

Southwest Climate Outlook

Vol. 9 Issue 1



Source: Jan Curtis, National Resources Conservation Service. January 25, 2010.

Photo Description: Powerful storms draped the Flagstaff, Arizona, area in deep snow; some places recorded more than 55 inches. This moonscape-like image shows SP Crater, north of Flagstaff on the morning of January 25.

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

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El Niño and La Niña are words frequently tossed around to explain weather conditions in the Southwest. The sibling events, born thousands of miles away in the air over the tropical Pacific Ocean and in its waters, can deliver copious rain and snow to the region or cause widespread drought...

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The first spring–summer streamflow forecast for the Southwest, issued on January 1, shows near-average to above-average flows for basins in the Mogollon Rim region of Arizona, below-average flows for most of the Upper Colorado River Basin...

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Moderate El Niño conditions continued through December and January, with sea surface temperatures (SSTs) remaining 1.5 degree Celsius above average across much of the central and eastern parts of the equatorial Pacific Ocean...



January Climate Summary

Drought— Moderate to severe drought conditions remain across Arizona due to the exceptionally dry 2009 summer and fall. Dry conditions in December and the first half of January have expanded the abnormally dry drought status across central and southern New Mexico. Recent storms, however, will likely improve subsequent drought conditions.

Temperature— New Mexico and the Colorado Plateau have been cooler than average, while warm conditions continue in southwestern Arizona.

Precipitation— Recent storms in January are following the typical El Niño circulation pattern, bringing wet conditions to the Southwest.

ENSO— El Niño conditions remained at moderate levels this past month with sea surface temperatures exceeding 1.5 degrees Celsius in the central and eastern equatorial Pacific Ocean. Weak to moderate El Niño conditions are expected to persist through the remainder of the winter and into early spring.

Climate Forecasts— Forecasts call for equal chances of above-, below-, and near-average temperatures through Arizona and western New Mexico into April. Precipitation forecasts suggest above-average precipitation for most of the Southwest through May, mostly due to the current moderate-to-strong El Niño event.

The Bottom Line— A series of Pacific storms beginning on January 17 and lasting about five days drenched the Southwest, dropping record-setting snow and rain in many areas of Arizona and New Mexico. These storms interrupted what had been a dry winter and finally reflected the influence of El Niño, which often causes the storm track to pass over the Southwest. Although the highlights in this issue do not reflect all of the precipitation that fell during late January, drought conditions will not be completely alleviated by one wave of storms. More winter precipitation will likely be on the way, as El Niño is forecasted to remain for at least a few more months.

Winter storms wallop Southwest

Three powerful winter storms rolled into the Southwest one after the other beginning on Monday, January 18. By Saturday, most of Arizona and the western half of New Mexico had been doused in heavy rain and snow and battered by strong winds. During the week, winds gusting up to 94 miles per hour pounded Tucson. On the evening of January 21, Sky Harbor International Airport in Phoenix recorded the lowest air pressure on record at that station, and by the time the clouds gave way to blue skies two days later, the Flagstaff area reported between 55 and 65 inches of snow.

Flagstaff's snowfall accumulation during the five days of stormy weather ranks among the area's top three largest snowfall events, said Brian Klimowski, meteorologist for the National Weather Service in Flagstaff. Most regions in northern Arizona received 20–30 percent of their annual precipitation in one week, he said.

The series of storms were swept into the region by a southerly jet stream that was strengthened and positioned over the Southwest in part by El Niño. El Niño, which often brings above-average rain and snow to the region, is currently a moderate-to-strong event and is forecasted to persist into the spring. More rain and snow is necessary to considerably improve drought conditions in many regions of the Southwest and make up for 2009 summer and fall precipitation deficits.

Disclaimer – This packet contains official and non-official forecasts, as well as other information. While we make every effort to verify this information, please understand that we do not warrant the accuracy of any of these materials. The user assumes the entire risk related to the use of this data. CLIMAS, UA Cooperative Extension, and the State Climate Office at Arizona State University (ASU) disclaim any and all warranties, whether expressed or implied, including (without limitation) any implied warranties of merchantability or fitness for a particular purpose. In no event will CLIMAS, UA Cooperative, and the State Climate Office at ASU or The University of Arizona be liable to you or to any third party for any direct, indirect, incidental, consequential, special or exemplary damages or lost profit resulting from any use or misuse of this data

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El Niño–Southern Oscillation: the causes, impacts in the Southwest, and future

By ZACK GUIDO

El Niño and La Niña are words frequently tossed around to explain weather conditions in the Southwest. The sibling events, born thousands of miles away in the air over the tropical Pacific Ocean and in its waters, can deliver copious rain and snow to the region or cause widespread drought.

Perhaps no other natural phenomenon influences the weather and climate of the Southwest more than El Niño and La Niña. However, the causes and consequences of these events are mysterious to many people. How can changes off the coast of Peru ripple across the globe to steer rain away from Arizona? Why does El Niño soak southern Arizona during the

winters but reduce snowfall in parts of the Rocky Mountains? Will climate change cause more El Niño or La Niña events, and if so, what does this mean for Arizona and New Mexico? Understanding the weather and climate of the Southwest isn't complete without a working knowledge of El Niño and La Niña.

The forces at play

El Niño and La Niña are part of the El Niño–Southern Oscillation (ENSO), a natural seesaw in oceanic sea surface temperatures and surface air pressure between the eastern and western tropical Pacific Ocean. The causes for this fluctuation have been studied since the 1950s, when ENSO became widely accepted in the scientific community.

ENSO's inner workings are complicated. The rotation of the Earth causes trade

winds in low latitudes to blow hard from the east, pushing warm surface water in the tropical Pacific Ocean westward near the northern coast of Australia like a snow plow.

As the warm water pools, it works in tandem with intense solar rays to heat the surrounding air. The hot air then rises like a balloon, creating a zone of low air pressure.

As the air ascends, it cools and condenses, forming cotton-ball clouds that burst with rain. That air then travels east and descends near the coast of Peru and Ecuador. Sinking air piles on the Earth's surface, forming a high pressure zone that acts like a vice. The pressure difference squeezes air in the east toward the west, where it fills the void created by the hot, rising air.

In this way, a large circular pattern known as the Walker circulation is completed. Although the Walker circulation is always in motion, its movement is tuned by El Niño and La Niña events, which regulate sea surface temperatures and wind speed.

During El Niño events, the trade winds slacken, enabling an eastward migration of warm water. The center of rain follows, moving east to the middle of the Pacific Ocean near Tahiti.

La Niña events behave in the opposite way; the trade winds intensify and stack the warm surface water in the west even more than in normal years—the waters near Australia are often five feet higher than the ocean surface in the east during La Niña episodes (Figure 1). The area of intense rainfall is dragged back toward Australia.

One event often lasts less than a year and returns two to seven years later. In the meantime, the ocean and atmosphere are either in the La Niña or El Niño phase or

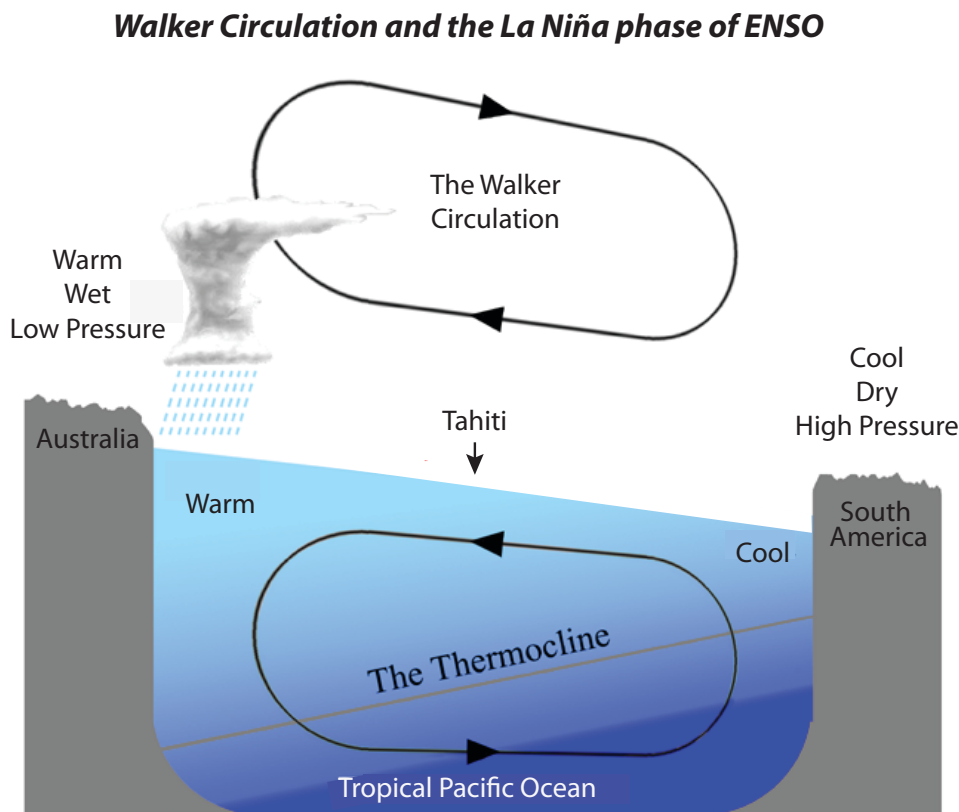


Figure 1. La Niña events modify the Walker circulation—the circular flow in air over the tropical Pacific Ocean—while moving the location of warm sea surface waters and intense rain. These changes, and those caused by El Niño episodes, impact the weather in the US Southwest.

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El Niño, continued

hovering around the historical average, deemed “neutral” conditions.

The transition from one event to another is a natural example of a climate system regulating itself. ENSO events would become stronger and stronger without a switch. In a La Niña, for example, a self-reinforcing cycle would begin with strong trade winds, which would enhance the pressure difference between the east and west. This would in turn cause stronger winds, amplifying La Niña on and on.

This doesn't occur. Instead, El Niño and La Niña events flip-flop because the air and oceans respond to each other at different speeds. Winds react to the warming or cooling sea surface temperatures within days. It takes the ocean months to respond to changes in the winds. A memory of the departed winds is expressed as a wave that develops and propagates along a temperature boundary called the thermocline, which separates deeper, cold water from warmer, surface water.

For example, strong winds push warm water westward during a La Niña, which creates a valley in the thermocline and increases the thickness of the pool of warm water. The valley then migrates east toward Peru. When it reaches the coastal region it warms the water there, setting up conditions for an El Niño. The interval between one El Niño or La Niña and another is therefore determined by the speed of the subsurface wave.

Defining El Niño and La Niña

ENSO events are commonly defined by how high or low sea surface temperatures are compared to the average. An El Niño event is judged to have taken hold when average monthly temperatures in a defined region in the middle tropical Pacific Ocean exceed 0.4 degrees Celsius (approximately 0.7 degrees Fahrenheit) and endure for more than five consecutive months.

Higher temperature differences create

stronger events. In the winter of 1997–1998, during one of the strongest El Niño events recorded, the average sea surface temperature difference was about 2.4 degrees C above average (approximately 4.3 degrees F). La Niña events have the same criteria but require that the temperature difference be greater than 0.4 degrees C below average.

To reveal how ENSO events alter atmospheric circulation, the Southern Oscillation Index, or SOI, evaluates the pressure difference in the central and western Pacific Ocean. The SOI is calculated based on the differences in air pressure anomalies between Tahiti and Darwin, Australia. A negative SOI, which is characteristic of El Niño events, indicates air pressure over Tahiti is less than at Darwin. Both the sea surface temperature index and the SOI are used together to help evaluate several factors, including the early and late stages of an ENSO event when conditions are not obvious, the duration of the events, and their strength.

The effect of ENSO on weather in the Southwest

El Niño and La Niña episodes tend to develop between April and June and peak between December and January, when sea surface temperatures reach their warmest and coldest states, respectively. As a result, changes to atmospheric circulation, and therefore weather, are most prominent in the winter.

The ENSO fingerprint on the Southwest is principally caused by shifting jet streams. During El Niño events, the Pacific jet stream is straighter and is pulled south (Figure 2), and storms form in the Pacific Ocean just west of California, in part because waters are warmer than average in this region during El Niño events. The combination of the jet stream and storms often results in a wet winter and increased rain and snow across California and the southern United States.

La Niña events, on the other hand, often bring dry conditions to Arizona and New Mexico. In La Niña winters, the jet streams take a more serpentine path. The Pacific jet stream usually carves north and enters North America through the northwestern US, bringing wetter-than-average conditions to that region and diverting storms away from the Southwest.

The effect El Niño and La Niña events have on the weather is nuanced. An El Niño does not always cause wet winters, nor does a La Niña consistently deliver dry conditions. Between 1896 and 2002 in Arizona, for example, about 50 percent of the winters experiencing an El Niño event received more than 115 percent of average precipitation, while roughly 25 percent of the winters received less than 85 percent of the average.

The amount of precipitation during ENSO events also changes by region in Arizona and New Mexico and beyond. During an El Niño, the southern regions of both states often receive more winter rain and snow than northern regions.

Critical winter precipitation for the Southwest also falls as snow in the headwaters of Arizona's most important river, the Colorado. About 70 percent of that water originates in the mountains of Utah, Wyoming, and Colorado. However, when the southern regions of the Southwest are wet, precipitation in the Upper Colorado River Basin is often average or below average.

For example, during El Niño events between 1896 and 2002, the Colorado portion of the Upper Colorado River Basin received less than 115 percent of average precipitation about 60 percent of the time; it experienced dry conditions in which rain and snow measured less than 85 percent of average nearly one-third of the time. During this same period, the Arizona portion of the Lower Colorado

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El Niño, continued

River Basin experienced wet conditions with rainfall greater than 115 percent of average about half of the time.

The impact of ENSO on summer weather is not as clear-cut as the changes that occur in winter. El Niño events often are associated with two phenomena that have opposite effects on precipitation in the Southwest. On one hand, an El Niño can stifle summer rains in Arizona and New Mexico because they can weaken and reposition the subtropical high that guides moisture into the Southwest. On the other hand, El Niño events also can foment a higher number of tropical storms, some of which deliver copious summer and fall rains to the region.

The future of ENSO

Debate continues about whether the character of ENSO events will change as the world warms in response to increased levels of greenhouse gases. One hypothesis suggests that a warmer world will cause stronger or more frequent El Niño events, which would help moderate warming because much of the heat released from the ocean during El Niño years eventually makes its way into space.

The other hypothesis calls for a spike in La Niña events, which would help mitigate global warming by sequestering some of the incoming heat into deeper waters. Because both El Niño and La Niña play a prominent role in the weather of the Southwest, changes will have consequences. A more La Niña-like future could

strain already limited water resources, and more intense events could deliver more frequent floods or droughts.

To help resolve this debate, scientists are monitoring ENSO and using climate models to simulate future conditions. A recent study shows that the easterly trade winds have weakened and suggests this may be behind the prevalence of more El Niño-like conditions in recent years.

Other studies have documented a change in the location of intense rainfall and the pattern of sea surface temperatures of El Niño events, and a decrease in the vigor of the Walker circulation. Although these observations and projections are insufficient to foretell the future, it is clear that ENSO is on the move.

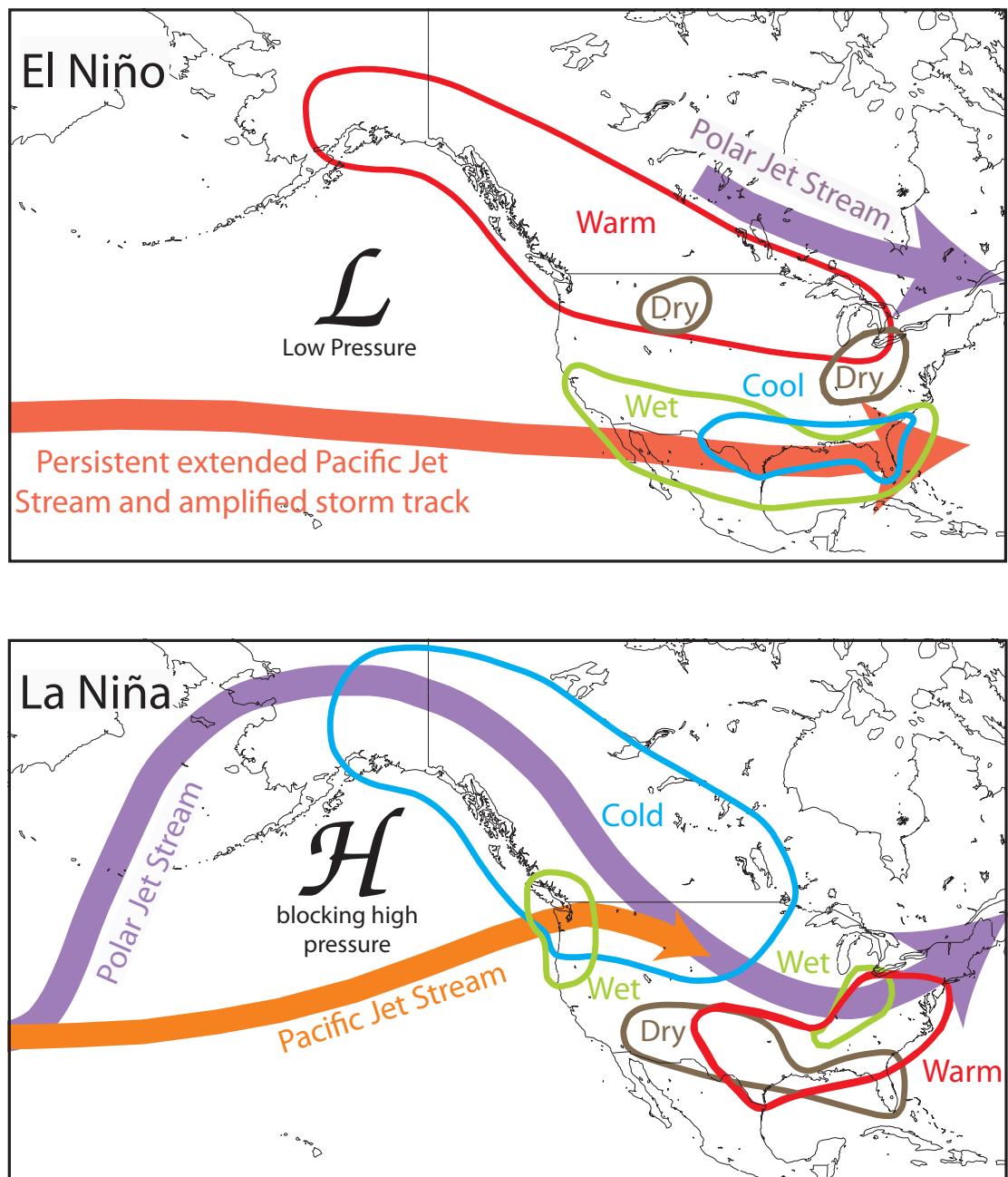


Figure 2. El Niño and La Niña events cause the path of the jet streams to move over the US in different locations, often causing wet winters during El Niño episodes and dry winters during La Niña events in the Southwest.

Temperature (through 1/20/10)

Source: High Plains Regional Climate Center

Temperatures since the beginning of the water year on October 1 have averaged 55–65 degrees Fahrenheit in the southwest deserts of Arizona, 45–55 degrees F in southern New Mexico, and 35–45 degrees F on the Colorado Plateau in Arizona and the northern two-thirds of New Mexico (Figure 1a). The highest elevations in Arizona and New Mexico have averaged 20–35 degrees F. These temperatures have been 0–2 degrees F colder than average across the Colorado Plateau and most of New Mexico (Figure 1b), and a few locations in northwestern and southwestern New Mexico have been 2–4 degrees F colder than average. The southwestern two-thirds of Arizona, including the high elevation areas in the White Mountains along the Arizona-New Mexico border and the higher elevations of central and southern Arizona, have been 0–2 degrees F warmer than average.

Temperatures during the past 30 days have been 0–2 degrees F warmer than average in southwestern Arizona and the northeast corner of New Mexico, and generally 0–4 degrees F colder than average elsewhere in both states (Figures 1c–d). A few locations in northwest and west-central New Mexico and east-central Arizona have been 4–6 degrees colder than average. These low temperatures have been the result of two cold winter storms in late December that dipped down into northeastern Arizona and New Mexico, missing the southwestern half of Arizona.

Notes:

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

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

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

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

On the Web:

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

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

Figure 1a. Water year '09–'10 (through January 20, 2010) average temperature.

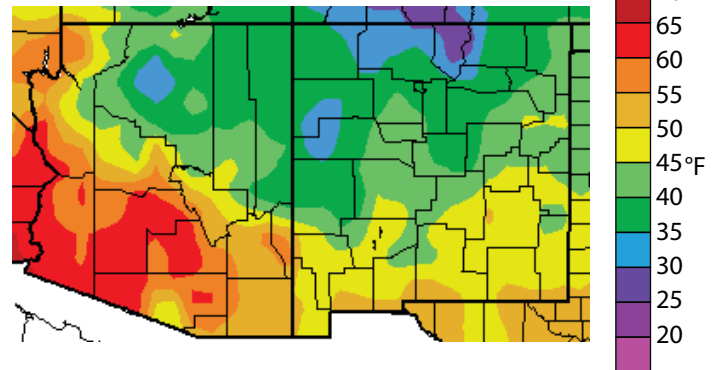


Figure 1b. Water year '09–'10 (through January 20, 2010) departure from average temperature.

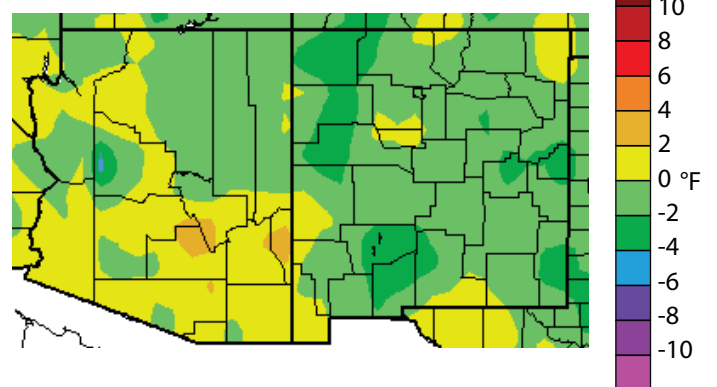


Figure 1c. Previous 30 days (December 22, 2009–January 20, 2010) departure from average temperature (interpolated).

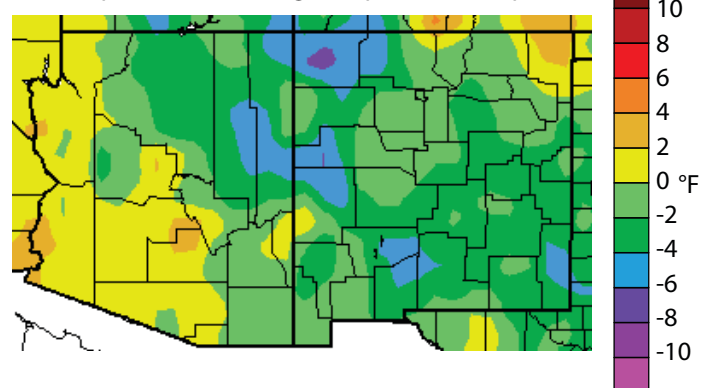
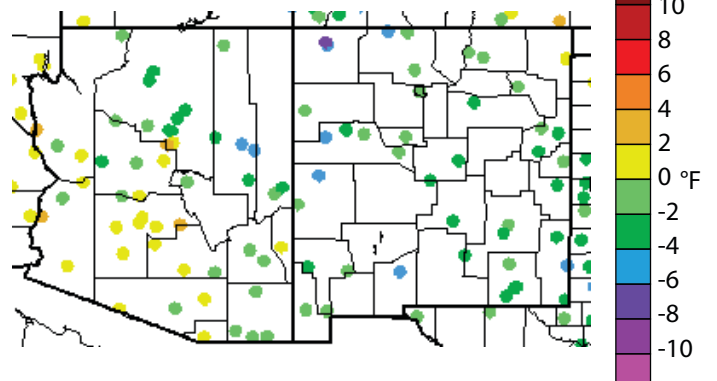


Figure 1d. Previous 30 days (December 22, 2009–January 20, 2010) departure from average temperature (data collection locations only).



Precipitation (through 1/20/10)

Source: High Plains Regional Climate Center

The 2010 water year began on Oct. 1 with dry conditions across Arizona and southwestern New Mexico. During November and December, several winter storms swept across the Southwest, but the precipitation was highly variable and localized. Most of Arizona and western New Mexico remained at less than 70 percent of average precipitation through January 20 (Figures 2a–b). Southeastern New Mexico and the higher elevations in northern New Mexico have received more than 100 percent of average precipitation for the water year. A narrow area in west-central Arizona also has received slightly above-average precipitation. These totals, however, do not include the most intense period of the record precipitation that fell during the recent storms.

Most of the precipitation of the water year fell within the past 30 days. Two storms in late December and two storms on January 19 and 20 improved conditions across most of Arizona, which had logged less than 25 percent of average precipitation. The storms produced 100 to more than 300 percent of average precipitation across central Arizona and northwest, west-central, and southeast New Mexico (Figures 2c–d). The most recent storms are the result of a typical El Niño circulation that brings very cold air southward and taps into the extremely moist subtropical jet stream. This circulation is expected to continue into early spring, which should result in wetter-than-average conditions across all areas of the Southwest.

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 January 20, 2010) percent of average precipitation (interpolated).

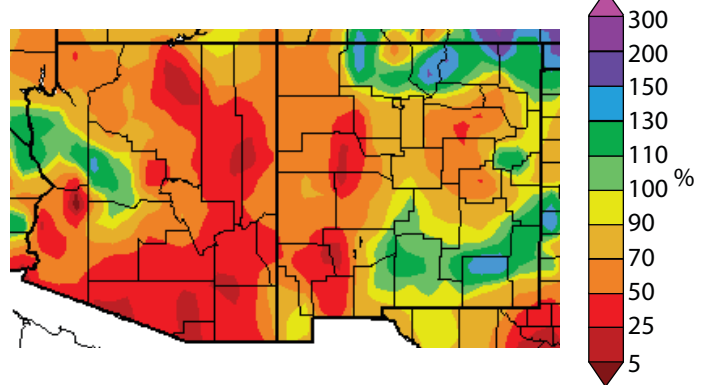


Figure 2b. Water year '09–'10 (through January 20, 2010) percent of average precipitation (data collection locations only).

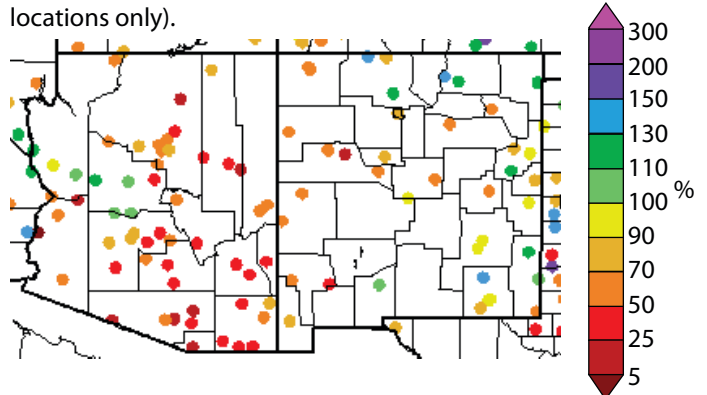


Figure 2c. Previous 30 days (December 22, 2009–January 20, 2010) percent of average precipitation (interpolated).

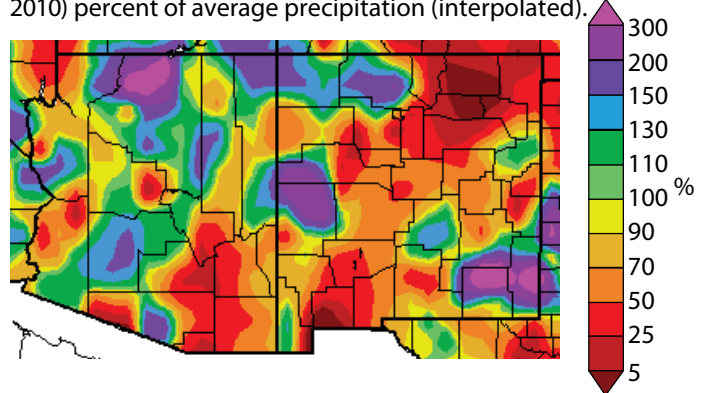
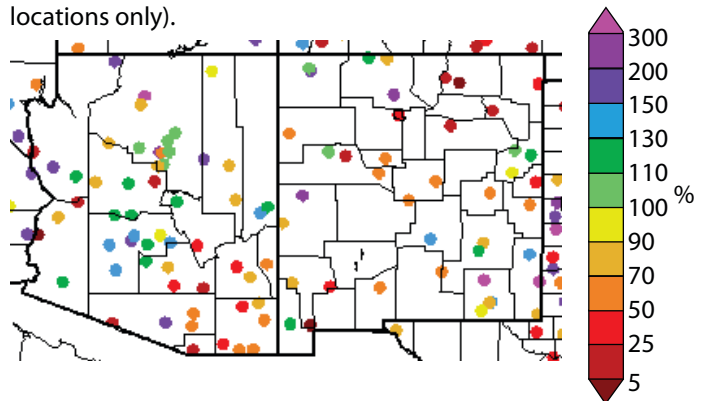


Figure 2d. Previous 30 days (December 22, 2009–January 20, 2010) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 1/21/10)

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

A dry December caused an expansion of drought conditions across the northern Rockies this past month. Northern Utah, eastern Idaho, and western Wyoming slid from normal status to abnormally dry and moderate drought, according to the January 19 update of the National Drought Monitor. Moderate to severe drought conditions persisted across much of California, Nevada, and Arizona. Abnormally dry conditions also expanded across central and southern New Mexico. More than 67 percent of the western US is observing some level of drought, with 13.6 percent at a severe level or greater.

Until recent Pacific storms began to batter the western US, particularly California and Arizona, there was little reason for

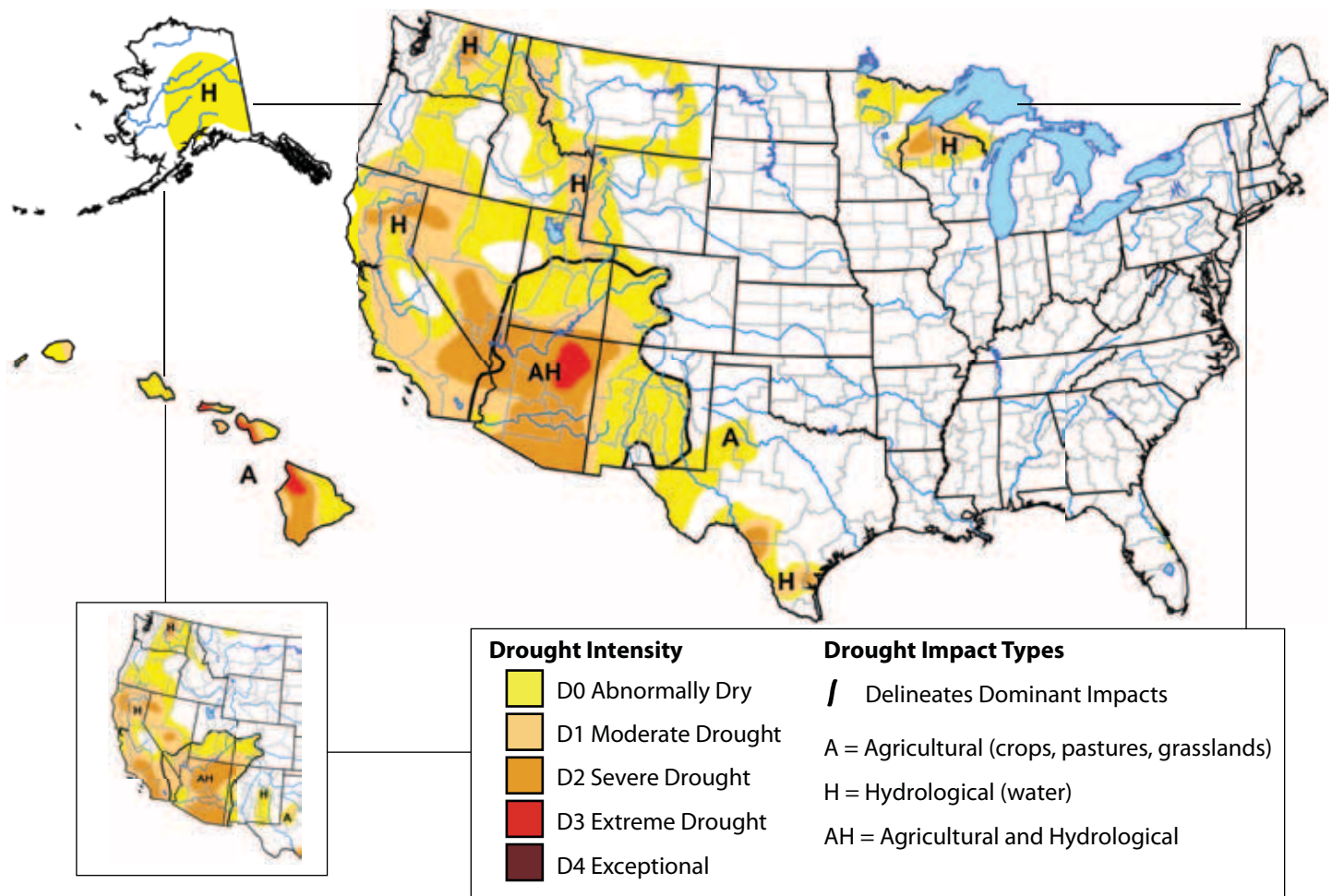
any drought improvement in the Southwest. The situation rapidly changed as the first in a series of Pacific storms hit California, with heavy precipitation and severe weather on January 17–18. Although it is not reflected in this issue of the Drought Monitor, heavy precipitation continued in parts of the Southwest through January 23.

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 David Miskus, NOAA/NWS/NCEP/CPC

Figure 3. Drought Monitor released January 21, 2010 (full size), and November 19, 2009 (inset, lower left).



On the Web:

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

Arizona Drought Status (released 1/21/10)

Source: U.S. Drought Monitor

Drought conditions across Arizona remained largely unchanged from the previous month, according to the January 19 update of the National Drought Monitor map. The entire state has abnormally dry conditions or worse, and about 78 percent of Arizona is classified as experiencing severe drought (Figures 4a–b). Severe drought conditions expanded slightly west across Mohave County to reflect residual drought impacts that continue to be felt from the exceptionally dry 2009 summer and fall. Precipitation in December and early January was spotty and left most of the state with average to below-average precipitation. This did little to improve short-term drought conditions across Arizona. However, recent storms soaking the region beginning on January 18 may influence drought conditions in February.

Several drought impact reports were submitted to Arizona DroughtWatch in December detailing specific observations in watersheds across southeast Arizona. Municipal officials and resource managers in Pima County, for example, noted a dramatic episode of plant mortality and shift in composition at a field site in the Tucson area due to dry summer and fall conditions. They also noted a need for supplemental irrigation of vegetation at a municipal site and subsequent costs due to lack of precipitation. Continued rangeland impacts and vegetation stress also were reported by agricultural producers in Graham and Greenlee Counties. Visit <http://azdroughtwatch.org> for more drought-related impact reports across Arizona.

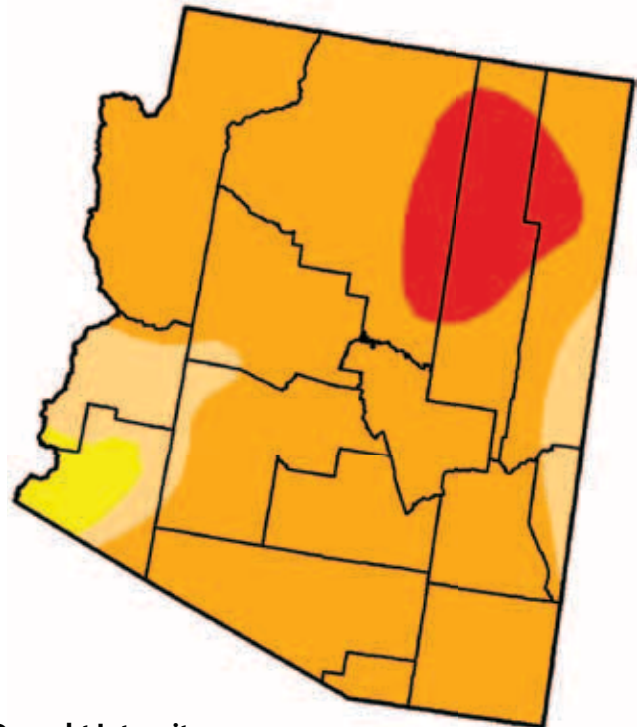
Notes:

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 19.



Drought Intensity



Figure 4b. Percent of Arizona designated with drought conditions based on data through January 19.

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.0	100.0	97.3	88.0	9.6	0.0
Last Week (01/12/2010 map)	0.0	100.0	97.3	88.0	9.6	0.0
3 Months Ago (10/27/2009 map)	0.0	100.0	84.6	53.5	0.0	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 (01/20/2009 map)	62.3	37.7	1.0	0.0	0.0	0.0

New Mexico Drought Status

(released 1/21/10)

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

Abnormally dry conditions have expanded across much of central and southern New Mexico this past month, according to the January 19 update of the National Drought Monitor (Figures 5a–b). Dry conditions in November and December have worsened drought conditions across these regions. North-central and northeastern New Mexico remain drought-free due to above-average precipitation delivered to this area in December by a strong early-winter storm. Currently, more than 70 percent of New Mexico is experiencing some level of drought, up from 43 percent in mid-December (Figure 5b). In comparison to late October, drought conditions have expanded from covering only about 21 percent of the state to more than 70 percent. As a result, approximately 58 percent of the state has very dry moisture levels in the shallowest 6 inches in the topsoil, according to the US Department of Agriculture.

The U.S. House of Representatives approved the Taos Pueblo Indian Water Rights Settlement Act and the Aamodt Litigation Settlement Act. These measures assure water resources for the Nambe, Pojoaque, San Ildefonso, Tesuque, and Taos pueblos, while also providing for non-Indian water needs in the region (Associated Press, January 21).

Figure 5a. New Mexico drought map based on data through January 19.

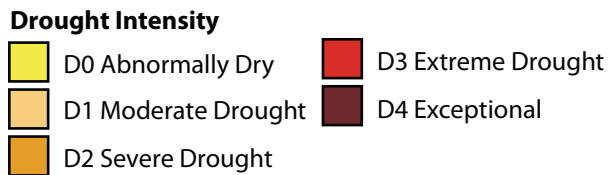
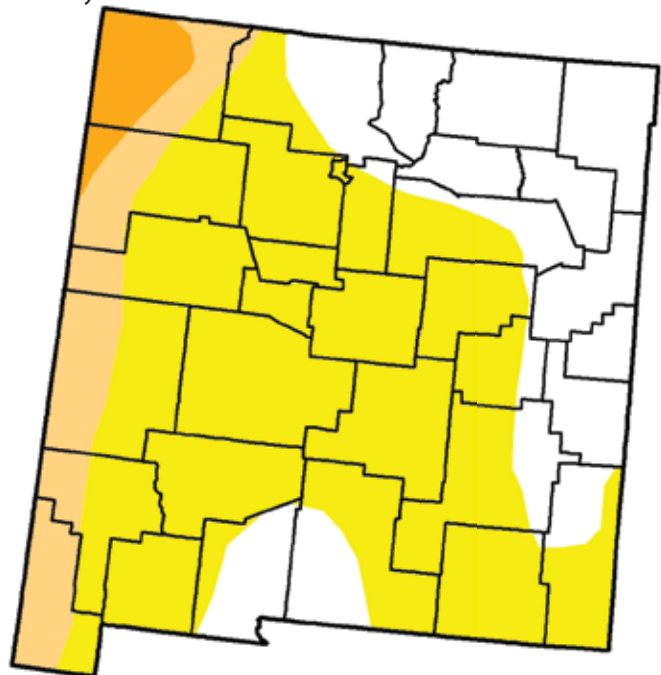


Figure 5b. Percent of New Mexico designated with drought conditions based on data through January 19.

	<i>Drought Conditions (Percent Area)</i>					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	29.5	70.5	13.1	3.0	0.0	0.0
Last Week (01/12/2010 map)	29.5	70.5	13.1	3.0	0.0	0.0
3 Months Ago (10/27/2009 map)	79.2	20.8	5.5	2.1	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 (01/20/2009 map)	69.8	30.2	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 12/31/09)

Source: NRCS, National Water and Climate Center

Water storage in Lake Powell declined by 556,000 acre-feet in December and currently stands at 59 percent of capacity (Figure 6). Observed unregulated inflow into Lake Powell in December was 71 percent of the 30-year average, according to the U.S. Bureau of Reclamation. Lake Mead, on the other hand, gained 250,000 acre-feet in December. Combined storage in the Salt and Verde river basin systems increased in December and remains well above average. As of January 21, storage in the San Carlos reservoir was still at minimum pool level—the minimum amount required to protect fish—and releases to irrigators were being curtailed.

In water-related news, a new dam is about 88 percent complete in Southern California, about 25 miles west of Yuma, Arizona. The dam will store water that is often not used (*Yuma Daily Sun*, January 2). The Central Arizona Project, Metropolitan Water District of Southern California, and the Southern Nevada Water Authority are funding the project.

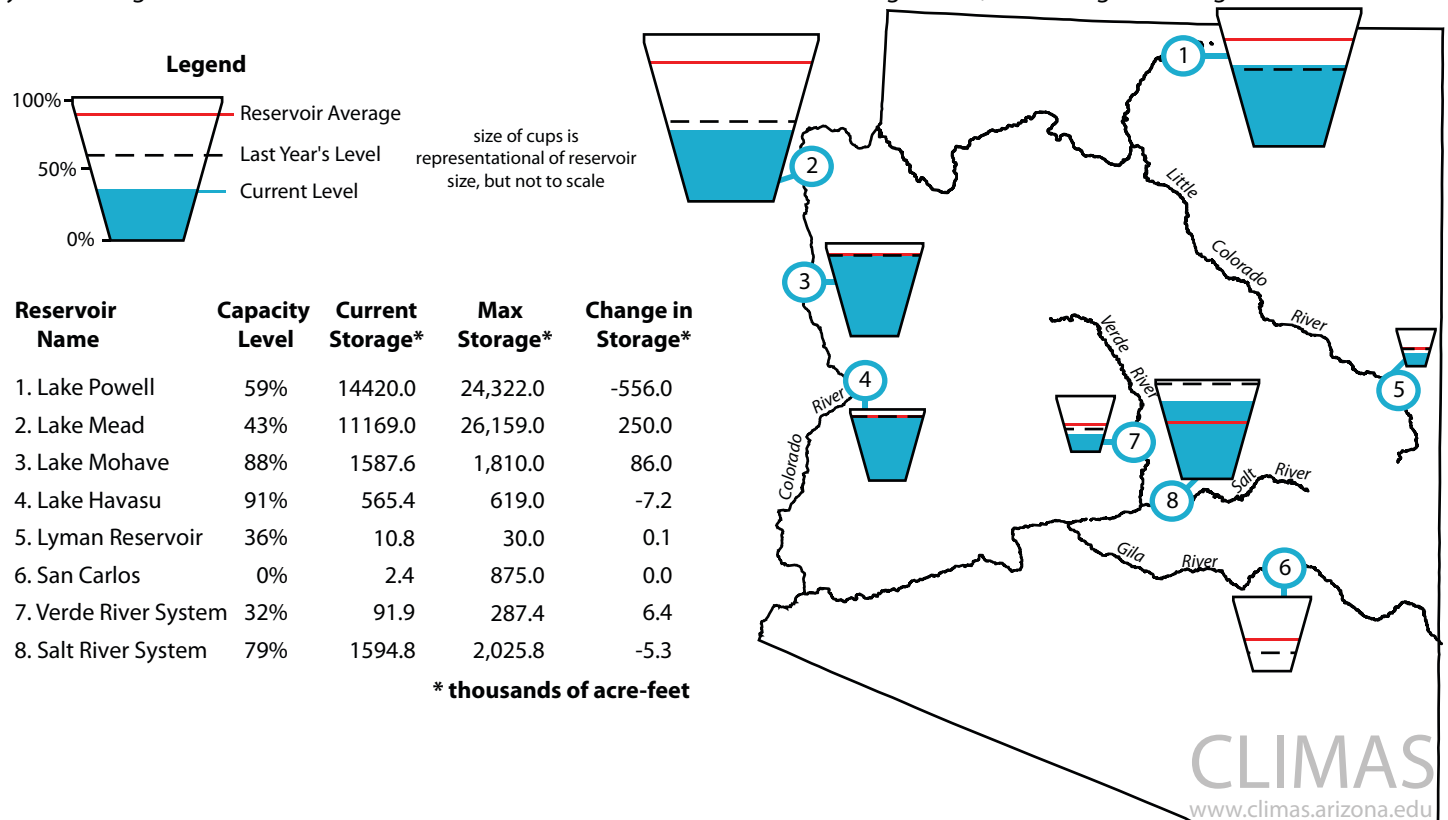
Notes:

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



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 12/31/09)

Source: NRCS, National Water and Climate Center

The total reservoir storage in New Mexico increased by about 13,700 acre-feet in December (Figure 7). The largest storage decreases were in the Navajo and Heron reservoirs, which combined for a loss of about 31,000 acre-feet. Elephant Butte, however, gained 35,900 acre-feet.

In water-related news, the US Section of the International Boundary and Water Commission has awarded federal stimulus funds to rehabilitate Rio Grande levees (KRWG News, January 14). Levee improvements will help mitigate the risk of flood damage, like that which occurred during the September 2006 floods.

The Portales City Council voted to support New Mexico House Bill 15, which would establish an Eastern New Mexico Water Utility Authority to manage the Ute Water Pipeline project (Pntonline.com, January 19). Under the bill, the lion's share of funding must come from the federal government.

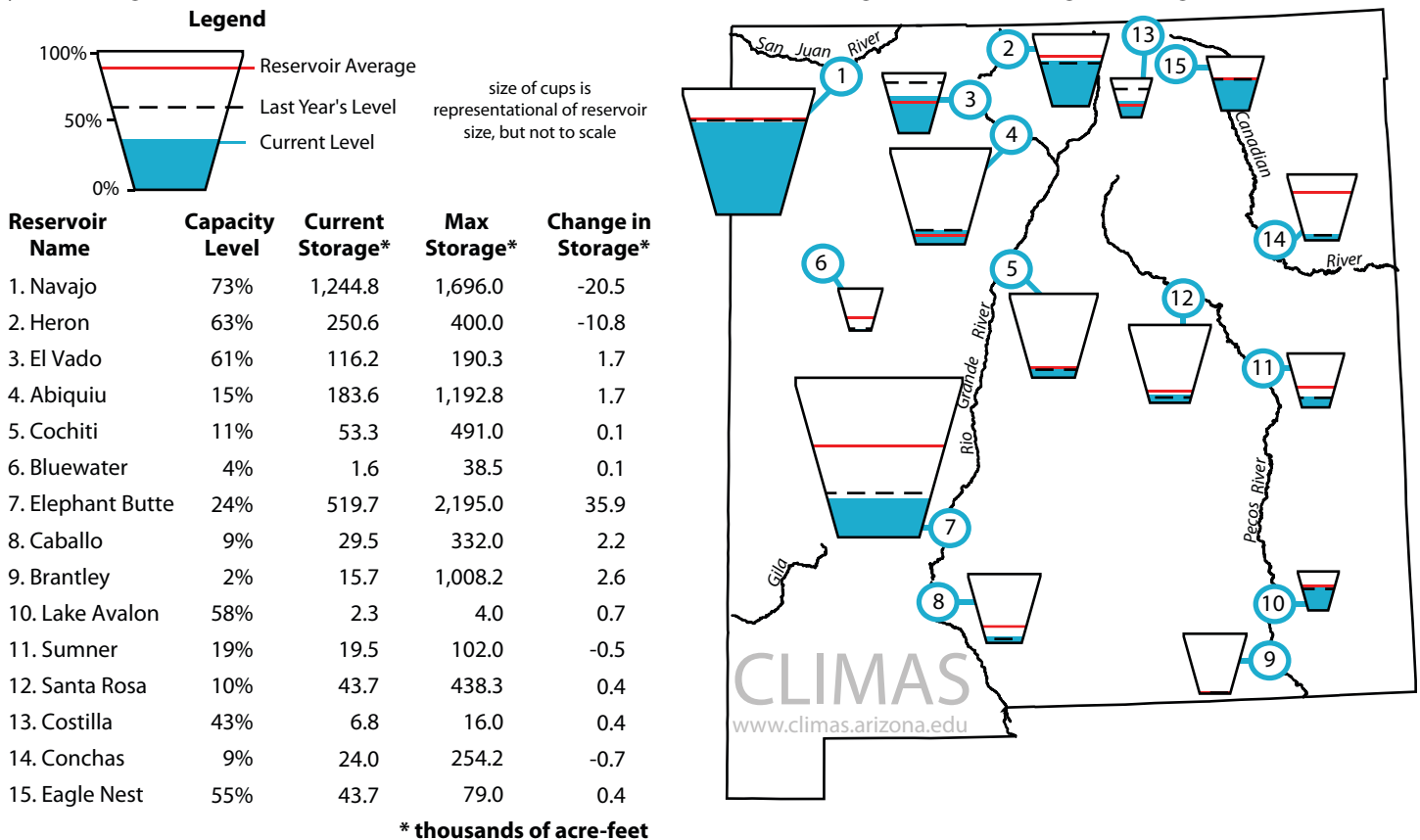
Notes:

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

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

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

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



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/revs_rpt.html

Southwest Snowpack

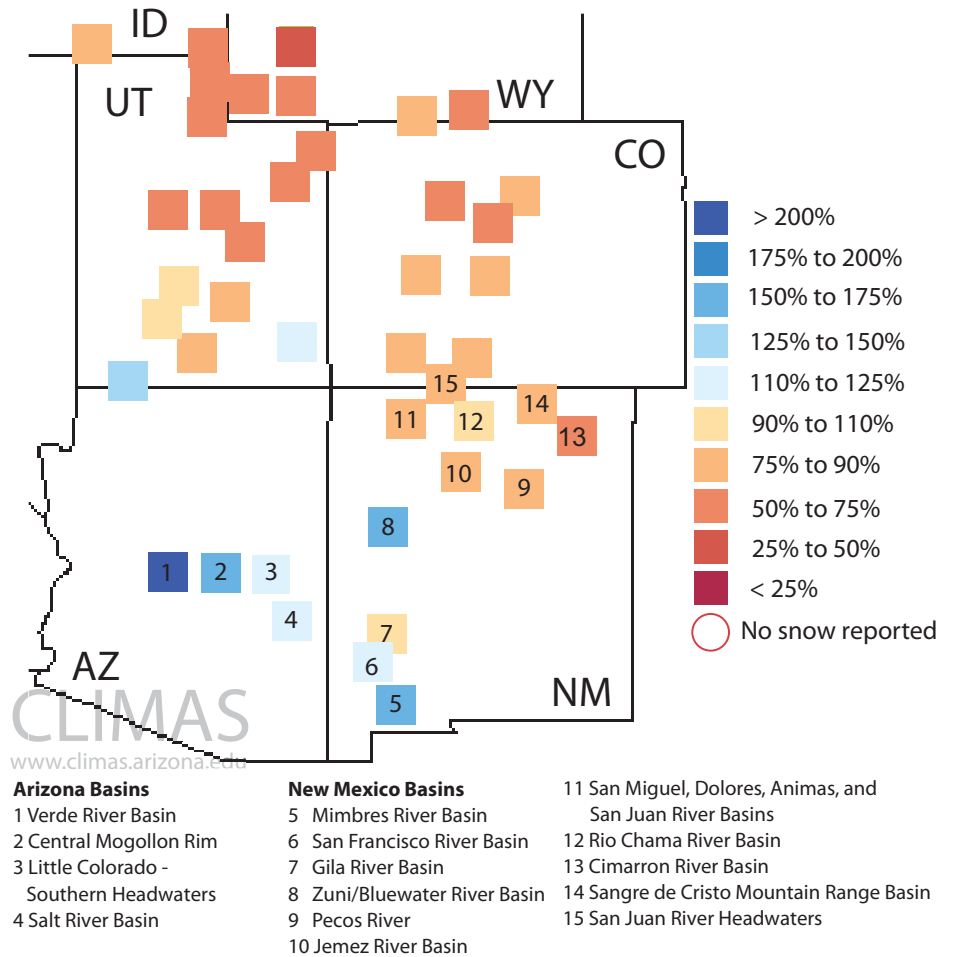
(updated 1/21/10)

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

As of January 21, average snow water equivalent (SWE) measured by snow telemetry stations in the Salt, Verde, and Little Colorado river basins in Arizona ranged between 113 and 205 percent of the 30-year average (Figure 8). In New Mexico, the SWE was below average in most northern river basins and above average in southern river basins. For example, the Upper Gila and the Mimbres river basins had 102 and 156 percent of average SWE, respectively, while in northern New Mexico the SWE was 67 percent in the Cimarron basin and 85 percent in the Sangre de Cristo mountain range basin.

A major storm system moved through the Southwest beginning Monday, January 18, and dumped copious rain and snow across the region. The Flagstaff area, for example, received between 55 and 65 inches of snow, which ranks among the top three highest snowfall accumulations during a five-day period there. The most intense precipitation fell on January 21 and 22, and the aforementioned SWE values do not reflect these accumulations. After tallying snowfall from these storms, SWE values in Arizona and New Mexico jumped. As of January 25, the Verde River basin had SWE of about 322 percent of average, while the Little Colorado and Salt river basins increased to 208 and 214 percent of average, respectively. In New Mexico all river basins reported above-normal to well-above-normal snowpack levels. The Mimbres river basin, for example, reported SWE values of 237 percent of average. Northern New Mexico watersheds reported increases ranging from 91 percent of average SWE in the Cimarron basin to 125 percent of average SWE in the Rio Chama basin.

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of January 21.



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–July 2010)

Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (NOAA–CPC) long-lead temperature forecasts show equal chances of above-, below-, and near-average temperatures throughout much of the Southwest into April; there are elevated chances of cooler-than-average temperatures in eastern New Mexico during this period (Figure 9a). The influence on temperature of the current moderate-to-strong El Niño will lessen in the spring, and temperature outlooks for May through July show warmer-than-average conditions for the Southwest. The spring outlooks reflect the warming trend experienced throughout the West. In other regions in the contiguous US, El Niño conditions are expected to bring warmer-than-average conditions throughout most of the northern tier of the country (with the exception of New England) and cooler-than-average temperatures through most of the southern tier (Figures 9b–d).

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 2010.

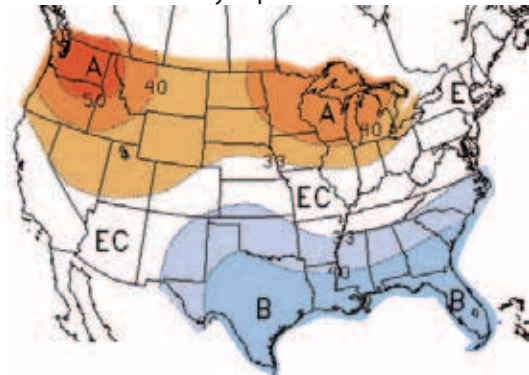


Figure 9b. Long-lead national temperature forecast for March–May 2010.

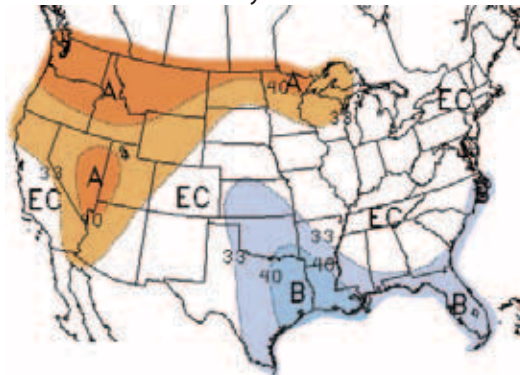


Figure 9c. Long-lead national temperature forecast for April–June 2010.

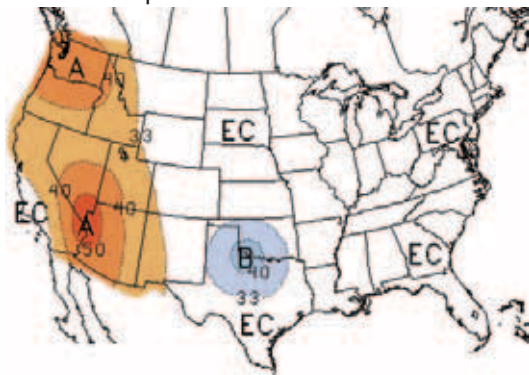
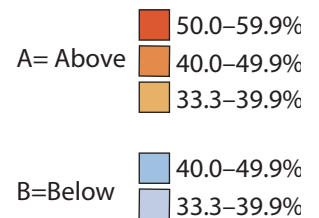
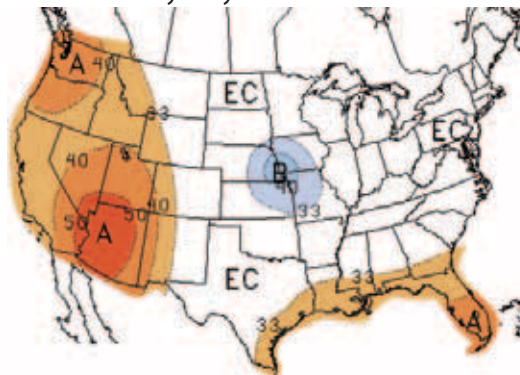


Figure 9d. Long-lead national temperature forecast for May–July 2010.



EC= Equal chances. No forecasted anomalies.

On the Web:

For more information on CPC forecasts, visit:

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

For IRI forecasts, visit:

http://iri.columbia.edu/climate/forecast/net_asmt/

Precipitation Outlook

(February–July 2010)

Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (NOAA–CPC) long-lead precipitation outlooks through May indicate increasing chances for above-average precipitation along the southern tier of the US, and increasing chances of below-average precipitation throughout the Pacific Northwest (Figures 10a–b). For Arizona and New Mexico, the forecast through spring 2010 indicates a tilt in the odds toward above-normal precipitation. These outlooks rely heavily on the expected impacts of the current El Niño event. El Niño typically brings wetter winter conditions to the southern part of the US and drier conditions to the northwestern regions as well as the Ohio and Mississippi valleys. As the forecasts move into summer, the entire US shows equal chances of above-, below-, and near-normal precipitation (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 February–April 2010.

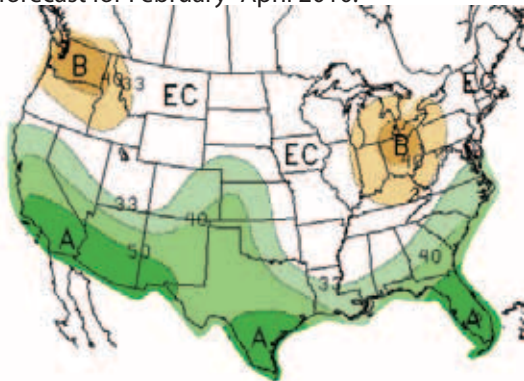


Figure 10b. Long-lead national precipitation forecast for March–May 2010.

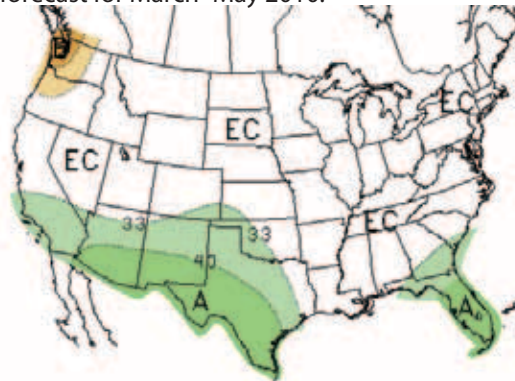






Figure 10c. Long-lead national precipitation forecast for April–June 2010.



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

Source: NOAA-Climate Prediction Center (CPC)

This summary is excerpted and edited from the January 21 Seasonal Drought Outlook technical discussion produced by NOAA-CPC and written by forecaster Richard Tinker.

The Southwest is expected to experience some improvement in drought conditions due in large measure to the El Niño conditions that have been influencing the region (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. In the past week, a series of storms brought heavy precipitation to many parts of the Southwest, and storminess should continue periodically through early February. Forecast confidence is high for the Southwest and Great Basin and for California and southern Oregon.

In other regions in the US, drought is forecast to persist in central Washington and in areas near the Montana and Idaho border and should expand to cover the area between these two regions. Although odds favor a wet end to January in this region, drier-than-average weather is forecast to prevail from

February through April, which is consistent with conditions often created by El Niño episodes. Farther east, some improvement may occur in the recently-identified drought area along and near the Idaho and Wyoming border and in the protracted hydrologic drought affecting parts of the western Great Lakes region. Elsewhere, most signs point to continued recovery for the residual drought areas in southern Texas, but existing short-term precipitation shortfalls and expected below-average February–April precipitation should allow drought to develop in parts of northwestern Ohio by the end of the period. Finally, drought is expected to expand and intensify throughout Hawaii as below-normal rainfall, consistent with El Niño conditions, is expected to continue.

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 21).



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)

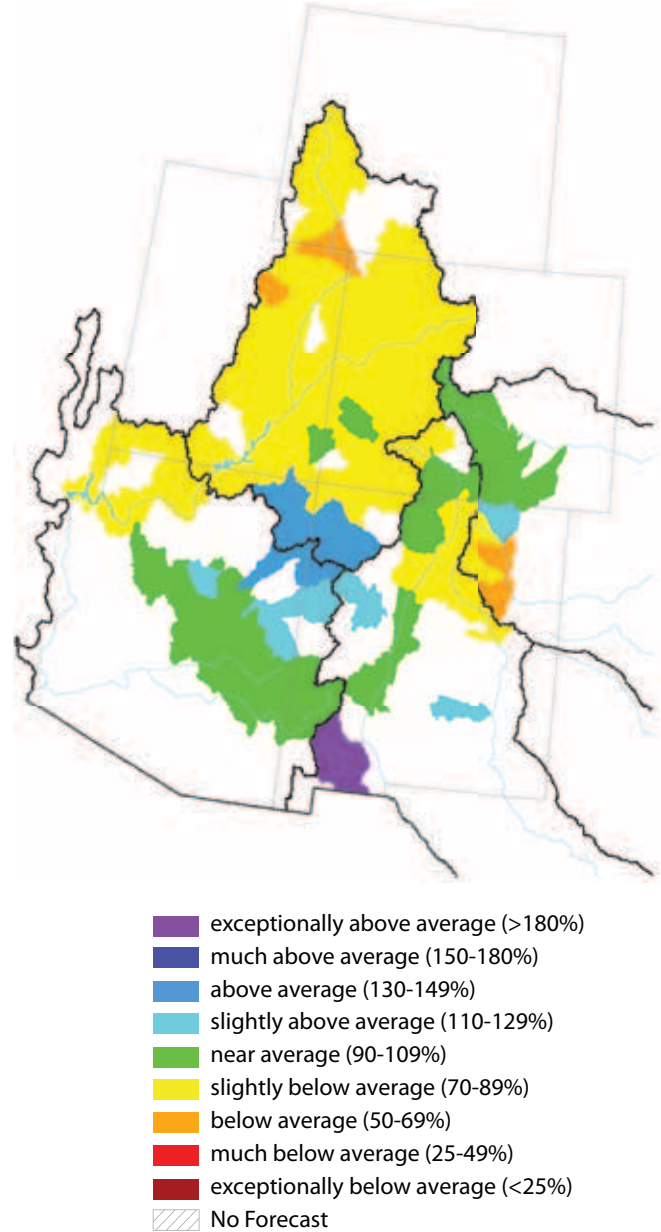
Source: National Water and Climate Center

The first spring–summer streamflow forecast for the Southwest, issued on January 1, shows near-average to above-average flows for basins in the Mogollon Rim region of Arizona, below-average flows for most of the Upper Colorado River Basin, and a wide range of flows for New Mexico basins (Figure 12). Recent storms that drenched the Southwest between January 18 and January 23, however, will likely increase flow forecasts. For example, most of the mountains in Arizona had more than 200 percent of average snow water equivalent as of January 23. These storms will be reflected in February’s streamflow forecast.

There is at least a 50 percent chance that inflow to Lake Powell will be more than 76 percent of the 30-year average for April–July, but only a 30 percent chance that inflow will be near the average of 9.4 million acre-feet. 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 130 percent of average flows. For the Salt, Verde, and Gila river watersheds, there is a 50 percent chance that flows will be more than 135, 229, and 118 percent of average, respectively, for the period between January 15 and May 31.

In New Mexico, the January 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 Rio Hondo, Zuni/Bluewater, and Mimbres basins because snowpack conditions were above average when the forecast was issued. The forecasts for the Rio Grande, San Francisco and Upper Gila, Canadian, and San Juan river basins indicate near-average runoff through the spring runoff season. The National Resources Conservation Service (NRCS), however, cautions that it is still early in the snow season and conditions can change easily in coming months.

Figure 12. Spring and summer streamflow forecast as of January 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 January and April, and for New Mexico between January and May.

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

On the Web:

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

For information on interpreting streamflow forecasts, visit:
<http://www.wcc.nrcs.usda.gov/factpub/intpret.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 in the equatorial Pacific Ocean continued through December and January, with sea surface temperatures (SSTs) remaining 1.5 degree Celsius above average across much of the central and eastern parts of the basin. The International Research Institute for Climate and Society (IRI) notes that the pattern of above-average SSTs has become more organized this past month and appears to be taking on more of a classical El Niño “look,” with convection spreading into the eastern Pacific. The Southern Oscillation Index (SOI; Figure 13a) remained negative in December, indicating that the atmosphere was responding to the warm SSTs with the current ENSO event. Subsurface water temperatures along the equator in recent weeks also have remained well above average, indicating that this warm water will help feed above-average SSTs in coming weeks.

All of these signs point towards the continuation of at least weak to moderate El Niño conditions for the next several months. The chance of El Niño conditions persisting through at least April stands at more than 90 percent, according to the latest IRI ENSO forecast (Figure 13b). Neutral conditions are expected

Notes:

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

to return rapidly in the May–July period, which is typical of El Niño events because they normally dissipate in the spring. In the meantime, moderate El Niño conditions are expected to impact winter weather in the Southwest over the next several months. A strong subtropical jet forming in response to the unusually warm waters in the eastern Pacific is expected to influence the winter storm track and bring an increased chance of above-average precipitation to Arizona and New Mexico in the February–April period (see Figure 10a).

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

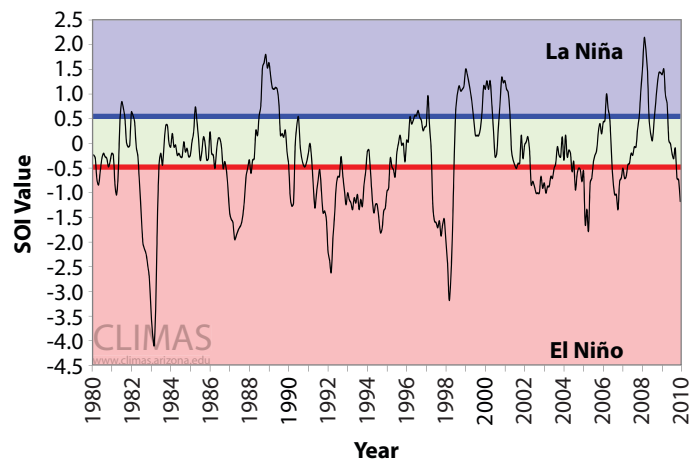
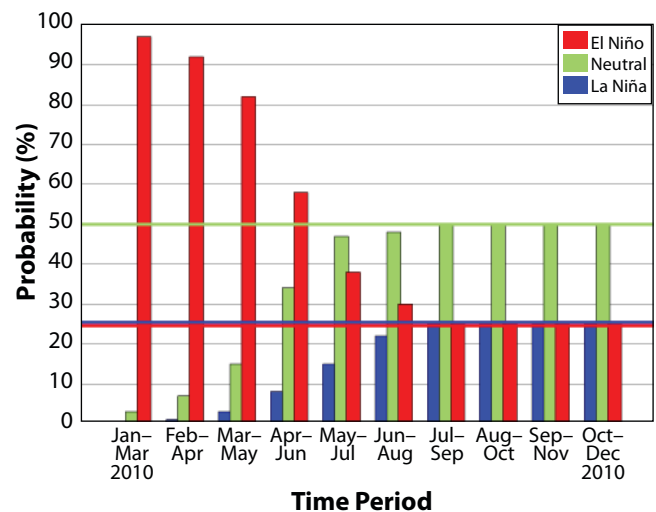


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released January 21). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification (February–July 2010)

Source: Forecast Evaluation Tool

For a thorough description of the interpretation of these maps, see the feature article (page 6) 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 are most reliable in southeast Arizona, while the rest of Arizona and central and southwestern New Mexico have exhibited slightly less accurate forecasts (Figure 14a). Forecast skill—a measure of the accuracy of the forecast—for northern 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 western two-thirds of New Mexico (Figure 14b). The three- and four-month lead time forecasts historically have been more accurate than equal chances in southern and western Arizona and southwestern New Mexico (Figures 14c–d). Bluish hues suggest that the NOAA–CPC historically 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 February–April 2010.

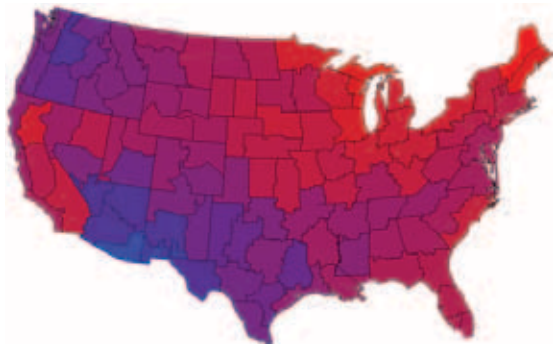


Figure 14b. RPSS for March–May 2010.

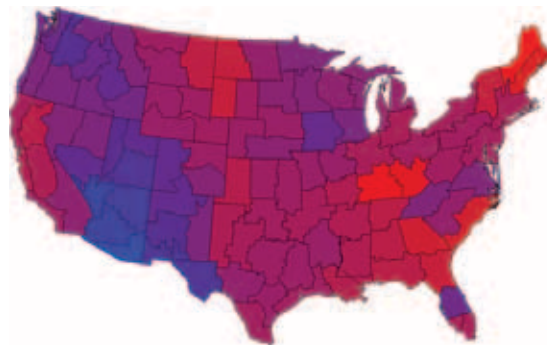


Figure 14c. RPSS for April–June 2010.

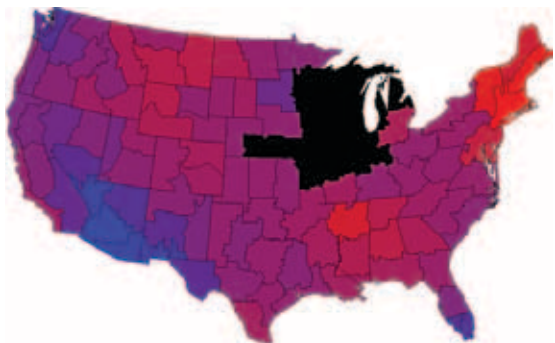
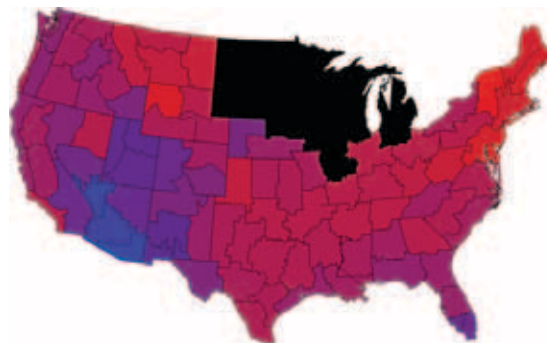


Figure 14d. RPSS for May–July 2010.



■ = NO DATA (situation has not occurred)

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 (February–July 2010)

Source: Forecast Evaluation Tool

For a thorough description of the interpretation of these maps, see the feature article (page 6) 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 are most reliable in southern New Mexico and most of Arizona (Figure 15a). Forecast skill—a measure of the accuracy of the forecast—for northern 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 January for March–April) has been slightly more accurate and slightly less accurate than equal chances in all of Arizona and New Mexico, respectively. The three-month lead time forecasts have been less accurate than equal chances in all regions of Arizona and New Mexico (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 2010.

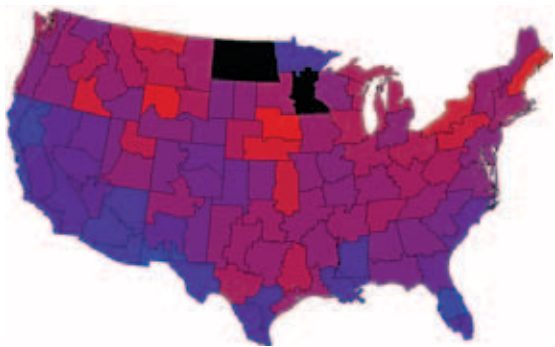


Figure 15b. RPSS for March–May 2010.

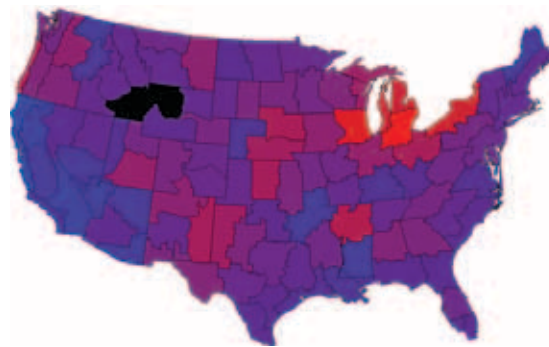


Figure 15c. RPSS for April–June 2010.

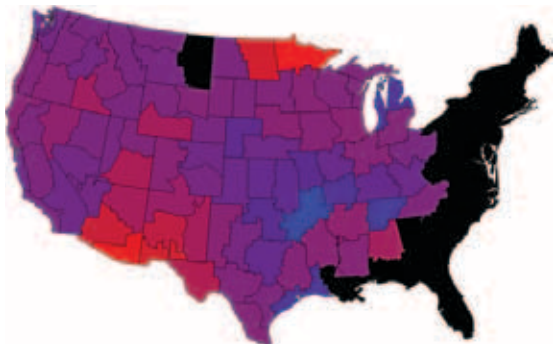
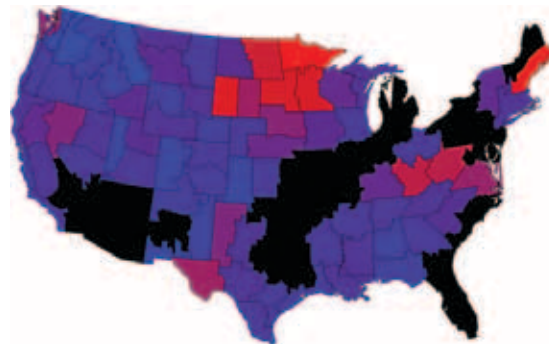


Figure 15d. RPSS for May–July 2010.



■ = NO DATA (situation has not occurred)

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