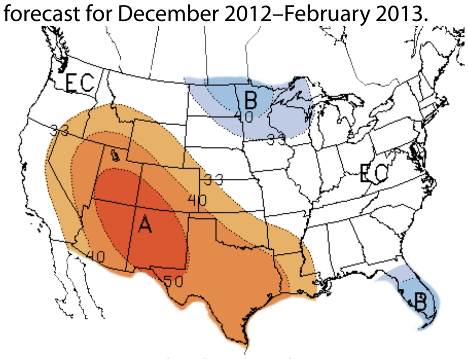
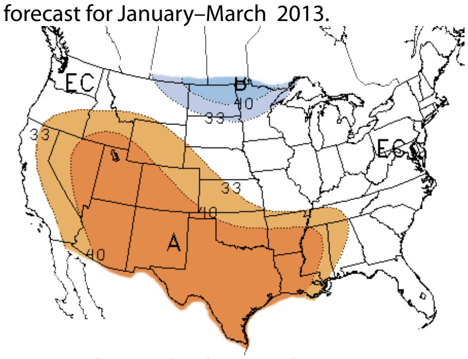


Figure 9b. Long-lead national temperature forecast for January–March 2013.



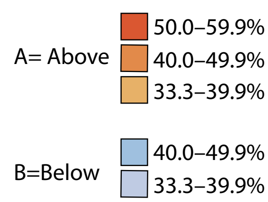


Figure 9c. Long-lead national temperature forecast for February–April 2013.

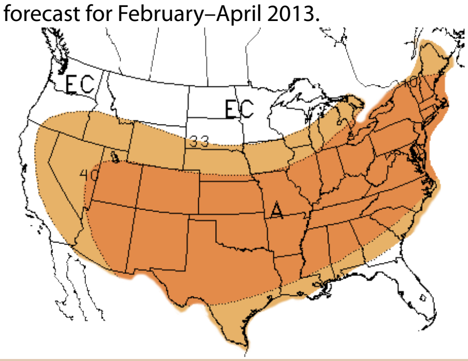
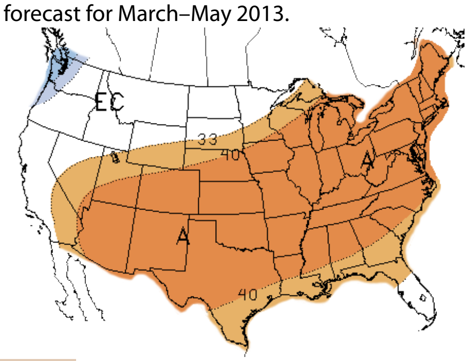


Figure 9d. Long-lead national temperature forecast for March–May 2013.



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

For seasonal temperature forecast downscaled to the local scale, visit http://www.weather.gov/climate/l3mto.php

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

Precipitation Outlook
(December 2012–May 2013)
Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal precipitation outlooks issued by the NOAA-Climate Prediction Center (CPC) in November call for equal chances that precipitation during the December–February period will be above , below , or near average (*Figure 10a*). However, the CPC indicates that precipitation during the three-month seasons that follow have a greater chance of being drier than average (*Figures 10b–d*). Only a few months ago, the CPC considered an El Niño event likely, which would have increased chances for above-average precipitation. However, the El Niño recently sputtered and neutral conditions are now favored. During neutral ENSO events and when the Pacific Decadal Oscillation (PDO) is negative—which is the current state—the West historically receives about 91 percent of average precipitation. Also, during these conditions, all climate divisions in Arizona experience, on average, less than 80 percent of average rain and snow (see pages 3–5 for more information). Although the physical influence of the PDO remains a topic of hot scientific debate, most of the CPC models simulate precipitation patterns similar to the signature of a negative PDO measured in historical data.

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 1981–2010 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 no forecast skill has been demonstrated or there is no clear climate signal; 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 December 2012–February 2013.

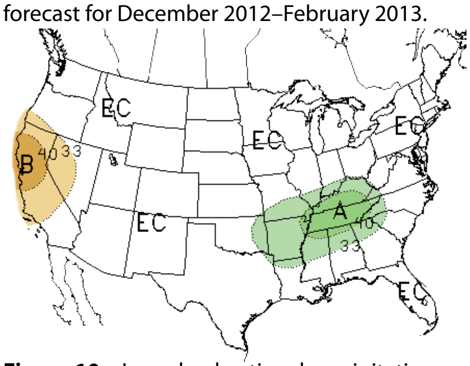


Figure 10b. Long-lead national precipitation forecast for January–March 2013.

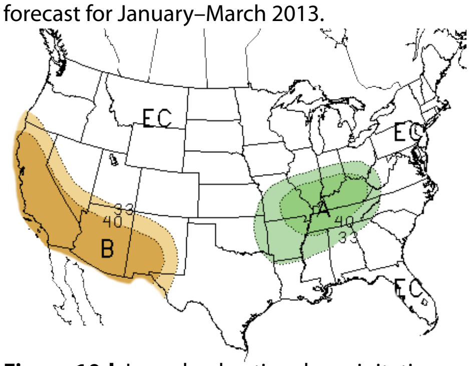


Figure 10c. Long-lead national precipitation forecast for February–April 2013.

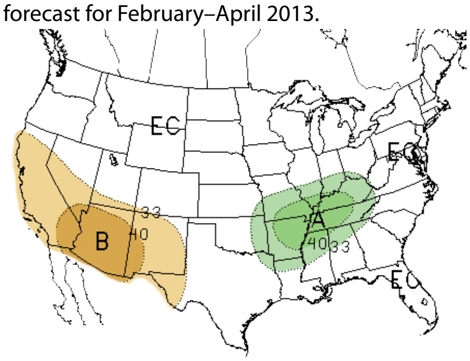
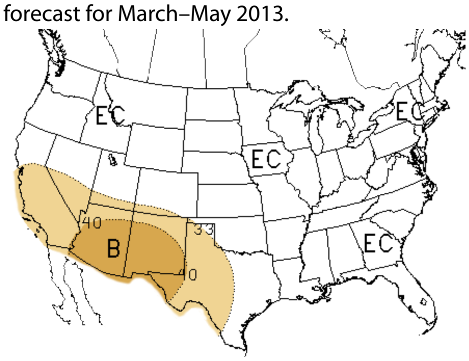


Figure 10d. Long-lead national precipitation forecast for March–May 2013.



A = Above: 40.0–49.9%; 33.3–39.9%

B = Below: 60.0–69.9%; 50.0–59.9%; 40.0–49.9%; 33.3–39.9%

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 March load slowly on your computer)

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

Seasonal Drought Outlook
(through February 2013)

Data Source: NOAA–Climate Prediction Center (CPC)

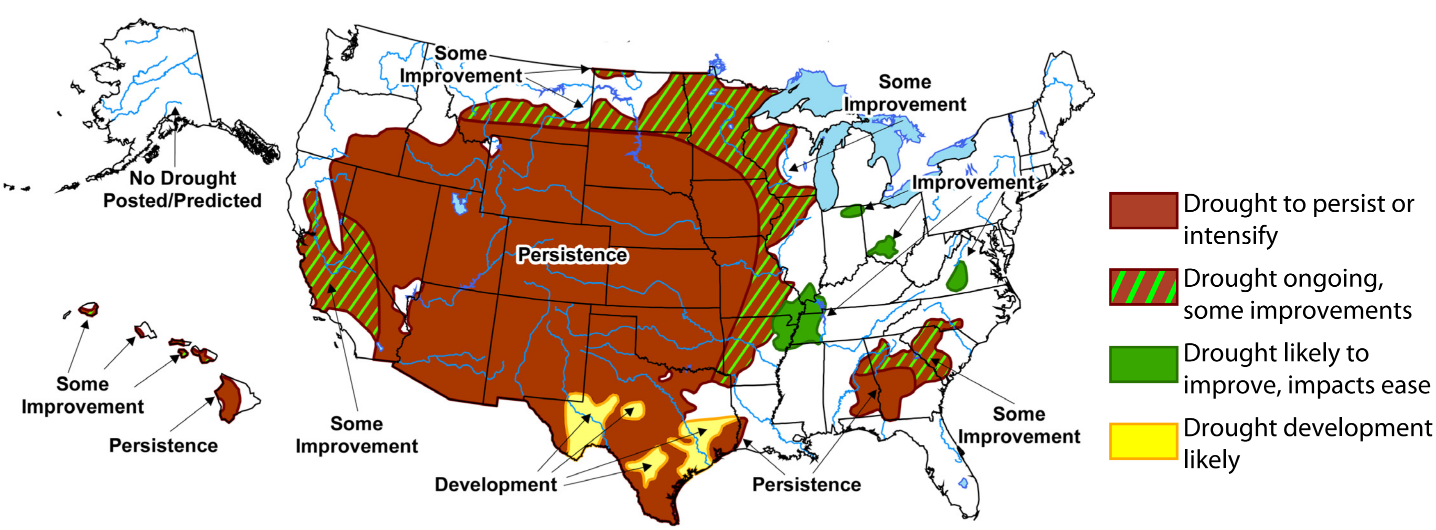
Since the beginning of November, a few storms have delivered up to 2 inches of precipitation over parts of the Four Corners region, with heavier amounts reported over higher elevations. While these quantities help improve short-term drought conditions, below-average precipitation is still widespread over the longer time period. A drier pattern is expected in the next two weeks, according to weather forecasts. For longer-term forecasts, the NOAA-Climate Prediction Center's (CPC) December outlook calls for equal chances that rain and snow will be either below or above average. During the January–March period, however, the CPC notes increased chances for below-average precipitation. El Niño, which had been forecasted to develop in previous months, is now unlikely to develop, and this switch, in addition to other drying signals, suggests that drought in the Southwest will persist and may even intensify in coming months (*Figure 11*). The CPC assigns a moderate confidence to this outlook.

In other regions in the West, the CPC assigns equal chances that the Upper Colorado River and Rio Grande basins will receive either above- or below-average rain and snow. These areas are currently experiencing severe to extreme drought, and uncertainty in the precipitation outlook leads to a forecast for drought persistence.

Notes:

The delineated areas in the Seasonal Drought Outlook 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 February 2013 (released November 15).



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

El Niño Status and Forecast

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

The evolution of tropical Pacific Ocean conditions during the last month have not been good news for El Niño enthusiasts. The NOAA-Climate Prediction Center (CPC) canceled its El Niño Watch in mid-November and expects that ENSO-neutral conditions will persist through the winter season. Typically, forecasters have very high confidence in the fate of ENSO by November.

Although sea surface temperatures (SSTs) along the equator in the middle and eastern Pacific Ocean maintained above-average conditions over the past 30 days, the atmosphere continued to ignore the ocean. The Southern Oscillation Index (SOI) remained in ENSO-neutral conditions and even increased slightly in the last month, moving opposite the direction it would take if El Niño were gaining steam (*Figure 12a*). The lack of coordination between the atmosphere and the ocean means there is limited potential for El Niño to develop over the next several months. Slightly above-average SSTs may linger in the Pacific Ocean over the winter season but are expected to have little to no impact on the winter circulation pattern over the western U.S.

Notes:

The first figure shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through October 2012. 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.

The second figure 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, 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/

Official forecasts issued in early November jointly by the CPC and the International Research Institute for Climate and Society (IRI) depict a greater chance of neutral conditions persisting rather than the development of an El Niño event over the next several months (*Figure 12b*). While there is a 76 percent chance for neutral conditions during the November–January period, El Niño has only a 24 percent chance of forming; it's nearly certain that a La Niña will not emerge. The chance of neutral conditions persisting rises over the winter and crests at 79 percent. As a result of the neutral event, the equatorial Pacific Ocean will have limited impact on the winter circulation pattern, allowing other forces to come into play. Dynamical global circulation models are picking up on a weak dry pattern for the winter season across the Southwest. However, confidence in these forecasts remains low due to the lack of a strong ENSO signal.

Figure 12a. The standardized values of the Southern Oscillation Index from January 1980–October 2012. 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).

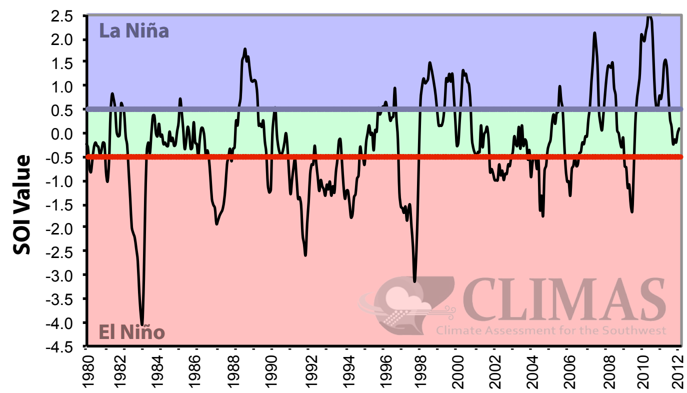


Figure 12b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released November 15). Colored lines represent average historical probability of El Niño, La Niña, and neutral conditions.