February 24, 2010

Southwest Climate Outlook

Vol. 9 Issue 2

Source: Zack Guido, CLIMAS. January 24, 2010.

Photo Description: Snow has repeatedly draped the higher elevations in Pima Canyon in the Santa Catalina Mountains outside Tucson this winter. Many parts of the Southwest have received above-average snowfall this winter.

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: macaulay@email.arizona.edu

In this issue...

CLIMAS Climate Assessment for the Southwest

Arizona Cooperative Extension, The University of Arizona • College of Agriculture and Life Sciences

Arizona

NM State University

February Climate Summary

Drought– Nearly all of Arizona experienced improvement in drought conditions; only about 15 percent of the state is currently suffering severe drought or worse. New Mexico also experienced significant improvements and is mostly drought free or abnormally dry.

Temperature– Much of the Southwest experienced colder-than-average temperatures in the last month.

Precipitation– Extremely wet winter storms blanketed the Southwest during the last month, with most of Arizona and New Mexico exceeding 200 percent of average precipitation.

ENSO– Moderate El Niño conditions persisted across the equatorial Pacific Ocean again this month and are expected to continue over the next several months. ENSO-neutral conditions are forecast to return later this spring.

Climate Forecasts– Temperature outlooks suggest elevated chances of warmer-than-average conditions for the foresummer and summer. The March–April precipitation outlooks suggest elevated chances for wet conditions, reflecting the expectation that El Niño will persist and deliver more rain and snow to the region.

The Bottom Line– In late January, the Pacific jet stream clipped moisture from the tropical Pacific Ocean and delivered it to the Southwest. This classic El Niño pattern brought heavy rain and snow to both states. As a result, widespread drought improvement has been noted and spring streamflow forecasts are above average for many river basins. However, precipitation in the Colorado Rocky Mountains has been mostly below average, causing spring streamflow projections for the Colorado River to also be below average. More wet weather may be on the way, as forecasts suggest El Niño conditions will persist into the spring.

Warmest decade on record: 2000–2009

The average global temperature for 2009 tied with five other years for the second warmest year on record, according to global surface air temperature summaries released by NASA's Goddard Institute for Space Studies (GISS) on January 21. The warmest 10 years all have occurred since 1998. Only 2005 experienced a warmer global temperature since record keeping began in 1880. The 2000–2009 period was also the warmest decade on record.

The 2009 GISS temperature analysis shows that the surface air temperatures in all of Arizona and New Mexico were between 1 and 2 degrees Celsius, or about 2 to 3.5 degrees Fahrenheit, above average. Substantial year-to-year variability of global temperature is in part caused by sea surface temperature oscillations in the tropical Pacific Ocean that are characteristic of El Niño and La Niña events. In 2009, La Niña transitioned into El Niño, which became established by October. This El Niño event, which tends to elevate global temperatures, is expected to continue into at least the summer months. While year-to-year variability is a steadfast characteristic of the temperature record, the trend in the last 30 years has been warmer to the tune of about 1 degree F; temperatures have increased 1.5 degrees F since 1880.

For more info: http://data.giss.nasa.gov/

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Stephanie Doster, *Institute of the Environment Associate Editor*
Dan Ferguson, *CLIMAS Program Manager*
Gregg Garfin, *Institute of the Environment Deputy Director of Outreach*
Zack Guido, *CLIMAS Associate Staff Scientist*
Rebecca Macaulay, *Graphic Artist*
Nancy J. Selover, *Arizona State Climatologist*

This work is published by the Climate Assessment for the Southwest (CLIMAS) project and the University of Arizona Cooperative Extension; and is funded by CLIMAS, Institute of the Environment, and the Technology and Research Initiative Fund of the University of Arizona Water Sustainability Program through the SAHRA NSF Science and Technology Center at the University of Arizona.

Warmer means drier: comparing the 2000s drought to the 1950s drought

By Zack Guido

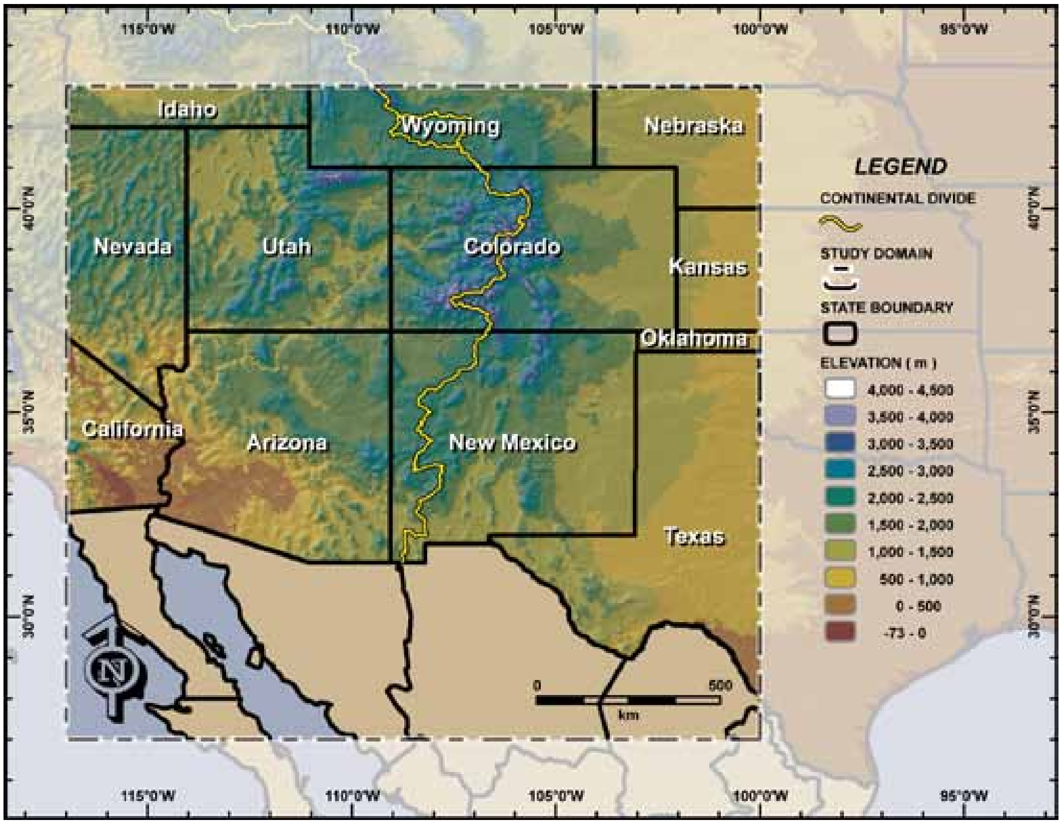


Figure 1. Area of study includes all of Arizona and New Mexico. Figure courtesy of Jeremy Weiss.

Jeremy Weiss wears many hats as a senior research specialist for the Environmental Studies Laboratory in the Department of Geosciences at the University of Arizona. His interests include studying past and present vegetation in western North America, worldwide changes in sea level, and visual methods for communicating science. His research, however, has one thing in common: it focuses on climate.

His latest research, with Christopher Castro, assistant professor of atmospheric sciences at the UA, and Jonathan Overpeck, a UA geosciences professor and lead principal investigator for the Climate Assessment for the Southwest (CLIMAS), dissected a hot topic in the Southwest—drought. Weiss and his team examined how recent drought has compared to past drought, the implications of warmer temperatures on drought severity, and how the combination of warmer temperatures and drought are mostly bad news for wildfire, air quality, and water demand.

In a February interview with Zack Guido, CLIMAS staff scientist, Weiss discussed his research results. His findings were published in the November 15 issue of the *Journal of Climate* in the paper, "Distinguishing Pronounced Droughts in the Southwestern United States: Seasonality and Effects of Warmer Temperatures."

Question: How does the title of your recent paper reflect the research?

Jeremy Weiss: The general topic of our article is drought in the Southwest. Drought is a normal part of the region's climate. We know this by looking at the last century of instrumental data, and we can identify drought periods using tree rings and other indicators stretching back hundreds of years. In this paper, we picked the two most recent droughts—the 1950s drought, which has been regarded as the most severe drought of the last 100 years, and the drought that we've experienced over the past decade.

The particular findings that came to the forefront during the research were the differences in temperatures between the droughts and the times of the year when these differences occurred. Quite convincingly, the 2000s drought was significantly warmer than the 1950s drought. Unfortunately for residents of the Southwest, these higher temperatures occurred during the warmer months of the year and were especially prevalent during the foresummer. This period right before the monsoon is exactly the time of year when you would not want hotter and drier conditions during a drought.

Q: What questions did you initially set out to answer?

JW: We wanted to detail how the most recent drought compared to the 1950s drought, get a better understanding of the relative severities of each, and look at what seasonal differences might have occurred. For example, we wanted to know which drought had less precipitation during the winter months and which had less precipitation during the summer months.

Q: What periods in the 2000s and 1950s did you compare?

JW: For the sake of being able to compare to other published studies, we looked at the four-year periods of 2000–2003 and 1953–1956. These years also arguably

continued on page 4

Warmer means drier, continued

represent when the most severe conditions occurred during each of the droughts.

Q: How did you analyze drought conditions?
JW: We looked at seasonal precipitation amounts, maximum and minimum temperatures, dew point temperatures, and vapor pressure deficits throughout the Southwest. The last two measures both can be thought of as an indication of moisture conditions in the atmosphere. The latter can be thought of as the atmosphere's ability to act like a sponge and take up moisture from soil and vegetation. In this study we strictly compared the state of the atmosphere near the Earth's surface, and not ground conditions such as reservoir levels or vegetation health.

Q: What is new and exciting about the results of this study?
JW: Hands down, the 2000s drought was significantly warmer than the 1950s drought, in particular maximum temperatures during the summer months and minimum temperatures from spring through early fall. These warmer conditions were widespread throughout the Four Corners region of the Southwest (Figure 1). If you were to draw a line basically straight down through the middle of Colorado and New Mexico, everything west of that line was 1–4 degrees Celsius (about 2–7 degrees Fahrenheit) warmer during the 2000s drought.

Warmer temperatures are important because temperature is a hydrologic variable. If you think of the atmosphere as a sponge, warmer temperatures allow that sponge to become larger, which means more moisture then can be taken up from soils, vegetation, and reservoirs. So, if you want a season to be drier, a good way to do that simply would be to make it warmer. And that is essentially what happened during the summers of the 2000s drought.

Q: How was precipitation different between the two droughts?
JW: There were differences between the two droughts, but it wasn't all drier or all wetter in one drought or the other. The differences were mixed, and here is where seasonality comes into play. The 2000s drought had less precipitation in early winter and from late spring through early summer in northern Arizona and nearby areas of neighboring states. The 1950s drought was significantly drier in Arizona and western New Mexico during fall and over most of New Mexico in early winter. Now, we didn't pinpoint the exact causes of the precipitation differences. But knowing at what time of year these differences occurred and being familiar with seasonal precipitation sources, one can begin to figure out such causes. For example, in the 2000s drought, it is possible that westerly frontal systems in late spring or the start of the monsoon in early summer didn't give us as much precipitation as during the 1950s drought. And in the 1950s drought, it is possible that the end of the monsoon or tropical cyclones from the Pacific Ocean in early fall didn't give us as much precipitation as during the 2000s drought.

Q: Why is temperature an important component of drought?
JW: Temperature can control the amount of moisture that the atmosphere can hold—that is, the size of the sponge that can take up moisture from soils and vegetation. As the atmosphere becomes warmer, the size of the sponge grows, and the atmosphere can take up more moisture. Now, there is an interesting twist to this relationship between temperature and the ability of the atmosphere to pull moisture from the surface. The size of the sponge grows faster when warming occurs during our summer than during the other cooler seasons. So, the relatively higher temperatures at the hottest time of the year during the 2000s drought made the sponge grow a lot and take up a lot of moisture from soil and vegetation.

Q: What are the impacts in the Southwest of warmer temperatures during droughts?
JW: We do not want a hotter and drier foresummer during drought. These conditions increase water demand. For example, I know that I used more water in recent years to keep the trees in my yard healthy. Air quality can suffer because hotter and drier conditions can lead to more dust in the air. Wildfire danger increases because hotter and drier conditions are better at drying out vegetation. And, what's worse, if you add a dry monsoon to the end of a hotter and drier foresummer, the wildfire season can continue further into the summer.

Q: Will warmer and therefore drier droughts in the Southwest be common in the future?
JW: First, drought is a normal part of our climate, and I have no reason to think that it will not occur in the future. The only question is when drought will occur. Second, I would bet on temperatures continuing to warm in the region, primarily due to human-caused climate change. So, I expect that any drought in the future would be warmer, and that the ability of the atmosphere to take up moisture from the surface – the size of the sponge – would be greater.

Q: What is the take-home message of your research?
JW: I'd like to think that we are helping people understand what a few degrees of warming means for the Southwest, in particular during drought. Given that the societal impacts of drought under warmer temperatures are mostly bad, and that the typically hottest and driest time of the year is hotter and drier, I haven't particularly enjoyed the 2000s drought, and I certainly would not look forward to the next one.

Temperature (through 2/17/10)

Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 generally have averaged between 45 and 65 degrees Fahrenheit across the deserts of southern Arizona, 45 to 50 degrees in southern New Mexico, and 35 to 45 degrees on the Colorado Plateau in Arizona and central and northern New Mexico (Figure 1a). In the higher elevations of both states, temperatures have been between 25 to 35 degrees F. These temperatures have been 0–2 degrees colder than average across the Colorado Plateau of northern Arizona and the southern half of New Mexico (Figure 1b). The higher elevations of New Mexico have been 1–4 degrees cooler than average, while the southern deserts of Arizona have been 0–2 degrees warmer than average.

Cold temperatures have come to the region in the past 30 days (Figures 1c–d). In New Mexico, temperatures have been 0–10 degrees F below average, with the coldest temperatures in the northeast. Much of Arizona has seen 0–4 degrees below-average temperatures over the past month, while a few isolated spots in Arizona have been 0–2 degrees warmer than average. The colder temperatures are due to the most recent winter storms that moved through the Southwest in late January and early February.

Figure 1a. Water year '09–'10 (through February 17) average temperature.

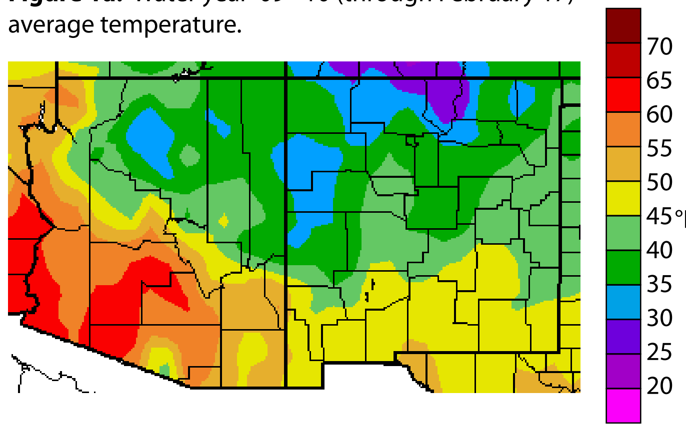


Figure 1b. Water year '09–'10 (through February 17) departure from average temperature.

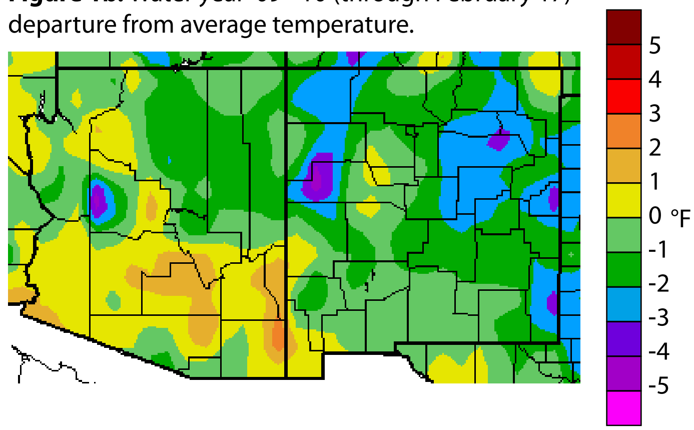


Figure 1c. Previous 30 days (January 19–February 17) departure from average temperature (interpolated).

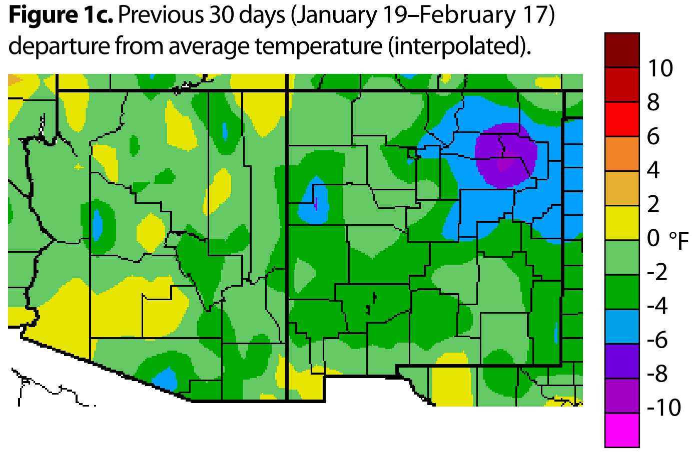
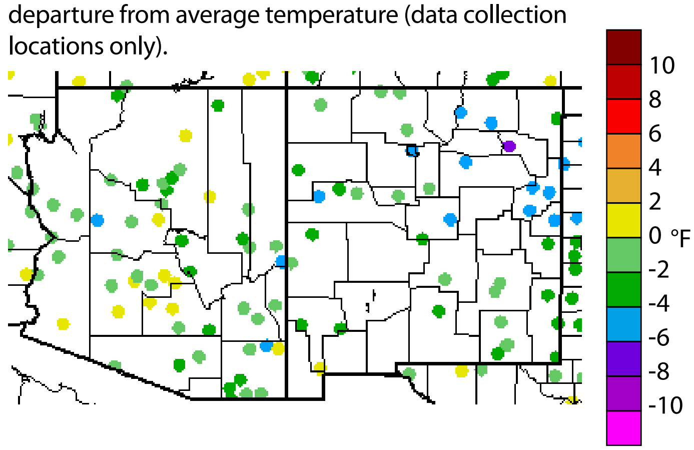


Figure 1d. Previous 30 days (January 19–February 17) departure from average temperature (data collection locations only).



Notes:

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

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

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

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

On the Web:

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

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

Precipitation (through 2/17/10)

Source: High Plains Regional Climate Center

A series of strong winter storms in December and January have alleviated the dry conditions that marked eastern New Mexico and western and central Arizona during the first two months of the water year, which began on October 1 by (Figures 2a–b). The October through mid-January precipitation was not uniformly distributed across the two states. Regions in eastern and southern Arizona and central New Mexico are still below 90 percent of average precipitation, while southeastern and northern New Mexico and western Arizona have received 150 to 300 percent of average precipitation.

During the past 30 days, almost all areas of both states received 200 to 1,000 percent of average precipitation (Figures 2c–d). Only a small area in east-central Arizona, on the Colorado Plateau, had below-average precipitation. The majority of the precipitation that drenched the Southwest fell in a series of storms between January 19 and 22. The El Niño circulation that brought the winter storms in December strengthened in January, merging very cold arctic air with very warm subtropical moisture, and dumped heavy wet snow across northern Arizona and New Mexico and high elevations across the south. The January storms set record precipitation totals for both single day and multi-day accumulations in many watersheds. This wet pattern has weakened slightly but is forecast to continue through April.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2009, we are in the 2010 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 '09–'10 (through February 17) percent of average precipitation (interpolated).

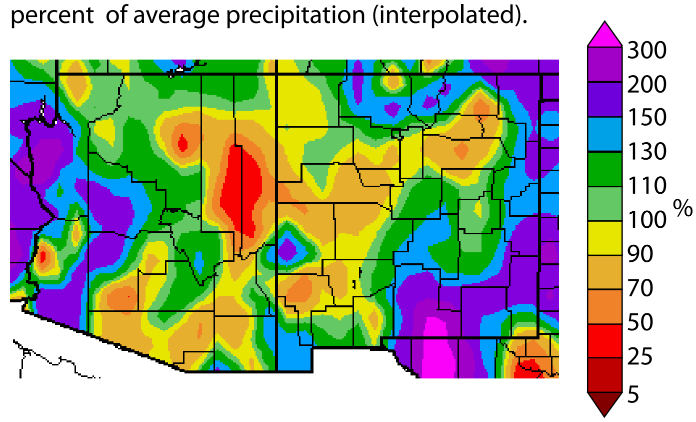


Figure 2b. Water year '09–'10 (through February 17) percent of average precipitation (data collection locations only).

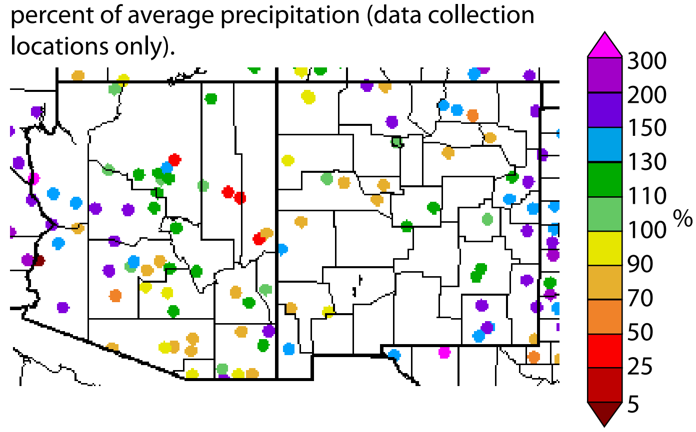


Figure 2c. Previous 30 days (January 19–February 17) percent of average precipitation (interpolated).

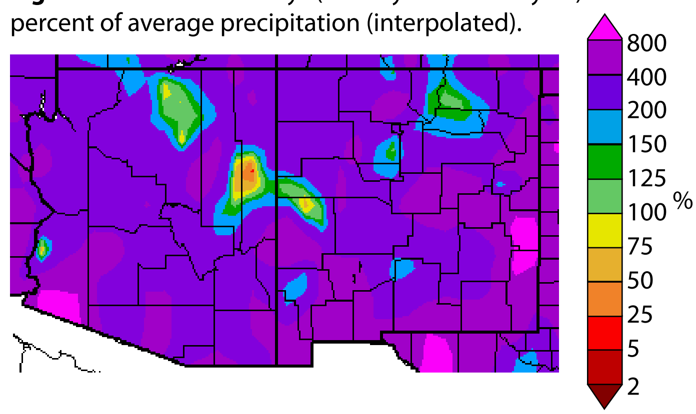
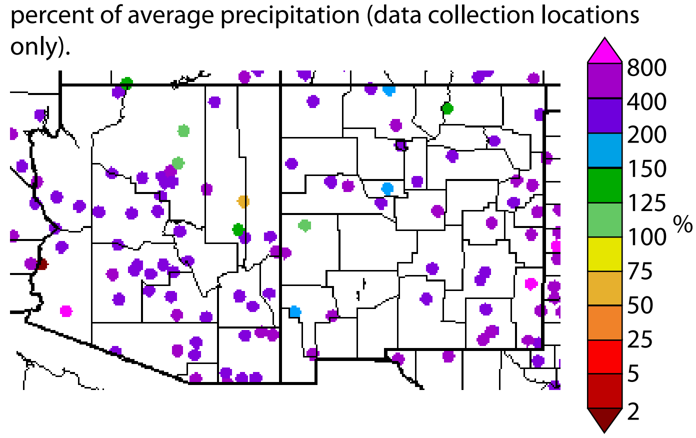


Figure 2d. Previous 30 days (January 19–February 17) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(data through 2/16/10)

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

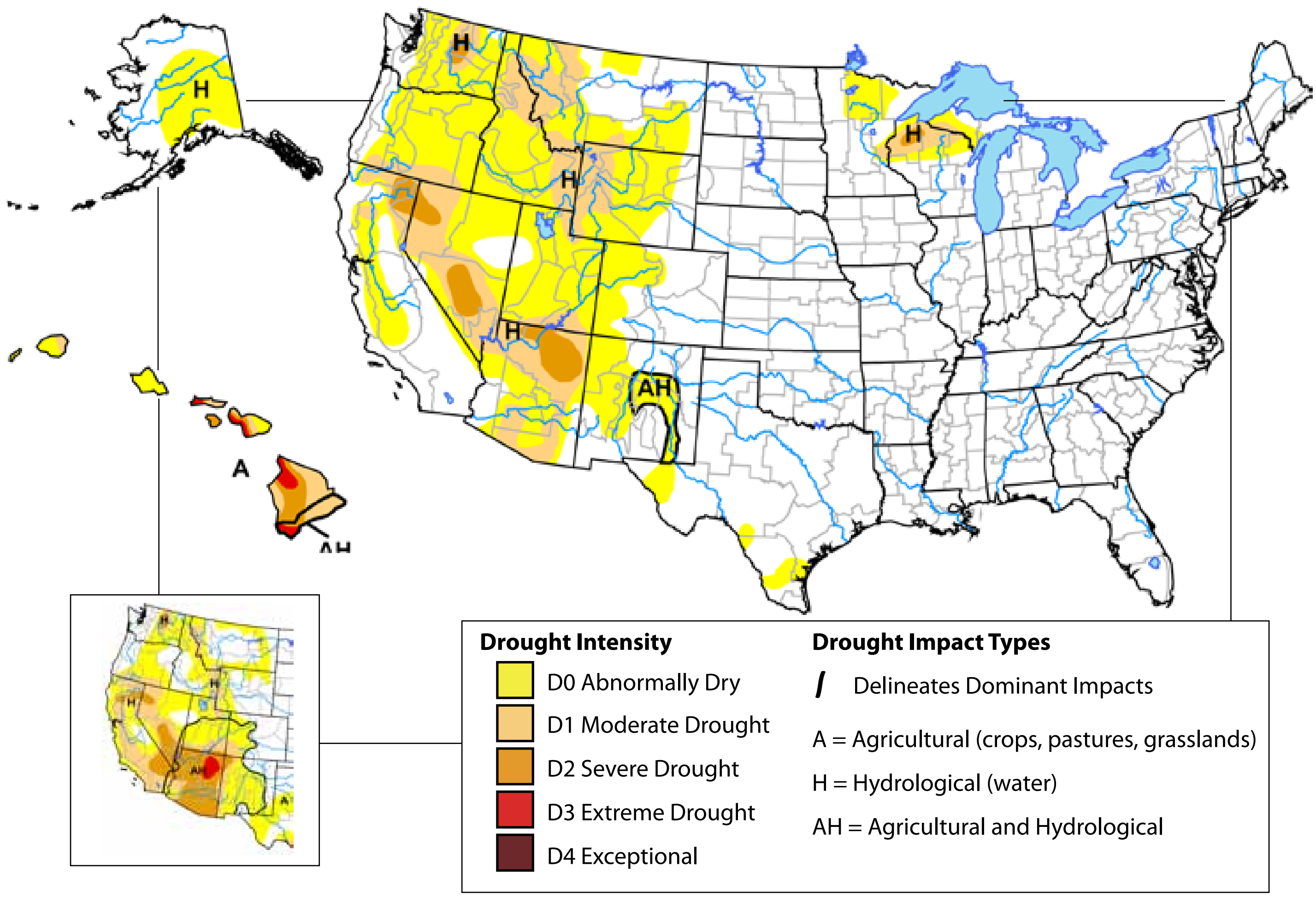
Winter storms brought precipitation and drought relief to much of the western U.S. this past month (Figure 3). Drought conditions improved dramatically across much of California and Arizona as several El Niño-fueled winter storms dumped record precipitation across the region. El Niño events tend to deflect the Pacific jet stream south, directing storms into the southern tier of the U.S. While a southerly storm track drenched Arizona and New Mexico this past month, it has brought dry conditions to the northern Rockies and has caused an expansion of abnormally dry conditions across much of Idaho, Wyoming, and Montana. The extent of area impacted by drought across the western U.S. remained nearly the same as last month, at around 66 percent, but the area impacted by moderate to extreme drought fell from 32 percent on January 19 to 21 percent on February 16. Only about 7.5 percent of the country has moderate drought conditions or worse, which is the lowest level since 1999 (*USA Today*, February 16).

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; the author of this monitor is Brian Fuchs, National Drought Mitigation Center.

Figure 3. Drought Monitor data through February 16 (full size), and January 19 (inset, lower left).



On the Web:

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

Arizona Drought Status

(data through 2/16/10)

Source: U.S. Drought Monitor

Exceptionally wet weather this past month has improved short-term drought conditions across Arizona. The recent National Drought Monitor map shows a dramatic shift from one month ago (Figure 4a). Currently 84.7 percent of the state has abnormally dry conditions or worse, and about 53 percent of the state has moderate drought or worse (Figure 4b). One month ago, the entire state had some drought classification, and moderate drought conditions or worse extended across nearly 78 percent of the state. Southeast and southwest Arizona observed the greatest improvements, moving from moderate and severe drought to a drought-free classification. Much of central Arizona improved from severe drought to abnormally dry conditions, and northwestern Arizona moved from extreme to severe drought. Additional wet weather this winter will help further improvements later this spring.

Drought impacts from exceptionally dry conditions last summer and fall continue to be observed across Arizona. Several reports detailing lingering drought impacts were submitted to Arizona DroughtWatch this past month (http://azdroughtwatch.org). For example, ranchers and natural resource managers in southeast Arizona report that low forage levels and vegetation impacts will continue until the next growing season later this spring. Recent rain has filled dry stock tanks and spurred on increased flows in springs but won't completely ameliorate impacts that emerged last summer. Also, soil moisture will need to hang on through the spring to help rangeland vegetation recover. The summer monsoon rains will also need to show up on time and in earnest to help mend the drought damage.

Notes:

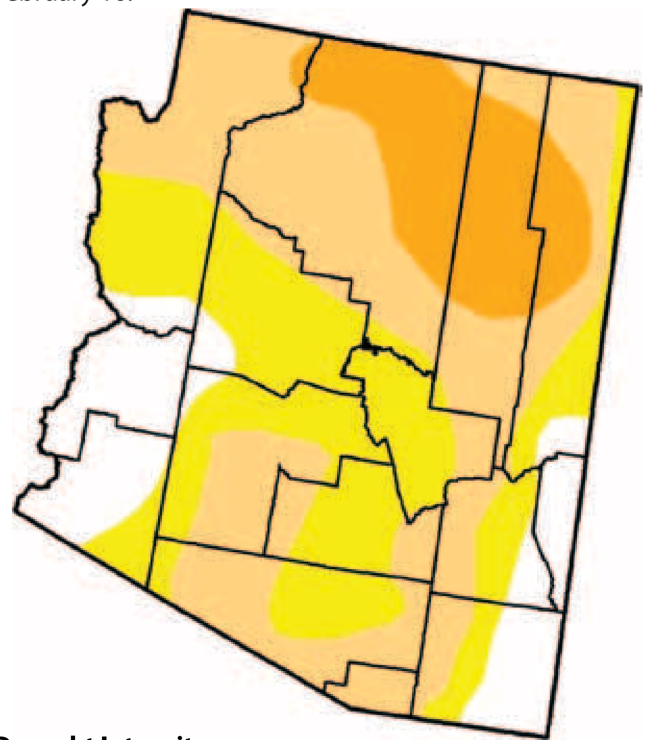
The Arizona section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, 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 16.



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 February 16.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	15.3	84.7	53.4	14.5	0.0	0.0
Last Week (02/09/2010 map)	15.2	84.8	53.4	14.5	0.0	0.0
3 Months Ago (11/24/2009 map)	0.0	100.0	97.2	75.6	5.4	0.0
Start of Calendar Year (01/05/2010 map)	0.0	100.0	97.2	71.1	5.1	0.0
Start of Water Year (10/06/2009 map)	1.4	98.6	80.3	10.7	0.0	0.0
One Year Ago (02/17/2009 map)	79.0	21.0	0.0	0.0	0.0	0.0

New Mexico Drought Status

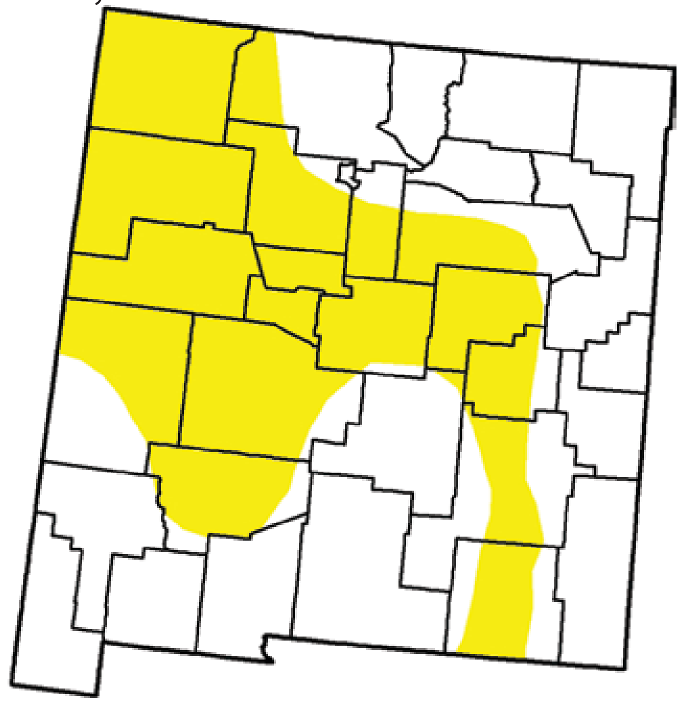
(data through 2/16/10)

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

A parade of winter storms in the past month improved drought conditions across New Mexico (Figures 4a–b). The February 16 update of the National Drought Monitor showed that much of the state was drought free except for abnormally dry conditions in parts of central and northwestern New Mexico. This is an improvement from last month, when all of the counties bordering Arizona were classified with moderate drought conditions or worse, including severe drought conditions in San Juan and McKinley counties. The New Mexico Drought Monitoring Working Group reported that record or near-record precipitation in southwestern regions of the state such as Catron and Grant counties has improved drought conditions in the regions from moderate drought conditions to abnormally dry conditions.

In drought-related news, recent dry conditions have added to an expansion of bark beetles that are ravaging pine forest across the Southwest U.S., and researchers from Arizona and New Mexico are partnering on a unique approach to control beetle infestation (*Seattle Post-Intelligencer*, February 14). A composer from the Art and Science Laboratory in Santa Fe, who has been recording the sounds of bark beetles, is working with forest ecologists at Northern Arizona University in Flagstaff, Ariz., to experiment on ways sound can disrupt their behavior.

Figure 5a. New Mexico drought map based on data through February 16.



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 February 16.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	57.3	42.7	0.0	0.0	0.0	0.0
Last Week (02/09/2010 map)	57.3	42.7	0.0	0.0	0.0	0.0
3 Months Ago (11/24/2009 map)	56.9	43.1	10.0	3.1	0.0	0.0
Start of Calendar Year (01/05/2010 map)	56.9	43.1	10.1	2.3	0.0	0.0
Start of Water Year (10/06/2009 map)	72.2	27.8	3.4	0.0	0.0	0.0
One Year Ago (02/17/2009 map)	49.6	50.4	1.5	0.0	0.0	0.0

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 1/31/10)

Source: NRCS, National Water and Climate Center

Water storage in Lake Powell declined by 417,000 acre-feet in January and currently stands at 58 percent of capacity (Figure 6). Observed unregulated inflow into Lake Powell in December was 75 percent of the 30-year average, according to the U.S. Bureau of Reclamation. Lake Mead, on the other hand, gained 324,000 acre-feet in January. Combined storage in the Salt and Verde river basin systems increased by 475,700 acre-feet in January and remains well above average. Storage in the San Carlos reservoir also increased substantially during January.

In water-related news, the communities of Prescott and Prescott Valley have signed an "agreement in principle" with the Salt River Project, which calls for the two sides to work together to negotiate, draft, and complete a list of comprehensive agreements (*Verde Independent*, February 16). The three parties and others have argued for 12 years over plans to withdraw groundwater from the Big Chino aquifer and transport it to Prescott's over-drafted basin.

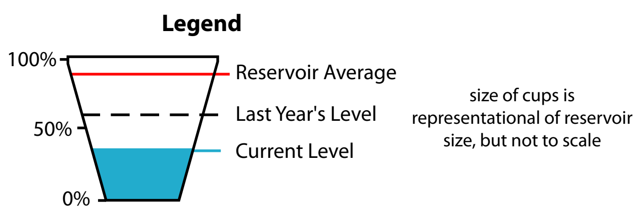
Notes:

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

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

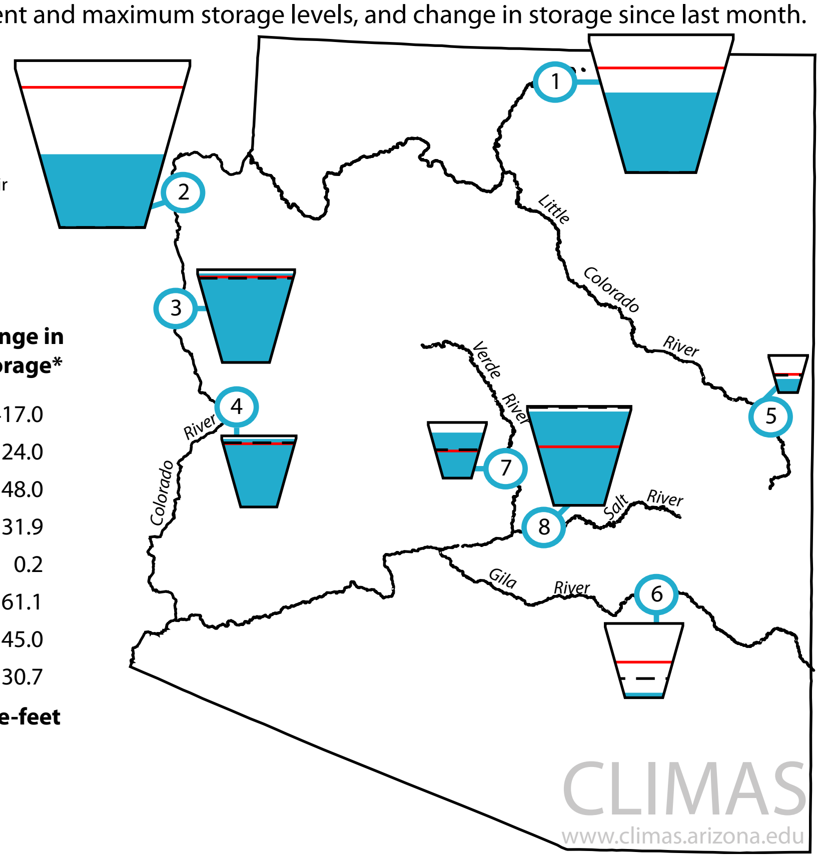
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Dino DeSimone, Dino.DeSimone@az.usda.gov.

Figure 6. Arizona reservoir levels for January 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	58%	14003.0	24,322.0	-417.0
2. Lake Mead	44%	11493.0	26,159.0	324.0
3. Lake Mohave	96%	1735.6	1,810.0	148.0
4. Lake Havasu	96%	597.3	619.0	31.9
5. Lyman Reservoir	37%	11.0	30.0	0.2
6. San Carlos	7%	63.5	875.0	61.1
7. Verde River System	82%	236.9	287.4	145.0
8. Salt River System	95%	1925.5	2,025.8	330.7

*** 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 1/31/10)

Source: NRCS, National Water and Climate Center

The total reservoir storage in New Mexico increased by about 25,800 acre-feet in January (Figure 7). Elephant Butte gained 41,800 acre-feet, while the largest storage decreases were in the Navajo and El Vado reservoirs, which combined for a loss of about 23,500 acre-feet.

In water-related news, The U.S. Bureau of Reclamation and New Mexico State University signed a $5 million cooperative agreement to conduct water treatment research, with a special emphasis on treating brackish groundwater (*Alamagordo Daily News*, February 18).

Also, the New Mexico Legislature has passed a bill to create the Eastern New Mexico Water Utility Authority, which will provide the structure for distributing water from the Ute Reservoir (qcsunonline.com, February 16). The project helps address problems related to the depletion of the Ogallala aquifer.

Notes:

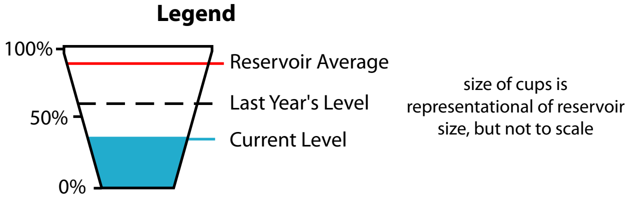
The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total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

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

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

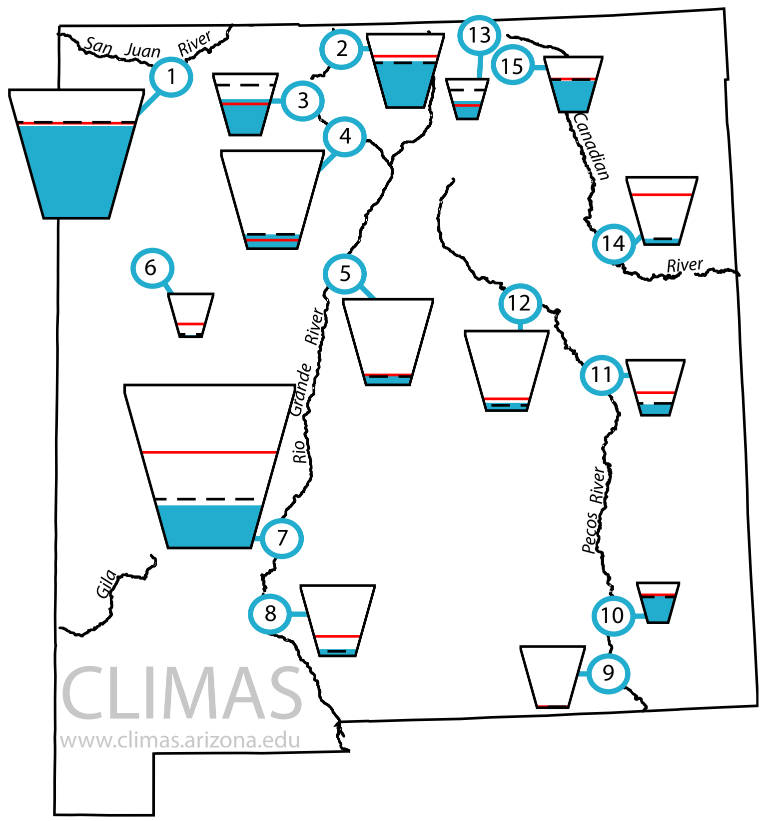
Figure 7. New Mexico reservoir levels for January as a percent of capacity. The map depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.

Legend



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	72%	1,226.0	1,696.0	-18.8
2. Heron	63%	251.1	400.0	0.5
3. El Vado	59%	111.5	190.3	-4.7
4. Abiquiu	15%	183.3	1,192.8	-0.3
5. Cochiti	11%	53.0	491.0	-0.3
6. Bluewater	4%	1.6	38.5	0.0
7. Elephant Butte	26%	561.5	2,195.0	41.8
8. Caballo	10%	31.6	332.0	2.1
9. Brantley	2%	19.0	1,008.2	3.3
10. Lake Avalon	68%	2.7	4.0	0.4
11. Sumner	20%	19.9	102.0	0.4
12. Santa Rosa	10%	44.2	438.3	0.5
13. Costilla	45%	7.2	16.0	0.4
14. Conchas	9%	24.0	254.2	0.0
15. Eagle Nest	56%	44.2	79.0	0.5

*** 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 2/18/10)

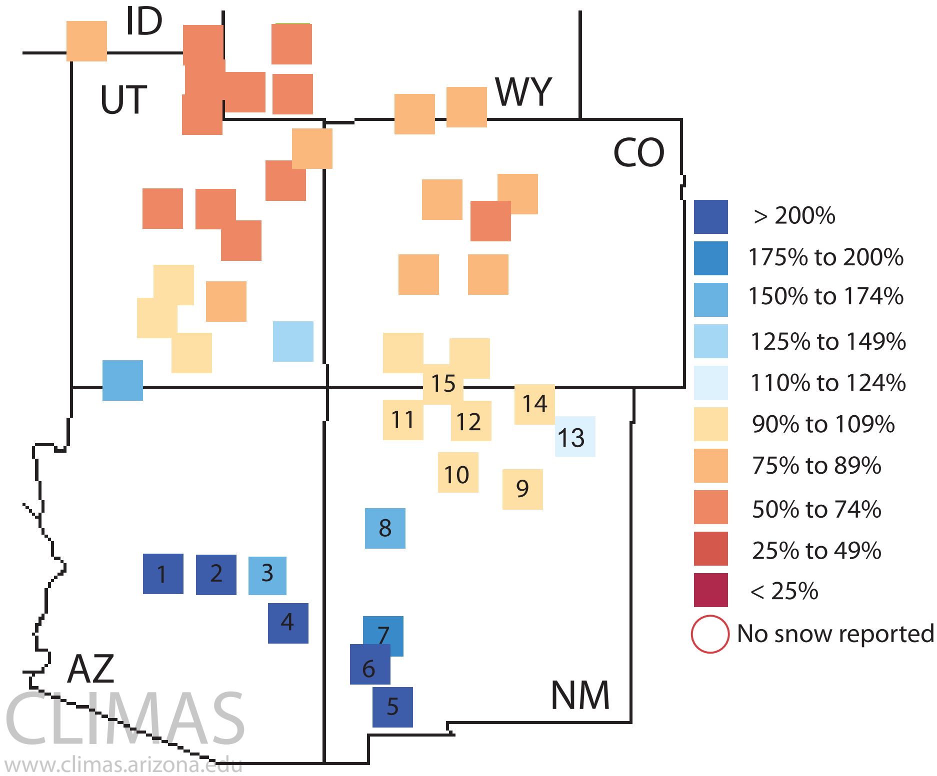
Sources: National Water and Climate Center, Western Regional Climate Center

Snowpack levels are near average to well above average in the river basins across Arizona and New Mexico (Figure 8). These levels are mostly due to snow accumulation from the major storms that occurred in late January; precipitation during the first half of February has been below normal across the Southwest. Snow water equivalent (SWE) in Arizona ranged from 179 percent of average in the Little Colorado headwaters to 240 percent of average in the Verde River Basin as of February 18, according to the Natural Resources Conservation Service's snow telemetry (SNOTEL) monitoring stations. New Mexico basins had slightly lower SWE, which ranged from 96 percent of average in the San Juan River headwaters to 230 percent in the Mimbres River Basin.

The current El Niño event has played a role in the numerous storms that have drenched the Southwest since January 1. Historically, El Niño conditions deflect the Pacific jet stream south, directing storms to the region. Additional rain and snow is likely because El Niño conditions are expected to continue into the spring months, according to the NOAA–Climate Prediction Center.

While the Southwest maintained above-average snowpack levels, many river basins in states to the north, which supply most of the water in the Colorado River and Rio Grande, had less-than-average to average snowpacks. For example, SNOTEL sites in the Upper Colorado River Basin showed 74 percent of average SWE, while SWE in the headwaters of the Upper Rio Grande measured 103 percent of average.

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of February 18.



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 content (SWC) or snow water equivalent (SWE) is calculated from this information. SWC refers to the depth of water that would result by melting the snowpack at the SNOTEL site and is important in estimating runoff and streamflow. It depends mainly on the density of the snow. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWC than light, powdery snow.

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

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 2010)

Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (NOAA–CPC) long-lead temperature outlooks show equal chances of above-, below-, and near-average temperatures throughout much of the Southwest for the March–May period (Figure 9a). NOAA–CPC outlooks show elevated chances for temperatures to be similar to the warmest 10 years in the 1971–2000 climatological record for late spring into summer, with a bulls-eye of the largest probability covering western Arizona in the April–June period and expanding to cover all of Arizona in June–August (Figures 9b–d). The outlook for elevated changes of warmer temperatures into the summer in large part reflects the recent warming trends during the hot foresummer and summer in the Southwest.

Notes:

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

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

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

Equal Chances (EC) indicates areas where 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 2010.

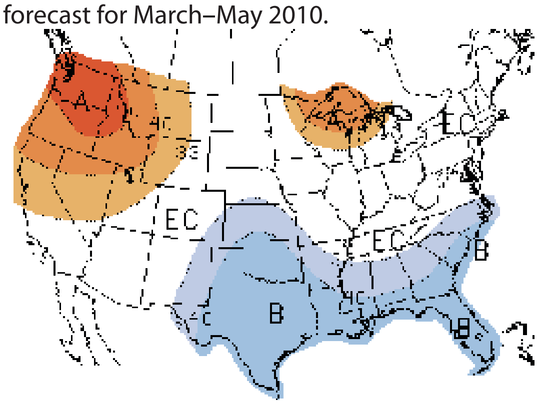
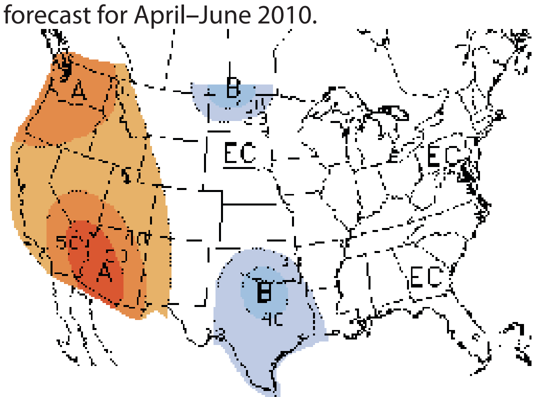
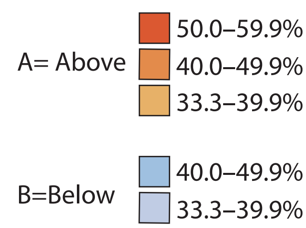


Figure 9b. Long-lead national temperature forecast for April–June 2010.





EC= Equal chances. No forecasted anomalies.

Figure 9c. Long-lead national temperature forecast for May–July 2010.

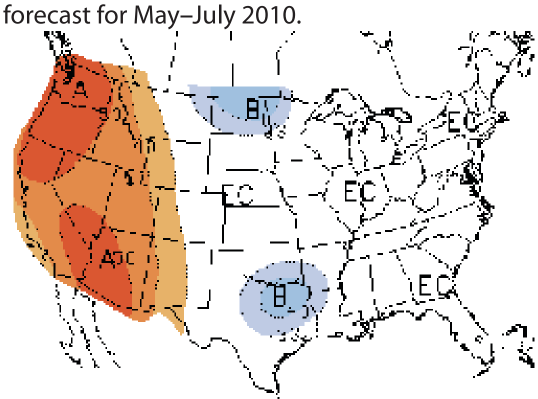
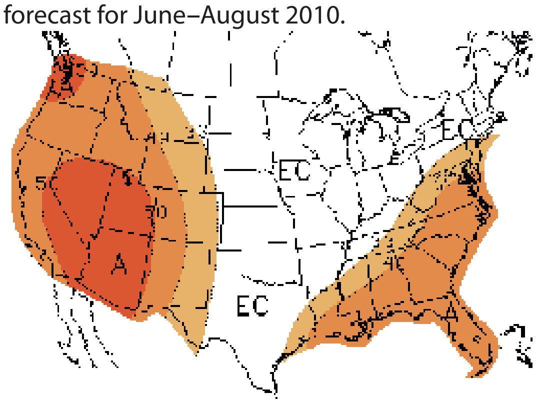


Figure 9d. Long-lead national temperature forecast for June–August 2010.



On the Web:

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

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

Precipitation Outlook

(March–August 2010)

Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (NOAA–CPC) long-lead precipitation outlooks for the March–May period indicate slightly elevated chances that precipitation in all of Arizona and New Mexico will be similar to the wettest 10 years in the 1971–2000 climatological record (Figure 10a). This outlook in part reflects the expectation that El Niño will persist through this period—El Niño events tend to deliver wetter-than-average winter conditions to the Southwest. NOAA–CPC forecasting models do not show skill in predicting conditions for late spring into summer, and the forecasts therefore show equal chances of above-, below-, and near-average precipitation throughout much of the Southwest (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 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

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

Equal Chances (EC) indicates areas where 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 2010.

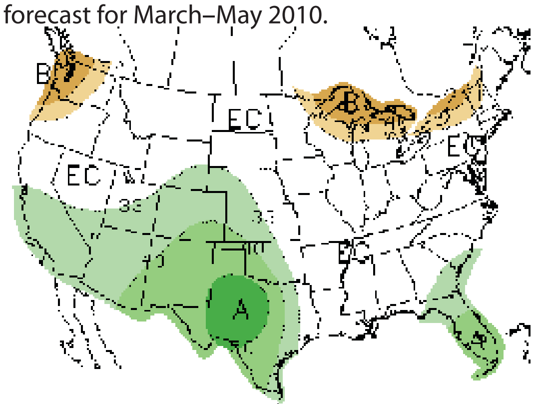


Figure 10b. Long-lead national precipitation forecast for April–June 2010.

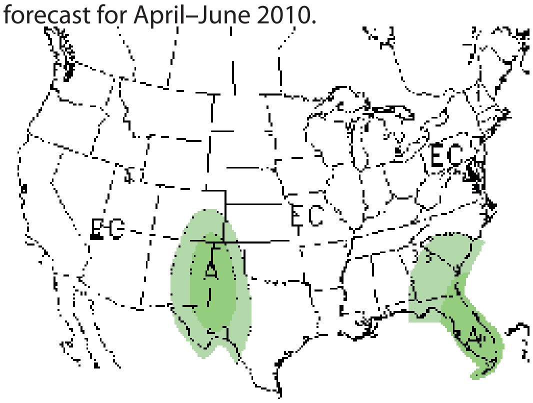


Figure 10c. Long-lead national precipitation forecast for May–July 2010.

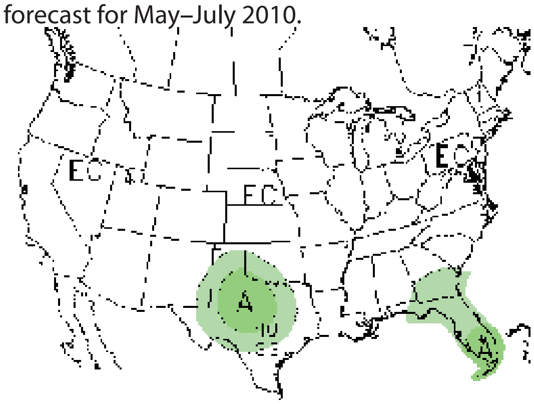
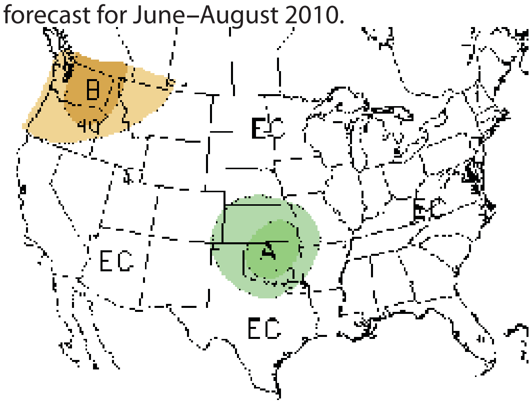


Figure 10d. Long-lead national precipitation forecast for June–August 2010.



B= Below
33.3–39.9%
40.0–49.9%

A=Above
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 may load slowly on your computer)

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

Seasonal Drought Outlook

(through May)

Source: NOAA-Climate Prediction Center (CPC)

This summary is excerpted and edited from the February 18 Seasonal Drought Outlook technical discussion produced by NOAA–CPC and written by forecaster A. Artusa.

Arizona is expected to experience some improvement in drought conditions due in large part to numerous storms in January and the expectation that El Niño conditions, which tend to deliver above-average winter precipitation to the Southwest, will continue for the next several months (Figure 11). Wetter-than-average conditions are forecasted by the NOAA–Climate Prediction Center (NOAA–CPC) across most of California, Nevada, and Arizona for time periods relevant to this outlook. Forecast confidence is high for the Southwest.

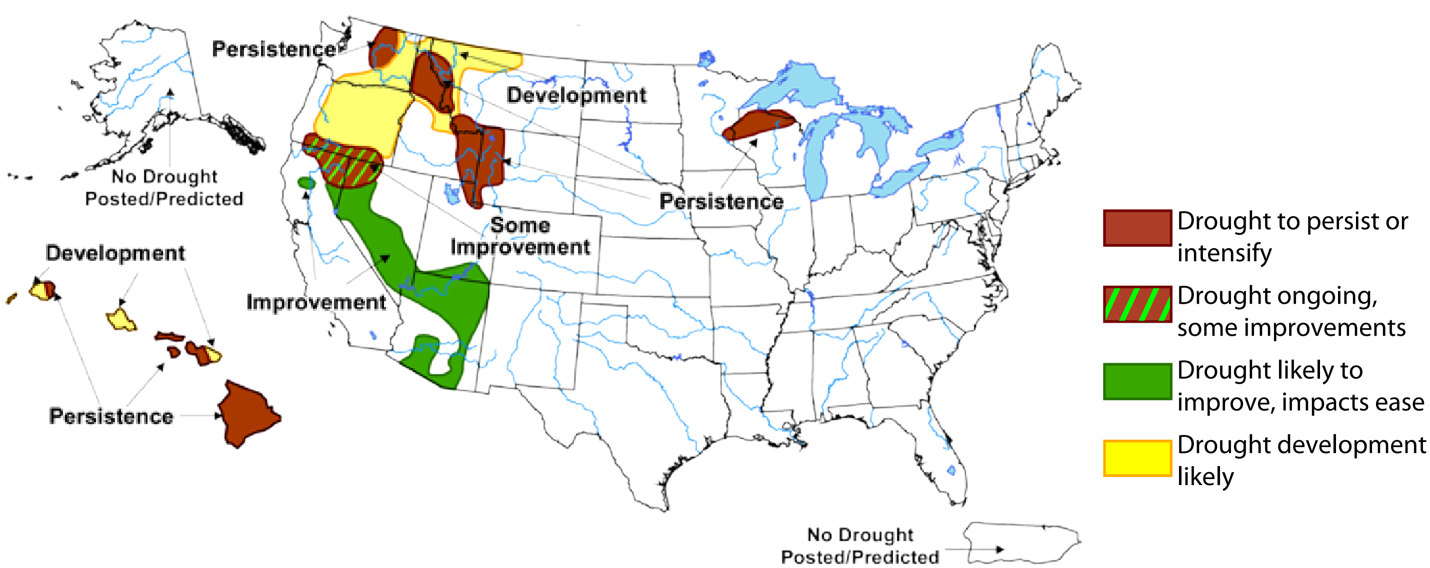
In other regions in the U.S., continued relief for the residual long-term drought areas in parts of southern Texas appears likely through the late winter and early spring. Long-range forecasts call for elevated chances of above-median precipitation, and the latest monthly and seasonal forecasts from NOAA–CPC continue to indicate relatively high probabilities for wetter-than-median conditions during March and the March–May period.

This is consistent with typical conditions for the region during El Niño events. In the Pacific Northwest, drought conditions should continue across central Washington and along Idaho's borders with Montana, Wyoming, and Utah. Drought development is expected across Oregon east of the Cascades. Water supply forecasts for this region are calling for below-average spring stream flows due to low snowpack. Forecasts on all time scales relative to this outlook indicate elevated chances for warmer and drier weather for much of the Pacific Northwest, which is consistent with typically-observed conditions during El Niño events. This dryness is largely due to the preferred tendency of the Pacific jet stream and associated storm activity being farther south during El Niño events, primarily over California and the Southwest.

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 18).



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)

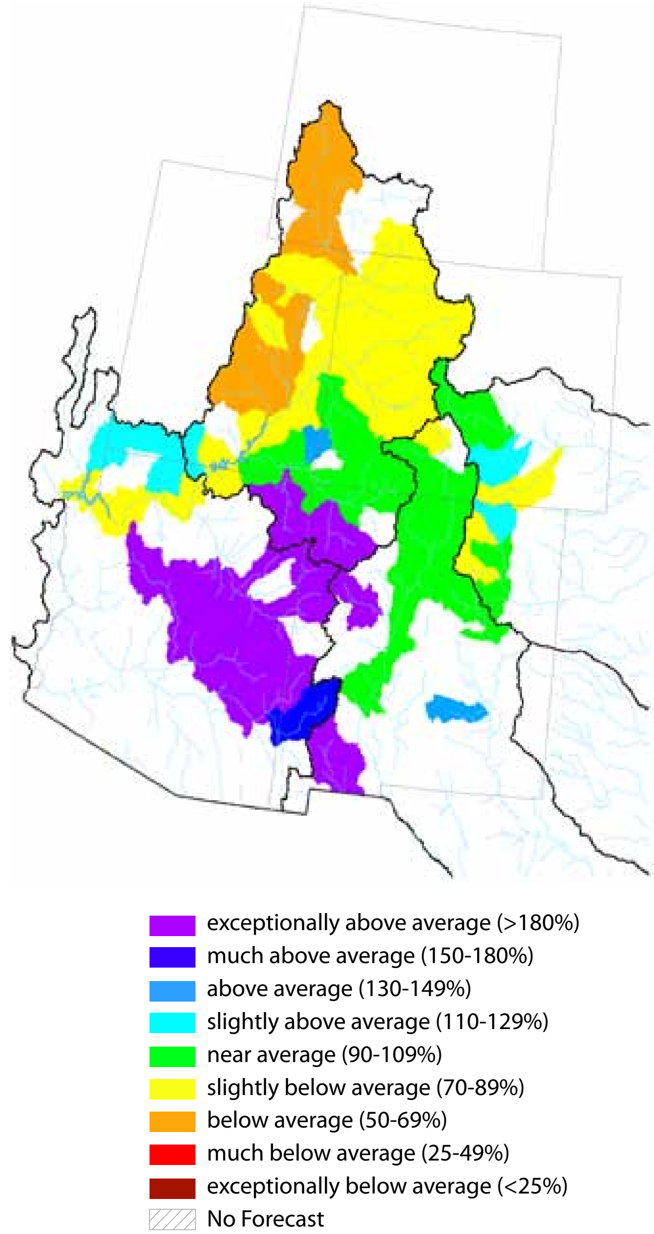
Source: National Water and Climate Center

The spring–summer streamflow forecast for the Southwest, issued on February 1, shows above-average flows for most basins in Arizona and southwest New Mexico, near-average flows for the Rio Grande and San Juan basins, and below-average flows for most of the Upper Colorado River Basin (Figure 12). Although the first two weeks in February were relatively dry, large and widespread storms drenched the Southwest in late January, building a large snowpack in Snow Telemetry (SNOTEL) monitored areas. For example, the Natural Resources Conservation Service reported on February 18 that most of the mountains in Arizona and southwest New Mexico had more than 200 percent of average snow water equivalent (SWE), while most of the monitored high country in northern New Mexico had slightly above-average SWE.

While the forecast calls for well above-average streamflow in all Arizona basins for the spring runoff period, inflow into Lake Powell will likely be less than average. There is at least a 50 percent chance that inflow to the lake will be more than 71 percent of the 30-year average for April–July, but only a 30 percent chance that inflow will be about 6.9 million acre-feet, or 1 million acre-feet below the 30-year April–July average. Predictions for streams in the Chuska Mountains for the March–May period are more optimistic, calling for a 50 percent chance that the four streams will have more than 275 percent of average flows. For the Salt, Verde, and Gila river watersheds, there is a 50 percent chance that flows will be more than 238, 291, and 234 percent of average, respectively, for the period between February 15 and May 31.

In New Mexico, the February 1 forecast shows that the majority of the New Mexico basins are on track for an average to slightly below-average runoff season. Above-average runoff is expected this spring in the Zuni/Bluewater and Mimbres basins because snowpack conditions were above average when the forecast was issued. The forecasts for the Rio Grande, Pecos, Canadian, and San Juan river basins indicate near-average runoff through the spring runoff season.

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



Notes:

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

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

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

El Niño Status and Forecast

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

Moderate El Niño conditions were the story again this past month as above-average sea surface temperatures (SSTs) persisted across much of the equatorial Pacific Ocean. The Southern Oscillation Index (SOI) dropped to -1.5 in January, indicating the strongest atmospheric response to El Niño conditions observed this winter season (Figure 13a). The International Research Institute for Climate and Society (IRI) notes that the pattern of SSTs along the equator displays a bull's eye of warm water that is more than 4.5 degrees Fahrenheit above-average just east of the International Date Line. IRI states that this pattern is ideal for directing Pacific storms into the western U.S. While some signs, such as cooling SSTs in the eastern Pacific Ocean, suggest that the current El Niño event is weakening, other factors suggest otherwise. For example, a strong connection between the ocean and atmosphere (reflected in the recent decrease in SOI value) could help keep warm SSTs and El Niño conditions in place during the next several months. In addition, the IRI notes that warm water below the ocean surface has built up over the past several months and will probably continue to feed moderate El Niño conditions for at least the next two months.

Notes:

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

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, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

On the Web:

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

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

The latest ENSO forecast issued by the IRI states a greater than 90 percent chance that El Niño conditions will continue through the February–April period (Figure 13b). Chances that El Niño will persist into the April–June period fall to 56 percent. The NOAA– Climate Prediction Center (NOAA–CPC) reports that nearly half of ENSO forecast models indicate the El Niño event will end sometime during the April–June period. ENSO impacts are expected to be felt for the remainder of this winter and likely into early spring. Seasonal precipitation forecasts issued by NOAA-CPC indicate elevated chances of above-average precipitation for much of Arizona and New Mexico through May.

Figure 13a. The standardized values of the Southern Oscillation Index from January 1980–January 2010. 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).

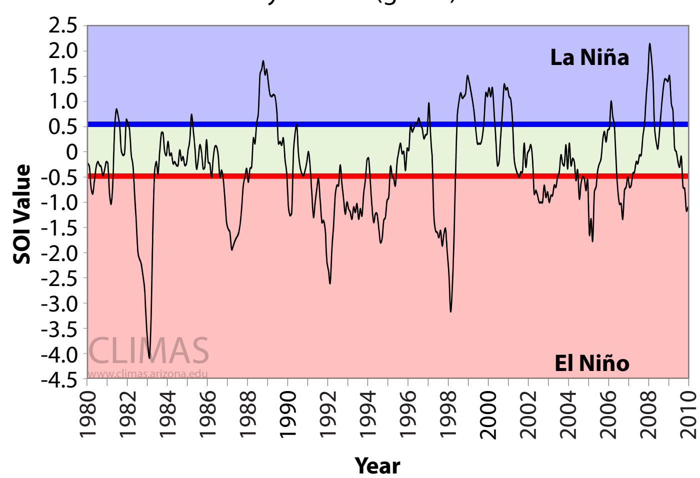
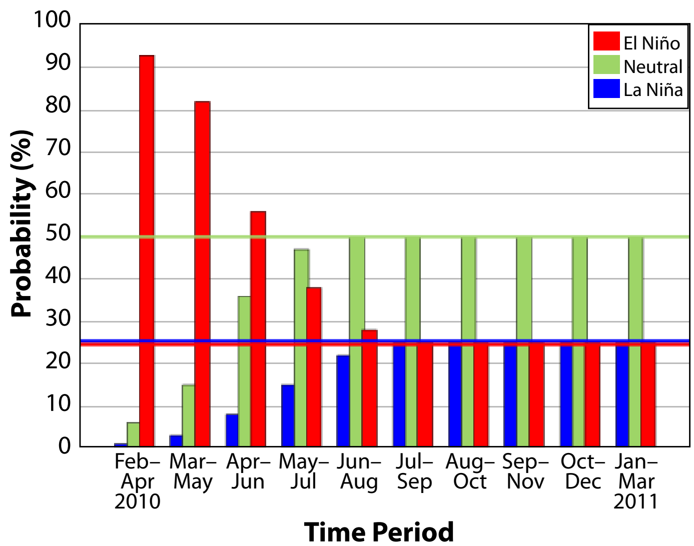


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released February 18). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification

(March–August 2010)

Source: Forecast Evaluation Tool

For a thorough description of the interpretation of these maps, see the feature article, "Evaluating forecasts with the RPSS," in the April 2009 issue of the Southwest Climate Outlook.

Comparisons of observed temperatures for March–May to forecasts issued in February for the same period suggest that forecasts have been more accurate than equal chances in all of Arizona and New Mexico (Figure 14a). However, forecast skill—a measure of the accuracy of the forecast—for northern and eastern New Mexico has been only slightly better than simply using equal chances as a forecast. Forecast skill for the two-month lead time forecasts historically have been more accurate than equal chances in all of Arizona and the southern two-thirds of New Mexico (Figure 14b). The three- and four-month lead time forecasts historically have been more accurate than equal chances in Arizona; forecast skill for most of New Mexico has been only slightly more accurate than equal chances for the June–August period (Figures 14c–d). Bluish hues suggest that NOAA–CPC historical forecasts have been more accurate than equal chances. However, caution is advised to users of the seasonal forecasts for regions with reddish colors.

Notes:

These maps evaluate the historical performance of the one- to four-month long-lead forecasts made by NOAA's Climate Prediction Center (CPC). The maps convey the historical accuracy of the CPC forecasts in relation to the reference forecast, which assigns a 33 percent chance to the three CPC categories, "above," "below," and "neutral." These categories indicate whether conditions are predicted to be similar to the warmest, coolest, or normal temperatures for 1971 to 2000. The maps are generated from the Forecast Evaluation Tool, which was developed by The University of Arizona in partnership with NOAA, NASA, NSF, and the University of California-Irvine.

The maps display the Ranked Probability Skill Score (RPSS). The more the forecasts and actual weather match, the bluer the color. A bluish or reddish RPSS indicates the forecast is more accurate or less accurate, respectively, than assigning a 33 percent chance to each of the three CPC categories.

The RPSS is calculated by comparing all the forecasts made since December 1994 for particular seasons and specified lead times to the actual weather of the season.

Figure 14a. RPSS for March–May 2010.

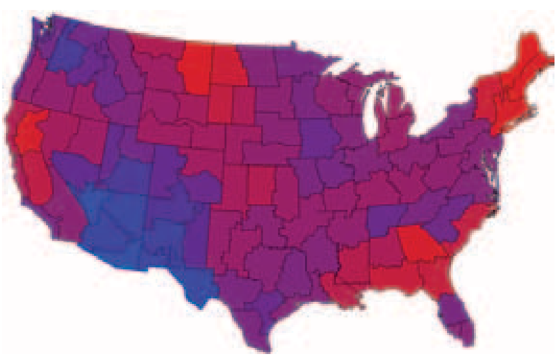
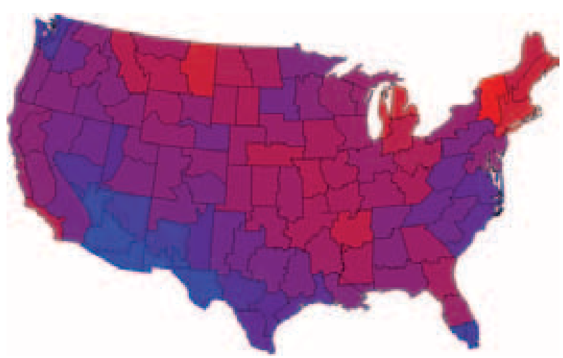


Figure 14b. RPSS for April–June 2010.



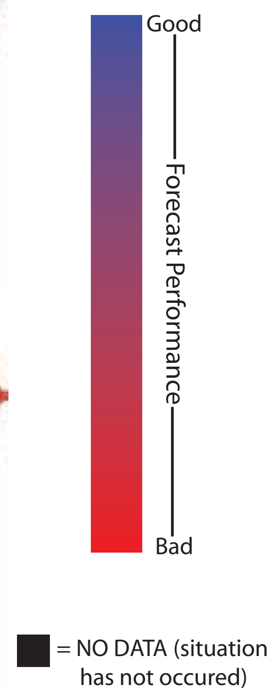


Figure 14c. RPSS for May–July 2010.

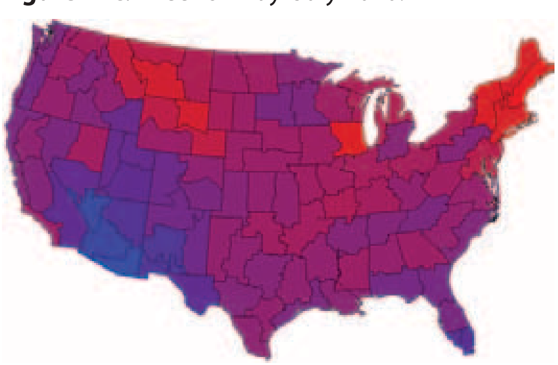
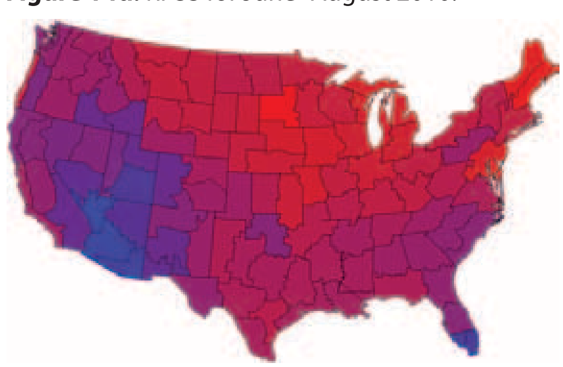


Figure 14d. RPSS for June–August 2010.



On the Web:

For more information on the Forecast Evaluation Tool, visit http://fet.hwr.arizona.edu/ForecastEvaluationTool/

For a CLIMAS publication that explains how to use the Forecast Evaluation Tool, visit http://www.climas.arizona.edu/forecasts/articles/FET_Nov2005.pdf

Precipitation Verification
(March–August 2010)

Source: Forecast Evaluation Tool

For a thorough description of the interpretation of these maps, see the feature article, "Evaluating forecasts with the RPSS," in the April 2009 issue of the Southwest Climate Outlook.

Comparisons of observed precipitation for March–May to forecasts issued in February for the same period suggest that forecasts are most reliable in northern Arizona (Figure 15a). Forecast skill—a measure of the accuracy of the forecast—for northern and eastern New Mexico has been slightly less accurate than simply using equal chances as a forecast. Forecast skill for the two-month lead times (forecasts issued in February for April–June) has been less accurate than equal chances in southern Arizona and southwestern New Mexico (Figure 15b). The three- and four-month lead time forecasts have been most accurate in southeast Arizona, but have been either less accurate or only slightly more accurate than equal chances in all other regions (Figures 15c–d). Regions with bluish hues suggest that the NOAA–CPC forecasts have historically been more accurate than equal chances. However, caution is advised to users of the NOAA–CPC seasonal outlooks for regions where the verification maps display reddish hues.

Notes:

These maps evaluate the historical performance of the one- to four-month long-lead forecasts made by NOAA's Climate Prediction Center (CPC). The maps convey the historical accuracy of the CPC forecasts in relation to the reference forecast, which assigns a 33 percent chance to the three CPC categories, "above," "below," and "neutral." These categories indicate whether conditions are predicted to be similar to the wettest, driest, or normal precipitation for 1971 to 2000. The maps are generated from the Forecast Evaluation Tool, which was developed by The University of Arizona in partnership with NOAA, NASA, NSF, and the University of California-Irvine.

The maps display the Ranked Probability Skill Score (RPSS). The more the forecasts and actual weather match, the bluer the color. A bluish or reddish RPSS indicates the forecast is more accurate or less accurate, respectively, than assigning a 33 percent chance to each of the three CPC categories.

The RPSS is calculated by comparing all the forecasts made since December 1994 for particular seasons and specified lead times to the actual weather of the season.

Figure 15a. RPSS for March–May 2010.

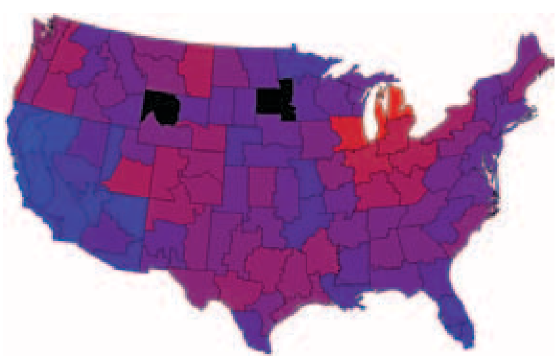


Figure 15b. RPSS for April–June 2010.

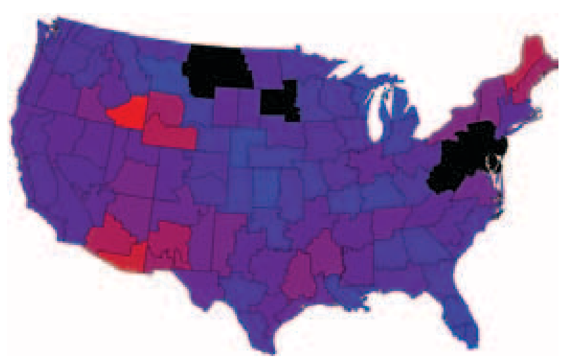


Figure 15c. RPSS for May–July 2010.

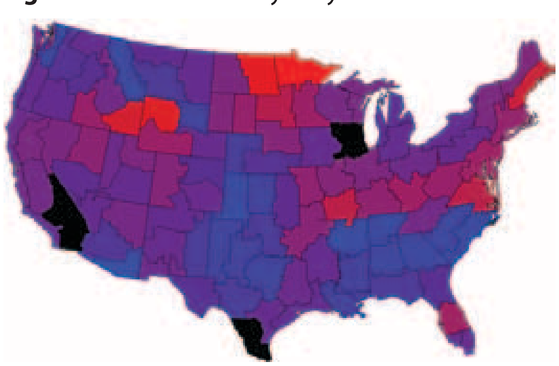
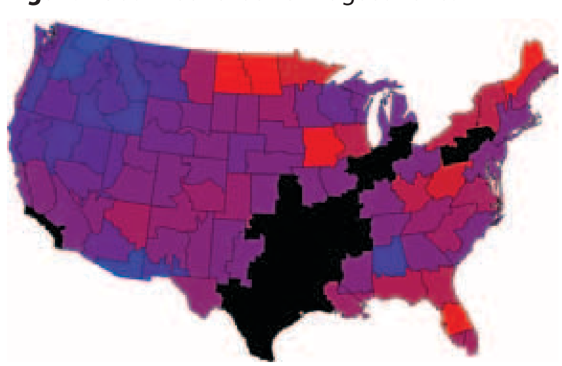


Figure 15d. RPSS for June–August 2010.



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