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Southwest Climate Outlook

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An elk cow foraging in a wintery Grand Canyon National Park on February 19.
Photo source: John Capuano

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: zguido@email.arizona.edu

In this issue...

Feature Article

Call it a tale of two winters. A wet December gave way to a dry January for the second year in a row. These alternating wet and dry winter spells in the Southwest are driven by the Madden Julian Oscillation, making it clear there is more to winter weather than El Niño or La Niña.

Snowpack

The water content in snowpacks across Arizona ranged from well below average to slightly below average as warm temperatures in January helped melt early winter snow. In New Mexico, the snowpacks in about half of the river basins have below-average water content.

El Niño Status and Forecast

Sea surface temperatures (SSTs) in the equatorial eastern Pacific Ocean in the last month were close to -1 degree C below average, indicating a weak to moderate event. Warming SSTs and increasing subsurface water temperatures both suggest La Niña may be peaking or may have peaked.

CLIMAS Climate Assessment for the Southwest

ARIZONA COOPERATIVE EXTENSION
THE UNIVERSITY OF ARIZONA • COLLEGE OF AGRICULTURE AND LIFE SCIENCES

ARIZONA

OFFICE OF THE STATE CLIMATOLOGIST

NM STATE UNIVERSITY

February Climate Summary

Drought: Warm and dry weather has caused short-term drought conditions to intensify across much of Arizona and persist in New Mexico.

Temperature: Warm temperatures have reigned in the last 30 days, largely because high pressure has dominated and few winter storms have traversed the region.

Precipitation: Several winter storms dipped into the Four Corners region before wafting northeast through Colorado in the last 30 days. While this storm track delivered wetter–than-average conditions to the Four Corners, it left most of Arizona and New Mexico very dry.

ENSO: The La Niña event is expected to continue for the next several months. The official forecast indicates a 74 percent chance that La Niña will continue during the February–April period, but chances for its continuation thereafter precipitously decline.

Climate Forecasts: March–May forecasts call for above-average temperatures and below-average rain and snow.

The Bottom Line: January and part of February have been dry and warm, conditions often associated with a La Niña event. The rain and snow that soaked the region in December—modestly improving drought—was relatively short-lived; drought is once again on the march. In Arizona, moderate to severe drought conditions increased by about 20 percent from one month ago. In New Mexico, severe, extreme, or exceptional drought continues to cover more than 60 percent of the state. Snowpack conditions in all of Arizona and most of New Mexico are below average, as are those in the Upper Colorado River and Rio Grande basins. As a result, there is a 50-50 chance that spring inflow into Lake Powell will be about 64 percent of the 1971–2000 average; chances for above-average flows are small. Last winter's exceptionally high streamflows, however, increased combined storage in Lakes Mead and Powell by about 2 million acre-feet more than average and will help buffer below-average flows in the Colorado River this year. More dry weather is expected to continue as forecasts call for the continuation of La Niña for at least the next several months.

Government report on adapting to climate change open to public comment

Rising temperatures and changing precipitation patterns present challenges to ecosystem health, according to a draft report that outlines strategies to help fish, wildlife, and plants adapt to climate change. The strategies include collaborating across all levels of government, working with non-government entities and private landowners, and engaging the public. The draft report, "National Fish, Wildlife, and Plants Climate Adaptation Strategy: Shared Solutions to Project Shared Values," was published in January.

In 2009, Congress urged the development of a government strategy to safeguard plants and animals from changing conditions that include thinner April snowpacks, more frequent wildland fires, and hotter and drier droughts. The report is a joint effort between the Council of Environmental Quality (CEQ), the National and Oceanic Administration (NOAA), and other organizations. It provides professionals and other decision makers with a basis for actions that can be taken in spite of existing climate uncertainty.

The public can provide feedback, which will be taken into consideration before the final report is published. Public comment is open until March 5. To learn more, visit http://www.wildlifeadaptationstrategy.gov.

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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.

The MJO and a Tale of Two Winters

By Zack Guido

Call it a tale of two winters.

For the past two years, a series of December storms dumped rain and snow across the southwestern U.S. before clear skies and record-setting warm temperatures rang in the new year.

A La Niña event prevailed during both of these winters, and while total winter precipitation during such an event is dependably below average in the Southwest, soggy interludes can punctuate the dry spells.

This familiar story, the wet-dry seesaw, is driven not by El Niño or La Niña, but by the Madden Julian Oscillation, a pulse of storms in the tropical Pacific Ocean that periodically migrate eastward. The MJO, as climatologists call it, substantially influences weather in the Southwest, making it clear there is more to winter weather in the region than El Niño or La Niña.

The Basics of MJOs

While El Niño-Southern Oscillation (ENSO) events dictate weather over many months, the leading cause of shorter-term winter variability is the MJO.

"Of all the climate fluctuations that influence the weather, ENSO is the granddaddy", said Mike Crimmins, climate extension specialist at the University of Arizona. "But intra-seasonal variability is controlled by the MJO."

The MJO is an atmospheric oscillation, in which intense convective activity begins over the warm waters of the Indian Ocean, travels eastward, and dissipates over the colder waters of the eastern Pacific Ocean. Every 30 to 60 days, on average, a new burst of convection forms, and the eastward march begins anew. MJOs occur regardless of the season or year, and scientists have yet to identify what sparks them.

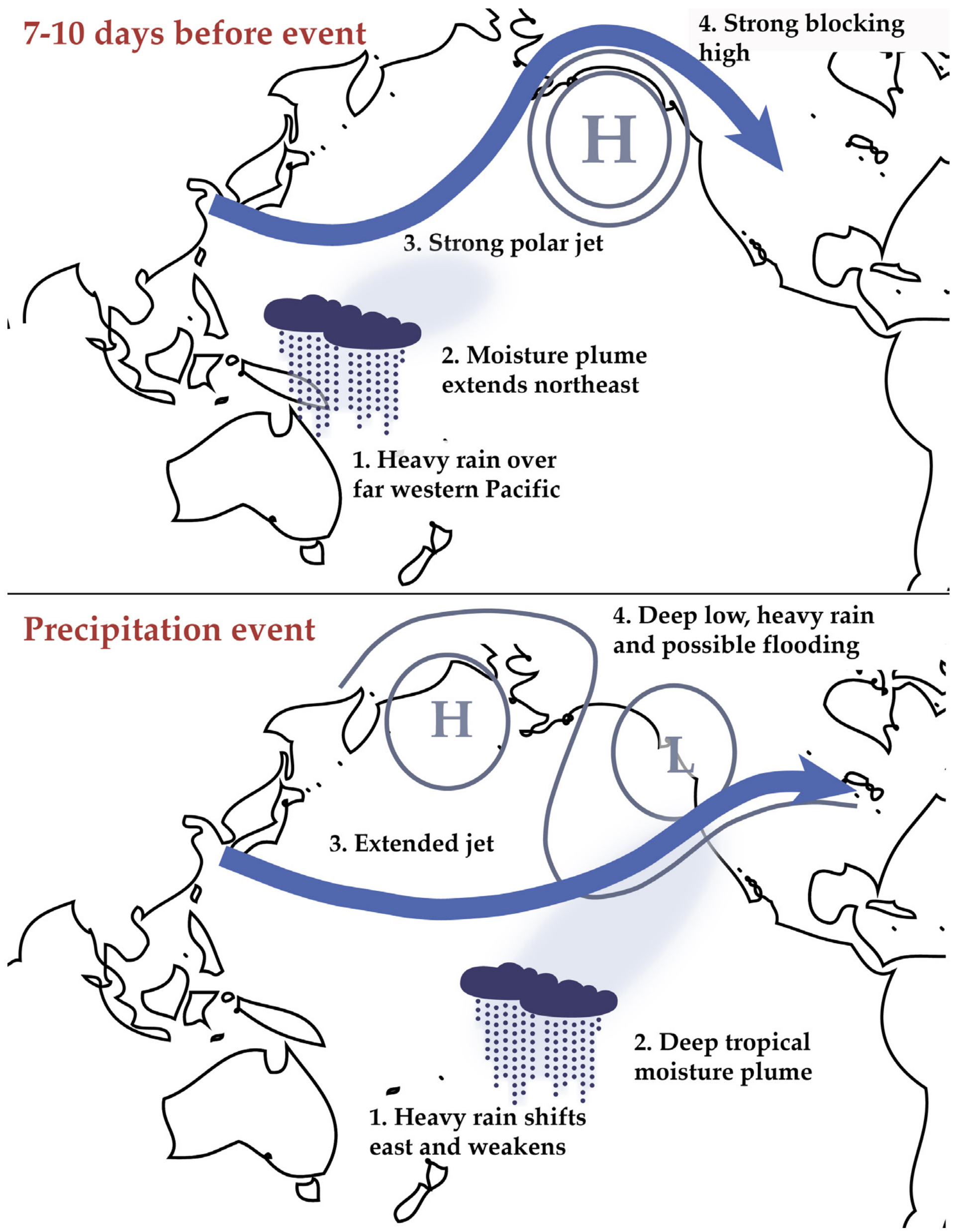


Figure 1. Generally, Madden-Julian Oscillations migrate east into the middle of the tropical Pacific Ocean where their moisture often is entrained in the jet stream and hurled into the West. *Source: modified from the NOAA-Climate Prediction Center*

"There are lots of theories about why they begin," said Wayne Higgins, director of NOAA's Climate Prediction Center (CPC). "There are about 100 peer review articles published about it, but I'd say it's still an open research question."

Researchers do understand how they evolve, however. Warm, moist air rises in the Indian Ocean, cools, and is squeezed like a sponge, eventually flowing east and west high in the atmosphere. That air ultimately descends, colliding with the Earth's surface and spreading horizontally. Some air is forced headstrong into the trade winds streaming from the east, causing moist air from both directions to converge and igniting another

continued on page 4

MJO, continued

round of vigorous convection. In this way the process repeats itself, and MJOs are propelled against the prevailing winds at about 11 miles per hour, or 5 meters per second. Most events pass through Indonesia and the western Pacific before waning in the central tropical Pacific Ocean. Usually only one fully developed MJO event exists at a given time. Occasionally, however, two weak events briefly coexist, with one forming while the other decays.

The effects of an MJO are far reaching, touching nearly every continent. They tune the intensity and frequency of precipitation across the Pacific islands, the Asian monsoon regions, western North America, and many other regions, and influence cyclone activity in the Pacific and Atlantic. In the U.S., Higgins said, impacts are most noticeable in the West, closer to the source.

MJO and ENSO

The frequency of MJOs appears to be related to the background climate condition unfurled by ENSO, which alters atmospheric patterns in reliable ways. During La Niña events, for example, stronger-than-average easterly winds plow warm water westward in the tropical Pacific Ocean.

The zone of rain, tethered to that warm water, also moves west. This, in turn, helps a bulge of high pressure develop off the coast of the northwestern U.S. that deflects northward the swift-moving winds in the jet stream.

This pattern partially explains why more winter storms drench the Pacific Northwest than the Southwest during La Niña events, but does not preclude wet winter spells in Arizona and New Mexico.

"When there are bursts of precipitation in the Southwest in the winter, more often than not they are related to MJO," Higgins said.

MJO events yank the atmospheric winds much like ENSO events do. As MJOs enter the central Pacific Ocean, they tug the high pressure bulge east and a low forms in its place. The low acts as a vortex, sucking air from the tropics. It also causes the jet stream to dive south, where it scoops moist air before slamming into the west coast (Figure 1).

MJOs tend to form more frequently during La Niña and neutral events than El Niño events and are therefore critical for providing some wet respites during otherwise dry conditions.

"In the historical record, extreme precipitation in the West occurs more often during La Niña or ENSO-neutral events," Higgins said.

But the strength of ENSO matters.

"If you have an El Niño in full effect, the easterly winds weaken a lot and there is no wind for the MJO to propagate into," Crimmins said. But if you have a strong La Niña, the easterly winds can be too strong, which also can cause an MJO to die out prematurely.

Weaker La Niña and neutral events present ripe conditions for more frequent MJOs. This helps explain why strong La Niñas, like the one last winter, cause drier conditions than weaker ones do.

The Near and Far

In recent years, global climate models (GCMs) have improved substantially, enabling better MJO forecasting.

The Coupled Forecast System Model, or CFS, used by the CPC, is successful at predicting MJO events and their impacts in the Southwest, said Higgins.

Based on models and current observations, the CPC provides weekly updates of MJO conditions. The most recent update, issued Feb. 13, states an MJO is on the march in the western pacific, suggesting increased chances for precipitation for some areas across the southern tier of the U.S. through the end of February. This would bring much needed rain and snow to the Southwest, which has generally received less than 50 percent of average in Arizona and southwestern New Mexico in the past 60 days.

Models have shown skill in accurately reproducing active hurricane periods during MJO events nine months into the future, so there is reason to believe that with continued research, outlooks that factor in MJO events will improve seasonal predictions.

Advanced information like this can help emergency managers prepare for potential floods, or reservoir managers take heed of possible swelling water storage. But the science is not quite advanced enough to forecast the effects of human-caused climate change on MJOs.

Accurately simulating MJOs in a warmer future is more challenging. It is harder to model phenomena that occur in relatively short periods, like 30 to 60 days, than it is for events that occur over longer periods. Scientists still need to be able to confidently forecast ENSO events years in advance to be able to predict how they will influence an MJO. Climate science is not yet there. Nevertheless, knowledge of MJO dynamics, the influence they wield, and how they in turn are altered add critical insights to the climate puzzle.

"We know a lot," Higgins said. "But I'd be misleading you if I said we know all the answers."

Temperature (through 2/15/12)

Data Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 have averaged between 50 and 65 degrees Fahrenheit in the southwest deserts and along the lower Colorado River, and 35 to 50 degrees F on the Colorado Plateau in northeastern Arizona and most of New Mexico. Temperatures in the higher elevations of both states have been between 30 and 35 degrees F (*Figure 1a*). These temperatures have been generally 0–3 degrees F warmer than average across most of Arizona and New Mexico (*Figure 1b*). There have been a few pockets of colder-than-average temperatures, including central Arizona and southwestern and north central New Mexico, where temperatures have been 0–4 degrees F below average. The cold spots in New Mexico have occurred in the areas receiving more precipitation relative to surrounding areas.

During the past 30 days, temperatures were largely 0–4 degrees F warmer than average across both states. In the southeast corner of Arizona, temperatures averaged between 4 and 6 degrees F above average. Warm conditions also have prevailed along the Arizona and New Mexico border and in south-central New Mexico (*Figures 1c–d*). Only western Yavapai County was colder than average. The unseasonably warm temperatures occurred because the storm tracks generally have remained north or south of Arizona and New Mexico. Although there have been several cold air outbreaks across the Southwest, they have been short lived.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2011, we are in the 2012 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 2011 (October 1 through February 15) average temperature.

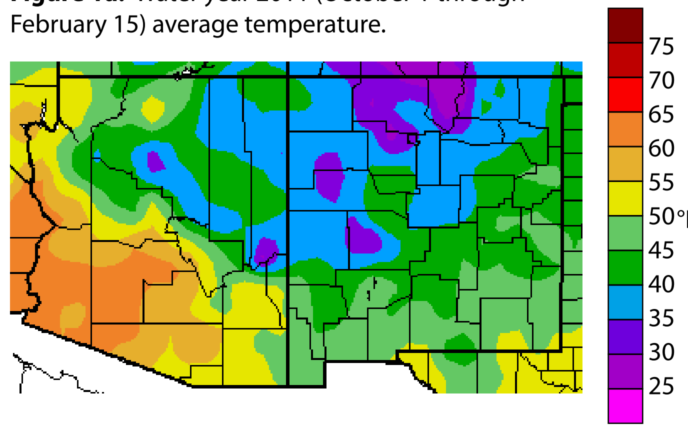


Figure 1b. Water year 2011 (October 1 through February 15) departure from average temperature.

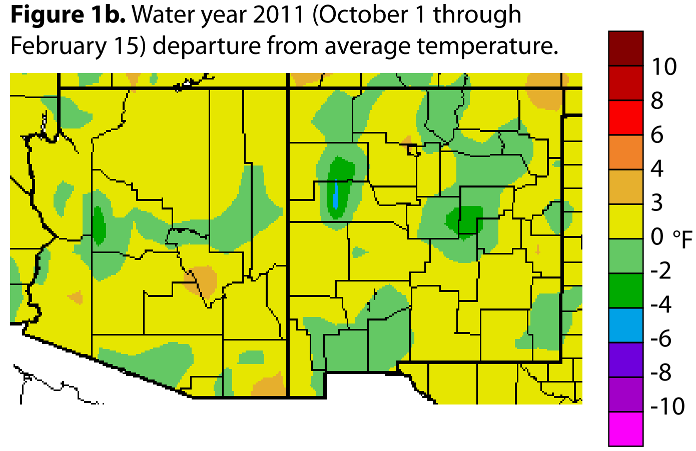


Figure 1c. Previous 30 days (January 17- February 15) departure from average temperature (interpolated)

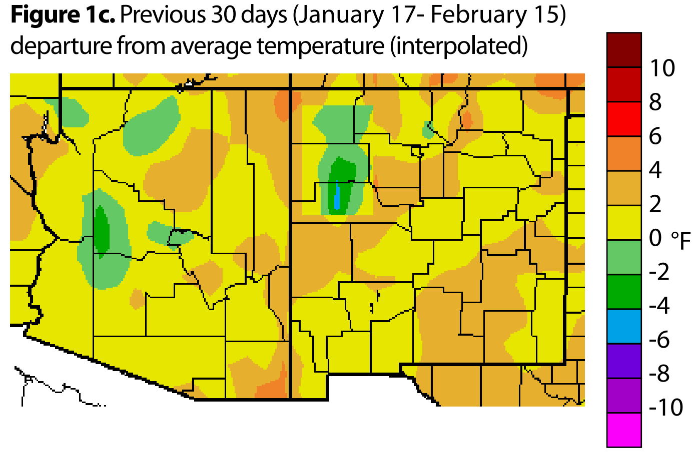
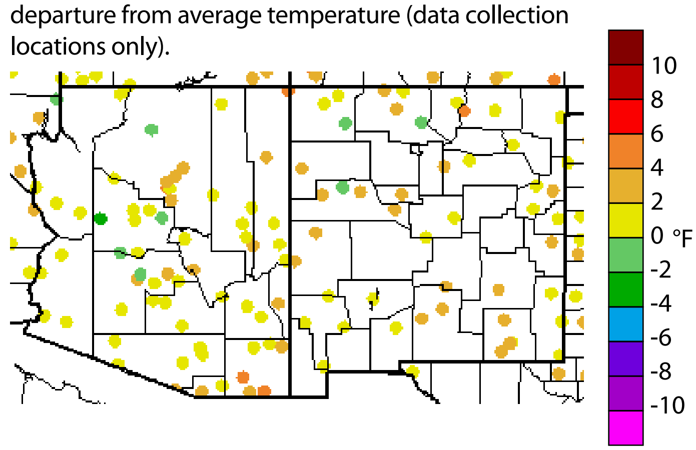


Figure 1d. Previous 30 days (January 17–February 15) departure from average temperature (data collection locations only).



Precipitation (through 2/15/12)

Data Source: High Plains Regional Climate Center

Precipitation since the water year began on October 1 generally has been below average in Arizona and southern New Mexico (*Figures 2a–b*). In Arizona, precipitation has been 25–90 percent of average across the state, with western Maricopa County and northern Apache County receiving less than 50 percent of average precipitation. Only a small sliver of the southwest corner of the state has received above-average rain. Precipitation in New Mexico has been more variable than in Arizona. While the southern third and eastern portion of the state have measured between 50 and 90 percent of average, the northwest quarter has received 110 to more than 300 percent of average. Most of the precipitation fell in November and December, although a few storms have moved across the northern third of both states during the past month. Some storms wafted north of Arizona before moving south into New Mexico, which explains why northern New Mexico is wetter-than-average while northern Arizona is not.

In the past 30 days, winter storms dipped into the northeast corner of Arizona and northwestern New Mexico before moving northeast through Colorado. These storms benefitted New Mexico the most, as rain and snow measured 150–800 percent of average (*Figures 2c-d*). The more northerly position of this storm track has left the southwestern two thirds of Arizona and the eastern half of New Mexico with less than 25 percent of average precipitation.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2011, we are in the 2012 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 2011 (October 1 through February 15) percent of average precipitation (interpolated).

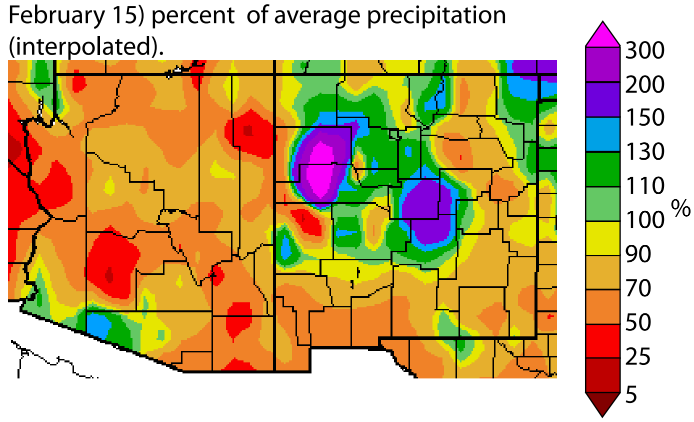


Figure 2b. Water year 2011 (October 1 through February 15) percent of average precipitation (data collection locations only).

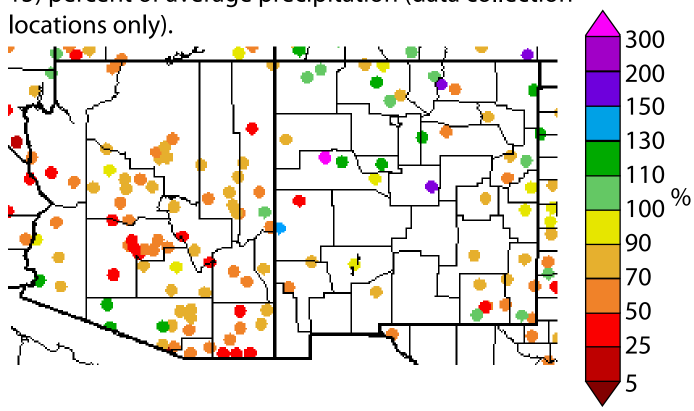


Figure 2c. Previous 30 days (January 17-February 15) percent of average precipitation (interpolated).

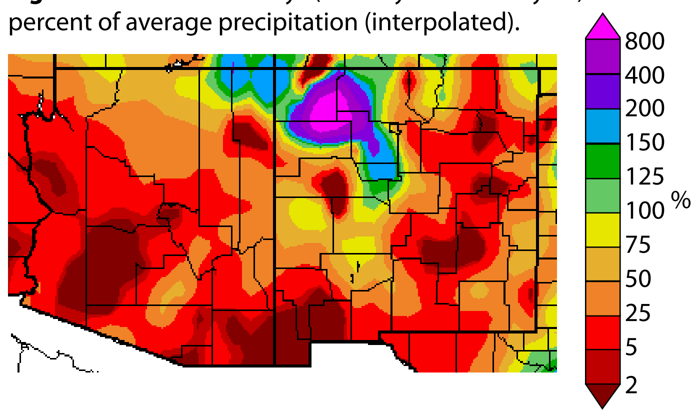
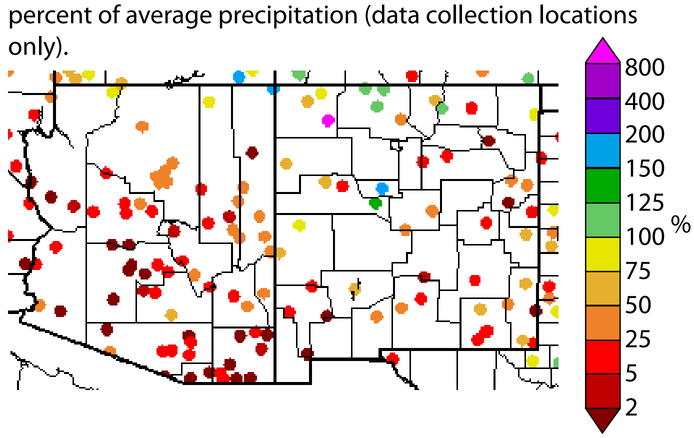


Figure 2d. Previous 30 days (January 17-February 15) percent of average precipitation (data collection locations only).



U.S. Drought Monitor (data through 2/14/12)

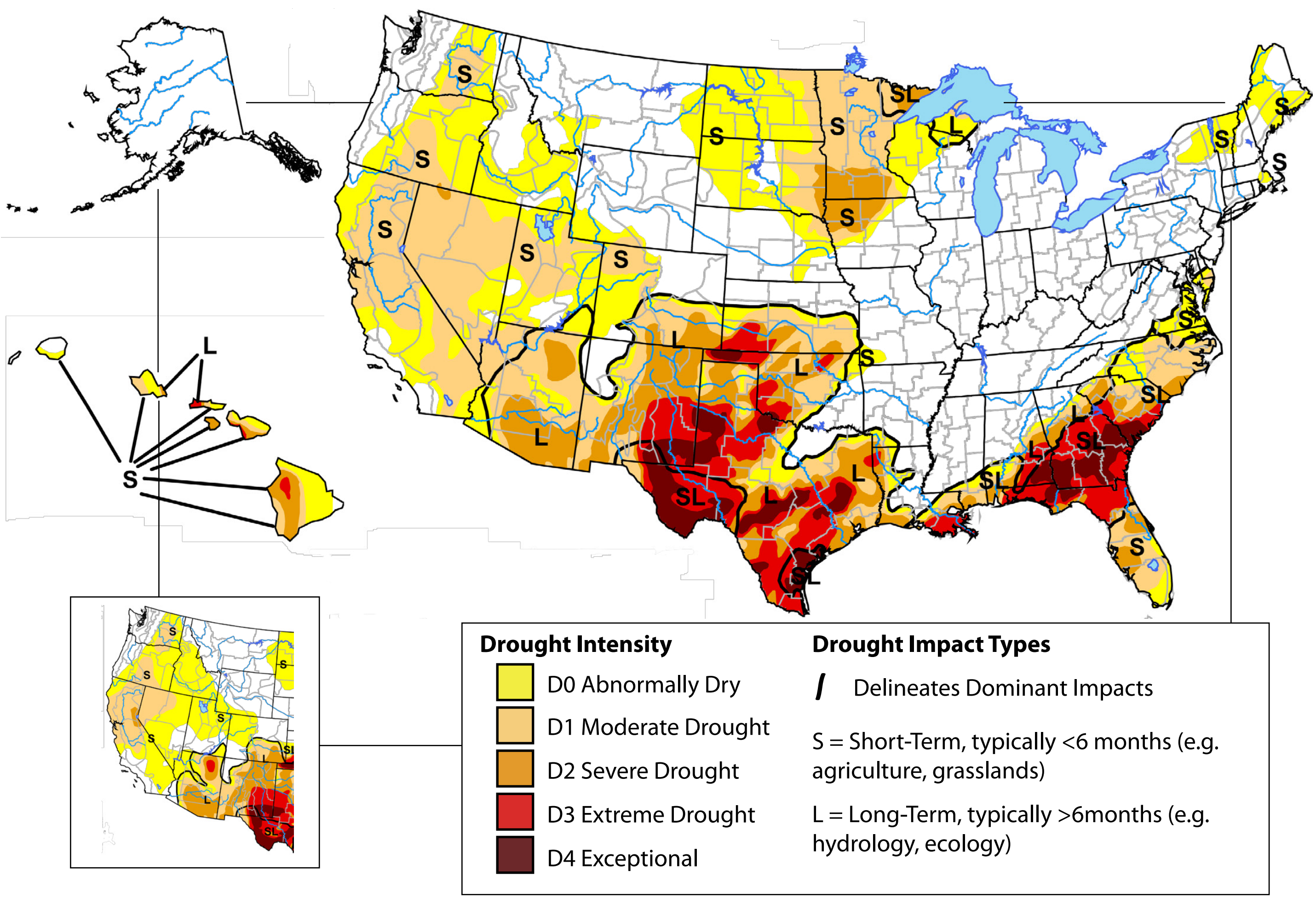
Data Sources: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

A very dry weather pattern settled over most of the western U.S. in January, leading to a continued expansion and intensification of drought conditions, particularly in northwest Arizona, Utah, and Nevada. Both warm temperatures and scant rain and snow played a role. Winter storms generally steered clear of the intermountain West and Southwest, paving the way for unusually dry and warm weather to dominate. Some storms pummeled the Pacific Northwest. Temperatures across much of the West were between 0 and 6 degrees F above average. As a result of the warm and dry weather, moderate or a more severe drought category expanded in the West from 29 percent in mid-January to about 41 percent in mid-February (*Figure 3*). Extreme and exceptional drought only occupies the southeast corner of New Mexico.

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 February 14, 2012 (full size), and January 17, 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 2/14/12)

Data Source: U.S. Drought Monitor

A stretch of unusually dry and warm weather during the past 30 days caused drought conditions to worsen across much of Arizona. Less than 50 percent of average precipitation fell across most of Arizona in the past month, and temperatures in January were 0–6 degrees F warmer than average. As a result, moderate to severe drought conditions increased by about 20 percent from one month ago to cover approximately 81 percent of Arizona, according to the February 14 U.S. Drought Monitor (*Figures 4a–b*). The largest changes in drought conditions occurred over the northwest quarter of the state, which was downgraded to moderate drought from abnormally dry conditions. In this region, many areas have accumulated precipitation deficits of 2–4 inches below average as of February 16. Also, severe drought conditions persisted across southeast Arizona due to both short- and long-term precipitation deficits; drought conditions in this region have been ongoing for more than 18 months. Although few and far between, there have been some drought improvements, most notably in the Four Corners region, where severe drought has replaced extreme drought.

Notes:

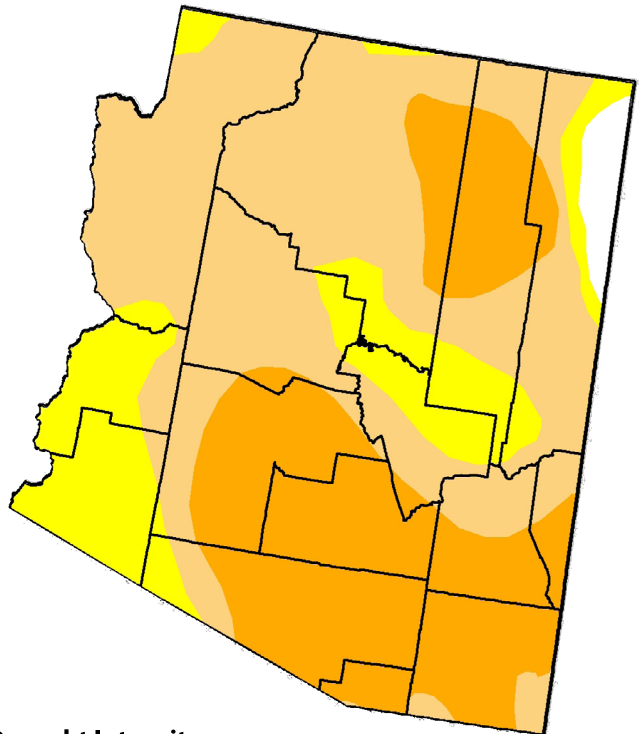
The Arizona section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, 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

Figure 4a. Arizona drought map based on data through February 14.



Drought Intensity

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

Figure 4b. Percent of Arizona designated with drought conditions based on data through Febryary 14.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.98	98.02	80.56	33.32	0.00	0.00
Last Week (02/07/2012 map)	1.39	98.61	81.05	36.56	2.78	0.00
3 Months Ago (11/15/2011 map)	1.53	98.47	72.24	48.80	29.99	1.24
Start of Calendar Year (12/27/2011 map)	16.70	83.30	60.34	36.56	2.78	0.00
Start of Water Year (09/27/2011 map)	0.02	99.98	69.76	42.81	15.34	1.67
One Year Ago (02/08/2011 map)	29.04	70.96	40.88	12.59	0.00	0.00

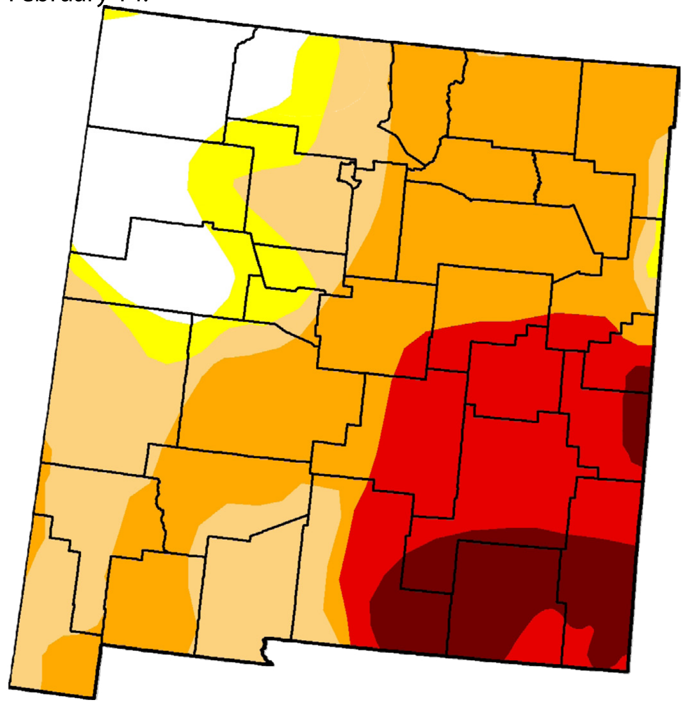
New Mexico Drought Status

(data through 2/14/12)

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

New Mexico experienced few changes in drought conditions during the past 30 days. As of February 16, precipitation was below or near average, which did little to help improve drought conditions that are firmly entrenched across much of the state. More than 90 percent of the state is experiencing some form of drought; severe, extreme, or exceptional drought covers 63 percent of the state, according to the February 14 update of the U.S. Drought Monitor (*Figures 5a–b*). The most severe drought conditions continued to cover the southeast quarter of New Mexico; this is the only region in the entire West with extreme or exceptional drought. Small improvements occurred across the far northwest corner of the state, where several winter storms delivered decent precipitation in the past several months. Several counties in this region are now drought-free.

Figure 5a. New Mexico drought map based on data through February 14.



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 Febryary 14.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.69	88.31	81.50	59.57	24.79	8.13
Last Week (02/07/2012 map)	8.10	91.90	87.63	63.73	24.79	8.13
3 Months Ago (11/15/2011 map)	6.28	93.72	90.69	85.60	63.04	26.11
Start of Calendar Year (12/27/2011 map)	8.63	91.37	87.60	72.15	23.37	7.57
Start of Water Year (09/27/2011 map)	0.00	100.00	96.40	88.99	69.61	35.13
One Year Ago (02/08/2011 map)	8.22	91.78	52.89	22.86	0.00	0.00

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 1/31/12)

Data Source: National Water and Climate Center

Lake Powell declined by 311,000 acre-feet in January, while Lake Mead increased by 125,000 acre-feet. Combined storage in both lakes decreased by 186,000 acre-feet (*Figure 6*). The discrepancy exists because operation of the reservoirs restores storage to Lake Mead according to the 2007 Interim Guidelines on joint operation of the two reservoirs. Despite the decline, combined storage is about 12 percent greater than it was one year ago. Storage in other reservoirs within Arizona's borders increased by more than 19,000 acre-feet in January. Salt River basin reservoirs, which supply water to the Phoenix metropolitan area, are at a healthy 72 percent of capacity, about 14 percent above their historical average.

In water-related news, business interests from Colorado, Utah, Arizona, New Mexico, and Nevada urged the Department of the Interior and legislators to consider strategies to keep the Colorado River flowing when demand outpaces supply (summitdailynews.com, February 4). More than 800,000 jobs in the West rely on the river.

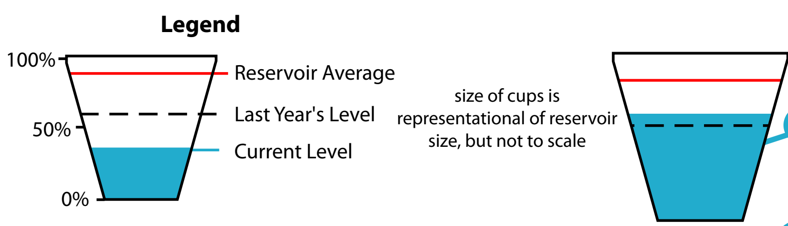
Notes:

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.

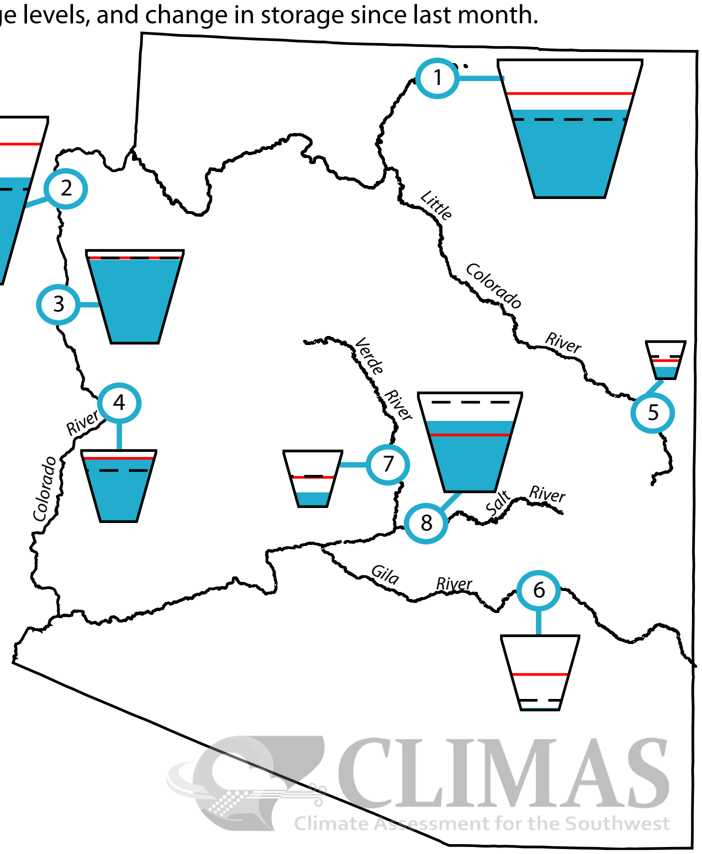
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Figure 6. Arizona reservoir levels for January 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	64%	15,648.0	24,322.0	-311.0
2. Lake Mead	57%	15,022.0	26,159.0	125.0
3. Lake Mohave	90%	1,627.7	1,810.0	-36.6
4. Lake Havasu	89%	553.9	619.0	16.6
5. Lyman Reservoir	32%	9.5	30.0	0.1
6. San Carlos	3%	23.7	875.0	9.5
7. Verde River System	26%	73.4	287.4	-8.7
8. Salt River System	72%	1,453.2	2,025.8	18.3

*** 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 1/31/12)

Data Source: National Water and Climate Center

Total reservoir storage in New Mexico increased by about 26,000 acre-feet in January (*Figure 7*). Storage in Elephant Butte Reservoir increased the most, gaining about 37,500 acre-feet. However, storage there is still low, at just 15 percent of average. The reservoir is about 7 percent lower than it was one year ago and 44 percent lower than average capacity for January.

In water-related news, New Mexico is on target to meet its water delivery obligations to Texas despite low storage in Elephant Butte, according to State Engineer Scott Verhines (The Associated Press, January 30). Also, New Mexico has been awarded funds for a 10-year, $6.75 million forest and watershed restoration project in the Zuni Mountains (The Associated Press, February 7). Projects will reduce wildfire risk and improve watershed conditions across about 56,000 acres.

Notes:

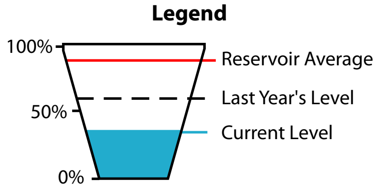
The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total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

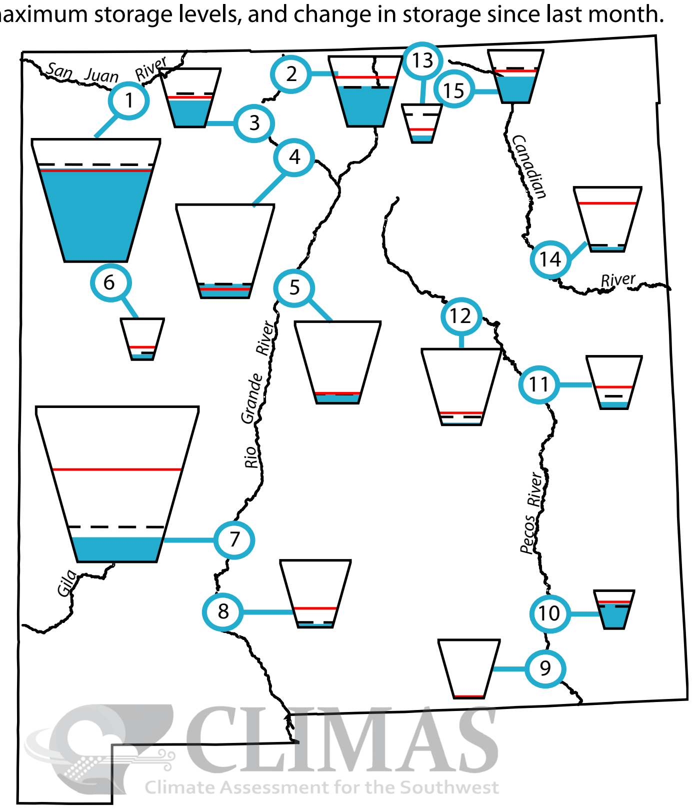
Figure 7. New Mexico reservoir levels for January as a percent of capacity. The map depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.

Legend



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	76%	1295.9	1,696.0	-15.0
2. Heron	57%	226.6	400.0	-0.3
3. El Vado	45%	86.3	190.3	0.1
4. Abiquiu	15%	178.4	1,192.8	-3.2
5. Cochiti	10%	51.2	491.0	0.4
6. Bluewater	12%	4.6	38.5	0.0
7. Elephant Butte	15%	331.9	2,195.0	37.4
8. Caballo	4%	14.8	332.0	1.2
9. Brantley	1%	13.2	1,008.2	2.1
10. Lake Avalon	65%	2.6	4.0	0.3
11. Sumner	12%	12.1	102.0	3.3
12. Santa Rosa	2%	10.2	438.3	0.1
13. Costilla	18%	2.9	16.0	0.3
14. Conchas	6%	15.6	254.2	-1.0
15. Eagle Nest	49%	38.5	79.0	0.4

*** 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

Southwest Snowpack

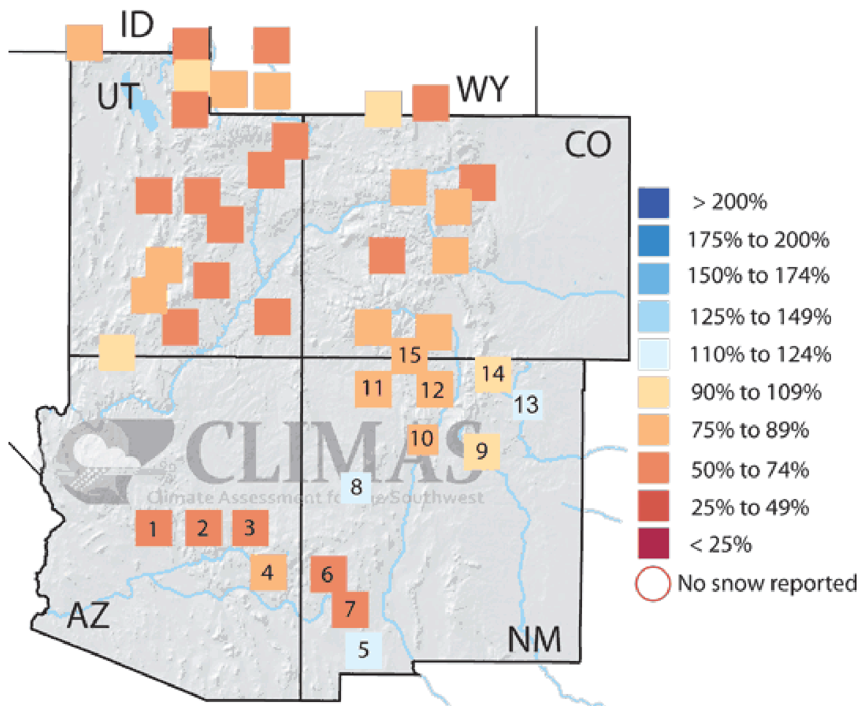
(updated 2/17/12)

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

At least five storms in December dumped copious snow in the higher elevations of Arizona and New Mexico, building above-average snowpacks. Wet conditions were somewhat unexpected given the presence of a La Niña event. However, warm and dry weather prevailed in January, causing substantial declines in the water contained in snowpacks, or snow water equivalent (SWE). Arizona and New Mexico experienced their 9th and 19th warmest January on record, respectively, and precipitation was less than 50 percent of average across most of both states during this month. Similarly dry conditions persisted in the first two weeks of February.

As of February 16, SWE measured by snow telemetry (SNOTEL) stations in Arizona ranged from well below average to slightly below average (*Figure 8*). The Verde River Basin had the lowest SWE, measuring 54 percent of average, while the San Francisco Peaks had the highest at 97 percent of average. As a whole, SWE in Arizona measured 57 percent of average. In New Mexico, five of the 11 basins reported in Figure 8 have above-average SWE. The highest values are in the Mimbres River Basin in the southwest corner of the state, where SWE is 119 percent of average. The San Francisco River Basin, also in the southwest corner of New Mexico, had the lowest SWE, with an average of 73 percent. Since mid-November, most of Colorado, Wyoming, and Utah also have had less than 70 percent of average precipitation, and all but three basins in these states report below-average SWE.

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of February 17, 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

Dry and warm conditions since the end of December likely will continue. The seasonal precipitation and temperature outlooks issued by the NOAA-Climate Prediction Center (CPC) show increased chances for below-average precipitation and above average-temperatures for most of the Southwest (see pages 13 and 14).

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
(March-August 2012)
Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal temperature outlooks issued by the NOAA-Climate Prediction Center (CPC) in February call for increased odds that temperatures for the three-month seasons spanning March to June will be similar to the warmest 10 years in the 1981–2010 period (*Figures 9a–d*). The seasonal temperature outlooks for the March–May period reflect recent late winter trends, which favor above-average temperatures across the southern continental U.S. For this period, there is a 50 percent chance that temperatures will be 0.4–1.0 degrees F above average in the western half of Arizona and southern half of New Mexico. The outlooks also forecast more than a 50 percent chance of above-average temperatures in the summer months, also in part reflecting current warming trends for these seasons.

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 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 March-May 2012.

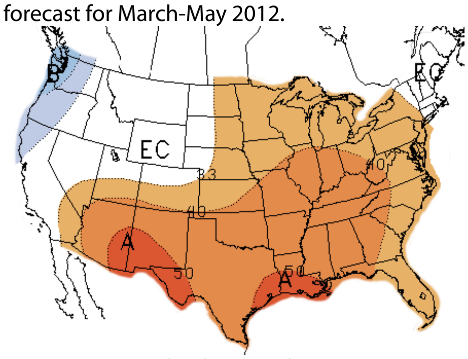


Figure 9b. Long-lead national temperature forecast for April-June 2012.

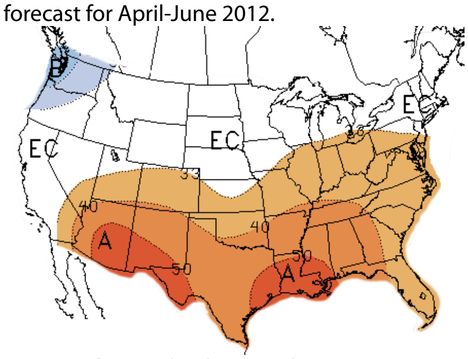


Figure 9c. Long-lead national temperature forecast for May-July 2012.

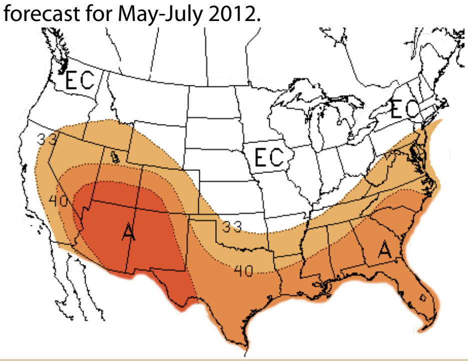
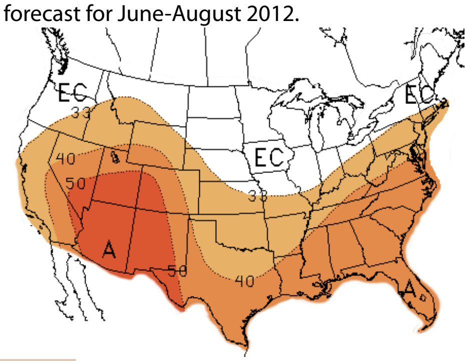
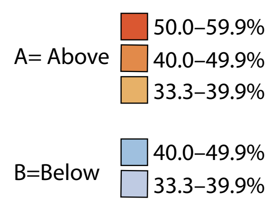


Figure 9d. Long-lead national temperature forecast for June-August 2012.





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
(March-August 2012)

Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal precipitation outlooks issued by the NOAA-Climate Prediction Center (CPC) in February call for increased chances that precipitation will be similar to the driest 10 years of the 1981–2010 period for the March–May and April–June periods in all of Arizona and New Mexico (*Figures 10a–b*). Probabilities for below-average precipitation are highest in March–May. For this period, there is a 50 percent chance that precipitation will be between 0.2 and 0.4 inches below average in nearly all of both states. A primary driver for these forecasts is the La Niña event, which likely will persist into spring but appears to be peaking or have peaked, according to the CPC. La Niña events historically bring dry conditions to the southern tier of the U.S., including Arizona and New Mexico, and wetter-than-average conditions to the Pacific Northwest. Outlooks for May–July and June–August call for equal chances for above-, below-, or near-average conditions in Arizona and most of New Mexico (*Figures 10c–d*).

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 March-May 2012.

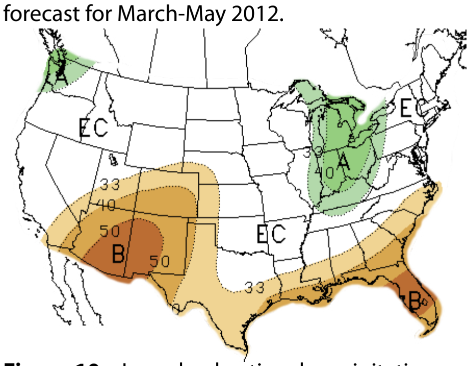
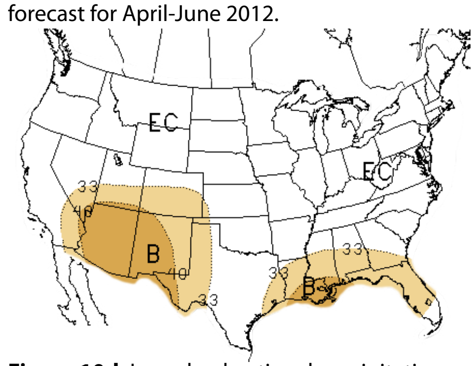


Figure 10b. Long-lead national precipitation forecast for April-June 2012.



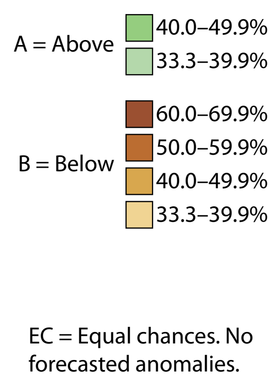


Figure 10c. Long-lead national precipitation forecast for May-July 2012.

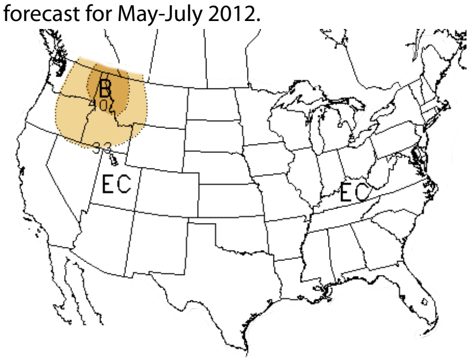
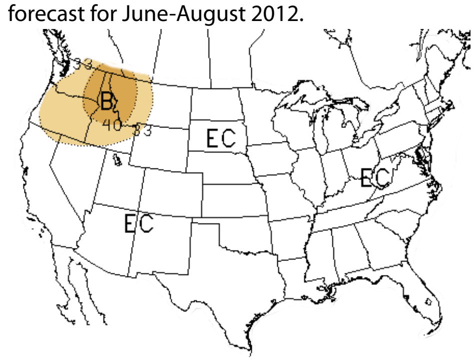


Figure 10d. Long-lead national precipitation forecast for June-August 2012.



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 May)

Data Source: NOAA–Climate Prediction Center (CPC)

This summary is partially excerpted and edited from the February 16 Seasonal Drought Outlook technical discussion produced by the NOAA-Climate Prediction Center (CPC) and written by forecaster A. Artusa.

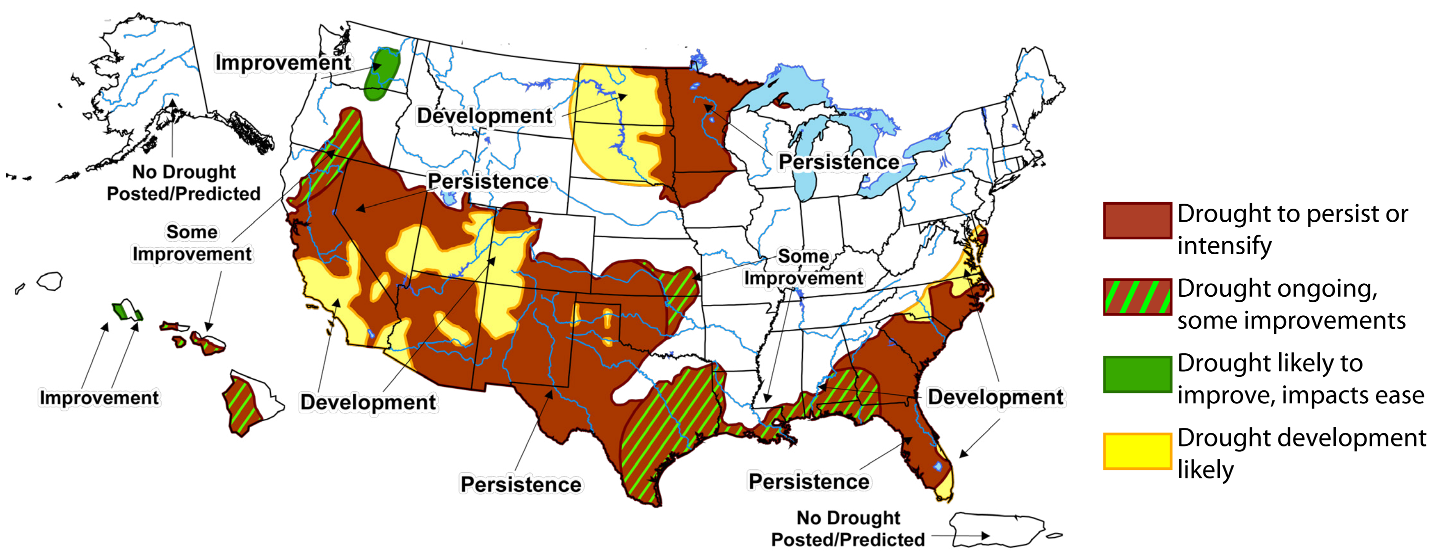
Precipitation since the water year began on October 1 is close to average across the mountains of Arizona and New Mexico; precipitation in the higher elevations of New Mexico has been greater. Totals were boosted by a wet period extending from mid-November into December, when numerous storms wafted south and dropped moderate to heavy snow and above-average precipitation across both states. A dry and warm period followed, and currently the water contained in snowpacks, or snow water equivalent (SWE), ranges from 75 to 125 percent of average in most of New Mexico and generally 50–75 percent of average across the Mogollon Rim of central Arizona. Looking ahead, forecasts on all time scales favor below-median precipitation for the Southwest, which is typical for a La Niña winter. In addition, there are increased odds for above-average temperatures in March–May. As a result, drought is forecast to persist, intensify, or develop across the Southwest, including many parts of the Upper Colorado River and Rio Grande basins (*Figure 11*). The CPC assigns a moderate to high confidence in this forecast.

Elsewhere in the West, drought is forecast to persist or intensify across most of California and Nevada, with development likely occurring in parts of those two states and Utah that are currently drought-free. The drought development is based on historic La Niña conditions and the CPC monthly and seasonal precipitation outlooks that indicate increased chances for below-median precipitation.

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 May (released February 16).



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

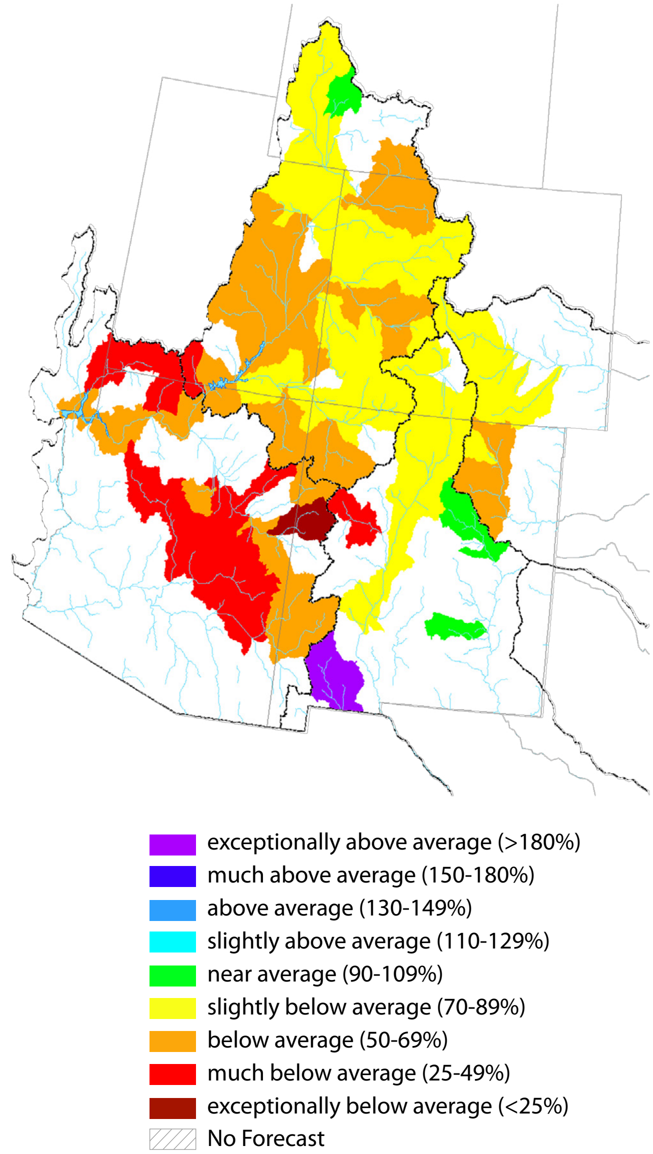
The spring–summer streamflow forecast for the Southwest, issued on February 1, shows a 50 percent chance that all basins in the upper and lower Colorado River and Arkansas basin swill be below average (*Figure 12*). Only a few basins in the Rio Grande are expected to have above-average flows.

In Arizona, the likelihood that the Salt, Verde, and Gila rivers will have streamflows of 37, 40, and 49 percent of the February–May average, respectively, is 50 percent.

Although widespread and copious rain and snow soaked many mountain regions in November and December, dry and warm conditions have since largely prevailed. These conditions are expected to continue, mostly because the La Niña event is expected to persist into spring. The La Niña also is influencing forecasts in New Mexico. There is a 50 percent chance that the March–July flow in the Rio Grande, measured at Otowi Bridge, and the Gila River, measured near Virden, will be 79 and 52 percent of average, respectively. On the other hand, near-average flows are expected in the Pecos River and above-average flows are forecast for the Mimbres River, largely because early winter snows dumped copious precipitation in these regions. Streamflow forecasts are issued every month for New Mexico and every two weeks for Arizona. The forecasts become progressively more accurate as the winter progresses.

In the Upper Colorado River Basin, spring inflow to Lake Powell is forecast to be about 64 percent of the 1971–2000 average for April–July, or about 3.2 million acre-feet. The forecast also indicates only 10 percent chance that Lake Powell inflow will be 108 percent of average. Last winter's exceptionally high streamflows, which increased combined storage in Lakes Mead and Powell by about 7 million acre-feet between April and July—about 2 million acre-feet more than average—will buffer below-average flows in the Colorado River this year.

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



Notes:

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

The NRCS provides a range of forecasts expressed in terms of percent of average streamflow for various exceedance levels. The 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. The CBRFC provides a range of streamflow forecasts in the Colorado Basin ranging from short fused flood forecasts to longer range water supply forecasts. The water supply forecasts are coordinated monthly with NWCC.

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/wsf/westwide.html
http://www.cbrfc.noaa.gov

El Niño Status and Forecast

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

The La Niña event is expected to continue for the next several months, according to the NOAA-Climate Prediction Center (CPC). Sea surface temperatures (SSTs) in the equatorial eastern Pacific Ocean in the last month were close to -1 degree Celsius below average, indicating a weak to moderate event. Above-average, near-surface easterly winds also persisted over the central and west-central Pacific, causing the Southern Oscillation Index (SOI), which measures the atmospheric circulation in the tropical Pacific Ocean, to remain positive (*Figure 13a*). Positive SOI values are also indicative of a La Niña event, but the event appears to be waning. Observations of warming SSTs in the far eastern Pacific Ocean and increasing subsurface water temperatures both suggest La Niña may be peaking or may have peaked. In addition, this is the time of year when ENSO events historically begin to lose strength.

The official forecast issued by the CPC and the International Research Institute for Climate and Society (IRI) indicates a 74 percent chance that La Niña will continue during the February–April period (*Figure 13b*). However, based on both statistical and dynamical forecast models, chances precipitously drop for the continuation of La Niña into the March–May period and beyond. The impacts of the La Niña event, including drier-than-average conditions in parts of the southern U.S., likely will continue through the remainder of the winter and into the spring—despite a weakening event—because changes in atmospheric circulation lag behind changes in SSTs. This is reflected in the recent seasonal forecasts that call for below-average precipitation for both Arizona and New Mexico through the upcoming spring.

Notes:

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

Figure 13a. The standardized values of the Southern Oscillation Index from January 1980–January 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).

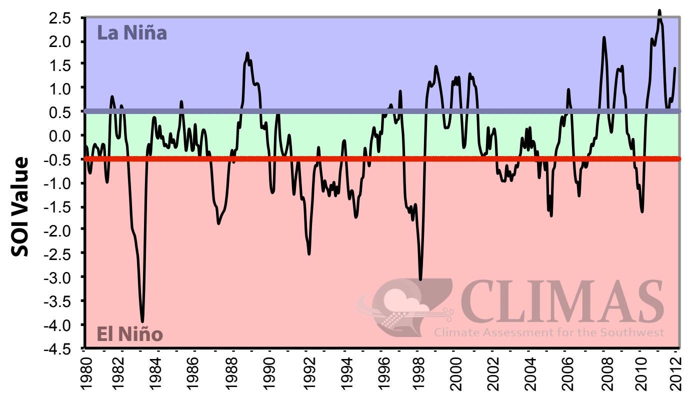


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released February 16). Colored lines represent average historical probability of El Niño, La Niña, and neutral conditions.