January 25, 2011

Southwest Climate Outlook

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Source: Zack Guido, CLIMAS.

Photo Description: Powerful storms walloped much of the West during late December, drenching many areas of the Colorado River Basin in rain and snow. During a brief reprieve, sun rays illuminated the resplendent sandstone towers in Monument Valley in the Four Corners Region.

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...

CLIMAS Climate Assessment for the Southwest

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

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January Climate Summary

Drought– A dry start to the new year has done little to help drought conditions across the Southwest. Moderate drought conditions continue to persist across much of southern Arizona and New Mexico.

Temperature– Warmer-than-average conditions in New Mexico have occured since the water year began on October 1, while Arizona has been cooler than average.

Precipitation– Dry conditions, which are characteristic of La Niña winters, have been the norm in most of the Southwest, and many southern areas have received less than 50 percent of average precipitation. Copious rains drenched some northern regions in late December but provided only scant moisture for other parts of the region.

ENSO– Moderate to strong La Niña conditions continue to dominate much of the equatorial Pacific Ocean. A large and cool pool of water beneath the sea surface in the eastern tropical Pacific suggests that the current moderate to strong event will persist in the next couple of months, and possibly longer.

Climate Forecasts– Forecasts, largely influenced by recent warming trends, call for temperatures to be warmer than average across the Southwest through the winter and early spring. Precipitation forecasts call for drier-than-average conditions into early spring, reflecting the historical effect of La Niña events in the region.

The Bottom Line– The moderate to strong La Niña event, which historically delivers scant rain to the region, has left a large hand print on the region, particularly southern Arizona and most of New Mexico where moderate drought conditions remain widespread. However, middle and late December storms drenched many parts of the West, including northwest Arizona, where short-term drought conditions have improved somewhat. With the expectation that the La Niña event will remain at its current strength for the next several months and possibly longer, precipitation forecasts call for below-average rain and snow. This could cause drought conditions to expand and intensify, and could prime the southwestern landscape for an active spring and early summer fire season.

2010 global temperature tied for warmest year in 131 years

The average global temperature for 2010 has made its way into the record books as the warmest year since 1880, when widespread measurements began. The planet was 1.12 degrees Fahrenheit (or 0.62 degrees Celsius) warmer than the 20th century average, tying the previous high mark recorded in 2005, according to the National Oceanic and Atmospheric Administration (NOAA). The record warmth was measured despite the rapid transition in July from El Niño to La Niña conditions. La Niña events are marked by a cooling of tropical Pacific Ocean sea surface temperatures, which has the effect of slightly cooling the planet. This was the 34th consecutive year with global temperatures exceeding the 20th century average; 2010 was also notable as being the wettest year on record. In the U.S., there was considerable temperature variability. Average temperatures in Arizona and New Mexico ranked as the 32nd and 23rd warmest on record, respectively, while Florida experienced the seventh coolest year on record.

Read more about the most recent global temperature analysis on NOAA's website: http://www.noaanews.noaa.gov/stories2011/20110112_globalstats.html

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SWCO Staff:

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Climate Change and Water in the Southwest: A summary of a special peer-review article series

By Zack Guido

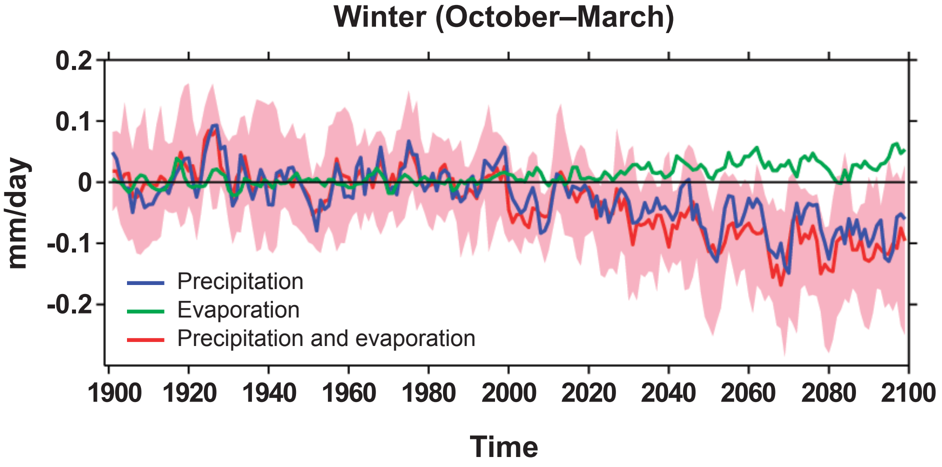

Figure 1. Many climate models project lower precipitation in the Southwest in the future driven predominantly by decreasing winter rain and snow. The combination of decreasing precipitation and increasing evaporation compound each other and make the region drier. The pink shading corresponds to the combined precipitation and evaporation and denotes the range in which half of the 24 models analyzed fall. Source: Seager and Vecchi, 2010, PNAS.

The Southwest is hot, and it has been getting hotter in recent years. Since around 1970, average temperatures have increased by about 2 degrees Fahrenheit, making warming in the region among the most rapid in the nation.

This has caused more rain to fall instead of snow and large swaths of piñon pine forests to die, the victims of high temperatures and severe drought. To make matters worse, the dry landscape and withered trees have combined to increase the frequency of large wildland fires. These and other changes are expected to continue. But the greatest impact of climate changes likely will be felt in changes to the water supply.

The Southwest has experienced prolonged drought in recent years. In 2002, 2003, 2007, and 2009 the average precipitation across California, Nevada, Utah, Arizona, and New Mexico was less than 25 percent of the 20th century average. Storage in Lakes Powell and Mead, which provide water to more than 30 million people in seven states and Mexico, plunged from nearly full in 1999 to about 49 percent of capacity at the end of December.

Many scientists also believe that the future will become drier at the same time that tens of millions of people flock to the region. The confluence of population growth, recurring droughts, and climate change raises a critical question: Is the increasing aridity in the Southwest capable of posing significant challenges to socioeconomic and environmental sustainability?

To help answer this question, the journal Proceedings of the National Academy of Sciences (PNAS) devoted a special series in December 2010 to water and climate change in the Southwest. The eight articles in the series help answer burning questions for the region, such as how will projected future warming impact water supplies and what strategies can be employed to create sustainable water use. Together, the articles suggest climate changes will likely make water scarcer in the region, accelerating the need for new innovative water use and management strategies.

A worst-case drought scenario

Tree rings, which are wider during wet years, have allowed researchers to extend the observational drought record in the Southwest back more than 1,200 years. The expanded account has helped scientists determine that recent dry conditions, which kicked off during the 1998–1999 La Niña event, have been warmer than past drought episodes.

Because observations from weather stations and models suggest that temperatures will continue to increase in the future, and because the region is naturally plagued by drought, scientists scrutinized the 1,200-year record for a dry period that can serve as a worst-case scenario for future episodes. They found the most severe and widespread of all past droughts smothered the western U.S. in the mid-12th century. It has been dubbed the megadrought and lasted more than 50 years.

"The drought in the mid-12th century far exceeded the severity, duration, and extent of subsequent droughts. The driest decade of this drought was anomalously warm, though not as warm as the current drought," Connie Woodhouse and co-authors wrote in their article "A 1,200-year Perspective of 21st Century Drought in Southwestern North America."

During the driest decade in the mid-12th century, drought covered more than 65.5 percent of the Southwest, more than double the average drought extent during the last 100 years. Colorado River flows were consequently low, averaging an estimated 11.5 million acre-feet per year, which is about 3.3 million acre-feet less than the average during 1900–2006. That decrease is also more than Arizona's total allocation of Colorado River water.

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Climate Change and Water, continued

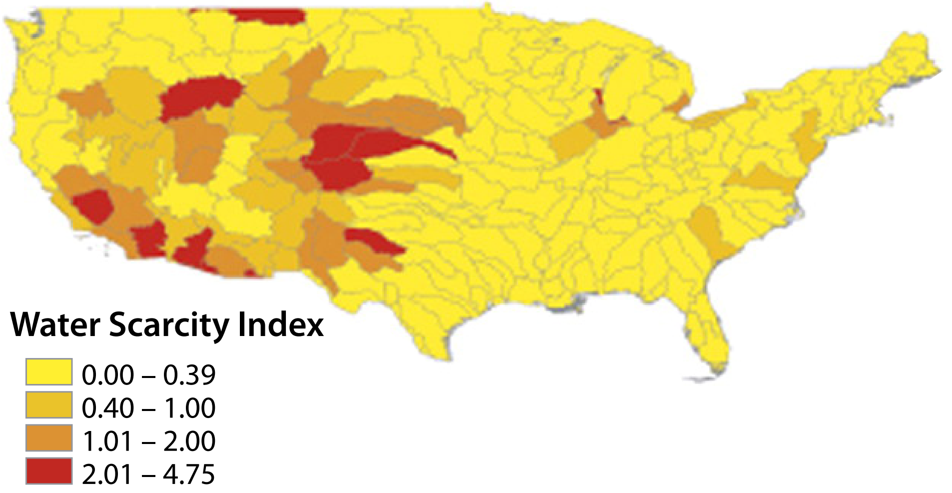

Figure 2. Water stress is commonly defined when the WSI is greater than 0.4, meaning more than 40 percent of the natural river flow is withdrawn. Many river basins in the Southwest are currently stressed; some have more water allocated than naturally flows in the river, requiring the use of groundwater to balance the deficit. Source: Sabo et al., 2010, PNAS.

These numbers beg the question: If a drought comparable to the mid-12th century were to occur today, would there be enough water to go around?

"I believe if we got to that stage, people would be rethinking the way water was allocated, and we might see some very creative approaches to at least making sure domestic and municipal water needs were met," Woodhouse said in an email. "As far as agriculture goes, I'm sure fields would be fallowed."

Future warming and its effect on water

Woodhouse and co-authors state that despite the severity and duration of the 12th century episode, the megadrought should be considered a best worst-case scenario for future droughts because it was at least 0.7 degrees F cooler than the current drought and likely cooler than severe future droughts.

Warmer temperatures make the landscape more arid by increasing evapotranspiration, the amount of water consumed by evaporation and vegetation growth. Past events, therefore, likely underestimate warm future droughts, all else being equal.

To assess possible future conditions, researchers also turn to sophisticated computer models. In their paper "Greenhouse Warming and the 21st Century Hydroclimate of Southwestern North America," Richard Seager and Gabriel Vecchi analyze changes in the combined values of precipitation and evaporation in 24 climate models used in the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment.

The researchers focus on the broad region extending from the California–Oregon border to southern Mexico, and slightly east of the Rocky Mountains to the Pacific Ocean. The models were driven by a "middle of the road" greenhouse gas (GHG) emission scenario known as the A1B scenario. (For a comprehensive description of GHG emission scenarios, see the August 2009 Southwest Climate Outlook feature article "Two or 12 degrees warmer? Greenhouse gas emission scenarios that drive future climate outlooks" on the Web at www.climas.arizona.edu/feature-articles/august-2009).

The authors report that the models robustly predict drying in the region throughout the current century due to rising greenhouse gases and that the drying is driven by a reduction in winter precipitation (Figure 1). Drier winters, the researchers explain, are caused by a poleward shift in storm tracks that originate in the Pacific Ocean.

However, changes in climate that have occurred in the last 30 years clearly demonstrate that natural climate variability also causes drying. El Niño–Southern Oscillation (ENSO) events and changes in sea surface temperatures in the north Pacific and Atlantic oceans play a role, and it is unclear how these natural oscillations will evolve in a warmer world. In fact, the authors are concerned with the inability of the climate models to accurately simulate Pacific sea surface temperatures, which cause precipitation projections to be less certain.

Modeling tests suggest slight warming or cooling in the tropical Pacific would both cause drying, although the severity of drying changes considerably between the warming and cooling scenarios. Temperature projections, however, do not suffer the same uncertainty because ENSO events do not influence temperature as strongly as they affect precipitation.

Nonetheless, the authors conclude that "despite ample uncertainties in model projections of hydroclimate change, and the continuation of natural climate variability on all timescales, it seems very probable that the southwest North America will be drier in the current century than in the one just past."

In a complimentary study, Dan Cayan and co-authors combine future climate projections with a hydrology model to assess how climate changes alter surface water. Their research, presented in the article "Future Dryness in the Southwest US and the Hydrology of the Early 21st Century Drought," relies on climate projections generated from "medium high" and "moderately low" greenhouse gas emis-

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Climate Change and Water, continued

sions scenarios, or the A2 and B1 scenarios, providing bookends for future projections.

Results suggest the Southwest would experience decreases in snowpack and soil moisture. This would cause the number of years of extreme drought—defined by the authors as water years (October 1–September 30) in which the averaged soil moisture spanning the entire study area is equal to or below the 5th driest year in the 1951–1999 period—to increase from five events observed during the historical period to between six and thirteen during the second half of the century, depending on the GHG emission scenario. The number of extreme events is higher for the medium-high emission scenario than for the moderately-low scenario.

The authors also point out that there is no change in the number of years of extreme drought in the first half of the 21st century for either scenario. Their results imply future extreme droughts are more likely; those droughts would in turn drive reductions in stream flows.

"Inevitably, there will be precipitation shortages, and during these times the resulting hydrological drought is aggravated by a trend toward much less snowpack, warmer temperatures, and diminished runoff and soil moisture," the authors conclude.

Other research corroborates this conclusion, stating that for each 1.7 degree F (1 degree Celsius) rise in temperature, runoff will decrease between 2 and 8 percent in the Colorado River basin. To put that number in perspective, if the Southwest warmed by 4 degrees F, reductions in the Colorado River could be as much as 2.8 million acre-feet, which equals Arizona's total Colorado River water entitlements.

Rethinking sustainable water use

In several of the articles in the series, including those mentioned above, the authors suggest a need for new water management strategies to deal with likely reductions in future water supply.

"We are entering a new era in water management," Peter Gleick writes in the paper "Roadmap for Sustainable Water Resources in Southwestern North America." Unlimited population growth, irrigation of crops in certain places, and water use habits that mimic areas with bountiful supplies can no longer be sustained in the region.

The ways of the past are no longer prudent in the Colorado River and other southwestern water systems, Gleick writes, because it is nearly impossible to withdraw additional water supplies.

John Sabo and co-authors illustrate this in their paper "Reclaiming Freshwater Sustainability in the Cadillac Desert." They compare the average amount of water withdrawn each year to the amount naturally available and show that on average, more water leaves many river basins in the Southwest than is available; reservoirs and groundwater makes this possible (Figure 2).

Other limitations also curtail future water supplies. Federal funding for traditional water systems such as reservoirs has largely evaporated, Gleick writes, while water withdrawals from every major aquatic ecosystem in the region, including the Colorado River Delta and the Salt, Verde, Gila, Santa Cruz, Rio Grande rivers, cause more ecological harm than benefit.

While the situation may appear bleak, it is not all bad news. Numerous strategies can help attain sustainable water use.

On the supply side, sources of water that were previously ignored or unusable could be tapped, including the desalination of brackish groundwater, reuse of treated wastewater, and rainwater harvesting.

On the demand side, limiting water used for residential landscaping and applying drip irrigation systems can help conserve huge amounts of water. For example, nearly half of the crops in California are grown with flood irrigation, Gleick writes.

Improving water management is also necessary. Institutions could generate and apply up-to-date information on water availability and use, and integrate climate change impacts into management.

"These new approaches have been used successfully here and there in the western U.S. and offer a way to effectively move toward water sustainability, but they have yet to be adopted in a comprehensive and widespread manner," Gleick concludes.

Take home messages

These PNAS highlighted articles and the other three in the series provide an overview of the state-of-the-science on water and climate change in the Southwest and represent the leading edge of research on the impacts of climate on water in the region. Several insights broadcasted from these articles strengthen several previously held beliefs:

- The most severe past drought, which presents a near worst-case scenario for future episodes, reduced Colorado River flows by about 3.3 million acre-feet.
- Many different climate models, each representing the climate dynamics in slightly different ways, predict drying in the Southwest.
- Future drying is principally controlled by reductions in winter precipitation as a result of a shift to the north in storm tracks.
- Water use strategies that will help the region attain sustainable water use include more efficient irrigation, limited residential landscape watering, desalination of brackish groundwater, reuse of treated wastewater, rainwater harvesting, and the use of climate change information in management decisions.

Temperature (through 1/19/11)

Data Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 on average have been between 55 and 65 degrees Fahrenheit in the southwest deserts of Arizona, 45 to 55 degrees F in southeastern Arizona and southern New Mexico, and 35 to 50 across most of central and northern New Mexico and the Colorado Plateau (Figure 1a). Average temperatures in the highest elevations of both Arizona and New Mexico have been between 30 and 40 degrees F, and temperatures across the two states have been largely between 1 and 3 degrees F warmer than average (Figure 1b). There has, however, been spatial variability, with some pockets seeing more than 4 degrees F warmer-than-average temperatures and other areas experiencing cooler-than-average temperatures.

Temperatures during the past 30 days generally have been 0 to 2 degrees F cooler than average across most of Arizona (Figures 1c–d). Western New Mexico has been up to 4 degrees F colder than average, while eastern New Mexico has been 2 to 4 degrees warmer than average. December was extremely warm, but two very cold winter storms moved through Arizona and western New Mexico during the latter half of the month. These storms brought record cold temperatures to many locations in both states. Temperatures in northwestern New Mexico were up to 6 degrees colder than average.

Notes:

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

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

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

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

On the Web:

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

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

Figure 1a. Water year '10–'11 (October 1 through January 19) average temperature.

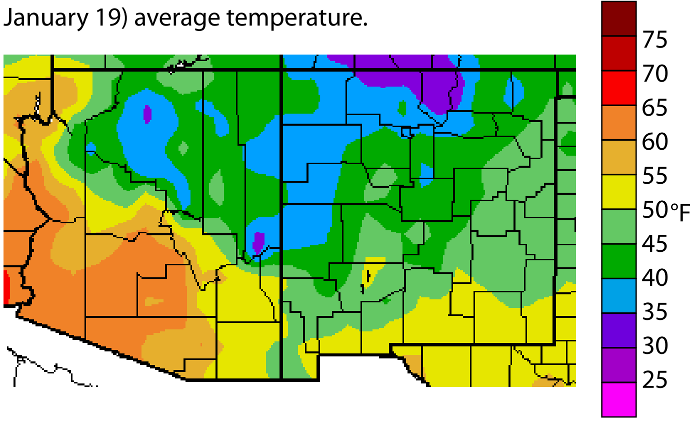


Figure 1b. Water year '10–'11 (October 1 through January 19) departure from average temperature.

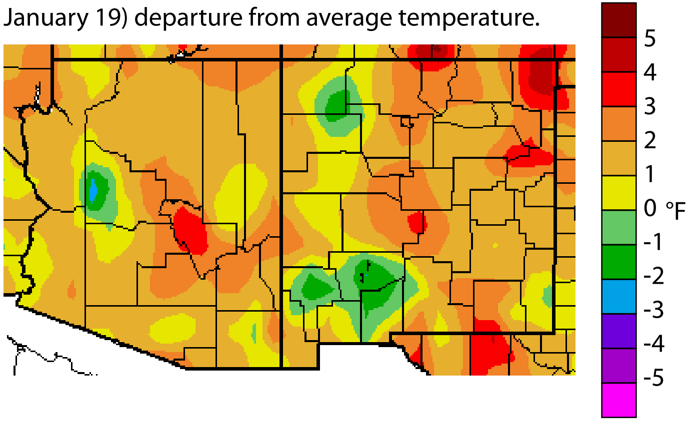


Figure 1c. Previous 30 days (December 21–January 19) departure from average temperature (interpolated).

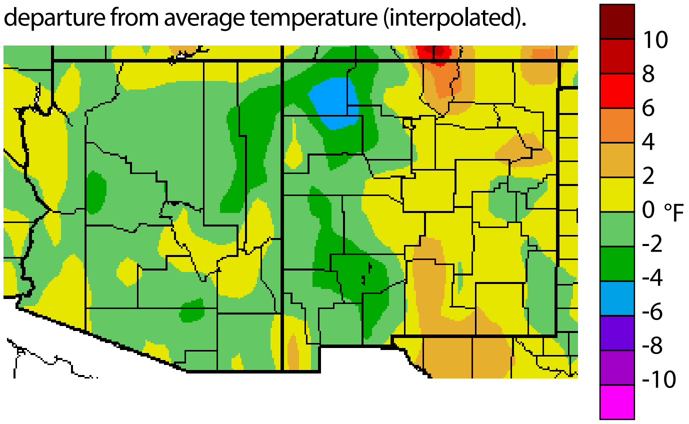
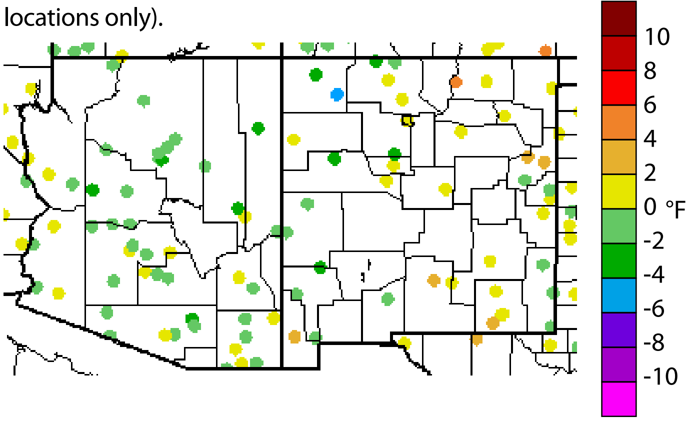


Figure 1d. Previous 30 days (December 21–January 19) departure from average temperature (data collection locations only).



Precipitation (through 1/19/11)

Data Source: High Plains Regional Climate Center

The Southwest has been generally dry since the water year began on October 1 but has experienced several periods of intense rain and snow. Storm tracks in November and December crossed Southern California and moved northeast across northwestern Arizona, leaving most of the Southwest with less than 75 percent of average precipitation (Figures 2a–b). The dry weather in many parts of both states is typical of the La Niña circulation that helped push storms north of Arizona and New Mexico. In the southern tier of both states, where La Niña typically causes drier conditions, precipitation has been less than 25 percent in New Mexico and less than 50 percent in Arizona. On the other hand, the northwestern corner of Arizona has received 150 to 800 percent of average precipitation, in large part from intense storms in middle and late December.

Virtually all the precipitation in the last 30 days fell in two storms at the end of December. All but the northwest quarter of New Mexico has had less than 50 percent of average precipitation in the past 30 days (Figures 2c–d). The northwest corners of both states have received 200 to 800 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, 2010, we are in the 2011 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 '10–'11 (October 1 through January 19) percent of average precipitation (interpolated).

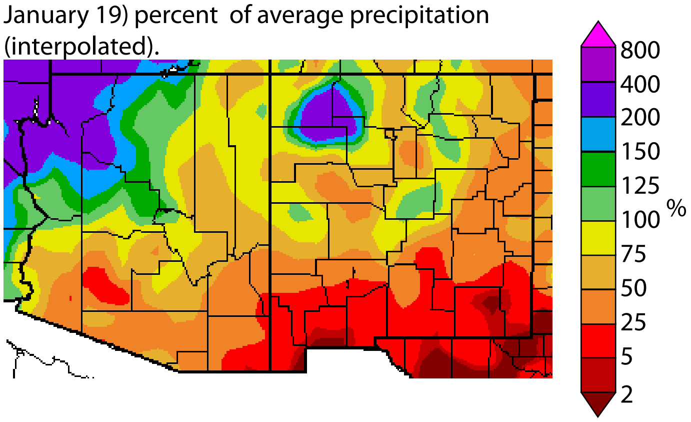


Figure 2b. Water year '10–'11 (October 1 through January 19) percent of average precipitation (data collection locations only).

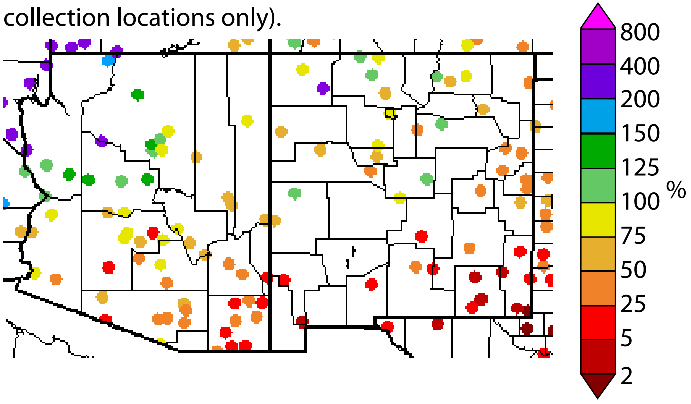


Figure 2c. Previous 30 days (December 21–January 19) percent of average precipitation (interpolated).

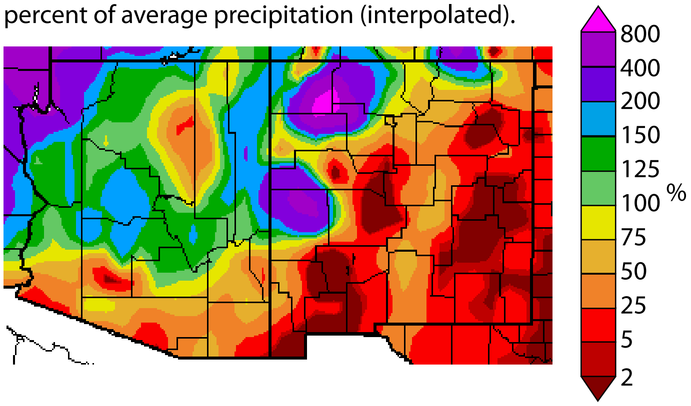
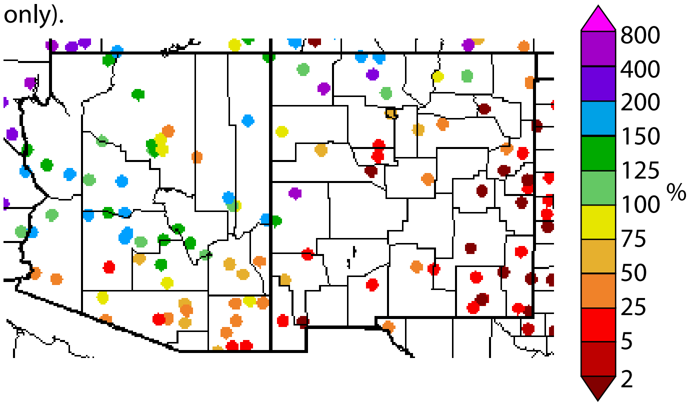


Figure 2d. Previous 30 days (December 21–January 19) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(data through 1/18/11)

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

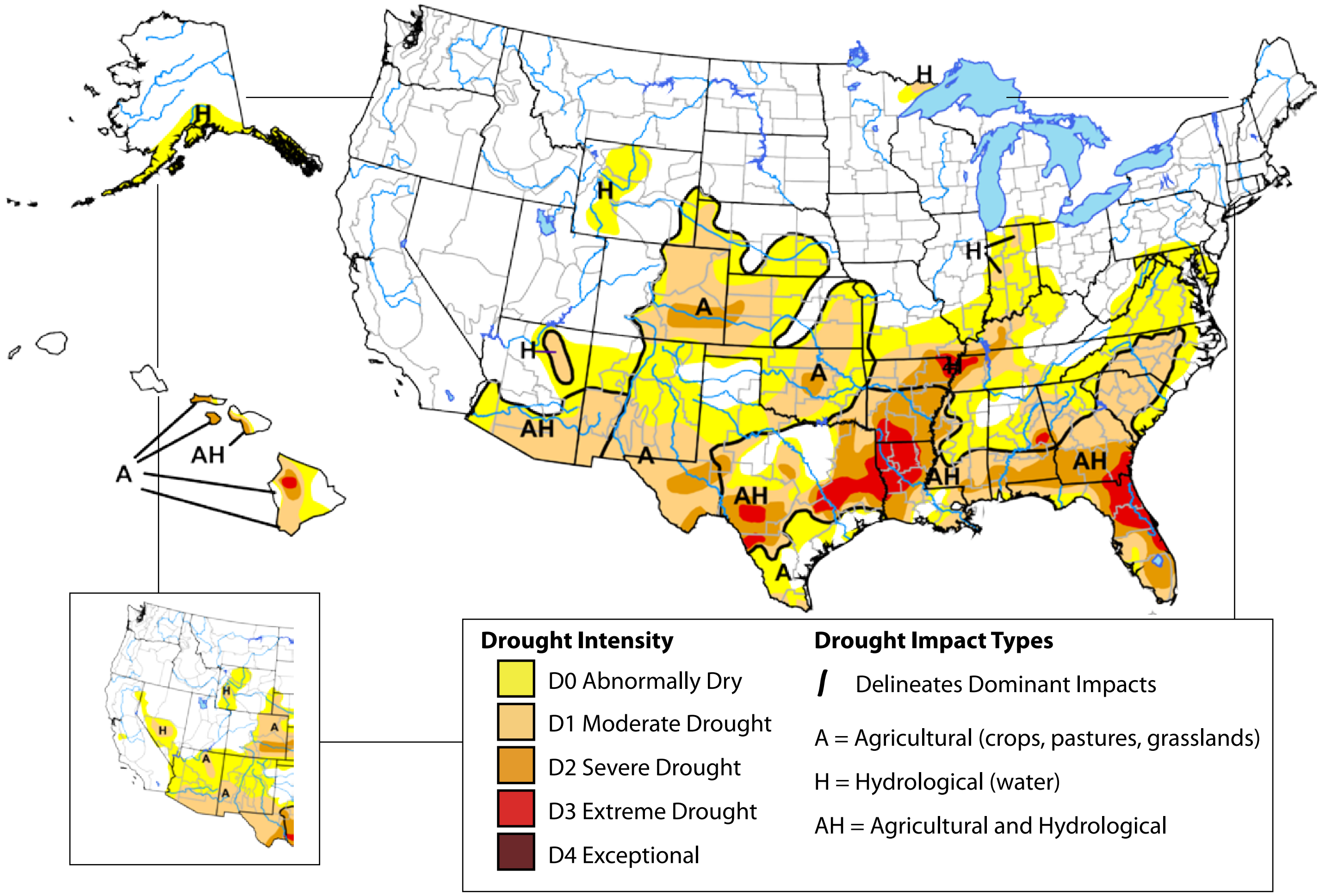
An active winter storm pattern dominated much of the western U.S. over the past 30 days, bringing average to above-average precipitation to almost all areas except southern Arizona and most of New Mexico. This has kept much of the western U.S. drought free and has even beaten back some short-term drought conditions that were present in Nevada and northwestern Arizona in mid-December (Figure 3). Often called Pineapple Express storms, several unusually strong storms in middle to late December tapped moisture from the tropical Pacific Ocean and dropped copious amounts of precipitation across Southern California, southern Nevada, and northwestern Arizona. The 30-day precipitation totals are in excess of 400 percent of average in some of these regions. Overall, only 23 percent of the area in the western U.S. is experiencing abnormally dry conditions or worse. In the Southwest, moderate to severe conditions are being experienced in southern Arizona, New Mexico and eastern Colorado.

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 Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC.

Figure 3. Drought Monitor data through January 18 (full size), and December 21 (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 1/18/11)

Data Source: U.S. Drought Monitor

A storm system in late December helped to reduce abnormally dry conditions across northern and central Arizona, but most of the southern half of the state remains under moderate drought conditions, according to the January 18 update of the U.S. Drought Monitor (Figure 4a). Although few winter storms have passed through the Southwest so far this winter, several powerful storms have dumped copious rain and snow in northern Arizona. However, very little precipitation has fallen anywhere in Arizona since January 1, perpetuating drought conditions in many regions, especially over the southeastern corner of the state. Currently, 32 percent of Arizona is experiencing moderate drought conditions, down from 36 percent about one month ago (Figure 4b). Also, 18 percent of the state is classified as abnormally dry, down from 58 percent on December 21.

Drought impact reports logged on Arizona DroughtWatch have helped confirm that conditions are improving across northern Arizona and that some regions are still mired in drought. Several reports note that earthen watering tanks for livestock have yet to fill southern Arizona. If conditions continue to be drier than average for the remainder of the winter, which is expected, ranchers could face problems later in the season. More drought impact reports can be viewed on Arizona DroughtWatch's webpage at http://azdroughtwatch.org/.

Notes:

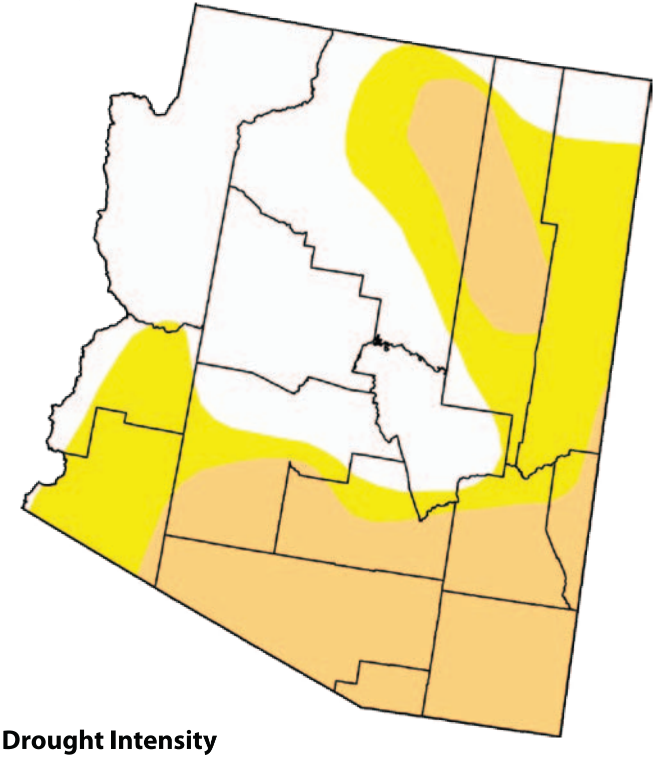
The Arizona section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation,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

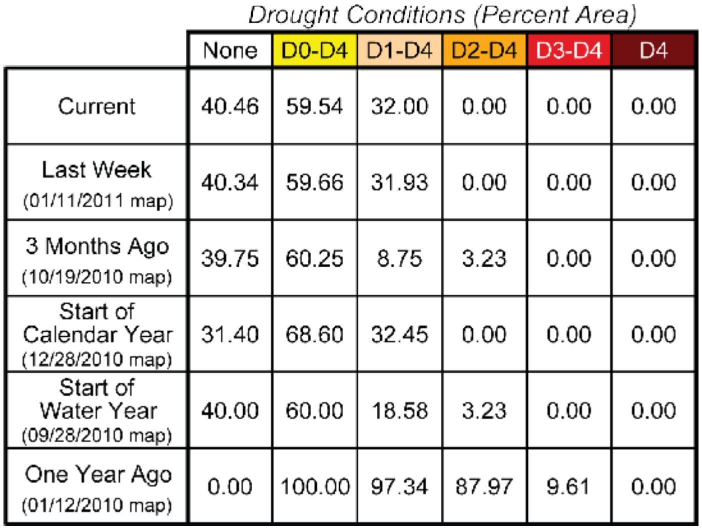
Figure 4a. Arizona drought map based on data through January 18.



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 January 18.



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	40.46	59.54	32.00	0.00	0.00	0.00
Last Week (01/11/2011 map)	40.34	59.66	31.93	0.00	0.00	0.00
3 Months Ago (10/19/2010 map)	39.75	60.25	8.75	3.23	0.00	0.00
Start of Calendar Year (12/28/2010 map)	31.40	68.60	32.45	0.00	0.00	0.00
Start of Water Year (09/28/2010 map)	40.00	60.00	18.58	3.23	0.00	0.00
One Year Ago (01/12/2010 map)	0.00	100.00	97.34	87.97	9.61	0.00

New Mexico Drought Status

(data through 1/18/11)

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

Drought conditions have remained largely unchanged across New Mexico over the past 30 days, according to the January 18 update of the U.S. Drought Monitor. Abnormally dry conditions cover about 49 percent of the state, down from about 55 percent one month ago (Figures 5a–b). However, moderate drought conditions have slightly expanded from about 40 percent to approximately 43 percent.

Storms have tracked to the north for most of the winter, leaving much of southern regions with substantial precipitation deficits. These areas have observed less than 50 percent of average precipitation during the past 90 days. Almost all of the southern half of New Mexico is categorized under moderate drought, while much of the remainder of the state is under the abnormally dry designation. A few winter storms clipped the far northwest corner of the state in late December, helping reduce short-term drought conditions in this region. The current moderate to strong La Niña event may continue to limit precipitation across the region. This could lead to rapid deterioration and expansion of drought conditions, especially in the southern half of New Mexico where the influence of La Niña events historically has been the strongest.

Figure 5a. New Mexico drought map based on data through January 18.

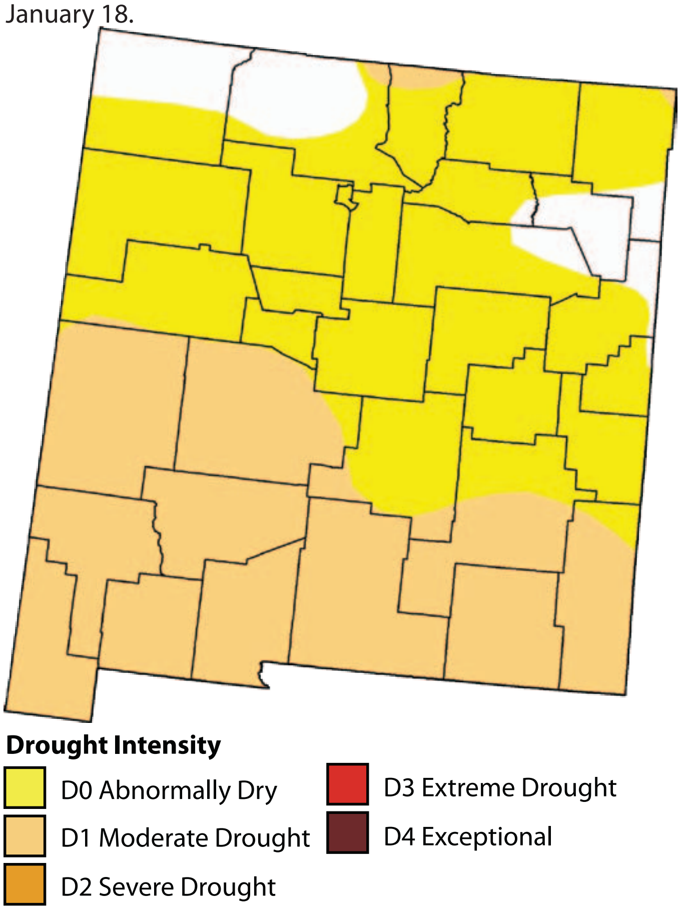
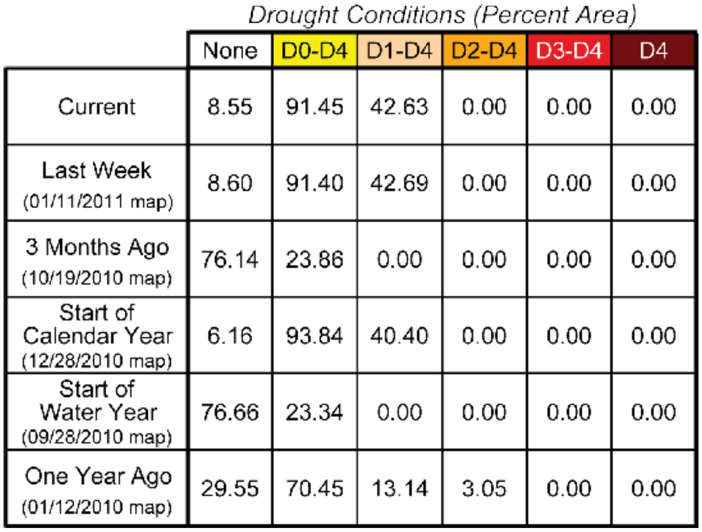


Figure 5b. Percent of New Mexico designated with drought conditions based on data through January 18.



	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	8.55	91.45	42.63	0.00	0.00	0.00
Last Week (01/11/2011 map)	8.60	91.40	42.69	0.00	0.00	0.00
3 Months Ago (10/19/2010 map)	76.14	23.86	0.00	0.00	0.00	0.00
Start of Calendar Year (12/28/2010 map)	6.16	93.84	40.40	0.00	0.00	0.00
Start of Water Year (09/28/2010 map)	76.66	23.34	0.00	0.00	0.00	0.00
One Year Ago (01/12/2010 map)	29.55	70.45	13.14	3.05	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 12/31/10)

Data Source: USDA-NRCS, National Water and Climate Ctr.

During the last month, combined storage in Lakes Mead and Powell decreased slightly. As of January 1, combined storage was at 49.1 percent of capacity, which is 1.7 percent less than a year ago (Figure 6). Storage in other reservoirs within Arizona's borders increased slightly in December, including small increases in the Salt and Verde River basins that offset a slight decrease in San Carlos Reservoir storage. Reservoir storage in Arizona is up compared with one year ago, due in part to management actions that anticipate spring reservoir depleting that is historically characteristic of La Niña winters.

In water-related news, the Cocopah Tribe has received a grant to restore parts of the lower Colorado River along the U.S.-Mexico border (*Yuma Sun*, January 12). The region has been modified as a result of flood control and water diversion activities, which have altered wetlands, vegetation, and wildlife and effectively rendered stretches of the river inaccessible to the tribe.

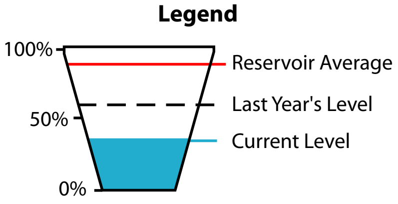
Notes:

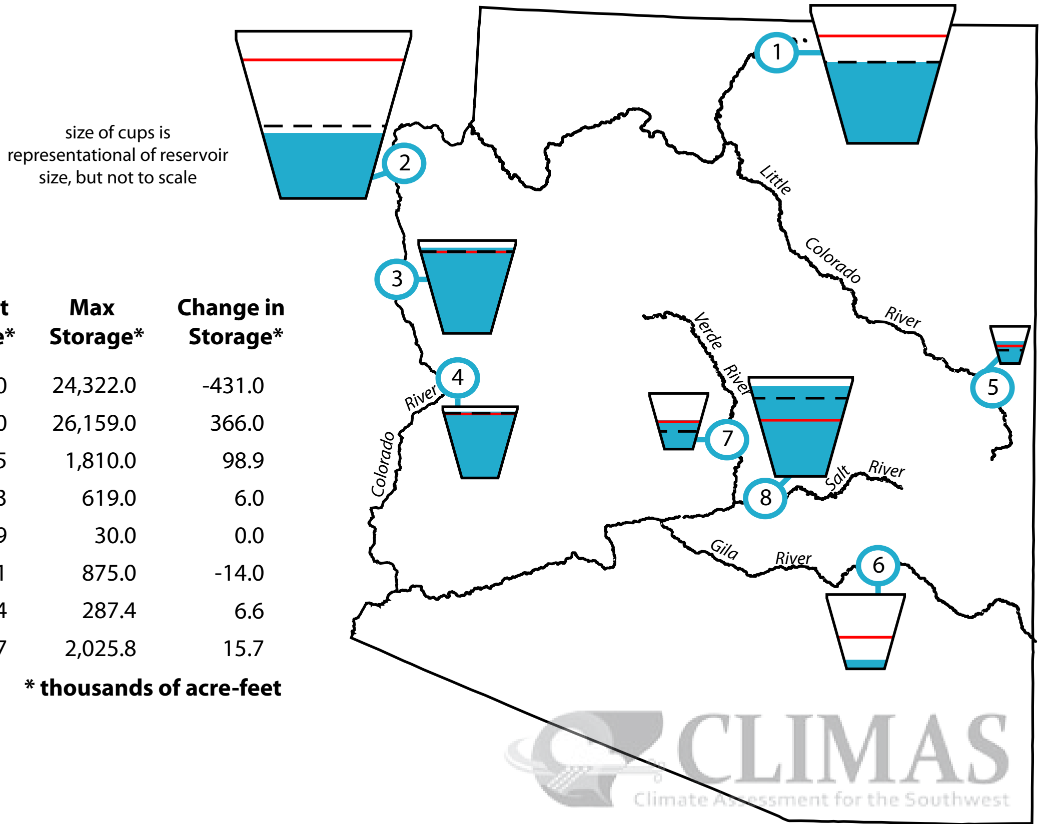
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 December 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	59%	14,457.0	24,322.0	-431.0
2. Lake Mead	39%	10,302.0	26,159.0	366.0
3. Lake Mohave	92%	1,665.5	1,810.0	98.9
4. Lake Havasu	93%	578.3	619.0	6.0
5. Lyman Reservoir	60%	17.9	30.0	0.0
6. San Carlos	12%	108.1	875.0	-14.0
7. Verde River System	52%	150.4	287.4	6.6
8. Salt River System	91%	1,835.7	2,025.8	15.7

*** 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 12/31/10)

Data Source: USDA-NRCS, National Water and Climate Ctr.

The total reservoir storage in New Mexico did not change substantially from one month ago (Figure 7). Storage in Elephant Butte Reservoir increased by 44,300 acre-feet in the last month, but it is down from this time last year by about 80,000 acre-feet. Storage in the Pecos and Canadian river basin reservoirs increased slightly in December. Storage in the Navajo Reservoir is up by about seven percent compared with one year ago.

In water-related news, New Mexico ranchers recently filed a motion with the state Water Quality Control Commission to repeal a new rule protecting headwater streams (Associated Press, January 12). Ranchers fear the new rule will be used to prohibit grazing on public lands. Also, domestic wells in eastern New Mexico's Curry County are drying up (cnjonline.com, January 11). Officials believe this is due to local variations in the depth of the Ogallala Aquifer and highlights the need for a speedy implementation of the Ute Water Pipeline.

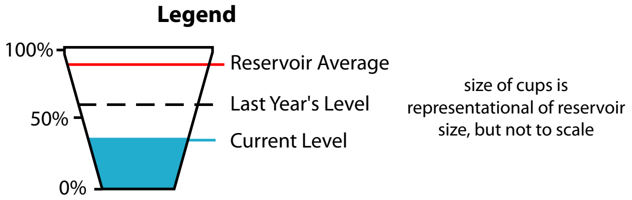
Notes:

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.

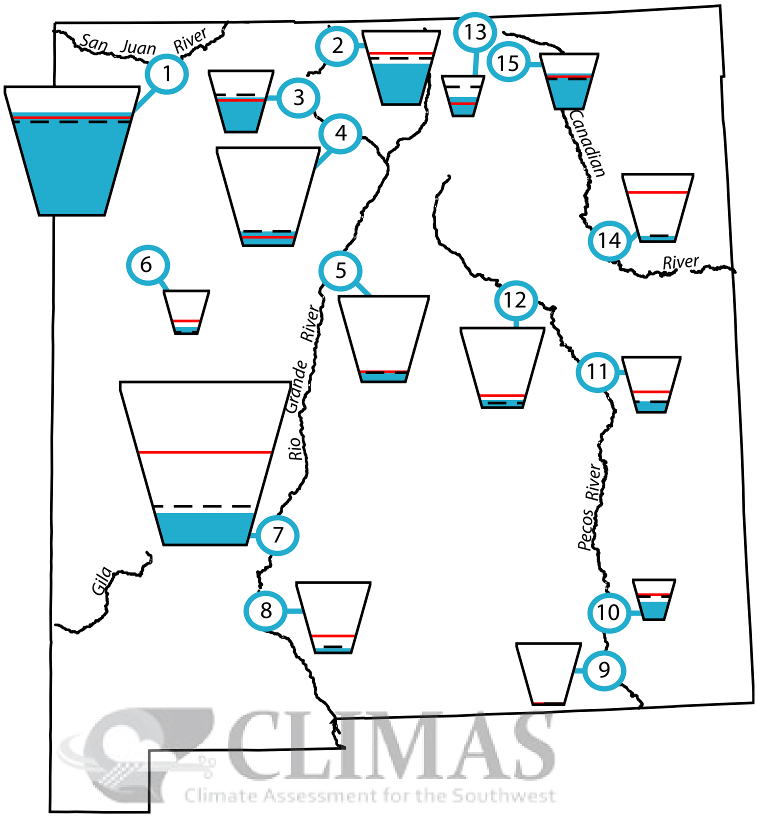
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Wayne Sleep, wayne.sleep@nm.usda.gov.

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



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	80%	1,362.0	1,696.0	-12.5
2. Heron	56%	225.2	400.0	-20.4
3. El Vado	57%	108.1	190.3	10.0
4. Abiquiu	15%	184.0	1,192.8	0.7
5. Cochiti	11%	52.9	491.0	1.0
6. Bluewater	16%	6.1	38.5	N/A
7. Elephant Butte	20%	437.2	2,195.0	44.3
8. Caballo	7%	22.0	332.0	2.0
9. Brantley	1%	11.2	1,008.2	2.3
10. Lake Avalon	45%	1.8	4.0	0.7
11. Sumner	20%	20.8	102.0	3.4
12. Santa Rosa	10%	42.8	438.3	0.1
13. Costilla	48%	7.7	16.0	0.4
14. Conchas	9%	21.7	254.2	0.3
15. Eagle Nest	65%	51.0	79.0	0.3

*** 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

Southwest Snowpack

(updated 1/20/11)

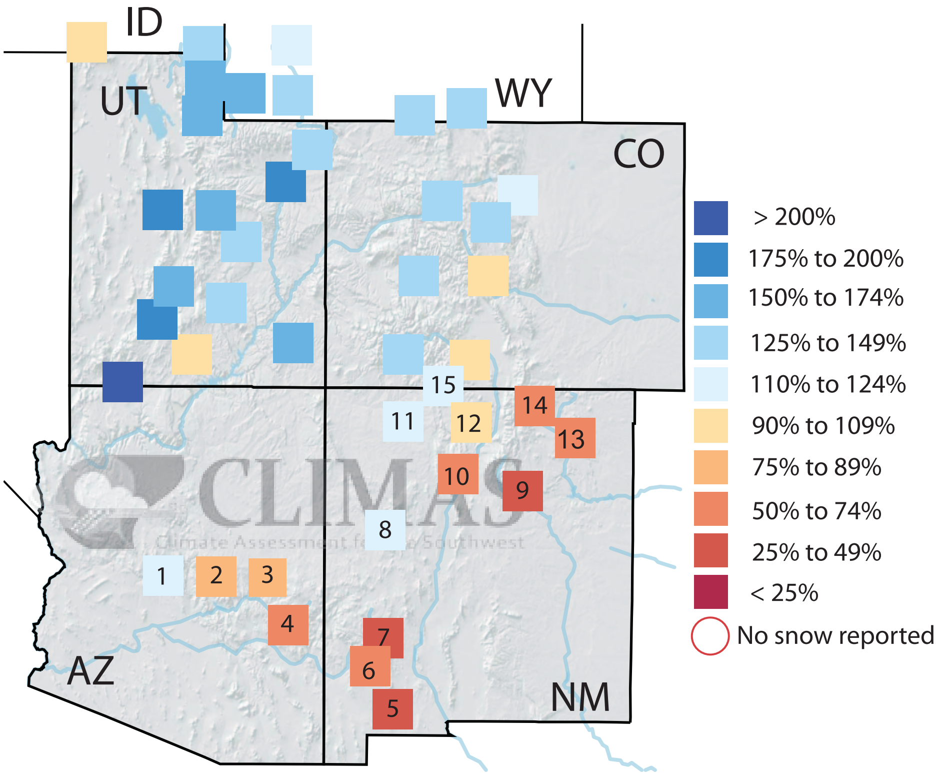
Data Sources: National Water and Climate Center, Western Regional Climate Center

The water contained in snowpack has been variable across Arizona and New Mexico (Figure 8). As of January 20, snow water equivalent (SWE) measured by snow telemetry (SNOTEL) stations ranged from 41 percent in the Gila River Basin to as much as 124 percent in the headwaters of the San Juan River. In Arizona, SWE ranged from 118 percent in the Verde River Basin to 74 percent in the Salt River Basin. Statewide, average snow levels were slightly above average. New Mexico, on the other hand, is experiencing a drier-than-average season so far, with scant precipitation falling across the state between October and December. Most basins recorded snowpack levels of less than 65 percent of average, except for the high elevation areas that include the Animas and San Juan river basins in southern Colorado and the Upper Rio Grande Basin in northern New Mexico.

The current moderate to strong La Niña event has played a large role in the dry winter in the Southwest. La Niña events typically steer storms north of the region and deliver warmer temperatures and less precipitation to the Southwest, especially in the southern areas. Current forecasts issued by the NOAA-Climate Prediction Center indicate a high chance that La Niña conditions will persist throughout the spring, likely delivering below-average rain and snow totals to the region.

States to the north of Arizona and New Mexico, which supply most of the water to the Colorado River and Rio Grande, are experiencing a wet winter. Currently the majority of snow monitoring stations in Colorado, Wyoming, and Utah measure more than 125 percent of average SWE.

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of January 20.



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

(February 2011–July 2011)

Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal temperature outlooks issued by the NOAA–Climate Prediction Center (CPC) in January call for increased chances for temperatures to be similar to the warmest 10 years during the 1971–2000 period through the winter and early summer. For the February–April period, CPC outlooks call for greater than a 50 percent chance that temperatures will resemble the warmest years in the climatological record in most of New Mexico, and greater than a 40 percent chance in most of Arizona (Figure 9a). For the March–May outlook, temperatures in nearly all of New Mexico and eastern Arizona also have greater than a 50 percent probability of being similar to the warmest 10 years in the climatological record (Figure 9b). For the April–June and May–July periods, probabilities for elevated temperatures are greater than 50 percent in nearly all of both states (Figures 9c–d). Recent decadal warming trends contribute to the enhanced probability of above-average temperatures in the West.

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 February–April 2011.

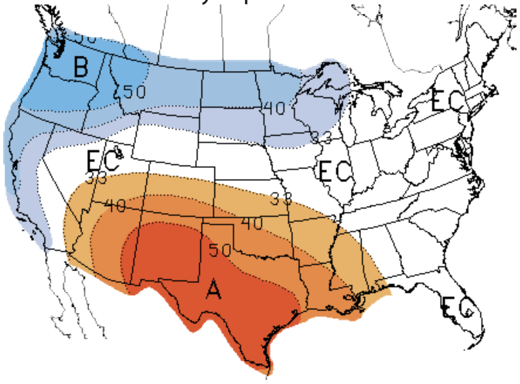


Figure 9b. Long-lead national temperature forecast for March–May 2011.

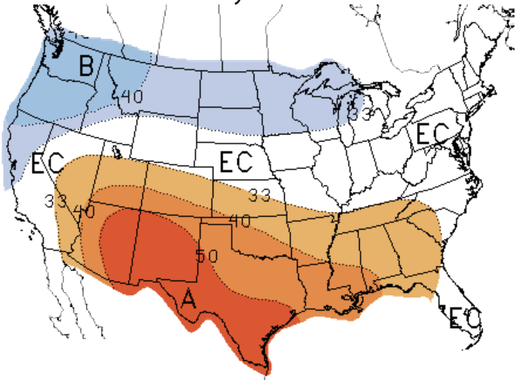


Figure 9c. Long-lead national temperature forecast for April–June 2011.

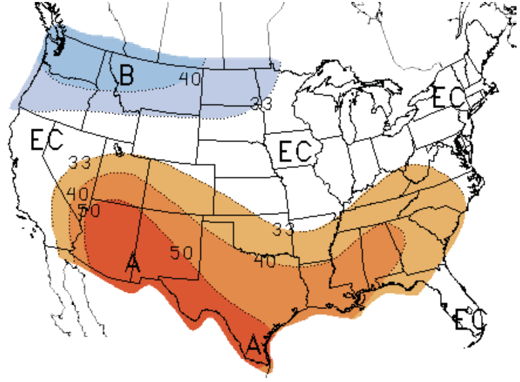
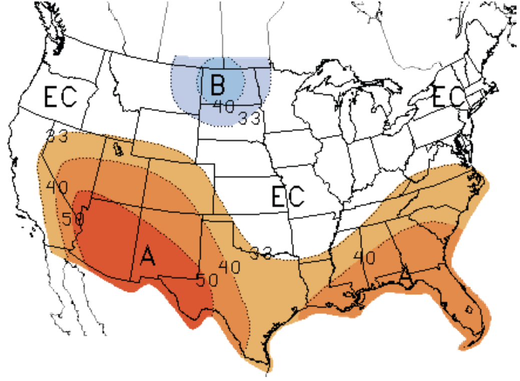


Figure 9d. Long-lead national temperature forecast for May–July 2011.



A = Above
🟥 50.0–59.9%
🟧 40.0–49.9%
🟨 33.3–39.9%

B = Below
🟦 50.0–59.9%
🟦 40.0–49.9%
🟦 33.3–39.9%

EC = Equal chances. No forecasted anomalies.

On the Web:

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

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

(February 2011–July 2011)

Data Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (CPC) precipitation outlooks suggest drier-than-average conditions into the spring for all of Arizona and New Mexico (Figures 10a–c). The highest chances for decreased precipitation will be in the February–April period, which in part reflects the expectation that the La Niña event will persist through March–May. Chances for below-average precipitation during the March–May period also are elevated, ranging between 40 and 50 percent for all of Arizona (Figure 10b). La Niña events typically are associated with below-average precipitation in the Southwest. Since 1950, winters in the southwestern U.S. and particularly Arizona have been dry between 60 and 80 percent of the time. Chances for below-average precipitation are slightly elevated during the April–June period (Figure 10c), and the late spring and early monsoon outlook calls for equal chances of above-, below-, or near-average conditions (Figure 10d).

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 February–April 2011.

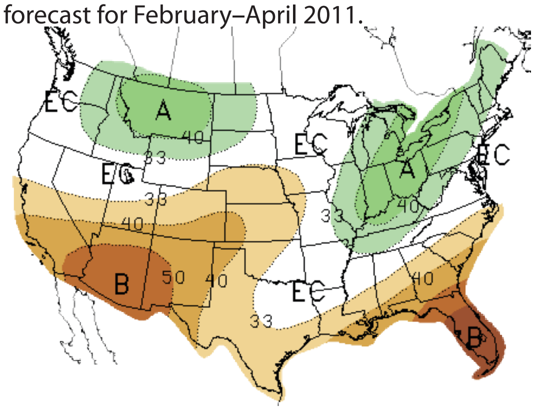


Figure 10b. Long-lead national precipitation forecast for March–May 2011.

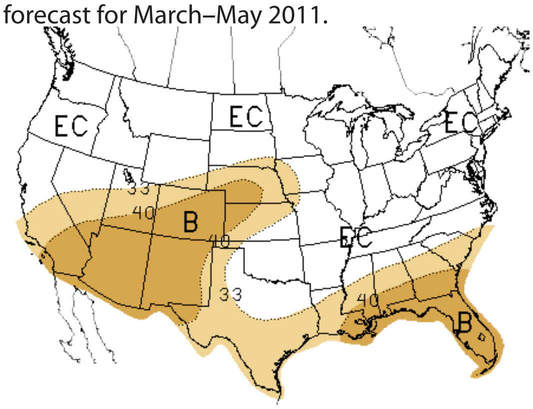


Figure 10c. Long-lead national precipitation forecast for April–June 2011.

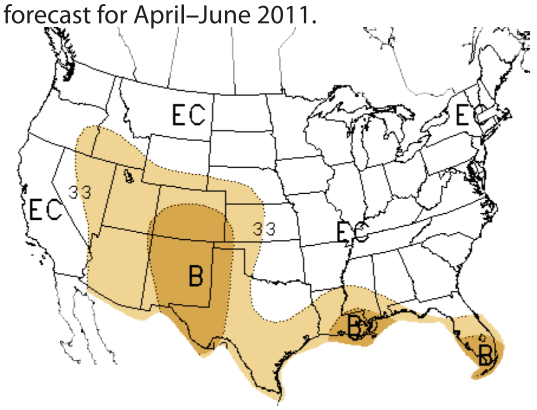
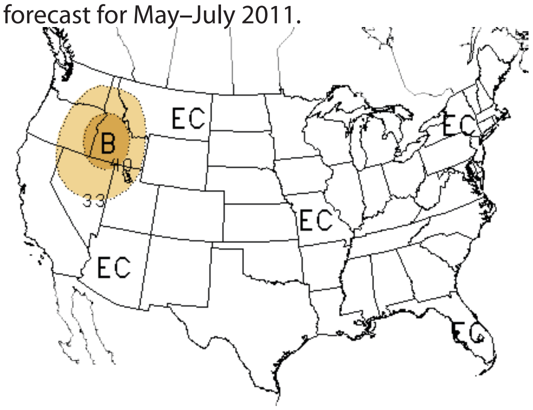


Figure 10d. Long-lead national precipitation forecast for May–July 2011.



A = Above
🟩 40.0–49.9%
🟩 33.3–39.9%

B = Below
🟫 60.0–69.9%
🟫 50.0–59.9%
🟫 40.0–49.9%
🟫 40.0–49.9%

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 January load slowly on your computer)

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

Seasonal Drought Outlook

(through April)

Data Source: NOAA-Climate Prediction Center (CPC)

This summary is excerpted and edited from the January 20 Seasonal Drought Outlook technical discussion produced by the NOAA–Climate Prediction Center and written by forecaster B. Pugh.

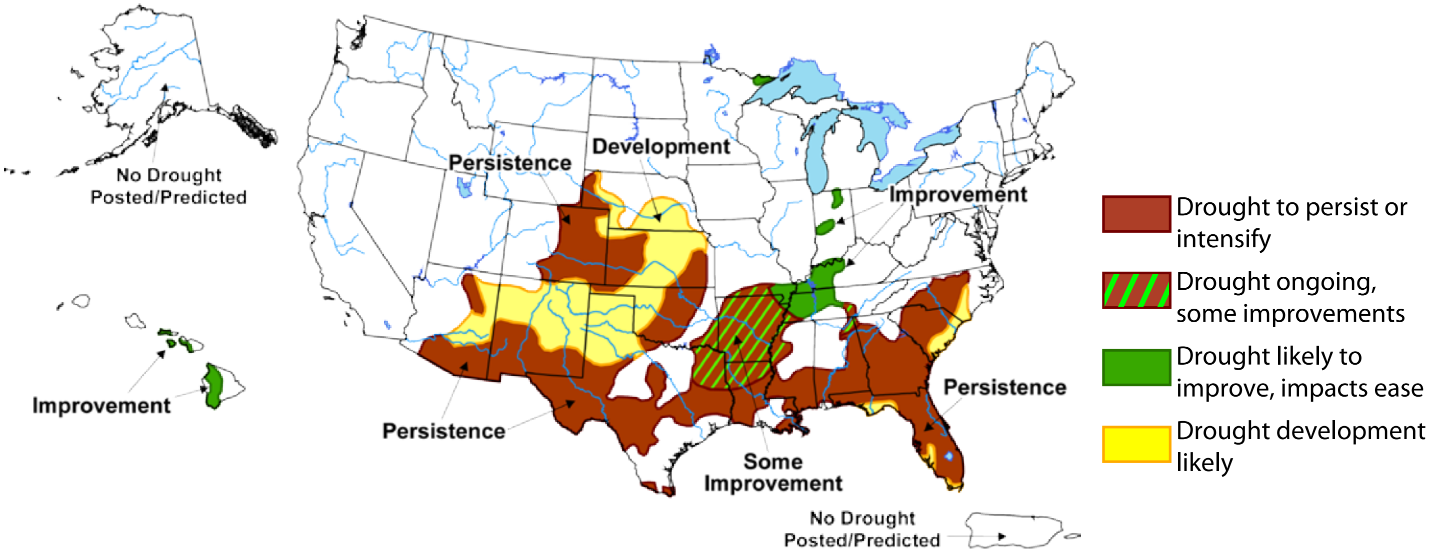
Short-term forecasts call for dry weather in the Southwest, and seasonal climate forecasts issued by the NOAA–Climate Prediction Center (CPC) suggest that the February–April period also will be dry. These forecasts are influenced heavily by the current La Niña event; many past moderate to strong events produced dry conditions in the Southwest. Currently, the water content contained in snowpack is between 25 and 75 percent of average in southeast Arizona and most of New Mexico. Due to a low snowfall so far this winter, a tendency for dry conditions during La Niña events, and forecasts for below-median precipitation, the drought forecast calls for persistence, expansion, and development across much of Arizona and New Mexico (Figure 11). The CPC assigns a high confidence for this forecast.

Elsewhere in the U.S., scant precipitation fell across the central and southern Plains and western Texas during the past month, causing drought conditions to expand or intensify across western Nebraska, eastern Colorado, Kansas, Oklahoma, and western Texas. Precipitation forecasts indicate elevated chances for below-average precipitation in these regions. Based on these forecasts, historical dry conditions during the up-coming three month period, and dry current conditions, drought is likely to persist and develop across the central and southern Plains and western Texas. In many other parts of the South, drought is forecasted to persist or intensify. This forecast is heavily influenced by the current moderate to strong La Niña event, which is expected to continue during the next three months. These events often are associated with dry conditions in these regions.

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 April (released January 20).



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 first spring–summer streamflow forecast for the Southwest, issued on January 1, shows below-average flows for basins in the Mogollon Rim region of Arizona, above-average flows for most of the Upper Colorado River Basin, and mostly near- to below-average flows for New Mexico basins (Figure 12). Widespread and intense storms that drenched California, northwest Arizona, and Utah beginning in mid-December have helped contribute to an optimistic spring streamflow forecast for the Colorado River Basin. The dry southern regions of Arizona and New Mexico reflect the influence of La Niña events, which often deflect the storms north.

The current forecast suggest at least a 50 percent chance that inflow to Lake Powell will be about 117 percent of the 1971–2000 average for April–July. The forecast also indicate a 70 percent chance that Lake Powell inflow will be slightly more than the historical average of 7.7 million acre-feet. Forecasts for the Salt River and Upper Gila, on the other hand, call for only a 30 percent chance that streamflows during the January–May period will be equal to or greater than 90 and 77 percent or average, respectively.

In New Mexico, the January 1 forecast shows the majority of the state on pace for a significantly below-average runoff season. The only average or above-average forecast is for the San Juan River Basin; this forecast reflects the above-average snowpack in northern New Mexico, southern Colorado, and the Upper Rio Grande. Streamflow forecasts decline south of these basins due to lower-than-average snowpack in these areas. However, it is still early in the snow season and conditions could rapidly change in Arizona, New Mexico, and across the West.

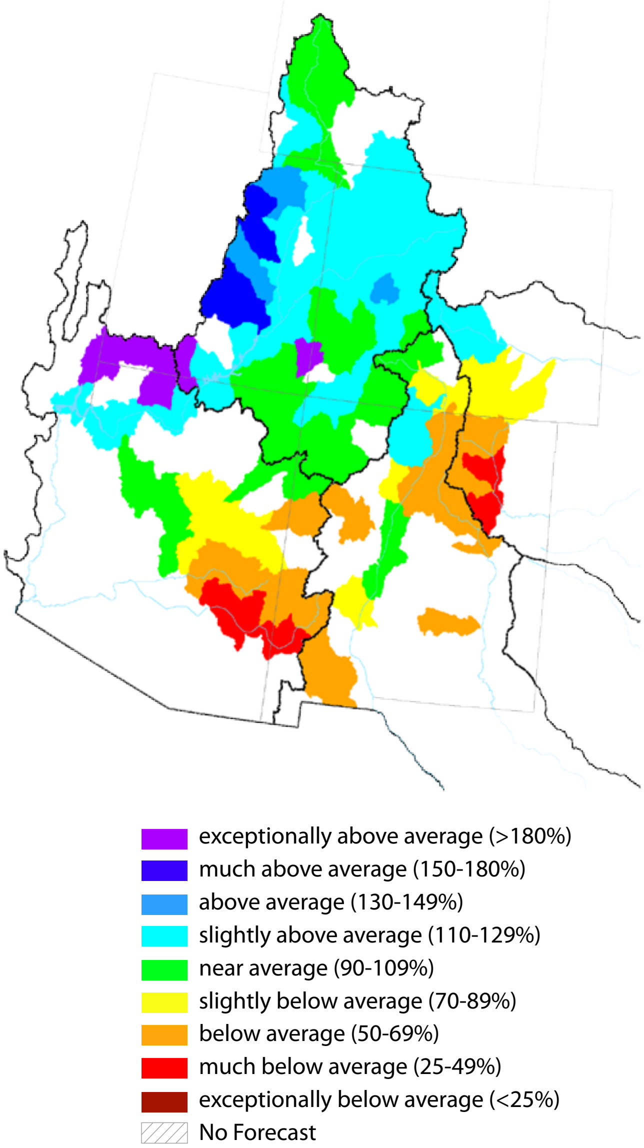
On the Web:

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

Figure 12. Spring and summer streamflow forecast as of January 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.

El Niño Status and Forecast

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

Moderate to strong La Niña conditions continue to dominate much of the equatorial Pacific Ocean, upholding the current A La Niña Advisory issued by the NOAA-Climate Prediction Center (CPC) in August 2010. Sea surface temperatures (SSTs) slightly cooled in early January, indicating the event is persisting and is showing no immediate signs of weakening. Across much of tropical Pacific Ocean SSTs were greater than 2 degrees Celsius (about 3.5 Fahrenheit) below average with isolated pools of temperatures greater than 2.5 degrees C (about 4.4 F) below average. The Southern Oscillation Index (SOI) and wind currents along the equator suggest a strong atmospheric response to the cold SSTs (Figure 13a). The International Institute for Climate and Society (IRI) notes that a large amount of unusually cold water lies just below the surface across much of the eastern Pacific Ocean. This cold reservoir most likely will make its way to the surface in coming months, helping to reinforce La Niña conditions through the upcoming spring season and perhaps prolong the event.

Official forecasts produced by IRI indicate a high probability that La Niña conditions will continue to persist into the spring season (Figure 13b). Current forecasts indicate a 98 percent chance that La Niña conditions will continue through the January–March period and a 67 percent chance for conditions persisting through the March–May period. The probability of neutral conditions returning to the Pacific Ocean rises to 50 percent by the May–July period. Given the strength of the current La Niña event and the high probability that it will continue through the remainder of the winter season, there is a high chance that the Southwest U.S. will continue to experience below-average precipitation, particularly in southern parts of the region where the influence of La Niña is most strongly felt. La Niña events typically cause winter season storms to track north of the region.

Notes:

The first figure shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through December 2010. 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/

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

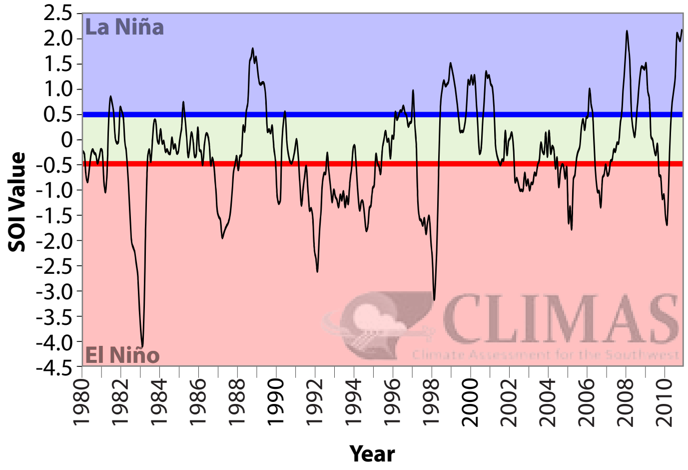
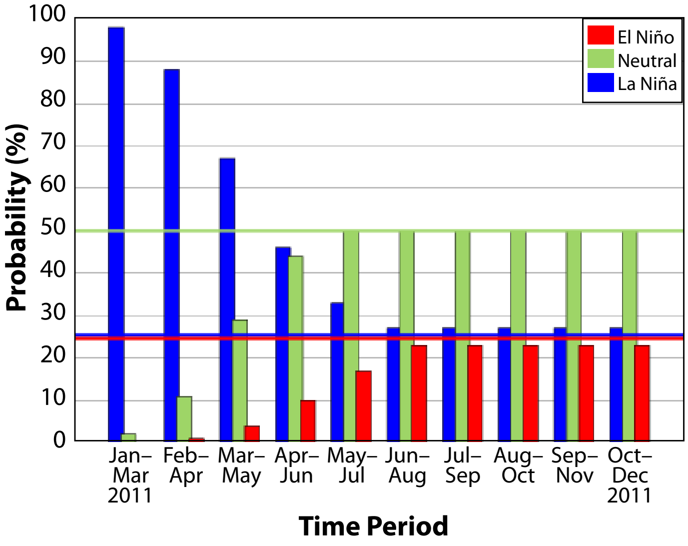


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released January 20). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification

(February 2011–July 2011)

Data 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 February–April to forecasts issued in January for the same period suggest that forecasts have not been more accurate than a forecast of equal chances (i.e., 33 percent chance that temperature will be above-, below-, or near-average) in all of Arizona and about half of New Mexico (Figure 14a). Forecast skill—a measure of the accuracy of the forecast—is substantially higher than equal chances in southeast Arizona for this period. For the March–May period, forecasts have been better than equal chances in all of Arizona, while forecasts in New Mexico have fared only slightly better than equal chances (Figure 14b). For the three-month lead times, forecasts issued in January generally have been more accurate in Arizona than in New Mexico (Figure 14c). Forecasts for the May–July period have been substantially more accurate than equal chances in Arizona (Figure 14d). While bluish hues suggest that NOAA–Climate Prediction Center (CPC) historical forecasts have been more accurate than equal chances, 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 February–April 2011.

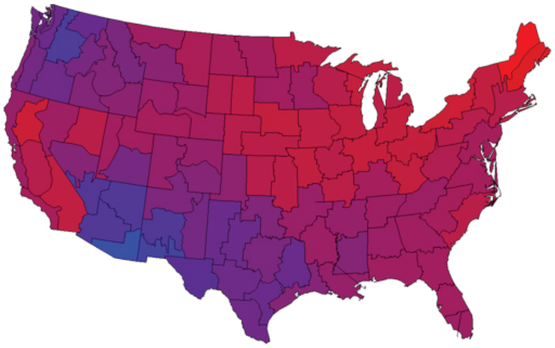


Figure 14b. RPSS for March–May 2011.

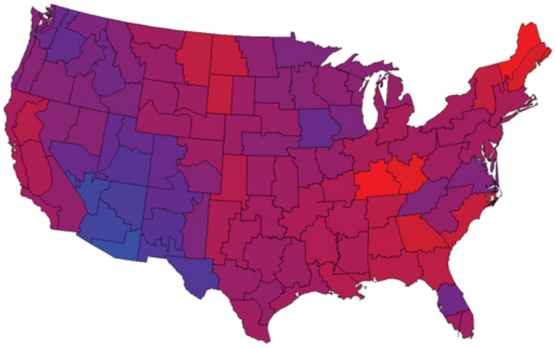


Figure 14c. RPSS for April–June 2011.

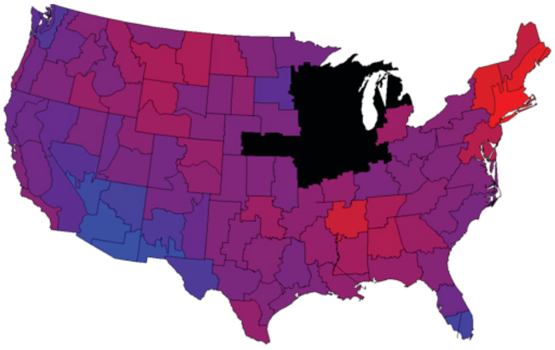
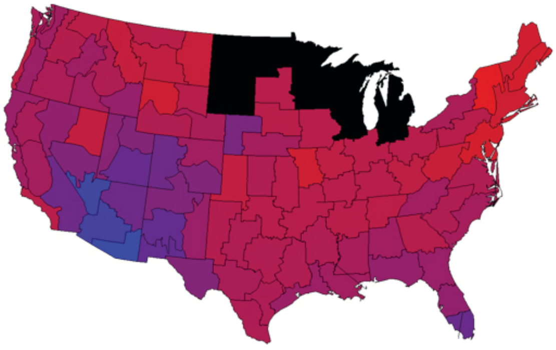


Figure 14d. RPSS for May–July 2011.



■ = NO DATA (situation has not occured)

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/feature-articles/november-2005

Precipitation Verification

(February 2011–July 2011)

Data 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 February–April to forecasts issued in January for the same period suggest that forecasts only in southwest New Mexico and southeast Arizona have been substantially more accurate than an equal chances forecast (Figure 15a). Forecast skill—a measure of the accuracy of the forecast—has been highest in northwest Arizona (Figure 15b). For the three-month lead time, forecasts in most of Arizona and New Mexico have been less accurate than an equal chances forecast (Figure 15c). The black zones in the four-month lead time forecasts occur because the NOAA–Climate Prediction Center (NOAA–CPC) has always issued an "equal chances" forecast for that region and time period, which precludes verification (Figure 15d). 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 February–April 2011.

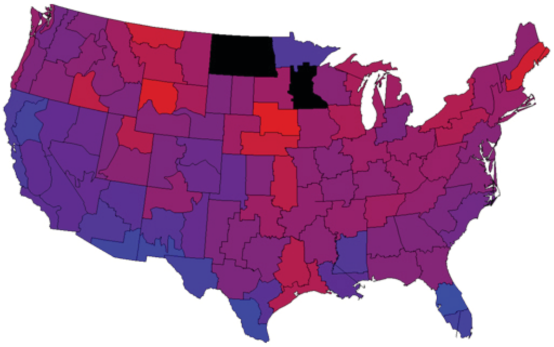


Figure 15b. RPSS for March–May 2011.

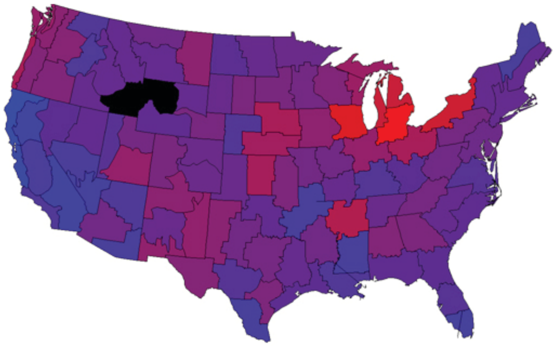


Figure 15c. RPSS for April–June 2011.

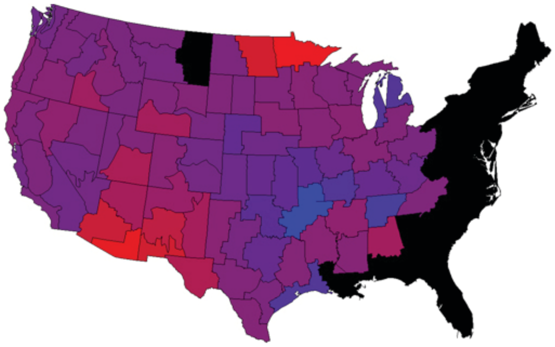
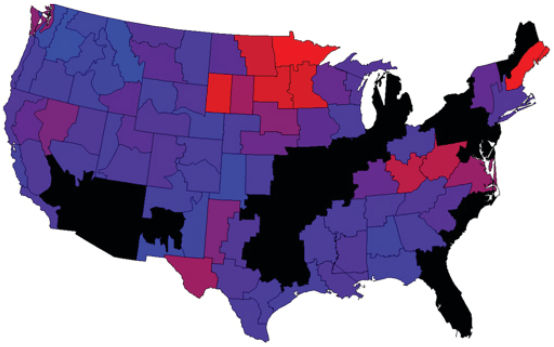
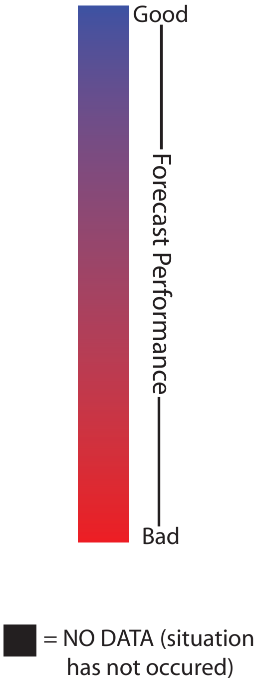


Figure 15d. RPSS for May–July 2011.





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