May 26, 2010

Southwest Climate Outlook

Vol. 9 Issue 5

Source: Betsy Bashline. March 24, 2010.

Photo Description: During the spring, the southwestern landscapes are often dappled in vibrant hues. Wildflowers this spring are especially numerous thanks to the widespread and heavy winter rains. Photograph was taken in the Estrella Mountains in Phoenix.

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

CLIMAS Climate Assessment for the Southwest

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

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In this issue...

May Climate Summary

Drought– Drought conditions have continued to improve across the Southwest this past month. Currently, most of southern Arizona and New Mexico are classified as drought-free. However, northeastern Arizona continues to experience moderate to severe drought conditions.

Temperature– The recent shift in the atmospheric circulation has brought cooler-than-average temperatures to the Southwest. Temperatures in most regions have been 0–4 degrees F below average.

Precipitation– The northward shift in storm tracks has left the Southwest drier than average during the past month. Rainfall in April and May in many parts of the region is, however, usually low.

ENSO– The El Niño event that began in October 2009 has transitioned into ENSO-neutral, which is expected to persist through the summer. However, there are signs that a La Niña event may develop towards the end of summer.

Climate Forecasts– Temperature outlooks show a 50 percent or greater chance that temperatures in the summer and early fall will be above average in most of Arizona and parts of western New Mexico. The precipitation outlooks for summer indicate equal chances of above-, near-, and below-average precipitation.

The Bottom Line– Copious winter precipitation in many parts of the Southwest improved drought conditions. Currently, only about three percent of Arizona is experiencing severe drought conditions or worse, down from 78 percent in mid-January. Only about 12 percent of New Mexico is currently abnormally dry, whereas in mid-January 70 percent of the state was abnormally dry or worse. Drought conditions, however, can rapidly develop if the monsoon season fizzles like it did last year. Early indication is that the monsoon rains will arrive on time or slightly later than usual, but there is no indication that rainfall will be above or below average. If a La Niña event develops in the second half of the summer, which some models suggest, the later half of the monsoon season could experience increased rain.

Despite Cool Weather in Southwest, Globe feels warmest April on Record

Many parts of Arizona and nearly all of California experienced a relatively cool April, with temperatures between 0 and 5 degrees Fahrenheit below average. Globally, however, the story has been different. Temperatures from monitoring stations on land and on the ocean surface indicate that the average global temperature was the warmest since record keeping began in 1880 for both April and the January–April period, according to the National Oceanic and Atmospheric Administration (NOAA). The combined land and ocean data sets for April were 1.37 degree F above the 20th century average, while the January–April temperature was 1.24 degrees F above the average.

In North America, warmer-than-average temperatures helped cause the extent of area covered in snow in April to be the smallest on record.

Two factors help explain the record temperatures. First, the long-term trend in average global temperature is positive. Second, the tropical sea surface temperatures were warmer than average, which is characteristic of El Niño events; this year's El Niño event began in October 2009 and persisted through April.

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Keeping pace with warming—can plants and animals move fast enough

By Zack Guido

The Southwest Climate Outlook first discussed changes in dates of first blooms in the Catalina Mountains in southern Arizona with Dave Bertelsen in the August 2009 issue. This article updates the observations during the last two years in Finger Rock Canyon and looks at the possible effects of rapid climate change on plants and animals.

Once a week Dave Bertelsen wakes up before most people go to bed, grabs his headlamp, and begins a 12-hour journey up and down the rugged Finger Rock Canyon trail near Tucson, Arizona. He's been doing this since 1981, and in that time he has logged 1,274 round trips, hiked more than 12,700 miles, and been air-lifted to a hospital two times.

The effort and pain has purpose. His systematic and meticulous observations of animals and blooming plants along the trail reveal rapid changes, particularly in recent years. Shifts in blooming locations of many plants, declines in the diversity of plants and animals, flowering booms and busts, and thriving heat-loving cacti all suggest that the flora and fauna profoundly feel the changes in the climate.

But can they adjust to the changes fast enough? Recent research suggests that the rate of warming will outpace the speed at which some species can migrate, essentially exposing them to new climates for which they have not evolved. In the Finger Rock Canyon, Bertelsen is witnessing seasonal snapshots of the effects of unfamiliar climes, and the hot and dry 2009 monsoon season and parched early winter months may be a window into the future of the ecosystem.

Flowering changes in the Catalina Mountains

Bertelsen is a self-trained naturalist with perhaps the most in-depth knowledge in the world of plants in the Catalina Mountains. Within a distance of 30 feet from the trail—which ascends five miles and more than 4,000 vertical feet to the summit of Mount Kimball—he can identify 600 different kinds of plants.

By the end of 2009, Bertelsen had cataloged 131,369 observations of flowering species and noted 63,800 observations of animals, including birds, frogs, and snakes.

Subtle changes often don't elude Bertelsen. He began counting individual amphibians and reptiles in 1996 when he noticed a drop in their numbers. He also has witnessed a decrease in diversity of both animals and plants, particularly at lower elevations. On his treks between 1984 and 1987, Bertelsen saw on average 7.5 animal species per mile. That number dropped to 4.3 species per mile between 2007 and 2009, a 42 percent decline. The number of flowering plants per mile between those same periods also fell by about 19 percent.

Another change in Finger Rock Canyon has been that more plant species are blooming at higher elevations in recent years. While Bertelsen is not tracking the movement of species specifically, changes in the elevation range of flowering plants are a good indication that plants are on the move. His observations have revealed that more than 15 percent of the species bloom at elevations as much as 1,000 feet higher than in the early 1980s. He's also witnessed contractions, expansions, and nearly every other kind of range shift possible (Figure 1).

The claret-cup hedgehog blooms in the Finger Rock Canyon between April and July. Since 2002, nearly all the large claret-cup hedgehog clusters with 50 or more stems have died. Photo courtesy of Dave Bertelsen.

But species also are not moving and not blooming earlier in the year, which is contrary to what many scientists expect with increasing temperatures. Only 25 percent of the 363 species between 1984 and 2003, or about 90 species, exhibited a significant change in their upper or lower limits, or both, according to a peer-reviewed article published in Global Change Biology in 2009. These observations concern Bertelsen.

"Most of the plants species show no signs of moving; they seem not to be adapting," he said. Also "only 25 species, or about 10 percent of the diversity, have changed their blooming time, and 19 of them are blooming later and not earlier." If plants bloom later, Bertelsen said, their growing season is shorter because plants cannot withstand the summer heat. This may affect seed production and throw out of whack the synchronicity between flowering and pollinators.

While temperatures in the region have trended upward during the period of Bertelsen's observations, it is possible that the temperature threshold of many species in the Finger Rock Canyon has yet to be crossed. Or, for most plant species, it takes

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longer to migrate than can be discerned from Bertelsen's blooming observations.

Can plants and animals keep pace with climate change?

Conventional ecological wisdom says that as the climate warms, the plants and animals intolerant to the new temperature will seek higher elevations with cooler temperatures. There is solid evidence for this. In the Southwest along the Colorado River corridor, for example, most plant species currently inhabit landscapes 2,300-3,000 feet higher than they did during the colder period of the last glaciation. This implies that the most threatened ecosystems in the Southwest are those in the peaks of the sky islands—mountain islands of forests isolated by intervening valleys of grassland or desert—which have limited vertical real estate above them.

The survival of a particular species, however, also depends on its ability to move at the same rate as climate change. This has been observed in the past, when some trees species in North America and Europe migrated north at about 0.6 miles per year to keep pace with gradual warming that followed the height of the last glaciation about 20,000 years ago. Similarly, fossil records from 228 animal species unearthed in the United States showed that animals migrated predominantly to the northwest and southwest an average of 730 miles, roughly the distance from Salt Lake City to Tucson, as the climate warmed following the peak of the last glaciation. From about 10,000 years ago to present 303 animal species moved predominantly to the northwest an average of about 850 miles.

The context then, however, was different than it is today. In the past 40 years, global temperatures have soared by about 1 degree Fahrenheit, and it is difficult to pluck from the past the response of plants and animals to rapid climate changes.

Will climate change outpace the speed at which plants and animals move? A peer-edited article appearing in a December 2009 issue of Nature analyzed the travel speeds necessary to maintain a constant temperature. To do this, the authors assimilated moderate warming projections produced from global climate models used in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report and digital elevation data that mimics Earth's topography.

Essentially, in the context of global warming, the distance a species has to travel to maintain a constant temperature depends on topography. In a slightly sloping region similar to western Kansas or Nebraska,

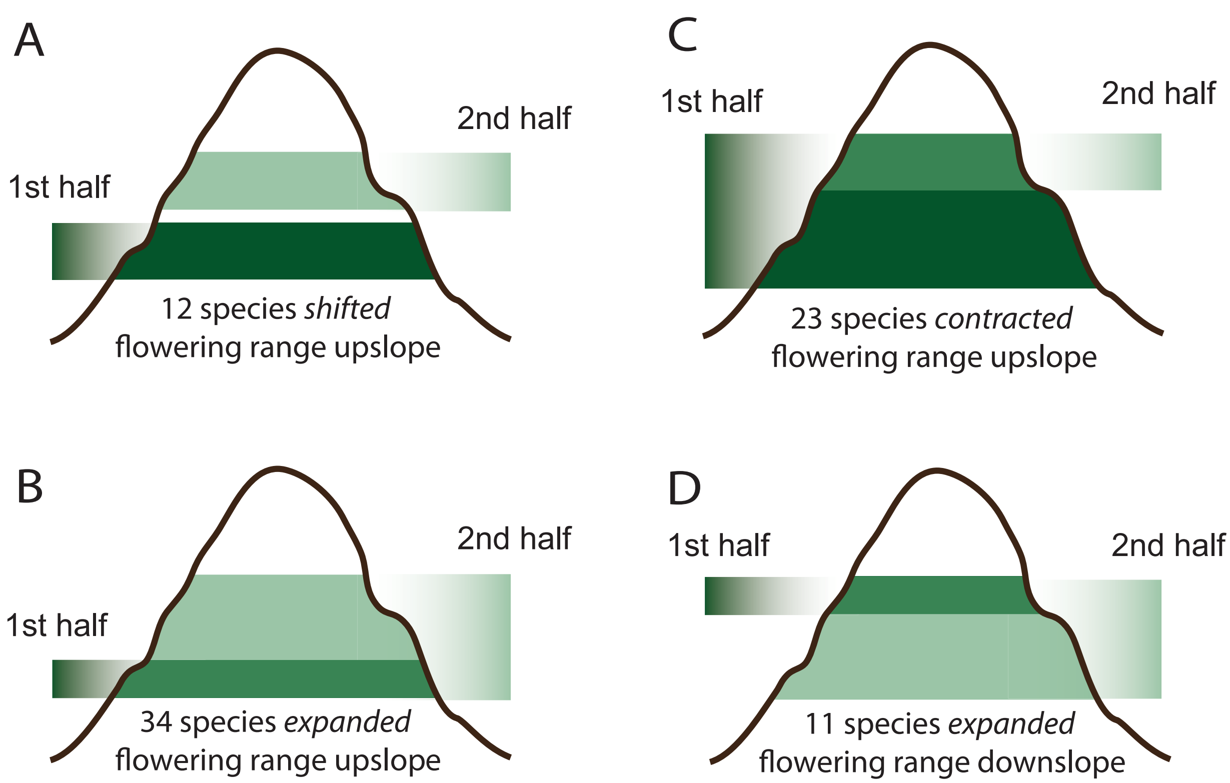


Figure 1. Bertelsen has witnessed shifts in the flowering ranges of species between the first half of the record (1984–1993) and the second half (1994–2003). The four most common changes have been: A) 12 species shifted flowering range upslope, B) 34 species expanded flowering range upslope, C) 23 species contracted flowering range upslope, and D) 11 species expanded flowering range downslope. Figure modified from Crimmins and others (2009) "Flowering range changes across and elevation gradient in response to warming summer temperatures."

Keeping pace, continued

for example, species must migrate longer distances to reach higher elevations. On the other hand, on the steeper slopes of a sky island, a one-degree F drop in temperature can be reached in only a mile or two, as temperatures generally decreases by 1 degree F for every 350 vertical feet.

As a result, in mountainous biomes species can move at a slower rate than they can in flatter environments such as grasslands and deserts, making it easier for flora and fauna to keep pace with climate change. In desert environments of the Southwest, the authors suggest that species will be required to move at about 0.5 miles per year to survive. It remains to be seen which species will adapt and which will disappear.

Ecosystem changes and responses to extreme seasonal climates

Dave Bertelsen is paying close attention to the changes in the flora and fauna in the Finger Rock Canyon. In the past decade he has noticed that the numbers of Mohave and spineless prickly pears are increasing, which is expected because cacti thrive in hot climates. He also is witnessing how closely connected the ecosystem is to seasonal climate.

The summer of 2009 shaped up to be one of the driest on record in the Tucson area and in many regions around the Southwest. Many parts of Arizona experienced the driest monsoon since 1950, including southeast Arizona, where rains totaled only 68 percent of average. Although New Mexico was not as dry, most regions received below-average rainfall as well. The plants responded.

"The quantity of blooming annuals plummeted last summer. The scarlet morning glories usually number in the millions, literally, and not one plant flowered last summer. Most other common annuals also showed this pattern. I have never seen that before. It was just unbelievable," Bertelsen said.

While scant rains defined the 2009 monsoon season, the flowering crash also may have been related to the timing and spacing of rains.

"Last summer the annual plants didn't germinate, and I think the spacing between the rains was too far apart," Bertelsen said. "Unless you have pulses of rain to continue to keep the ground moist, plants don't reproduce."

Animal sightings also were down following the dry monsoon. On an average day in November, Bertelsen normally sees about 100 birds. Before the winter rains came in January, bird sightings dipped to around 30.

The dry weather finally broke in January, when a cavalcade of storms drenched many parts of the Southwest. But because November and December were dry, Bertelsen expected a poor spring flowering season. He was mistaken.

"I saw 154 species in bloom in early May, which was a record for a single day in spring. Perhaps the cool spring gave the plants an opportunity to use the winter precipitation more than in the past," he said.

The close connections between temperatures and the timing and amount of rains emphasize the need to better understand future climate scenarios, particularly the monsoon season. Although climate model projections are highly uncertain for summer precipitation, Bertelsen's observations serve as a good example of what could happen. It's possible that a warmer spring combined with a dry November and December could cause spring annuals to bust, while summer annuals would be scant if the monsoon fizzles.

Looking ahead

What concerns Bertelsen is that the Sonoran Desert ecosystem evolved over thousands of years, but current changes are occurring much more rapidly.

"If I can see changes in 24 years of data, things are happening really fast. I'm worried that the diversity will plummet if the ecosystem can't adapt quick enough," Bertelsen said.

It's also difficult to look into the past for clues about the future because most studies of species responses to climate change pertained to periods in which the Earth warmed from colder times, or vice versa. Today, warm climates are getting warmer, and the rate of temperature change projected for the future is 10–100 times faster than that experienced during the transition from cool to warmer climate during the last glacial retreat. This may require species to migrate at rates much faster than those observed during in the past and suggests that rapidly changing climate will favor more mobile and opportunistic species, resulting in altered community composition and structure, ecosystem properties and processes, and reducing biodiversity.

"If I could fast forward 20 years and hike the trail, I may see an open oak scrub savanna in place of oak-pine forest in the higher elevations. However, it's hard to know right now. But, I do think the native biodiversity will decline."

Temperature (through 5/19/10)

Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 generally have averaged between 60 and 65 degrees Fahrenheit in the southwestern deserts of Arizona, and between 50 and 60 degrees F in southeastern Arizona and across southern New Mexico (Figure 1a). Temperatures in central New Mexico and along the Mogollon Rim and Colorado Plateau in Arizona have averaged between 40 and 50 degrees F. High elevations in northern Arizona and across northern and west central New Mexico have averaged between 30 and 40 degrees F (Figure 1b). These temperatures have been 0–1 degree F cooler than average across southern Arizona, and 1 to 2 degrees F cooler than average across northern Arizona. New Mexico's temperatures have been much more variable, averaging between 0 and 4 degrees F colder than average.

The recent shift in the atmospheric circulation pattern has brought unseasonably cool weather in the past 30 days to the Southwest (Figure 1c–d). Temperatures in New Mexico generally have been 0–2 degrees F ~~above~~ (edited on May 26) below average through most of the central and northern parts of the state. The state has experienced 0–2 degrees F warmer-than-average temperatures in a few isolated spots. Arizona experienced cooler-than-average temperatures everywhere except the White Mountains in east -central Arizona, which were 0–2 degrees F above average. The western two-thirds of the state has generally been 2– 4 degrees F colder than average for this time of year.

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 (October 1 through May 19) average temperature.

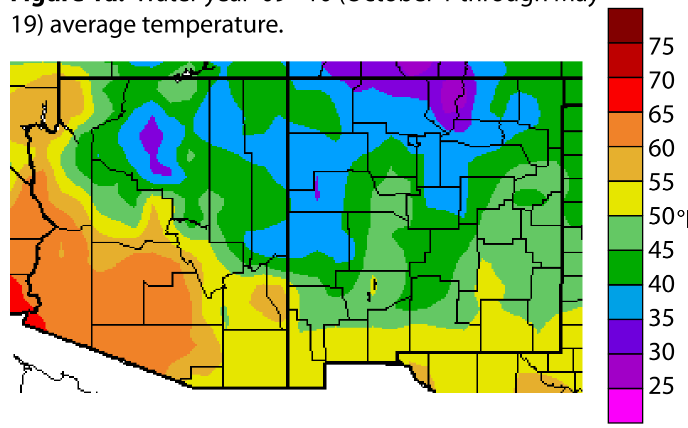


Figure 1b. Water year '09–'10 (October 1 through May 19) departure from average temperature.

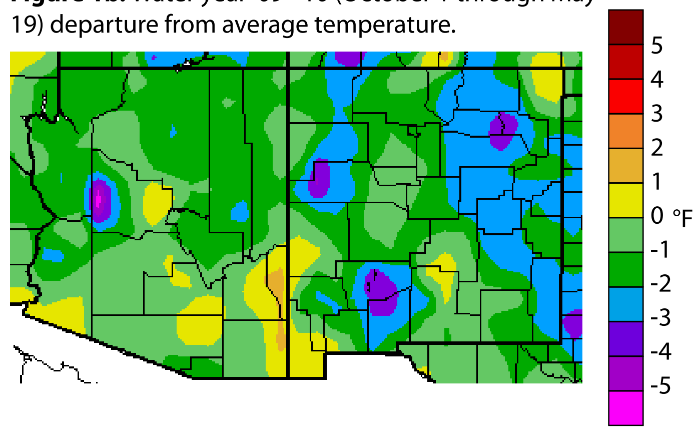


Figure 1c. Previous 30 days (April 20–May 19) departure from average temperature (interpolated).

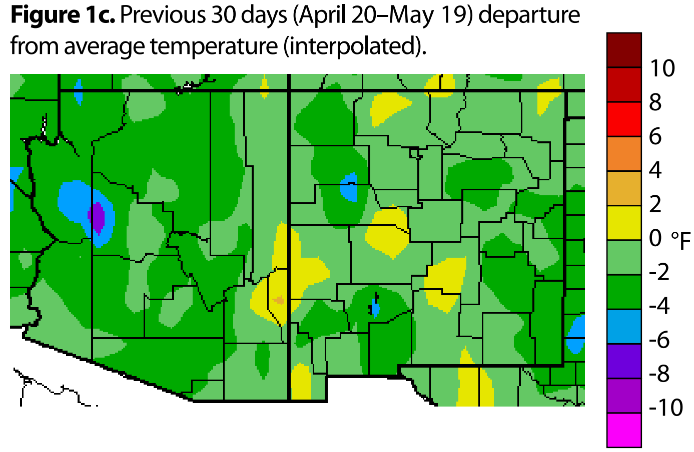
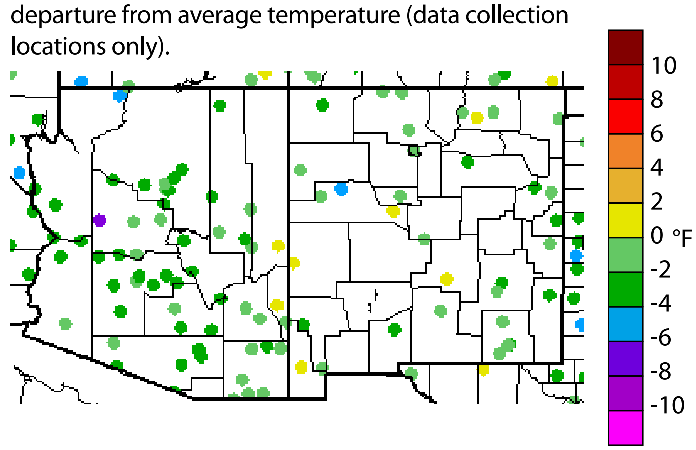


Figure 1d. Previous 30 days (April 20–May 19) departure from average temperature (data collection locations only).



Precipitation (through 5/19/10)

Source: High Plains Regional Climate Center

Precipitation since the water year began on October 1 has been extremely variable across the Southwest (Figures 2a–b). Eastern New Mexico and western Arizona have experienced 130 to 300 percent of average precipitation, while south-central and northwestern Arizona and west-central New Mexico have received 50 to 100 percent of average precipitation. The driest area has been the Colorado Plateau in northeastern Arizona which has received between 5 and 70 percent of average.

The El Niño event has continued to weaken during the past 30 days, resulting in a northward shift of storm tracks. As a result, precipitation has bypassed most of Arizona and New Mexico. Most of Arizona has been exceptionally dry, receiving less than 25 percent of average for this time of year (Figures 2c–d). New Mexico has fared slightly better, at 5 to 75 percent of average precipitation. A few areas have received above-average precipitation, including the southern border region of Arizona and central New Mexico which received 200 to 800 percent of average precipitation. This number, however, does not translate into large rainfall totals since late April and May are relatively dry months. With the monsoon seasons within sight, there are no strong indications that summer precipitation will be wetter or dryer than average.

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 (October 1 through May 19) percent of average precipitation (interpolated).

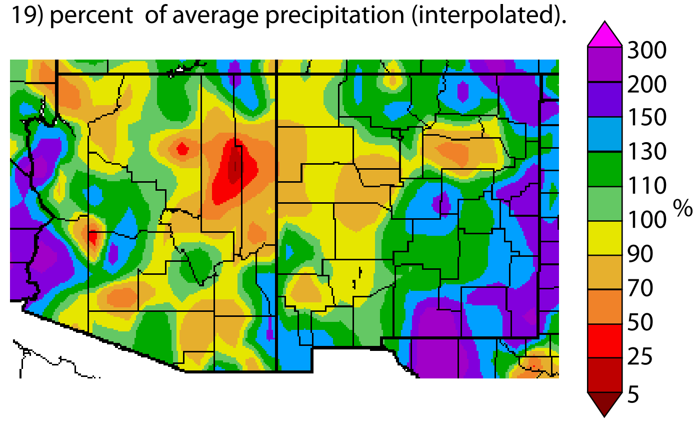


Figure 2b. Water year '09–'10 (October 1 through May 19) percent of average precipitation (data collection locations only).

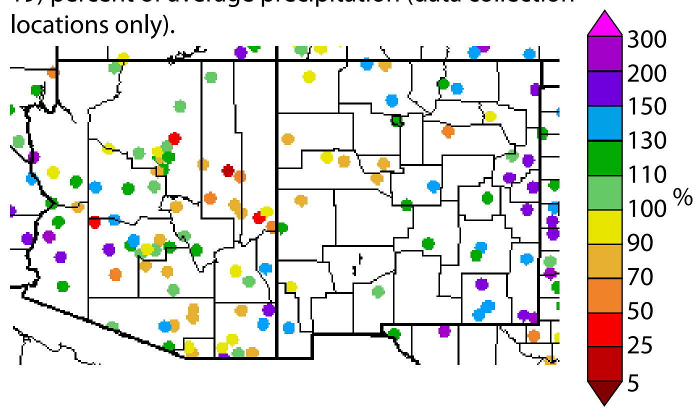


Figure 2c. Previous 30 days (April 20–May 19) percent of average precipitation (interpolated).

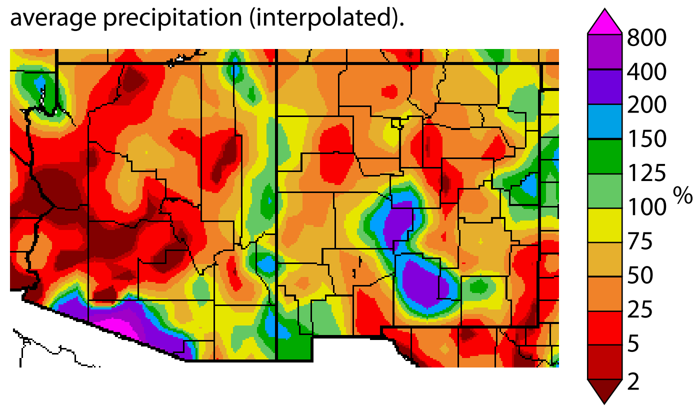
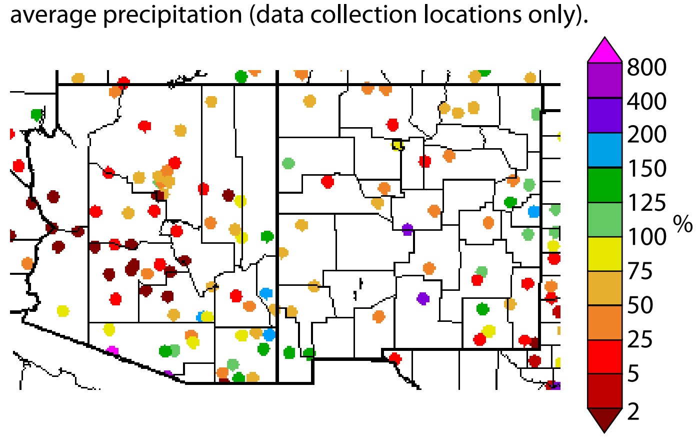


Figure 2d. Previous 30 days (April 20–May 19) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(data through 5/18/10)

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

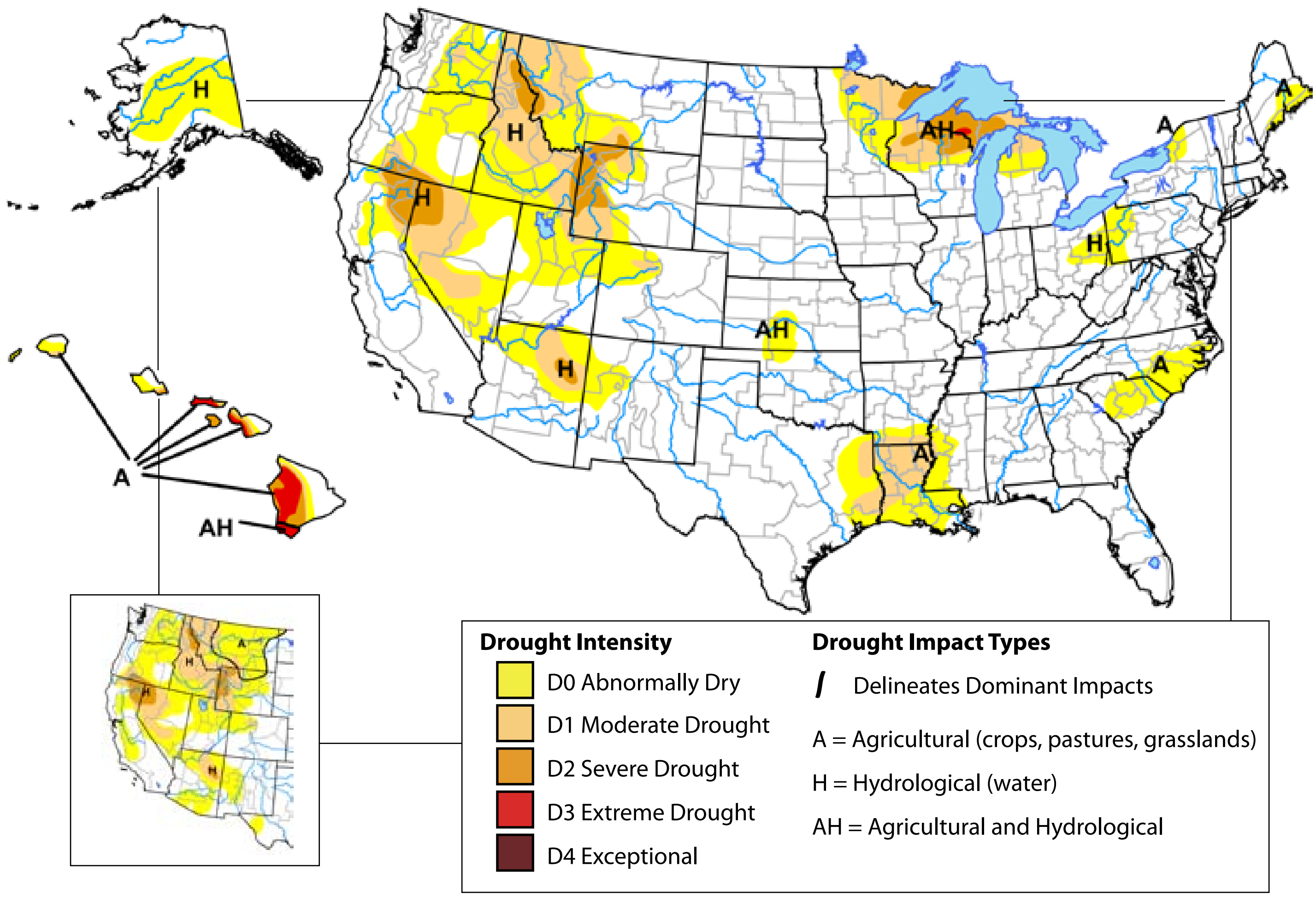
The pattern of drought across the western U.S. did not changed much from mid-April to mid-May, according to the May 18th update of the National Drought Monitor. Moderate to severe drought persisted in northern California, western Wyoming, and northern Idaho (Figure 3). The biggest change was in Montana where abnormally dry conditions across the eastern half of the state became drought-free as a result of above-average precipitation during the past 30 days. Overall, 43 percent of the eleven conterminous western U.S. states (states west of and including the Rocky Mountains) were experiencing some form of drought in mid-May. This is down from 57 percent in mid-April. The moderate to severe drought conditions in the northern Rockies are prompting fears of an above-average fire season across this region. Fire officials at the National Interagency Fire Center are bracing for a big fire year due to the dry conditions that plagued the region this past winter, according to the Associated Press, May 10.

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 Eric Luebehusen, U.S. Department of Agriculture.

Figure 3. Drought Monitor data through May 18 (full size), and April 13 (inset, lower left).



On the Web:

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

Arizona Drought Status

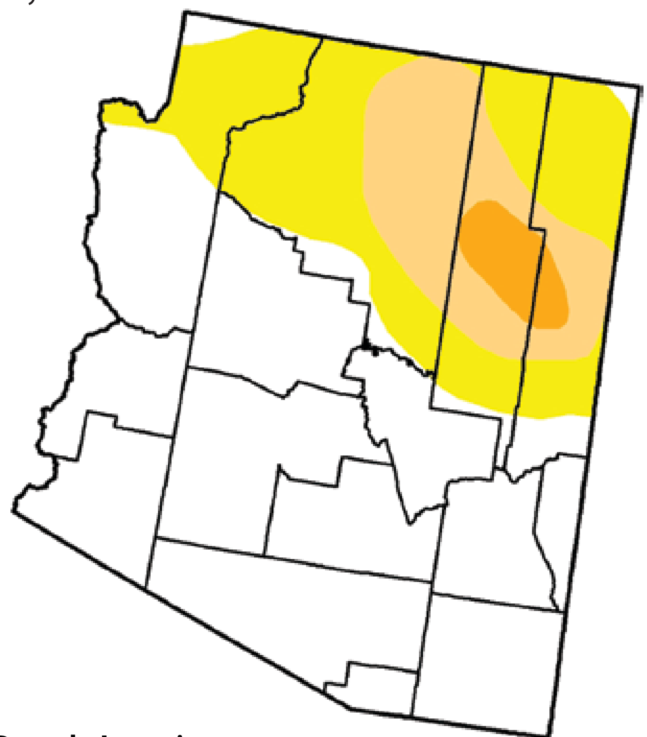
(data through 5/18/10)

Source: U.S. Drought Monitor

Drought conditions continued to improve from mid-April through mid-May with much of southern Arizona now drought-free, according to the May 18th update of the National Drought Monitor. Abnormally dry, moderate, and severe drought conditions now exist across only northern Arizona, with the worst conditions confined to the northeastern corner of the state (Figure 4a). Overall, the geographic coverage of drought conditions fell from 60 percent of the state in April to about 37 percent in mid-May (Figure 4b). Only about 14 percent of the state has moderate drought conditions or worse. Only three months ago, on January 21, all of Arizona had abnormally dry conditions or worse, and 78 percent of the state was classified as experiencing severe drought.

Impacts from drought cataloged by Arizona DroughtWatch (http://azdroughtwatch.org) include poor rangeland conditions and increased erosion from longer-term drought conditions in northeastern Arizona. These impacts are consistent with the moderate and severe drought status covering this area. Detailed observations of these impacts including photos are available through the "Detailed Report Summary" on AZ DroughtWatch.

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

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	63.4	36.6	14.4	2.7	0.0	0.0
Last Week (05/11/2010 map)	43.1	56.9	14.4	2.7	0.0	0.0
3 Months Ago (02/23/2010 map)	15.3	84.7	53.3	14.5	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 (05/19/2009 map)	17.2	82.8	34.8	0.0	0.0	0.0

Notes:

The Arizona section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies.

On the Web:

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

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

New Mexico Drought Status

(data through 5/18/10)

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

There were no large changes in drought conditions from last month's status for New Mexico. The May 18th update of the National Drought Monitor shows only about 12 percent of the state is experiencing abnormally dry conditions, a slight decrease from 24 percent reported last month; no area is experiencing drought conditions worse than abnormally dry conditions (Figures 5a–b). McKinley and Cibola counties are mostly experiencing the dry conditions and are part of a drier, larger area that extends across northeast Arizona. A wet winter and relatively cool conditions this spring have helped limit the emergence of short-term drought conditions across the state. Only three months ago, on January 21, the National Drought Monitored reported that more than 70 percent of New Mexico was experiencing some level of drought.

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

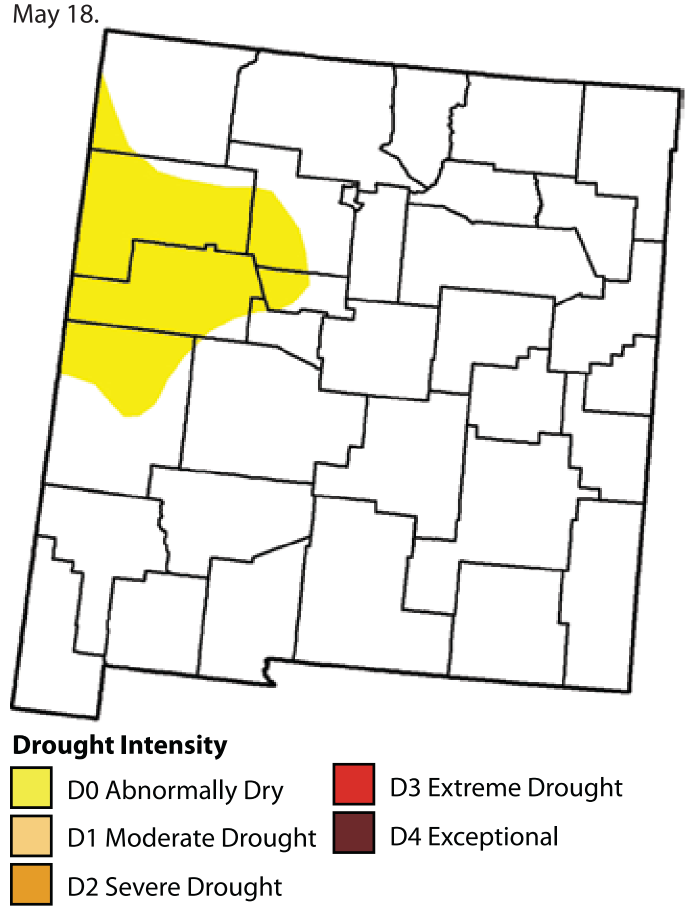


Figure 5b. Percent of New Mexico designated with drought conditions based on data through May 18.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	88.3	11.7	0.0	0.0	0.0	0.0
Last Week (05/11/2010 map)	79.2	20.8	0.0	0.0	0.0	0.0
3 Months Ago (02/23/2010 map)	57.6	42.4	0.0	0.0	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 (05/19/2009 map)	21.8	78.2	50.3	26.4	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 4/30/10)

Source: USDA-NRCS, National Water and Climate Center

Combined water storage in Lakes Mead and Powell declined by 130,000 acre-feet in April (Figure 6). Colorado River Basin runoff is occurring earlier than expected, according to the U.S. Bureau of Reclamation reports. Storage in the Salt and Verde River systems is at 100 percent of average; these systems added almost 49,000 acre-feet of storage in the last month.

In water-related news, the Arizona Department of Water Resources (ADWR) budget was reduced by 58 percent in recent cuts, which has forced the closure of the regional offices (*Arizona Daily Star*, May 12, 2010). Also, the Southern Nevada Water Authority (SNWA) recently unveiled a $25 million custom-made tunneling machine that will be used to create a deeper water intake from Lake Mead (*Las Vegas Business Press*, May 10). The new intake provides the SNWA with insurance in case the lake level continues to drop—water levels in Lake Mead have dropped 110 feet since 2000.

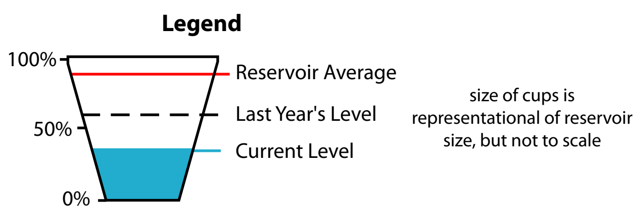
Notes:

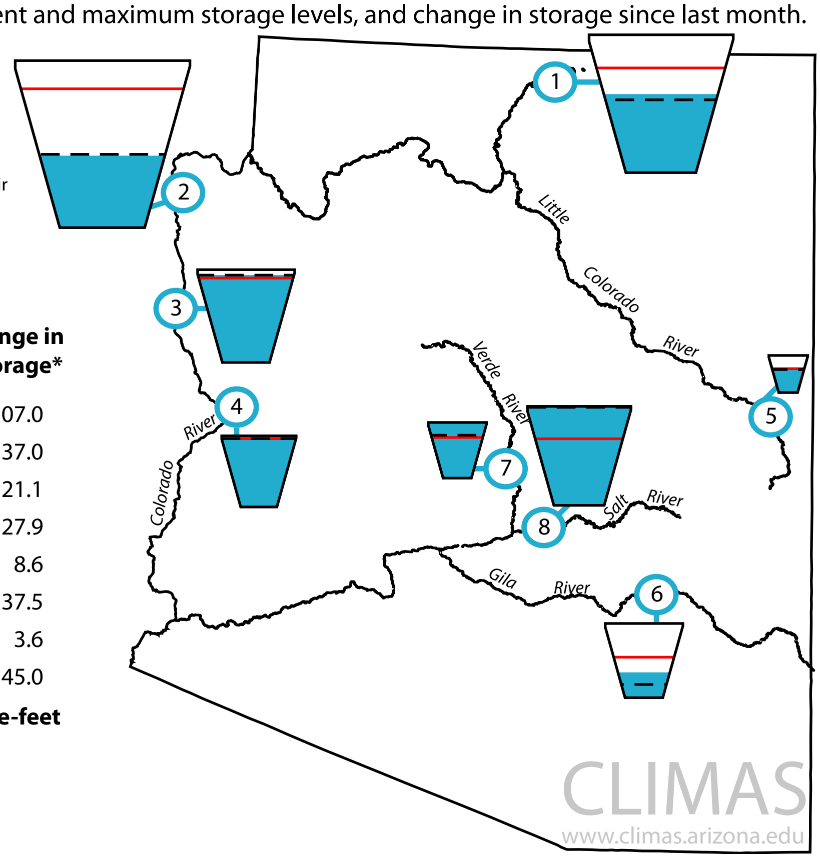
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 April 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	57%	13,816.0	24,322.0	107.0
2. Lake Mead	43%	11,313.0	26,159.0	-237.0
3. Lake Mohave	94%	1,697.1	1,810.0	21.1
4. Lake Havasu	96%	591.8	619.0	27.9
5. Lyman Reservoir	67%	20.1	30.0	8.6
6. San Carlos	34%	293.4	875.0	37.5
7. Verde River System	100%	286.6	287.4	3.6
8. Salt River System	100%	2,025.2	2,025.8	45.0

*** thousands of acre-feet**

On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

New Mexico Reservoir Levels

(through 4/30/10)

Source: USDA-NRCS, National Water and Climate Center

The total reservoir storage in New Mexico increased by about 245,000 acre-feet in April (Figure 7). Most reservoirs experienced increases in water storage, especially reservoirs in the northern part of the state, such as Navajo and Heron reservoirs. The Navajo reservoir currently is at 81 percent capacity. However, Elephant Butt, Brantley, and Abiquiu reservoirs—the other three reservoirs with a storage capacity greater than 1 million acre-feet—are only 25, 3, and 16 percent full, respectively.

In water-related news, the U.S. Bureau of Land Management hopes to improve watershed health along the Pecos River south of Carlsbad, New Mexico by burning saltcedar trees (Current-Argus, May 12). In addition, the New Mexico Environmental Department recently received more than $380,000 in grant funds from the Environmental Protection Agency (EPA) to map and classify wetlands in the Canadian River Basin in order to help improve protection of sensitive river areas (The Associated Press, May 10).

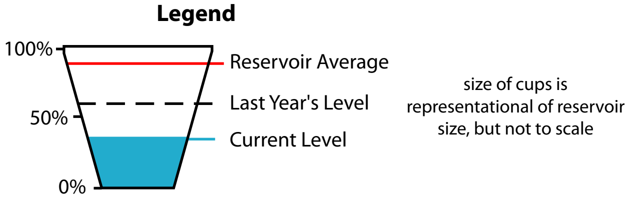
Notes:

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.

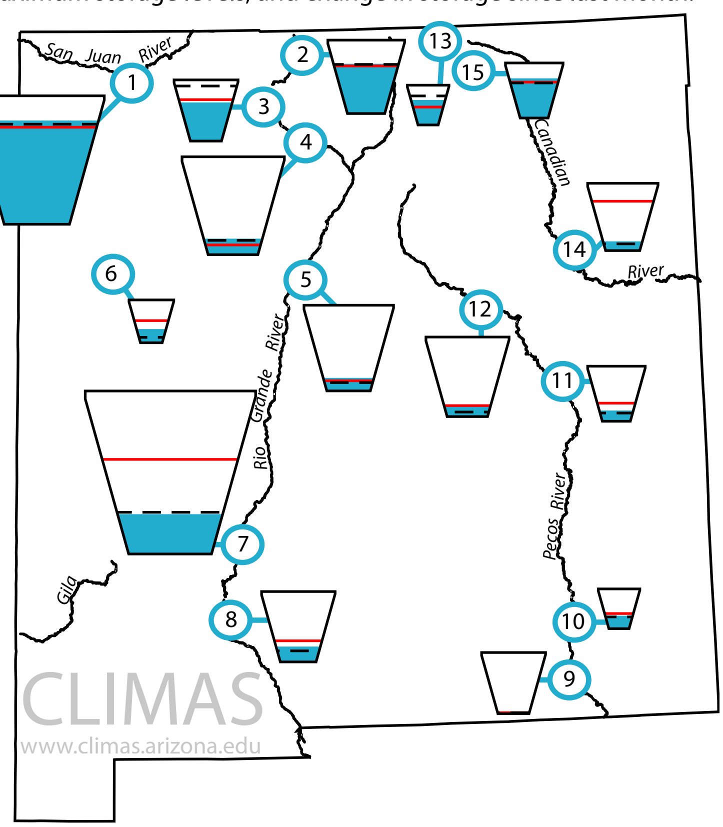
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Wayne Sleep, wayne.sleep@nm.usda.gov.

Figure 7. New Mexico reservoir levels for April 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	81%	1,376.5	1,696.0	129.9
2. Heron	68%	273.1	400.0	20.5
3. El Vado	63%	119.5	190.3	5.9
4. Abiquiu	16%	196.0	1,192.8	15.9
5. Cochiti	15%	75.0	491.0	21.7
6. Bluewater	32%	12.2	38.5	8.2
7. Elephant Butte	25%	542.5	2,195.0	1.9
8. Caballo	22%	71.5	332.0	14.1
9. Brantley	3%	29.6	1,008.2	-2.4
10. Lake Avalon	33%	1.3	4.0	-2.0
11. Sumner	20%	20.5	102.0	-1.5
12. Santa Rosa	13%	57.1	438.3	10.9
13. Costilla	63%	10.1	16.0	2.1
14. Conchas	14%	35.7	254.2	9.0
15. Eagle Nest	72%	57.1	79.0	10.9

*** 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 5/20/10)

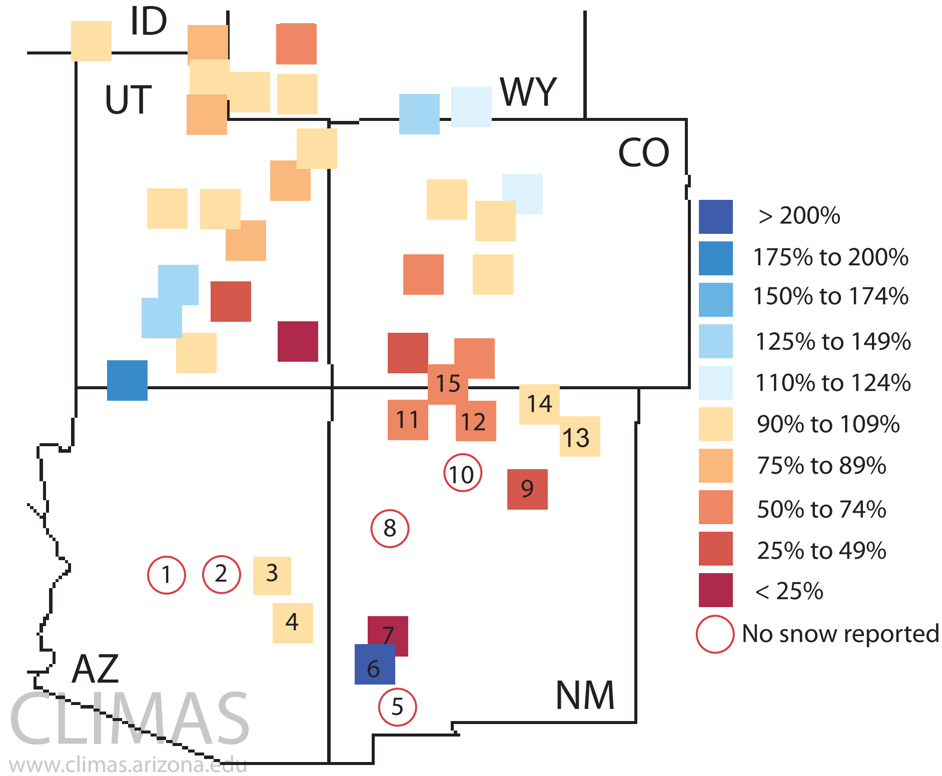
Sources: National Water and Climate Center, Western Regional Climate Center

The snowpack in Arizona is nonexistent or extremely low at all but the highest elevation sites. In the higher elevations of the San Francisco peaks area around Flagstaff, Arizona, water contained in the snowpack, or snow water equivalent (SWE), is more than 300 percent of average for this time of year (Figure 8). In the basins of the Sangre De Cristo mountain range in New Mexico, SWE is about 107 percent of the 1971–2000 average.

Since the water year began on October 1, rain and snow have been above average at many Snow Telemetry (SNOTEL) monitoring stations located in the higher elevations of Arizona and New Mexico.

River basins in states to the north of Arizona and which supply most of the water in the Colorado River and Rio Grande are experiencing below average to near average SWE values. For example, SNOTEL sites in the Upper Colorado River Basin are at 94 percent of average as of May 20, while SWE in the headwaters of the Upper Rio Grande measured 48 percent of average. In both basins, average accumulated winter precipitation is near 100 percent.

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

Southwest Fire Summary
(updated 5/19/10)

Source: Southwest Coordination Center

The Southwest has experienced relatively low fire activity through May 19. In part, this has been the result of the above average snowpack and wetter-than-average conditions during the winter and spring months. These conditions, however, have the countervailing effect of damping early-season fire activity but encouraging the growth of fine fuels which can increase chances for an active grassland fire season during the summer.

The Southwest Coordination Center (SWCC), an interagency effort to share information and help coordinate fire support, reports that 462 fires have started in Arizona and New Mexico between January 1 and May 19 (Figure 9a). Of these, lightning caused only 13 of them while humans ignited the rest. In Arizona, only 3,800 acres have burned in total this year, which is much less than the approximately 43,000 acres burned last year in the state by this date. Only four large fires greater than 100 acres have charred the landscape this year in Arizona. The most recent fire was the Fraguita Fire which started on May 16 in the Coronado National Forest, about five miles south of Arivaca, Arizona.

New Mexico has also experienced less fire activity this year than last year through May 19. To date, only 13,350 acres have burned this year as compared to approximately 166,000 acres last year. The most recent large fires include the Yucca Fire, which started on May 16 in Carlsbad Caverns National Park, and the Elk Fire, which also started on May 16 due to a lightning strike near Espanola. The Elk Fire scorched a total of 350 acres.

Notes:

The fires discussed here have been reported by federal, state, or tribal agencies during 2009. The figures include information both for current fires and for fires that have been suppressed. The top figure shows a table of year-to-date fire information for Arizona and New Mexico. Prescribed burns are not included in these numbers. The bottom two figures indicate the approximate locations of past and present "large" wildland fires and prescribed burns in Arizona and in New Mexico. A "large" fire is defined as a blaze covering 100 acres or more in timber or 300 acres or more in grass or brush. The name of each fire is provided next to the symbol.

On the Web:

These data are obtained from the Southwest Coordination Center website:
http://gacc.nifc.gov/swcc/predictive/intelligence/daily/ytd_all_wf_by_state.pdf

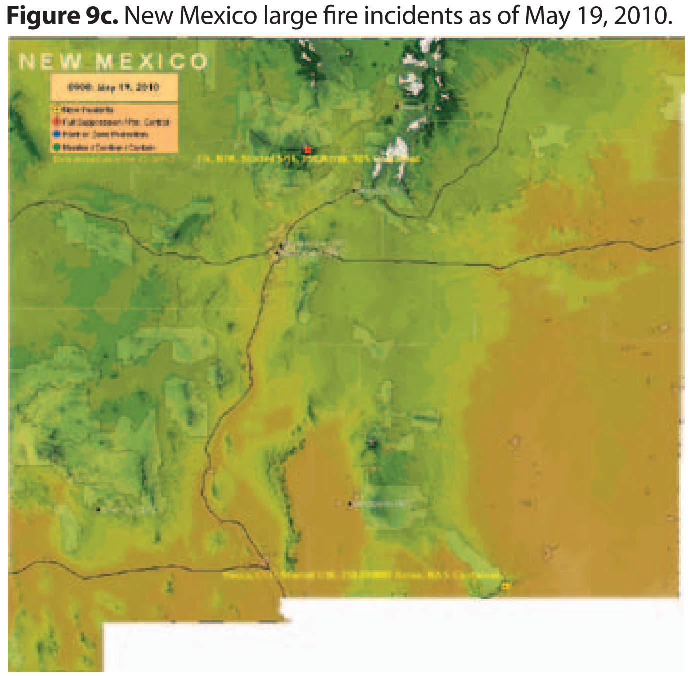
http://gacc.nifc.gov/swcc/predictive/intelligence/maps/wf/swa_fire_combined.htm

Figure 9a. Year-to-date wildland fire information for Arizona and New Mexico as of May 12, 2010.

State	Human Caused Fires	Human caused acres	Lightning caused fires	Lightning caused acres	Total Fires	Total Acres
AZ	213	3,769	4	62	217	3,831
NM	245	13,350	9	8,441	254	21,791
Total	458	17,119	13	8,502	471	25,622

Figure 9b. Arizona large fire incidents as of May 19, 2010.

Figure 9c. New Mexico large fire incidents as of May 19, 2010.



Temperature Outlook

(June–November 2010)

Source: NOAA-Climate Prediction Center (CPC)

The NOAA–Climate Prediction Center (NOAA–CPC) long-lead temperature outlooks show an increased likelihood of above-average temperatures in the Southwest for the summer and early fall seasons (Figures 10a–d). The forecast for the June–August period shows increased odds that temperatures will be similar to the warmest 10 years of the 1971–2000 record in most of Arizona and western regions of New Mexico, particularly in northwest Arizona (Figure 10a). There is greater than a 50 percent chance that temperatures in most of Arizona and parts of western New Mexico will be similar to the warmest 10 years of the 1971–2000 record for the three-month season between July and November (Figures 10b–d). The above-average temperature outlook in the interior Southwest is primarily based on the strong warming trend present for several years.

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 10a. Long-lead national temperature forecast for June–August 2010.

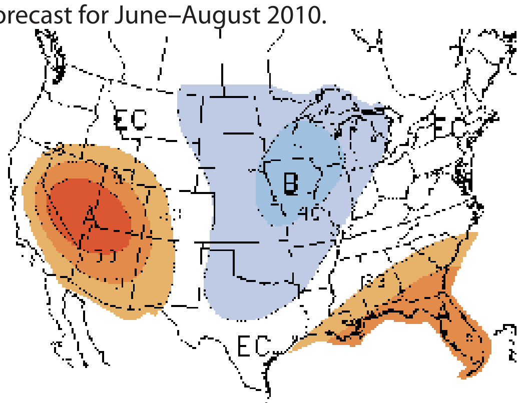


Figure 10b. Long-lead national temperature forecast for July–September 2010.

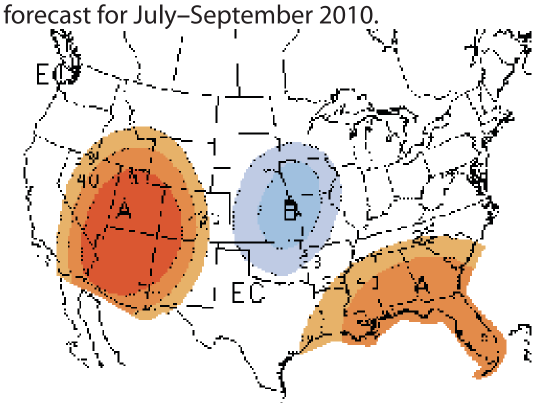


Figure 10c. Long-lead national temperature forecast for August–October 2010.

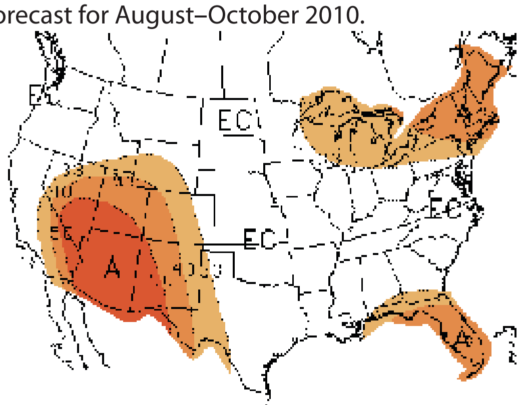
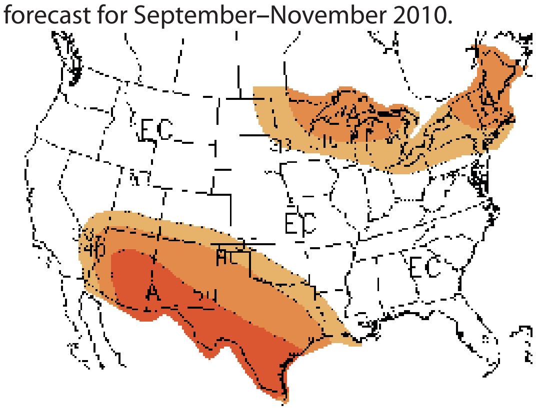


Figure 10d. Long-lead national temperature forecast for September–November 2010.



A= Above: 50.0–59.9%; 40.0–49.9%; 33.3–39.9%

B=Below: 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

(June–November 2010)

Source: NOAA-Climate Prediction Center (CPC)

There are no substantial precipitation signals present in the forecast tools—which include long term trends, El Niño–Southern Oscillation patterns, and current conditions—across the Southwest. As a result, the NOAA–Climate Prediction Center (NOAA–CPC) long-lead precipitation outlooks for the three-month summer seasons indicate equal chances of above-, near-, and below-average precipitation (Figures 11a–b). There is, however, a slight tilt in the odds toward drier-than-average conditions in northern Arizona for the September–November period (Figure 11d). Most of the United States also exhibits an equal chances forecast with three exceptions that include increased chances of above-average precipitation in the central Plains and the Southeast and increased chances for drier-than-average conditions in the Northwest (Figures 11a–c). The dry outlook for the Northwest is predominantly based on drying trends for these seasons.

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 11a. Long-lead national precipitation forecast for June–August 2010.

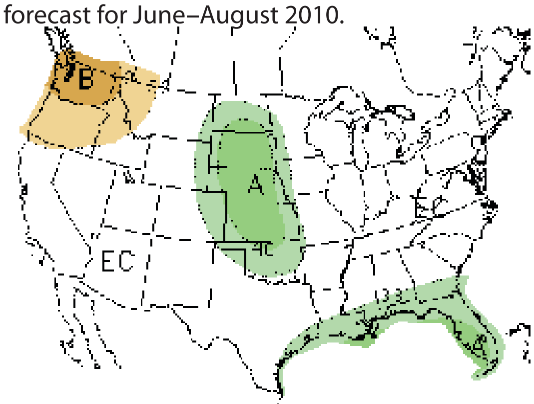


Figure 11b. Long-lead national precipitation forecast for July–September 2010.

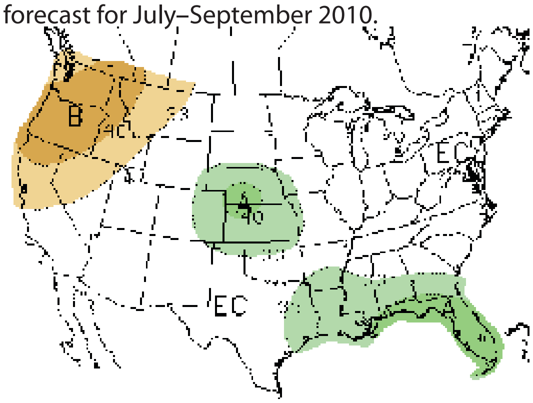


Figure 11c. Long-lead national precipitation forecast for August–October 2010.

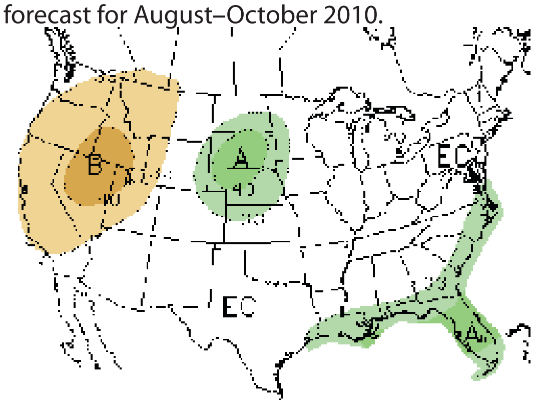
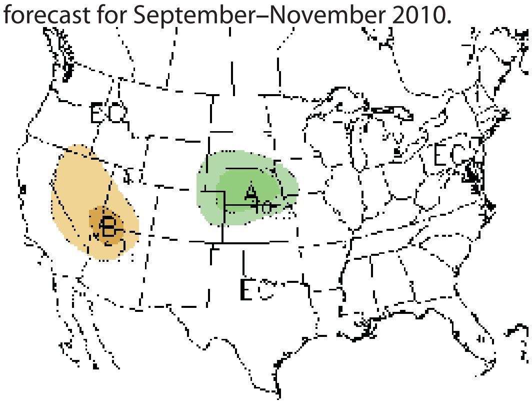


Figure 11d. Long-lead national precipitation forecast for September–November 2010.



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 August)

Source: NOAA-Climate Prediction Center (CPC)

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

In northeast Arizona and northern Colorado, little change is expected in drought conditions through June (Figure 12). Later in the summer, however, monsoon storms will begin bringing showers and thunderstorms in these areas. Although the strength of the monsoon relative to average years is uncertain, the historical occurrence of moisture in the summer months indicates that at least some improvement is likely. The NOAA–Climate Prediction Center (CPC) assigns a moderate confidence to this forecast.

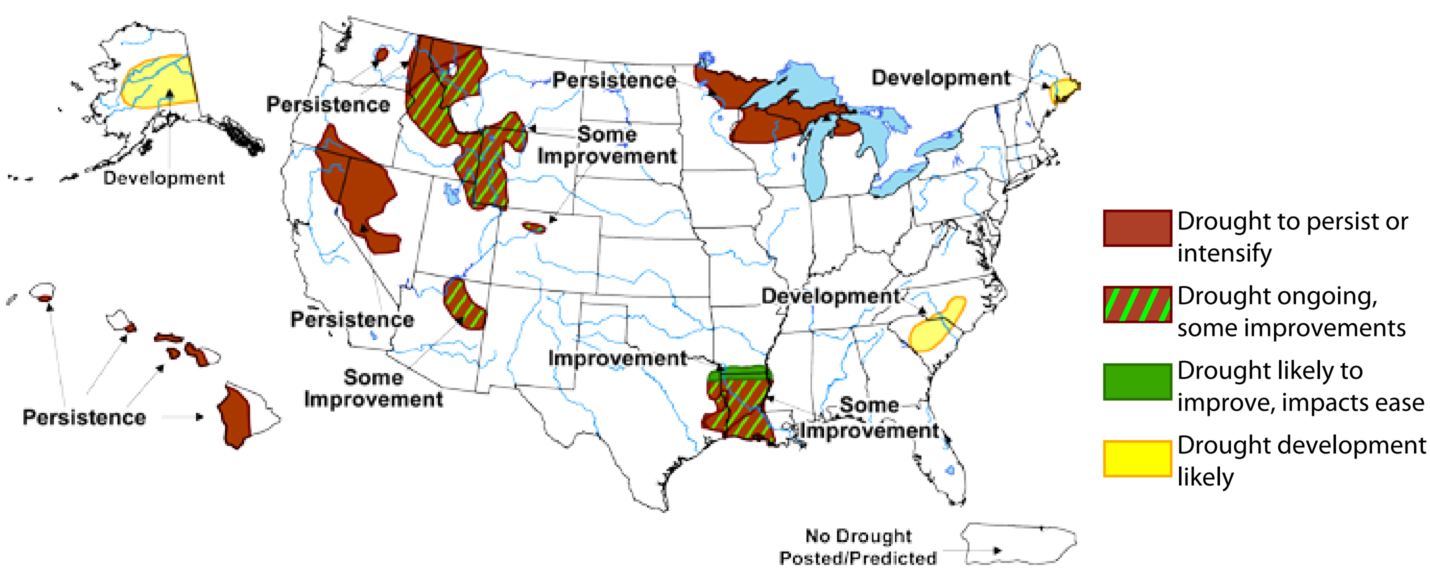
In the West, a series of winter-like storms in recent weeks moved across the region and improved drought conditions in western Wyoming and Montana and parts of Idaho. Additional drought improvement is expected in the short- to medium-range in these regions, with the best odds for drought amelioration centered on western Montana and central Idaho. The areas expected to see some of the most substantial precipitation through the end of May also have increased chances for below average June–August precipitation, limiting the potential for drought relief to continue into the end of the period. The contradictory nature of the indicators leads to low confidence in the forecast for these regions.

Elsewhere, a protracted drought in the northern Great Lakes region is forecast to persist despite some increased chance for wetness at the end of May and early June. Along the Louisiana and Arkansas border, heavy rains early in the period should lead to some drought improvement. Along the East Coast there is no drought to monitor presently, but drought development is forecast for areas currently experiencing abnormal dry conditions, low streamflows, and reduced soil moisture, such as Maine and parts of the interior Carolinas.

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 12. Seasonal drought outlook through August (released May 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)

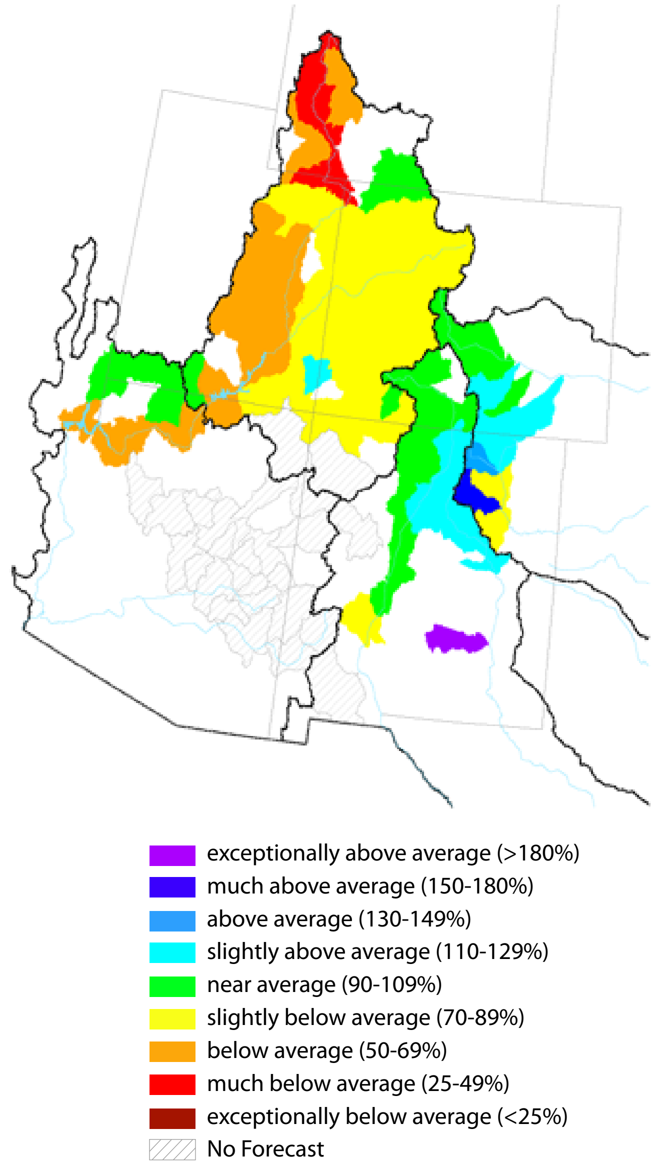
Source: National Water and Climate Center

Streamflow conditions in New Mexico are in general average to slightly above average, according to the Natural Resources Conservation Service (NRCS). However, some stations along the Rio Chama, Mimbres, San Francisco and Gila Rivers in Arizona were reporting well above-average streamflows as of May 1. New Mexico also experienced relatively high streamflow volumes throughout the month of April, indicating that the snowpack had been actively melting for most of April.

For New Mexico, the NRCS projects that summer streamflow for basins in northern New Mexico will generally fall between 90 and 129 percent of average (Figure 13). In the Canadian River Basin, the May–June streamflow forecast ranges from 121 percent of average for Rayado Creek near Cimmaron to 66 percent of average for the Mora River near Golondrinas. Inflow into Conchas Reservoir is expected to be 77 percent of median, or 20,000 acre-feet, for the forecast period.

The NRCS and the Colorado Basin River Forecast Center do not issue streamflow forecasts for Arizona after April 1. On April 1, the streamflow forecast for Arizona showed a wide range of projected flows, divided primarily along the geographic boundary for the Upper and Lower Colorado river basins (CRBs). The NRCS reported on April 1 that summer streamflow in most Upper CRB sub-basins has a 50 percent chance of being below average; thus, predicted inflow to Lake Powell for the April–July period is 63 percent of the 1971–2000 average. In contrast, there is a 50 percent chance that April–May flows on the Verde and Gila Rivers will be well above 200 percent of average, and streamflows in the Salt River will be close to 200 percent of average for the April–May period. Also a flow of more than 300 percent of average is predicted for the Chuska and Little Colorado River basins.

Figure 13. Spring and summer streamflow forecast as of May 1 (percent of average).



Notes:

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

The NRCS provides a range of forecasts expressed in terms of percent of average streamflow for various exceedance levels. The forecast presented here is for the 50 percent exceedance level, and is referred to as the most probable streamflow. This means there is at least a 50 percent chance that streamflow will occur at the percent of average shown in Figure 12. The CBRFC provides a range of streamflow forecasts in the Colorado Basin ranging from short fused flood forecasts to longer range water supply forecasts. The water supply forecasts are coordinated monthly with NWCC.

On the Web:

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

For information on interpreting streamflow forecasts, visit:
http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit:
http://www.wcc.nrcs.usda.gov/wsf/westwide.html
http://www.cbrfc.noaa.gov

Wildland Fire Outlook

(June–August 2010)

Sources: National Interagency Coordination Center, Southwest Coordination Center

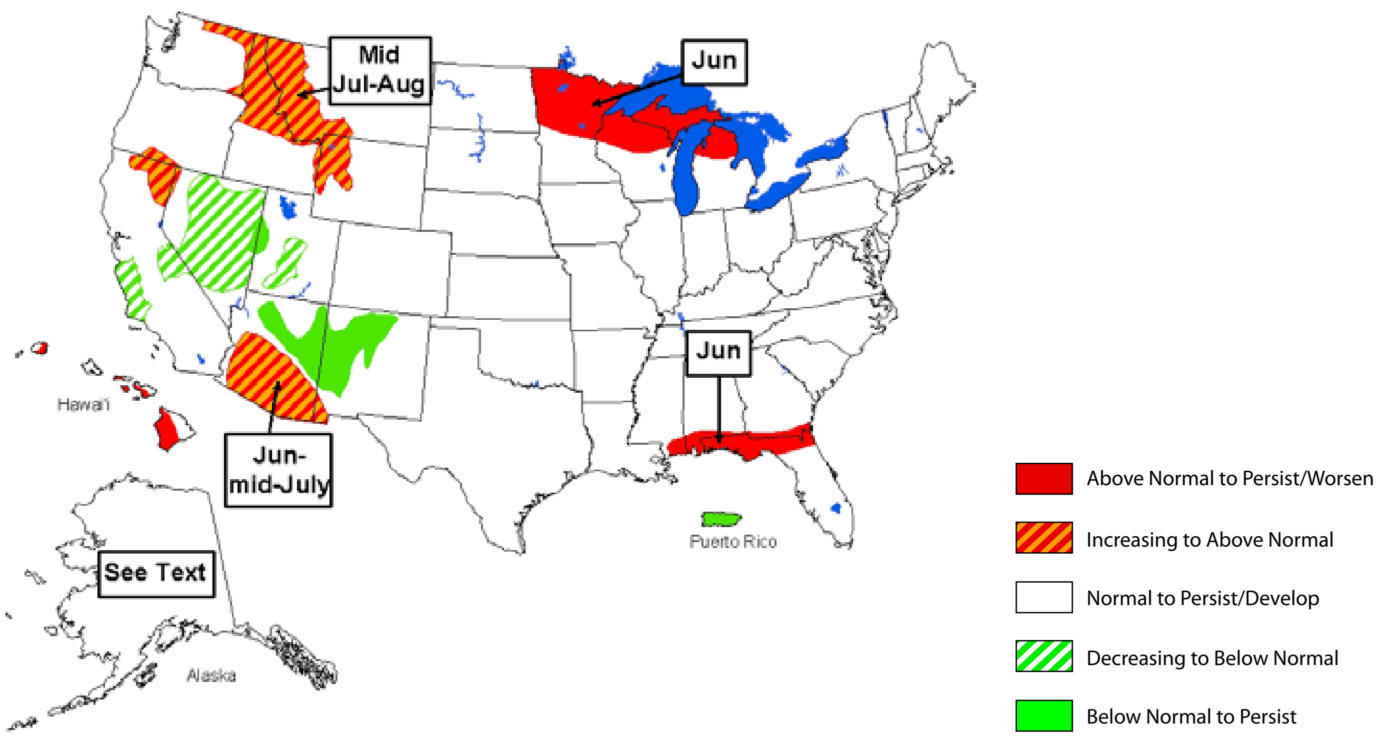
Above average precipitation and snowpack during the winter and spring months have contributed to relatively low fire activity in the Southwest since January 2010. However, wetter-than-average conditions have also encouraged the growth of fine fuels, such as thin branches, especially in southern Arizona and the tip of southwestern New Mexico. The abundance of fine fuels is expected to cause an active grassland fire season for 4 to 6 weeks beginning in June; this region is also forecasted to have increasing to above average fire potential during June through mid-July (Figure 14). According to the Predictive Services unit of the Southwest Coordination Center, June is the most critical period for fire in southern Arizona and New Mexico since warm and dry weather often causes fine fuels to cure rapidly. Below normal fire potential is expected to persist through August, especially in the forested areas in the higher elevations of the Mogollon Rim and the Arizona and New Mexico Colorado Plateau.

Once the monsoon season begins, rains will limit the number of fires. Forecasts state that the monsoon will likely arrive around mid to late June or slightly later. Also, there is some indication that La Niña could develop in the second half of the summer, which would enhance the rainfall in parts of the Southwest.

Notes:

The National Interagency Coordination Center at the National Interagency Fire Center produces seasonal wildland fire outlooks each month. The forecasts (Figure 13) consider observed climate conditions, climate and weather forecasts, vegetation health, and surface-fuels conditions in order to assess fire potential for fires greater than 100 acres. They are subjective assessments, that synthesize information provided by fire and climate experts throughout the United States.

Figure 14. National wildland fire potential for fires greater than 100 acres (valid June–August 2010).



On the Web:

National Wildland Fire Outlook web page:
http://www.nifc.gov/news/nicc.html

Southwest Coordination Center web page:
http://gacc.nifc.gov/swcc/predictive/outlooks/outlooks.htm

El Niño Status and Forecast

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

El Niño conditions continued to wind down through April, and sea surface temperatures (SSTs) across much of the equatorial Pacific Ocean are back to average values for this time of the year. The International Research Institute for Climate and Society (IRI) reported that SSTs in the mid-Pacific were near average (approximately -0.2 F), indicating that ENSO-neutral conditions have returned (Figure 15b). Many of the strong connections between the ocean and atmosphere have quickly dissipated in the past several weeks, including thunderstorm activity in the central Pacific Ocean that was evident most of the winter. The Southern Oscillation Index (SOI) also shifted from a negative to a positive value in recent weeks, further indicating a shift to ENSO-neutral conditions (Figure 15a). Additionally, there is some indication that a La Niña event is on the horizon. The IRI states that there is a significant amount of unusually cool water just below the surface that has accumulating in the western Pacific Ocean and has been moving eastward. Often cool water temperatures below the surface precede cooling of surface water. This suggests that the development of a La Niña event is not too far in the future.

The IRI ENSO forecast indicates that there is an 80 percent chance that the recent shift to neutral conditions will continue through the May–July period. By the middle to late summer (August–October), the chance that neutral conditions will persist falls to 55 percent, while the probability that La Niña conditions will develop increases to 42 percent. Chances remain around 42 percent through the fall that a La Niña event will develop. Seasonal forecasts produced by the NOAA Climate Prediction Center (CPC) reflect higher chances for a La Niña event. CPC assigns increased chances for below-average precipitation for the late fall and winter for the Southwest, which is typical during La Niña events.

Figure 15a. The standardized values of the Southern Oscillation Index from January 1980–March 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).

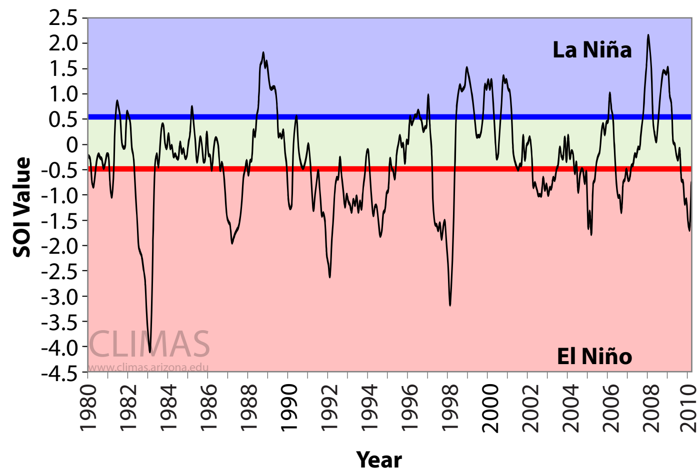
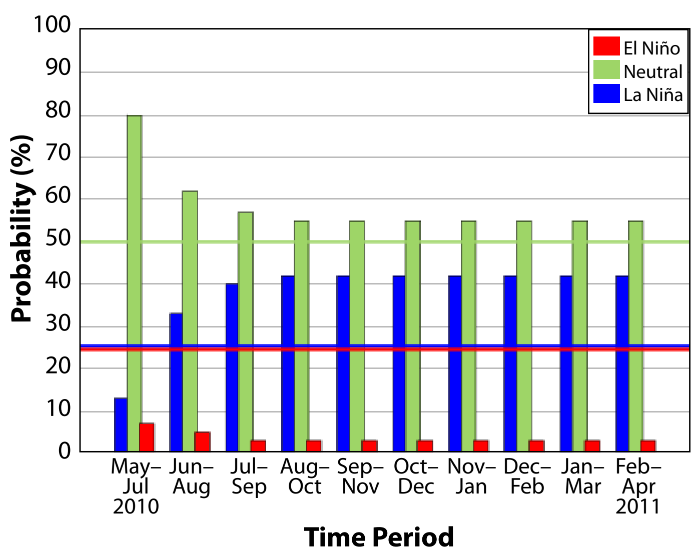


Figure 15b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released May 20). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Notes:

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

Temperature Verification
(June–November 2010)

Source: Forecast Evaluation Tool

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

Comparisons of observed temperatures for June–August to forecasts issued in May for the same period suggest that in most parts of Arizona forecasts have been more accurate than an equal chances forecast (Figure 16a). Forecast skill—a measure of the accuracy of the forecast—is highest in the southern and western regions of Arizona. Forecasts for New Mexico, however, are not better than an equal chances forecast. Skill for the two-month lead time forecasts for the July–September period has a similar pattern as the June–Aug period for Arizona; New Mexico forecasts have not been more accurate than equal chances (Figure 16b). The three- and four-month lead time forecasts historically have been more accurate than equal chances in the southern and western regions of Arizona, with relatively high skill score values, suggesting that forecasts for these periods are more likely to occur (Figures 16c–d). Forecasts for New Mexico for these periods, on the other hand, do not have the same skill and have been less accurate than an equal chances forecast. While deeper blue colors denote more accurate forecasts, 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 16a. RPSS for June–August 2010.

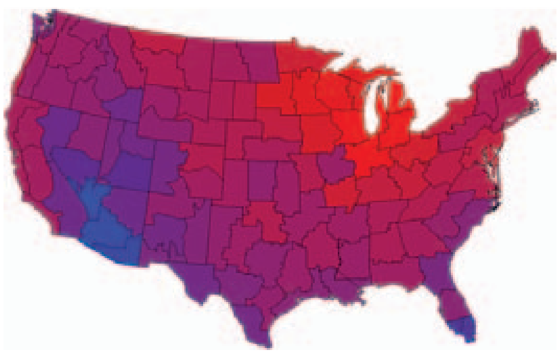


Figure 16b. RPSS for July–September 2010.

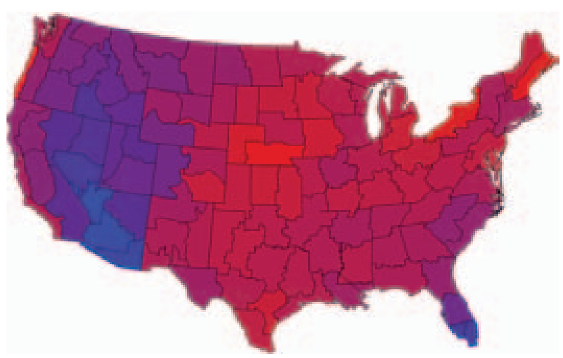


Figure 16c. RPSS for August–October 2010.

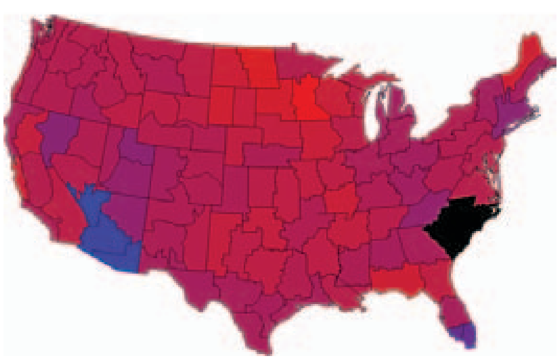
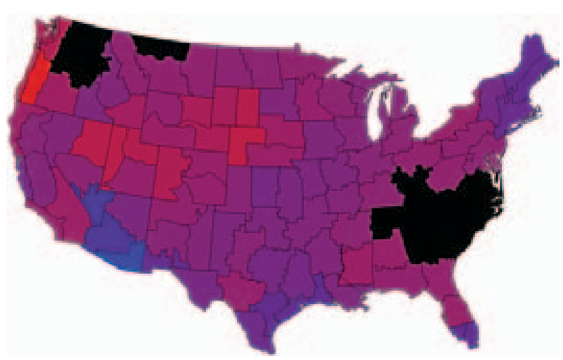
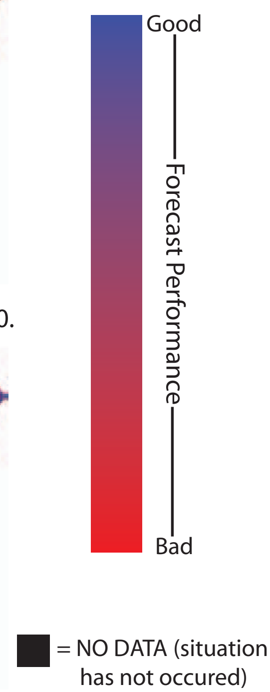


Figure 16d. RPSS for September–November 2010.





On the Web:

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

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

Precipitation Verification
(June–November 2010)

Source: Forecast Evaluation Tool

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

Comparisons of observed precipitation for June–August to forecasts issued in May for the same period suggest that forecasts are only slightly better than forecasting equal chances (i.e., 33 percent chance that rain will be above, below, or near average) for most of Arizona and New Mexico (Figure 17a). Forecast skill—a measure of the accuracy of the forecast—is highest in the southeast corner of Arizona and southwest New Mexico. Skill for the two-month lead time forecasts historically have been less accurate than equal chances in most of both states, particularly in southeastern Arizona (Figure 17b). This is caused in part by the monsoon rains, which are difficult to predict. The three- and four-month lead time forecasts have not been much better than an equal chances forecast in most of both states, with the exception of southeastern Arizona and northeastern Arizona for the September–November period (Figures 17c–d). Bluish hues suggest that NOAA–CPC historical forecasts have been more accurate than equal chances. However, caution is advised to users of the seasonal forecasts for regions with reddish colors.

Notes:

These maps evaluate the historical performance of the one- to four-month long-lead forecasts made by NOAA's Climate Prediction Center (CPC). The maps convey the historical accuracy of the CPC forecasts in relation to the reference forecast, which assigns a 33 percent chance to the three CPC categories, "above," "below," and "neutral." These categories indicate whether conditions are predicted to be similar to the 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 17a. RPSS for June–August 2010.

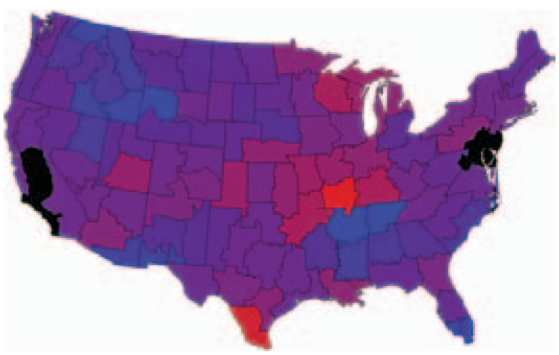


Figure 17b. RPSS for July–September 2010.

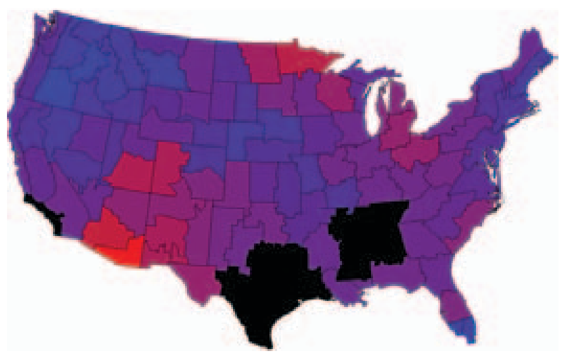


Figure 17c. RPSS for August–October 2010.

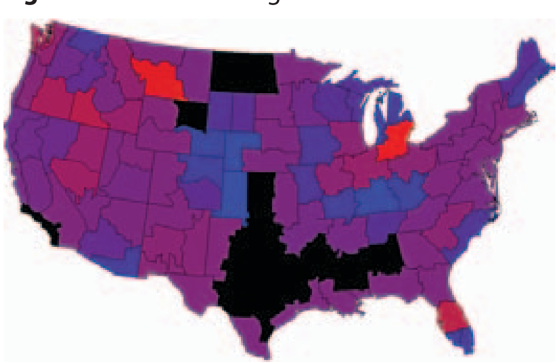
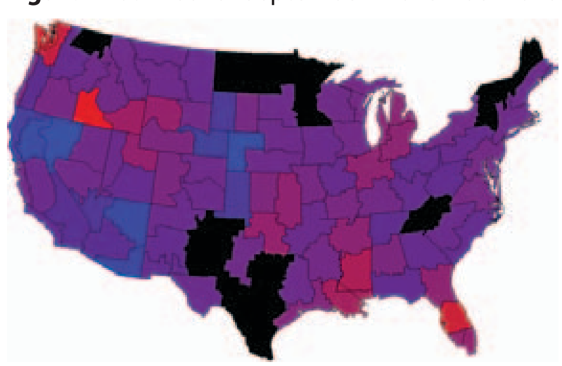
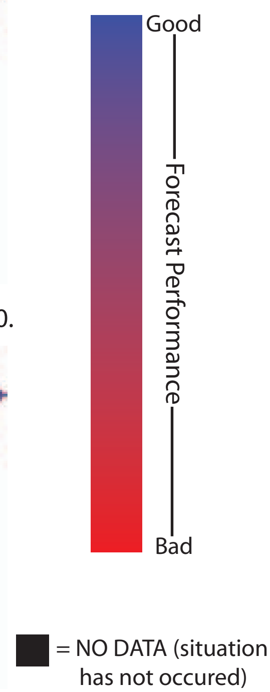


Figure 17d. RPSS for September–November 2010.





On the Web:

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