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Southwest Climate Outlook

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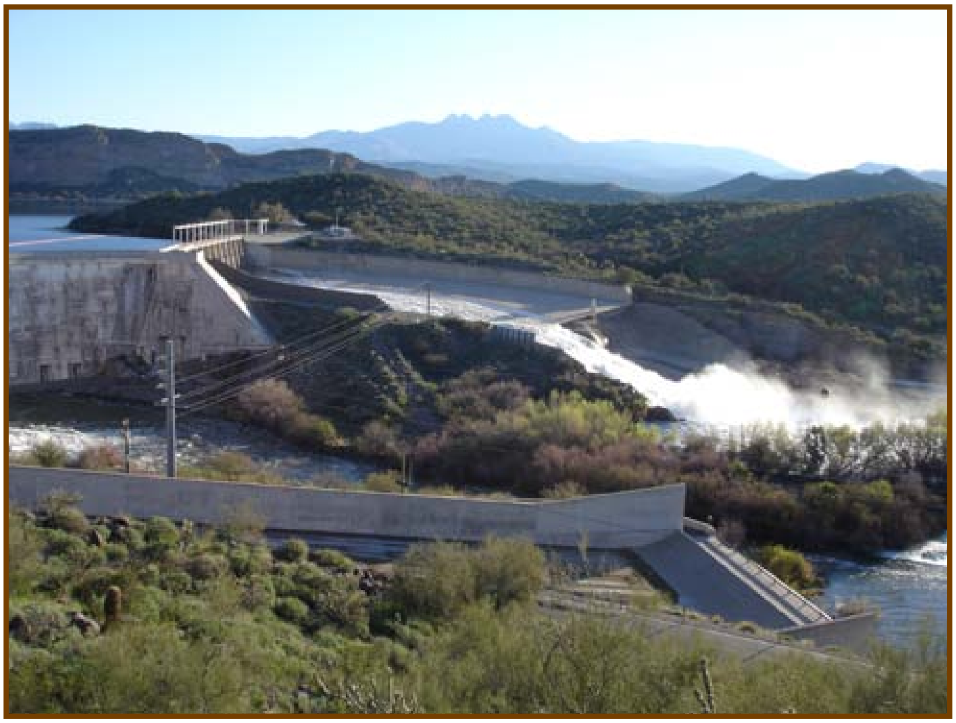

Source: Jonathan Overpeck, Institute of the Environment.

Photo Description: A wet El Niño winter throughout the upper Salt and Gila river basins has resulted in well above-average streamflows for both rivers. This photo of the Stewart Mountain Dam (operated by the Salt River Project), taken on March 16, shows Saguaro Lake near capacity and water flowing over the spillway.

Would you like to have your favorite photograph featured on the cover of the *Southwest Climate Outlook*? For consideration send a photo representing Southwest climate and a detailed caption to: macaulay@email.arizona.edu

In this issue...

CLIMAS Climate Assessment for the Southwest

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

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April Climate Summary

Drought– Drought conditions improved slightly again this month across the Southwest with much of southern Arizona and New Mexico classified as abnormally dry or drought-free.

Temperature– Cooler-than-average temperatures prevailed across much of Arizona and New Mexico again this month.

Precipitation– Very little precipitation was observed across much of the Southwest over the past 30 days as passing storms brought mostly wind and cooler temperatures.

ENSO– El Niño has dramatically weakened over the past month, with ENSO-neutral conditions expected to return later this spring or early summer.

Climate Forecasts– Seasonal climate outlooks point towards an increased chance of above-average temperatures across Arizona and New Mexico for much of this upcoming summer and a slightly increased chance of below-average precipitation for northern Arizona during the summer monsoon season.

The Bottom Line– El Niño weakened its grip on the weather pattern across the western U.S. this past month, letting storms track a bit farther north and with less sub-tropical moisture than was typical earlier this winter. This left much of Arizona and New Mexico to contend with dry, breezy, and cool conditions as late-season winter storms tracked north of the region, ushering in cool air. Even with the recent dry spell, short-term drought conditions continue to improve and snowpack levels remain high with the promise of delivering above-average streamflows to most basins in Arizona and New Mexico. Updated forecasts point towards a warm and possibly drier-than-average summer season, which may impact how fast and far short-term drought conditions continue to improve, especially across drought-stricken portions of northern Arizona.

Need for New Municipal Water Sources

Thousands of Arizona residents run their washing machines, douse their gardens, and fill their bathtubs with water drawn from the Central Arizona Groundwater Replenishment District (CAGRD). Unbeknownst to many of these residents, CAGRD water will likely fall short of future supply, causing changes in water prices (*Arizona Daily Star*, March 21). To address the problem, the Arizona Legislature is debating a bill that would authorize CAGRD to sell up to $500 million in bonds to buy new water supplies to its customers living in Pima, Pinal, and Maricopa counties. Possible sources of new supplies include water purchased from agriculture along the Colorado River, treated sewage effluent, and desalinated brackish groundwater.

In 1993, state legislation created CAGRD to allow development in areas that could not meet the 100-year assured water supply requirement of the Groundwater Management Act. Essentially, CAGRD uses about 40,000 acre-feet of “excess” Colorado River water delivered by the Central Arizona Project (CAP) to replenish groundwater used by its customers each year; 40,000 acre-feet is enough water to meet the yearly demand of approximately 120,000 houses. The problem is that future demand is expected to eclipse 340,000 homes by 2030, while water available to CAGRD from CAP may diminish if stores in the Colorado River continue to decline. The bill is currently awaiting House approval.

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

The final gasp: Pinyon pines die faster during warmer droughts

By Zack Guido

Trees are hearty, but they have their limits. Ask Henry Adams what it takes to kill a pinyon pine, and he smiles and his eyes light up as he explains that in experimental conditions, pinyons can survive for around 26 weeks without water, but higher temperatures cause them to wither faster. For the past three years he has been conducting elaborate experiments in Biosphere 2 near Oracle, Ariz., and more recently in Flagstaff, Ariz., to see how water-starved trees fair when subjected to two different types of conditions: current summer temperatures in the Southwest and warmer temperatures that global models project for the region by the end of this century.

Figure 1. Adams monitored watered and unwatered trees in two temperature environments—one similar to current summer temperatures and one about 7 degrees F warmer. The experiment was conducted at Biosphere 2 located in Oracle, Ariz. Figure courtesy of Henry Adams.

Adams, a PhD candidate in the School of Natural Resources and the Environment at the University of Arizona, is measuring the physical changes in withering trees to understand the causes of large forest die-offs that many western states have been experiencing. In recent years hot sun and bone-dry air have contributed to massive die-offs in the West that have affected nearly 80,000 square miles—about two-thirds the size of Arizona—including about 4,500 square miles of pinyon forests in the Four Corners region during 2002–2003. These once vibrant groves have been turned into tinder, posing a fire risk and denuding the landscape of colorful fall foliage that attracts tourists.

Understanding how trees die and the role temperature plays in expediting tree mortality has profound implications for the Southwest and beyond, particularly because droughts are projected to be longer, more frequent, and warmer, according to the latest United Nations Intergovernmental Panel on Climate Change (IPCC) report published in 2007. Enter Adams and his latest research, co-authored by several other UA researchers, which quantified how increased temperatures during droughts accelerate die-offs.

In a March 31 interview with Zack Guido, CLIMAS staff scientist, Adams discussed his research results. His findings were published in the September 22 issue of the *Proceedings of the National Academy of Sciences* in the article, "Temperature Sensitivity of Drought-induced Tree Mortality Portends Increased Regional Die-off Under Global Change-type Drought."

Question: What questions did you set out to answer in your research?
Henry Adams: We wanted to investigate if the observed elevated temperatures during the drought in 2002–2003 could have caused the pinyon tree die-off around the Four Corners region. There have been a bunch of studies that say the die-off is associated with a warmer drought, but we wanted to say that the die-off is caused by the elevated temperatures during the drought.

Q: How did you test the effects of temperature on tree mortality?
HA: We subjected the trees to two different temperature treatments while not giving them any water. Five trees were in a temperature environment that mimicked summer temperatures here in the Southwest, maintaining daily fluctuations. Another four trees were placed in a room that experienced about a 7-degree Fahrenheit (approximately 4 degrees Celsius) increase, again maintaining daily fluctuations. Each of the different environments had five control trees that were watered.

The trees were immediately aware that we had shut off the water valve. By about week three, the unwatered trees in both experiments were not using moisture in the soil, they were saving it. They were waiting out the drought, and we were going to outwait them.

continued on page 4

The final gasp, continued

Q: How did you set up the experiment?
HA: We trucked 50 pinyon trees from northern New Mexico to the Biosphere 2. The trees were about eight-feet tall and were several years old but were considered mature pinyons. They were planted in large sacks (Figure 1). We couldn't ship the soil from New Mexico so I had to make soil here, getting the organic content and chemistry of the soil as similar to the original make-up as possible. Once they were transplanted to Biosphere 2, we waited about seven months before beginning the experiment to make sure the trees survived the move. All but 10 did. In one room, we cranked up the temperature [to reflect the IPCC projections]. In the other room we maintained ambient conditions. The Biosphere gave us very good control over the environment.

During the experiment we measured the soil water content. We had three trees in each temperature environment on scales so we could see soil moisture changes—[as the trees use water the total weight of the tree decreases]. We also measured photosynthesis and respiration of the trees, among other things.

Q: Why did you choose to study pinyon pines?
HA: During the drought in 2002–2003, pinyon trees died all across the region while other species, like ponderosa pine, Douglas-fir, and aspen were mostly getting hit on the lower elevation ends of their ranges where they encountered the driest conditions. But pinyon pines were dying all through their elevation ranges, even at the moister sites, which was unusual and not what you would expect. It looked like a population crash. It made us wonder why the trees growing in choice sites were dying.

We also chose pinyon pines because they are fairly small when they are mature. If you want to do this study with a lodgepole or ponderosa pine, the big trees, you would have to study the sapling stage, which is morphologically less similar to full-size trees.

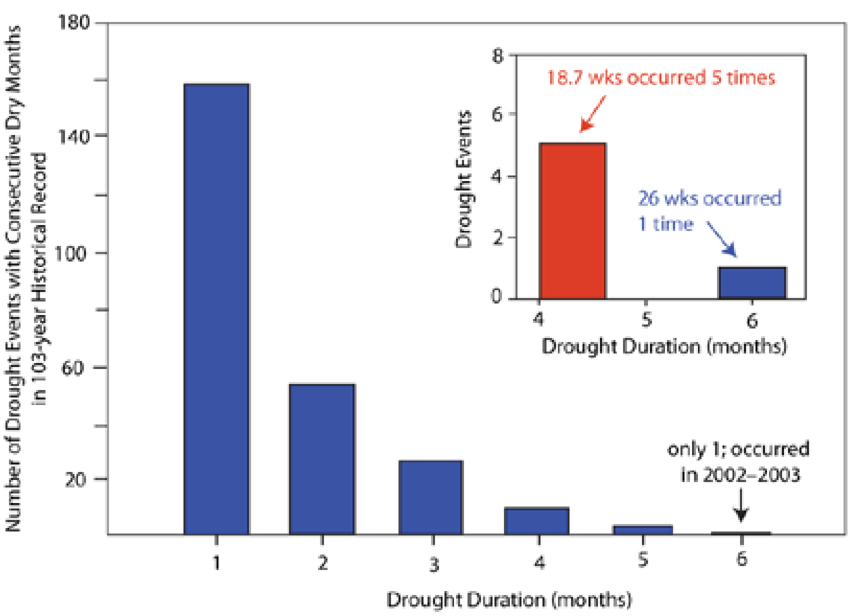


Figure 2. Shorter droughts are more common than longer ones. In the last 103 years, only the 2002–2003 drought lasted 26 weeks or longer, while five droughts were equal to or longer than 18.7 weeks. Since the results of the experiment suggest trees in warmer climes die faster than trees in cooler temperatures, a warmer future could cause more massive die-offs. Figure courtesy of Henry Adams.

Q: How long did it take to kill the trees?
HA: On average the trees in the warmer environment died in 18.7 weeks, while the trees in the ambient temperatures died in 26.1 weeks. This is a 28 percent difference. All the trees in the warmer temperatures died between about week 16 and 20 and all before the first death in the ambient conditions.

Q: What did you observe while the trees were dying?
HA: When they were getting close to dying, the skin of the bark was shriveling. I remember touching it and thinking it felt like loose skin. We told everyone working on the project not to touch the trees because the bark could rip apart and we wanted them to die naturally.

The trees were probably shrinking a bit as they dried out, too. Their foliage would first turn light green and then from light green to brown in about a week. After that, boom, they died fast. One week you might see about 50 percent brown needles. The next week there would not be a spot of green on them. When the trees were 90 percent brown we called them dead. Just to make sure, we turned the irrigation back on to see if they could recover. They didn't.

Q: How did the trees die?
HA: We were really hoping to observe the death rattle of the trees, a final gasp where the trees let loose the little bit of water they've been holding back. We didn't hear that. But, our data suggest that the trees in both temperature conditions died from carbon starvation.

[Carbon starvation occurs when trees close their pores, called stomata, to prevent water loss.] Stomata allow trees to inhale and exhale. They take in carbon dioxide, which they basically build their food out of, and they let out oxygen and water in a process called transpiration. During drought some trees maintain open stomata to continue to suck up carbon,

The final gasp, continued

while others close them to prevent moisture loss. There's a trade-off in doing either.

Our measurements show that photosynthesis drops to zero by about week five—so no carbon coming in—and respiration rates were greater than zero and were slightly higher in the warmer ambient temperatures. Even when trees stop transpiring they still use carbon. So each week their carbon reserves were getting smaller and smaller, and the warmer drought trees were burning through their carbon stores faster. This makes sense. It is well understood in biology that respiration rates are tied to temperature. Think about two people running a marathon in the summer. If you give them the same pasta dinner the night before, the person running in Chicago will have an easier time than the runner in Tucson when its 100 degrees F. Just before their death, on average, the trees had respired the same amount, even though the trees in the warmer drought conditions died about seven weeks sooner.

Q: Why did you choose 7 degrees Fahrenheit?

HA: About 7 degrees F is a mean estimate for the temperature scenario from the IPCC projections for 2100. It's also become standard for research looking into the effects of temperature, which makes it easier to compare results between studies. Also, 7 degrees F is a big enough change to show that there is a difference between ambient temperatures and the warmer scenario.

Q: Would there have been more die-offs if the past was warmer? In other words, will die-offs increase in a warmer future?

HA: In our experiment, when we cranked up the temperatures [about 7 degrees F], we found that it took about 28 percent less time to kill pinyons. What does this mean for a warmer future? It means that shorter droughts will become sufficient to kill trees, and there are more frequent shorter droughts than longer ones. We quantified this in our paper. Looking at the historical record, the drought that caused the 2002-2003 die-off lasted six months around the region and was the longest drought in the entire record. However, there were five droughts in the last 103 years that were 28 percent shorter (Figure 2). This could imply that a warmer future could have five times more die-offs.

Q: Why is this important for the Southwest?

HA: There are consequences of a warmer world and we are trying to show that. In the Southwest, pinyons aren't worth much and they don't even make good firewood. But in British Columbia, a regional die-off affecting about 50,200 square miles is starting to nail their timber industry. We looked at one species, but it's reasonable to think temperatures will impact others in similar ways.

Carbon sequestration is also impacted. People are counting on the biosphere to take up anthropogenic carbon dioxide, and it's been doing that. But the die-off in British Columbia is causing all that carbon sequestered in the trees to flow back into the atmosphere. What happens if a die-off occurs in the Amazon, [a major global sink of carbon dioxide]?

There are other implications for hydrology that are just starting to be explored. What does this mean for how much water is available in reservoirs? Will die-offs increase or decrease streamflow? People are studying this now.

Q: What are your next steps?

HA: We are currently repeating the experiment outside in Flagstaff. We have transplanted pinyon pines from a source location to a lower elevation, which equates to a warmer climate. These trees are not put in sacks but planted back into the ground. We have also transplanted pinyons from the same source location across the site, keeping them at the same elevation to compare transplanted trees at both locations. So far the temperature difference between the two areas has been about 6 degrees F (or 3.5 degrees C) on average. We are simulating drought by putting big tarps beneath the branches so they get full sunlight, but most of the water runs off to the side and away from the roots.

The idea is to repeat the experiment in an environment with realistic conditions. The problem with the Biosphere study is we don't want people to take the absolute survival time and apply it to wild trees. That's not correct. The trees planted in sacks survived for 26 weeks without water under ambient conditions, but trees in the ground should last longer. The downside is we are sacrificing control [in the Flagstaff experiment]; we don't know what our temperature treatments are going to look like.

We started simulating drought last September and the soil moisture has recently begun to decline, but we don't have any preliminary results yet. We think the 28 percent difference in the time it takes to kill trees between the two environments with different temperature will hold up. Publishable results will likely take a few years.

Temperature (through 4/14/10)

Source: High Plains Regional Climate Center

Average temperatures since the water year began on October 1 have been between 35 and 45 degrees Fahrenheit on the Colorado Plateau of northern Arizona and the northern two-thirds of New Mexico, with the highest elevations in the low 30s or upper 20s F (Figure 1). The elevation transition along the Mogollon Rim of Arizona and the southern third of New Mexico had temperatures in the upper 40s F. The southwestern deserts of Arizona have been between 55 and 65 degrees F, with temperatures varying from 1 degree below average to 1 degree above average. Northern Arizona and southern New Mexico have been 0–2 degrees colder than average, while the higher elevation areas of New Mexico have been 2–4 degrees colder than average (Figure 1b). The generally cooler temperatures are due to the El Niño circulation that brought cold winter storms south into the lower tier of states.

Temperature patterns over the past 30 days have been quite varied across the two states (Figures 1c–d). Western and central Arizona generally have ranged from 0 to 2 degrees colder than average, with the coldest air along the lower Colorado River. Eastern Arizona and south-central and northeastern New Mexico have been 0–3 degrees warmer than average, with the warmest temperatures in the northeast corner of New Mexico. The coolest readings in New Mexico occurred at higher elevation locations in the western mountains, where temperatures were up to 5 degrees below average.

Notes:

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

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

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

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

On the Web:

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

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

Figure 1a. Water year '09–'10 (October 1 through April 14) average temperature.

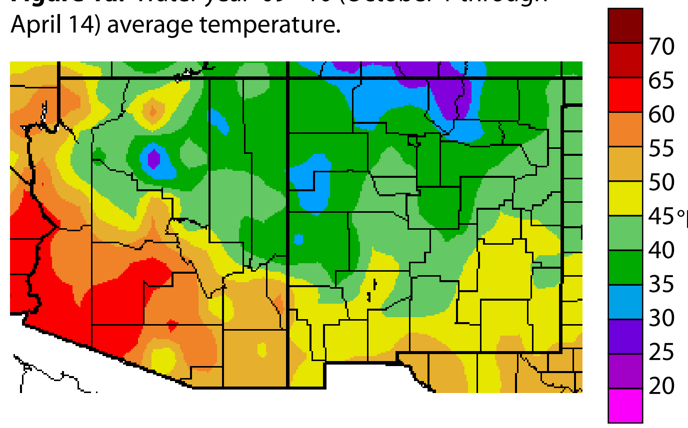


Figure 1b. Water year '09–'10 (October 1 through April 14) departure from average temperature.

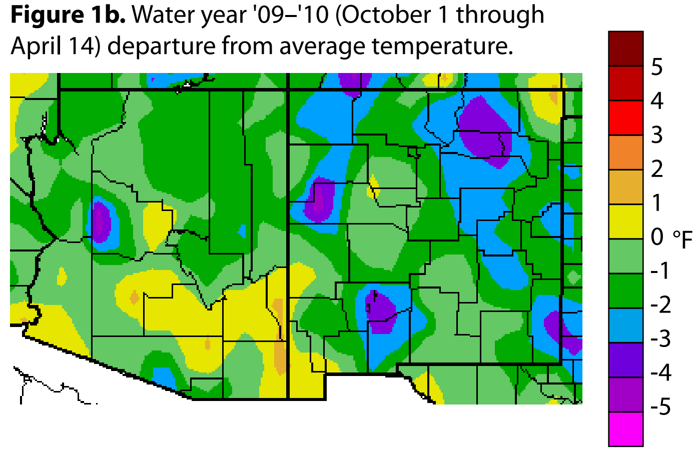


Figure 1c. Previous 30 days (March 16–April 14) departure from average temperature (interpolated).

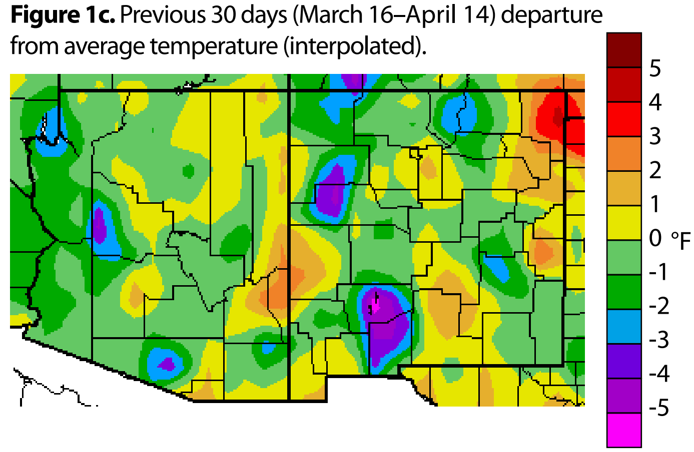
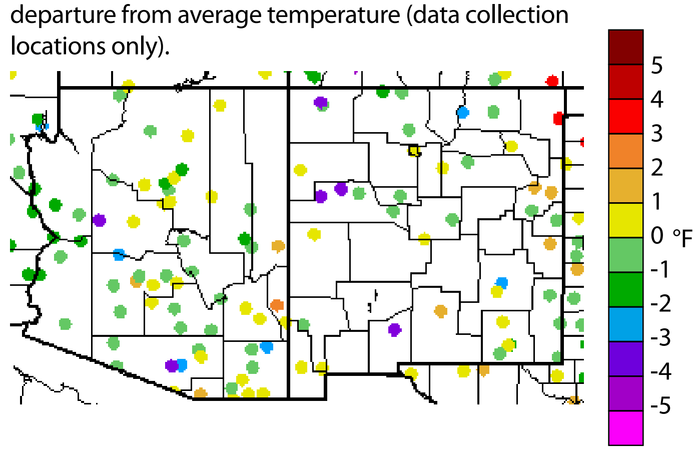


Figure 1d. Previous 30 days (March 16–April 14) departure from average temperature (data collection locations only).



Precipitation (through 4/14/10)

Source: High Plains Regional Climate Center

From October 1, when the water year began, through mid-March, conditions were much wetter than average across the Southwest as a strong El Niño circulation pattern brought a persistent subtropical moisture source and southerly winter storm track. Currently the water year precipitation is between 100 and 200 percent of average in western Arizona and eastern New Mexico (Figures 2a–b). Most of the Colorado Plateau and western New Mexico have received 50–90 percent of average precipitation. The White Mountains along the southern Arizona-New Mexico border have had 110–150 percent of average, and the wettest locations are the northeast and southeast corners of New Mexico, which are still above 150 percent of average.

During the past 30 days, the El Niño event has weakened and the circulation pattern has shifted to a more typical winter pattern, with storms tracking north of Arizona and New Mexico (Figures 2c–d). The subtropical moisture also has moved further south, so the storms that do cross the Southwest do not have much moisture to generate precipitation. The exception to this has been in southeastern New Mexico, where the subtropical moisture has brought 150 to more than 800 percent of average rainfall. Most of Arizona and western New Mexico have received 0–25 percent of average precipitation in the last four weeks.

Figure 2a. Water year '09–'10 (October 1 through April 14) percent of average precipitation (interpolated).

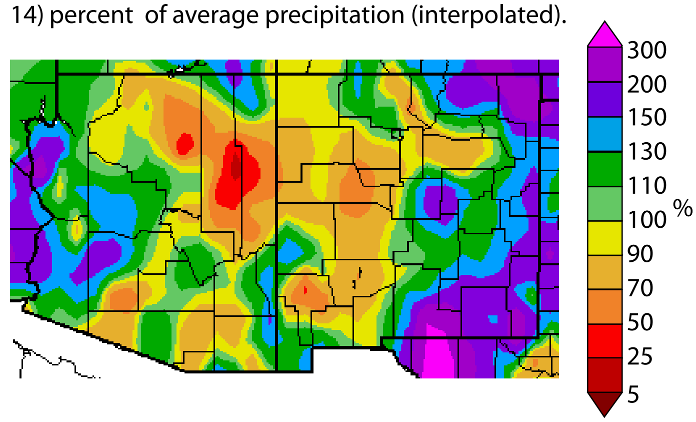


Figure 2b. Water year '09–'10 (October 1 through April 14) percent of average precipitation (data collection locations only).

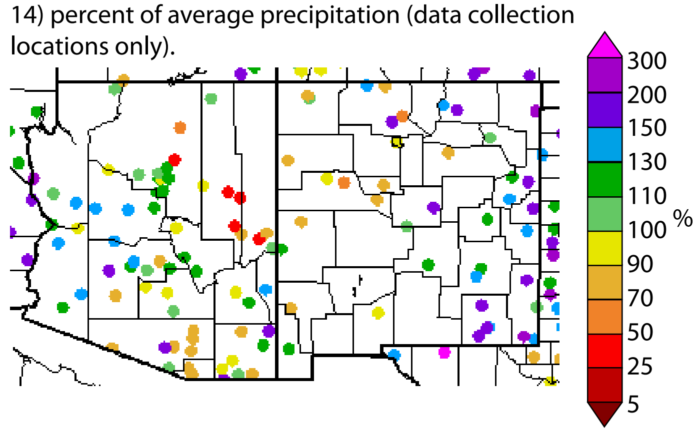


Figure 2c. Previous 30 days (March 16–April 14) percent of average precipitation (interpolated).

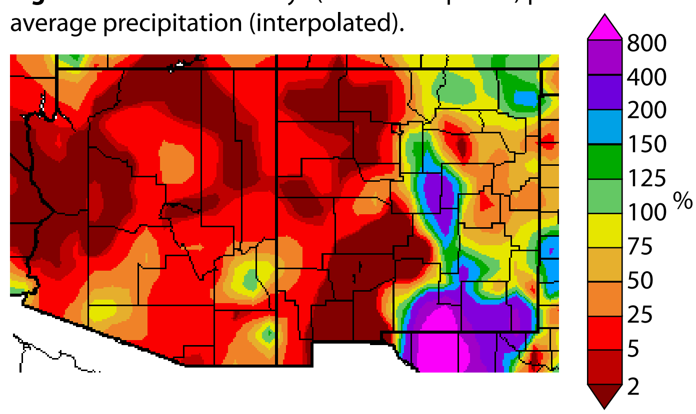
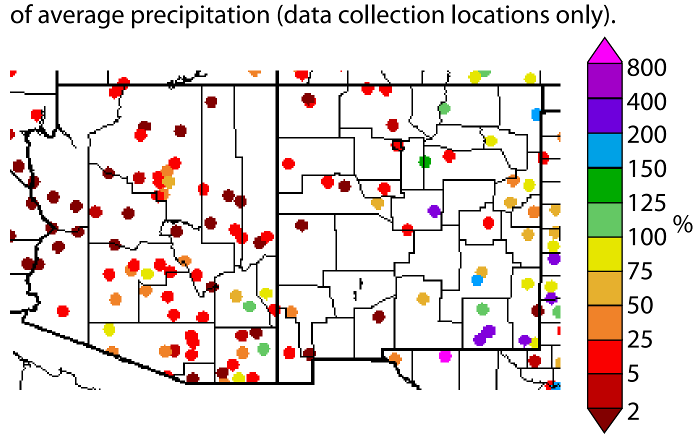


Figure 2d. Previous 30 days (March 16–April 14) percent of average precipitation (data collection locations only).



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

U.S. Drought Monitor

(data through 4/13/10)

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

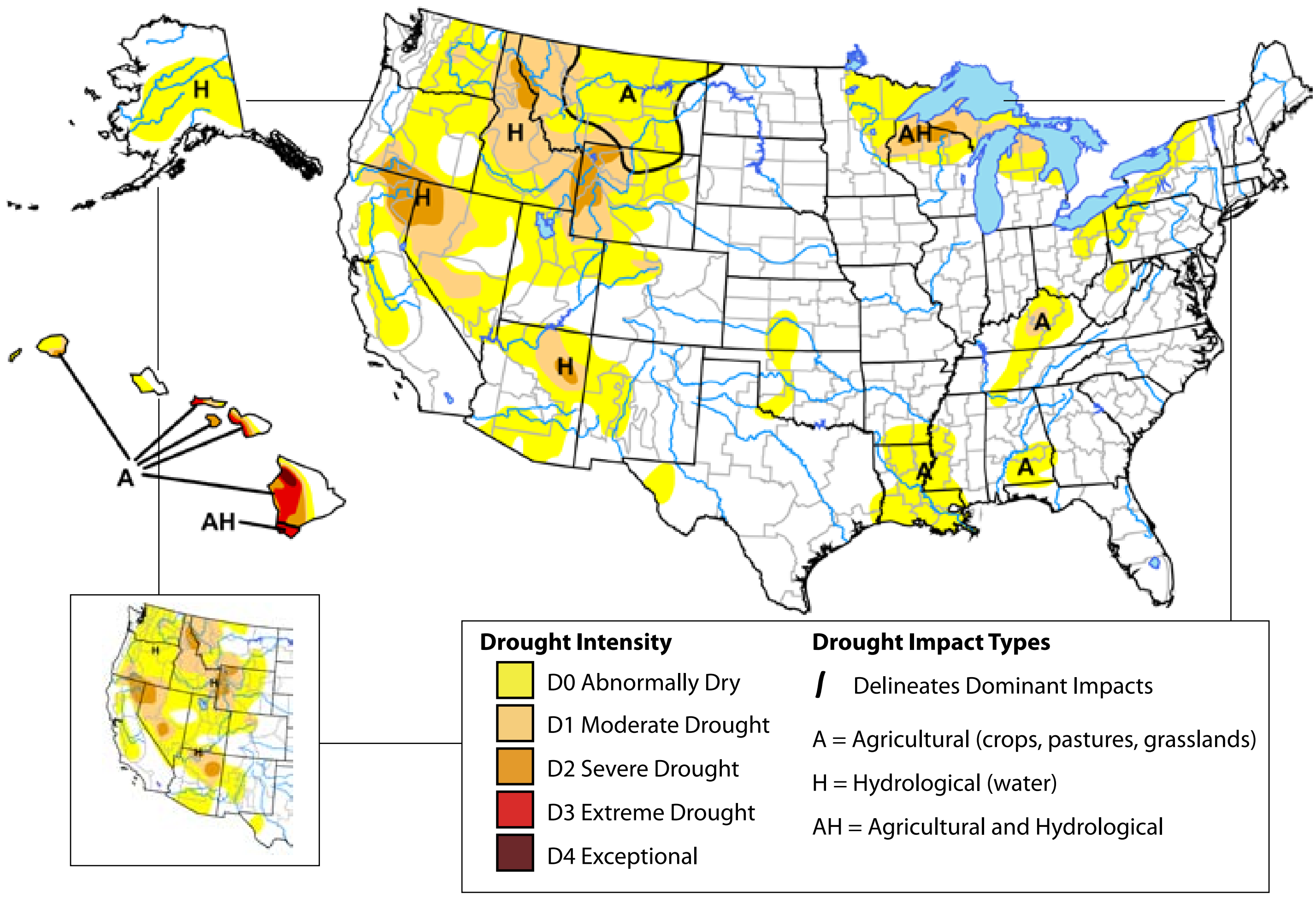
There were few major changes in the pattern of drought across the western U.S. this past month (Figure 3). Overall drought continued to retreat slightly across the Southwest and expand over the northern Rockies, which is consistent with springtime El Niño precipitation patterns. The biggest changes were the retreat of abnormally dry conditions in western Washington and Oregon and the expansion of abnormally dry conditions across eastern Montana. Overall, 42 percent of the western U.S. is classified as drought-free, up slightly from 38 percent last month. The coverage of severe (or worse) drought areas fell slightly from 5.6 percent in March to 4.5 percent in April. Severe drought conditions are still a major problem in western Montana and Idaho, where snowpack levels have hit record low levels. These low levels will most likely translate into record low streamflows later this summer, effecting water supplies across the region (*Missoulian*, April 14).

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, CPC/NCEP/NWS/NOAA.

Figure 3. Drought Monitor data through April 13 (full size), and March 16 (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 4/13/10)

Source: U.S. Drought Monitor

Even though the past 30 days were relatively dry for Arizona, short-term drought conditions have continued to improve on the momentum of above-average precipitation received earlier this winter (Figure 4a). The April 13 update of the National Drought Monitor showed a reduction in abnormally dry conditions across parts of southern Arizona and shrinking coverage of moderate and severe drought in northern Arizona. Overall, the portion of the state classified as drought-free rose from 28 percent in March to 39 percent in April (Figure 4b). Drought impacts reported through Arizona DroughtWatch (http://azdroughtwatch.org) support the improving conditions. A report from a natural resource manager in southeast Arizona indicated that previously dry stock ponds were filling and that spring forage conditions were improving based on winter precipitation. Several other Drought Watchers submitted "all clear" (no impacts observed) reports for areas in the Santa Cruz, Upper Gila, and Little Colorado river watersheds.

Figure 4a. Arizona drought map based on data through April 13.

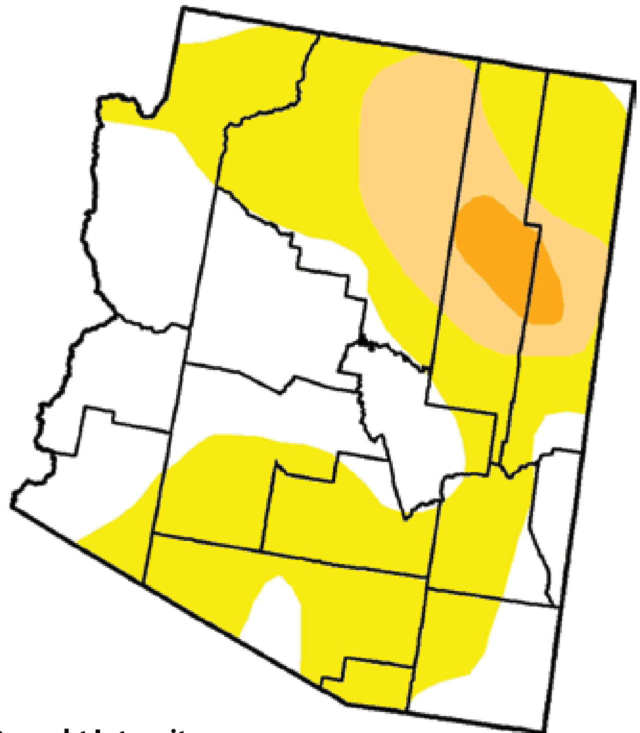


Figure 4b. Percent of Arizona designated with drought conditions based on data through April 13.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	39.4	60.6	14.4	2.7	0.0	0.0
Last Week (04/06/2010 map)	33.0	67.0	14.4	2.7	0.0	0.0
3 Months Ago (01/19/2010 map)	0.0	100.0	97.3	88.0	9.6	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 (04/14/2009 map)	43.0	57.0	1.7	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

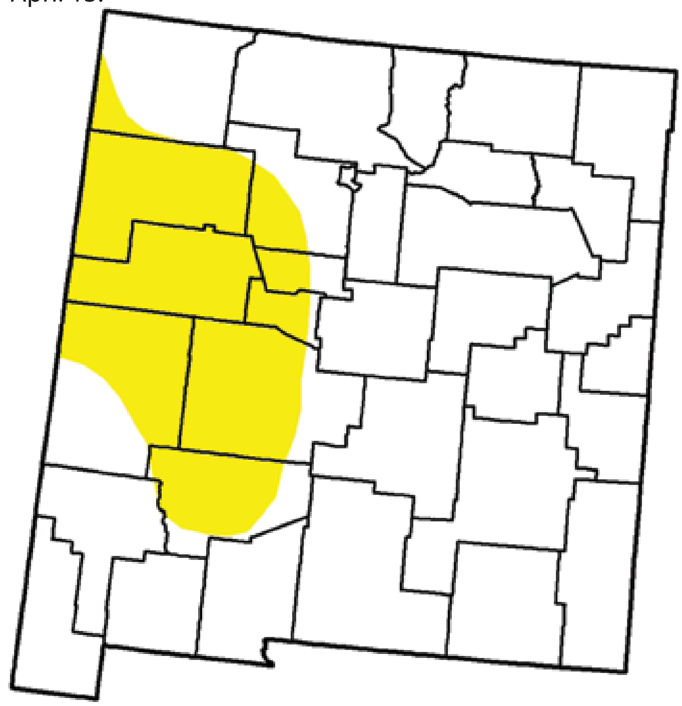
(data through 4/13/10)

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

There was little change in drought status across New Mexico this past month, according to the April 13 update of the National Drought Monitor (Figure 5a). Overall, much of the state remained drought-free, with a small area of abnormally dry conditions persisting in west-central New Mexico. Below-average precipitation over the western third of the state over the past 30 days helped the abnormally dry conditions dig in and persist, while near- to above-average precipitation in eastern New Mexico kept this area drought-free. Overall, 79 percent of New Mexico was classified as drought-free, up slightly from 76 percent in mid-March (Figure 5b).

The impacts from severe drought conditions that plagued southeastern New Mexico a year ago may still be lingering, but disaster aid is now available to help farmers and ranchers cope with losses incurred during this period. Dona Ana, Eddy, Lea, Otero, Quay, and Roosevelt counties have been declared federal disaster areas by the USDA Farm Services Agency and are eligible for low interest emergency loans (Associated Press, April 16).

Figure 5a. New Mexico drought map based on data through April 13.



Drought Intensity

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

Figure 5b. Percent of New Mexico designated with drought conditions based on data through April 13.

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	79.0	21.0	0.0	0.0	0.0	0.0
Last Week (04/06/2010 map)	79.0	21.0	0.0	0.0	0.0	0.0
3 Months Ago (01/19/2010 map)	29.5	70.5	13.1	3.0	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 (04/14/2009 map)	38.3	61.7	29.4	6.6	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 3/31/10)

Source: NRCS, National Water and Climate Center

Water storage in Lake Powell declined by 79,000 acre-feet in March, putting the reservoir at 56 percent of capacity (Figure 6). Water storage in Lake Mead fell by 230,000 acre-feet. Combined storage in these large Colorado River reservoirs is approximately 50 percent of capacity. Reservoirs on the Salt River systems slightly declined—by 12,900 acre-feet—while storage in the Verde River system increased by 21,600 acre-feet. San Carlos Reservoir experienced the largest increase, rising by 86,500 acre-feet. Current storage is above 90 percent of capacity in Lakes Havasu and Mohave and on the Verde and Salt River systems.

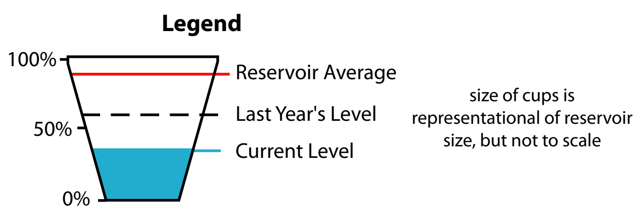
Notes:

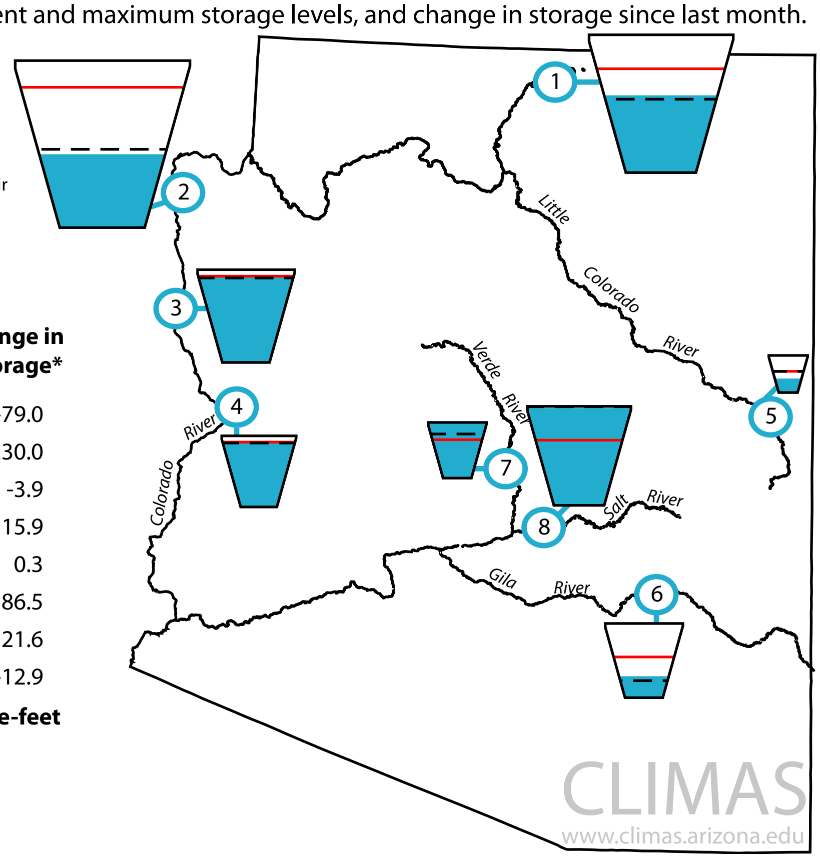
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 March 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	56%	13,709.0	24,322.0	-79.0
2. Lake Mead	44%	11,550.0	26,159.0	-230.0
3. Lake Mohave	93%	1,676.0	1,810.0	-3.9
4. Lake Havasu	91%	563.9	619.0	15.9
5. Lyman Reservoir	38%	11.5	30.0	0.3
6. San Carlos	29%	255.9	875.0	86.5
7. Verde River System	98%	283.0	287.4	21.6
8. Salt River System	98%	1,980.2	2,025.8	-12.9

*** 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

New Mexico Reservoir Levels

(through 3/31/10)

Source: NRCS, National Water and Climate Center

The total reservoir storage in New Mexico increased by about 11,600 acre-feet in March (Figure 7). Most reservoirs experienced increases in water storage; Navajo Reservoir experienced the largest gain, increasing by 32,300 acre-feet. Only Elephant Butte, Caballo, and Sumner reservoirs saw a decline. Currently, the water stored in the three largest reservoirs—Navajo, Elephant Butte, and Heron—are within a few percent of what they were one year ago. While Navajo and Heron reservoirs are at 74 and 63 percent of capacity, respectively, Elephant Butte stands at only 25 percent of capacity.

In water-related news, work began on the western portion of the Navajo Gallup Water Supply Project, which promises to deliver drinking water to 250,000 American Indian residents by 2040 (*Daily Times*, March 23). The project will divert nearly 38,000 acre-feet of water annually from the San Juan River and Cutter Reservoir near Bloomfield to Gallup, Window Rock, and communities on the Navajo Nation.

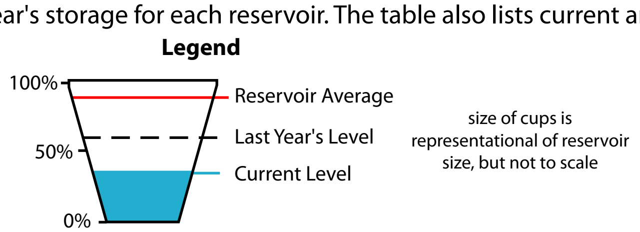
Notes:

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.

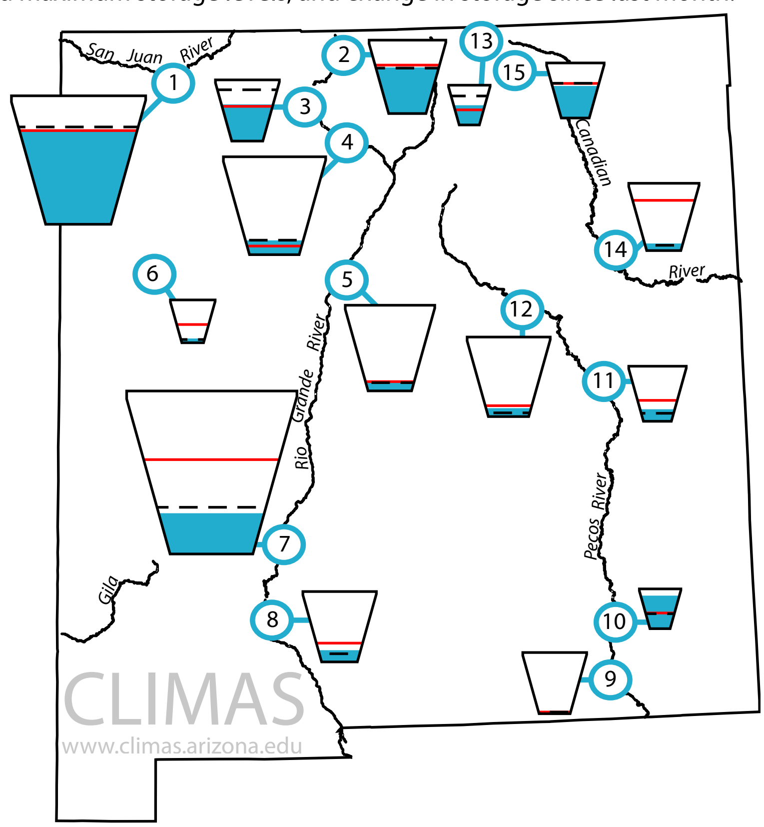
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Wayne Sleep, wayne.sleep@nm.usda.gov.

Figure 7. New Mexico reservoir levels for March 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	74%	1,246.6	1,696.0	32.3
2. Heron	63%	252.6	400.0	1.1
3. El Vado	60%	113.6	190.3	2.6
4. Abiquiu	15%	180.1	1,192.8	-2.2
5. Cochiti	11%	53.3	491.0	0.2
6. Bluewater	10%	4.0	38.5	2.3
7. Elephant Butte	25%	540.6	2,195.0	-26.5
8. Caballo	17%	57.4	332.0	-4.4
9. Brantley	3%	32.0	1,008.2	9.8
10. Lake Avalon	83%	3.3	4.0	0.2
11. Sumner	22%	22.0	102.0	-8.0
12. Santa Rosa	11%	46.2	438.3	1.3
13. Costilla	50%	8.0	16.0	0.4
14. Conchas	11%	26.7	254.2	1.2
15. Eagle Nest	58%	46.2	79.0	1.3

*** thousands of acre-feet**



On the Web:

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

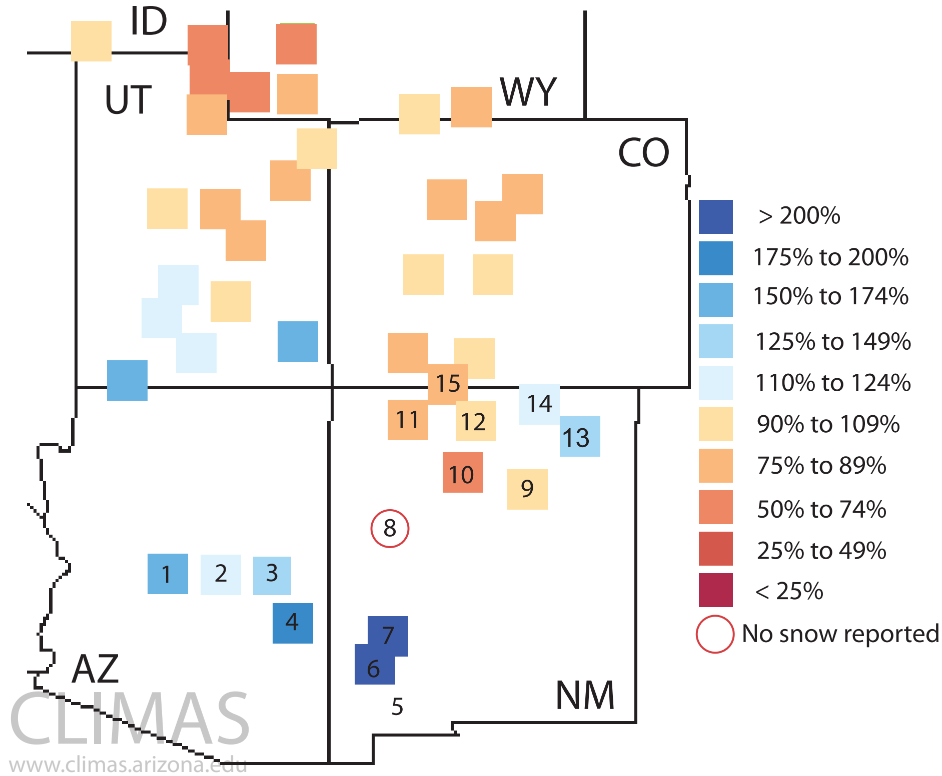
Southwest Snowpack

(updated 4/15/10)

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

Snowpack levels remained well above average in all Arizona river basins, while levels range from below average to well above average in New Mexico (Figure 8). Despite average to well below-average precipitation across most of the region in March, cooler temperatures helped keep most snowpack levels high. The snow water equivalent (SWE) in snowpack in Arizona ranged from 115 percent of average in the Central Mogollon Rim to 197 percent of average in the Salt River Basin as of April 15, according to the Natural Resources Conservation Service's snow telemetry (SNOTEL) monitoring stations. New Mexico basins had a broader range of SWE, from 56 percent of average in the Jemez River Basin to 255 percent of average in the San Francisco River Basin. The sizeable snowpack means a greater likelihood for average to well above-average streamflow levels for most river basins in the Southwest.

Figure 8. Average snow water equivalent (SWE) in percent of average for available monitoring sites as of April 15.



Arizona Basins
1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins
5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

Notes:

Snowpack telemetry (SNOTEL) sites are automated stations that measure snowpack depth, temperature, precipitation, soil moisture content, and soil saturation. A parameter called snow water content (SWC) or snow water equivalent (SWE) is calculated from this information. SWC refers to the depth of water that would result by melting the snowpack at the SNOTEL site and is important in estimating runoff and streamflow. It depends mainly on the density of the snow. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWC than light, powdery snow.

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

On the Web:

For color maps of SNOTEL basin snow water content, visit:
http://www.wrcc.dri.edu/snotelanom/basinswe.html

For NRCS source data, visit:
http://www.wcc.nrcs.usda.gov/snow/

For a list of river basin snow water content and precipitation, visit:
http://www.wrcc.dri.edu/snotelanom/snotelbasin

Temperature Outlook
(May–October 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 throughout the West from late spring through the summer and into early fall. The outlook through July shows a significant probability 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 (Figure 9a). Through summer and into fall, chances increase for warmer temperatures for most of New Mexico (Figures 9b–d). The above-average temperature outlook in the interior Southwest is primarily based on the strong warming trend present for several years. This trend is strong enough this season to overcome somewhat cool indications from dynamical models.

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 May–July 2010.

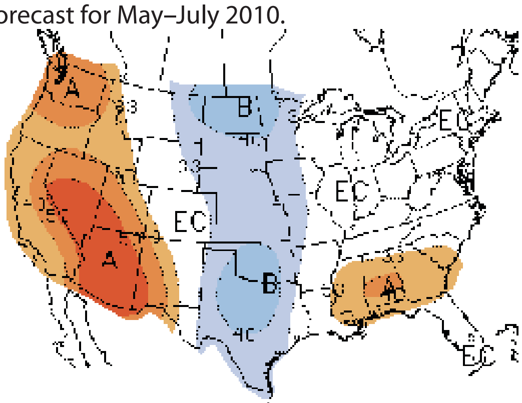
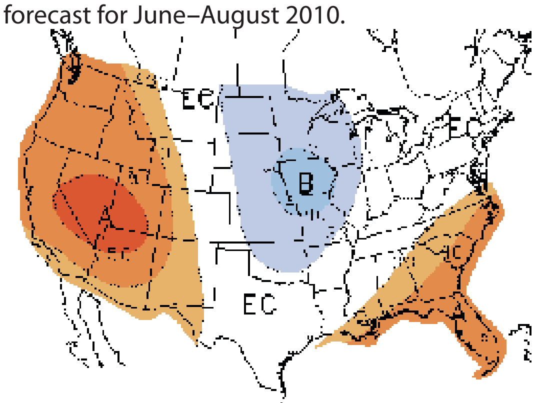


Figure 9b. Long-lead national temperature forecast for June–August 2010.



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

B=Below
40.0–49.9%
33.3–39.9%

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

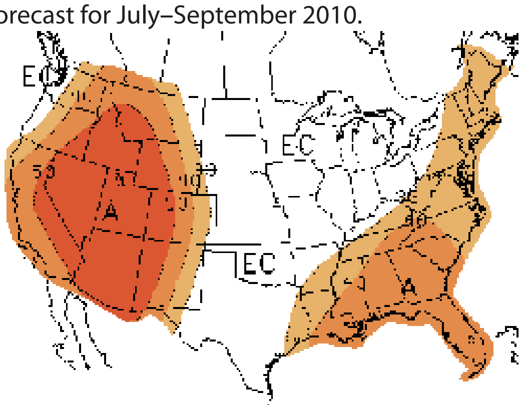
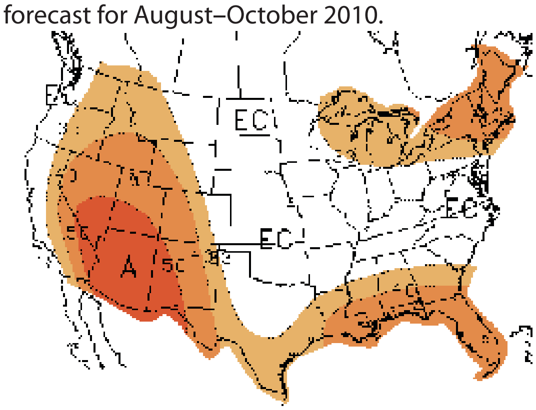


Figure 9d. Long-lead national temperature forecast for August–October 2010.



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
(May–October 2010)
Source: NOAA-Climate Prediction Center (CPC)

Because there are no substantial climate signals present from the forecast tools across much of the U.S., including the Southwest, the NOAA–Climate Prediction Center (NOAA–CPC) long-lead precipitation outlooks for the summer season indicate equal chances of above-, near- and below-average precipitation (Figures 10a–b). The two exceptions to this equal chances outlook are the central Plains and the Northeast, where increased chances for above-average precipitation are indicated. These outlooks are primarily based on climatological trends. The central Plains' wet and cool outlook is partly a result of initially wet soil conditions from this spring. Beginning in the July-August-September summer period (Figure 10c) and extending into the fall (Figure 10d), forecasts hint at a chance of below-average precipitation across the northern half of Arizona based on recent dynamical forecast model runs.

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 May–July 2010.

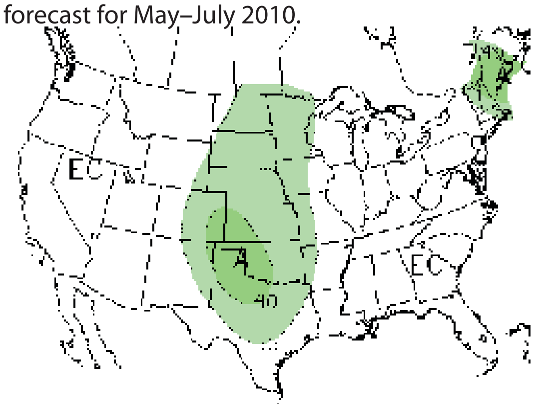


Figure 10b. Long-lead national precipitation forecast for June–August 2010.

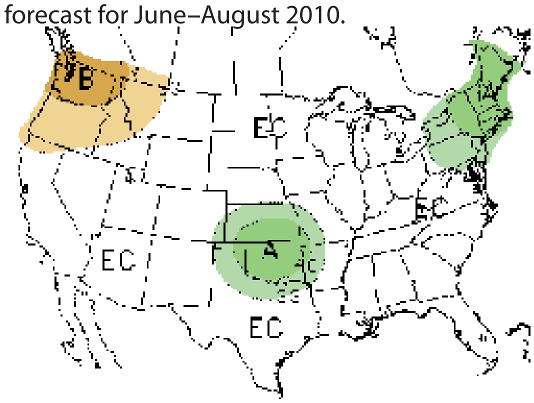


Figure 10c. Long-lead national precipitation forecast for July–September 2010.

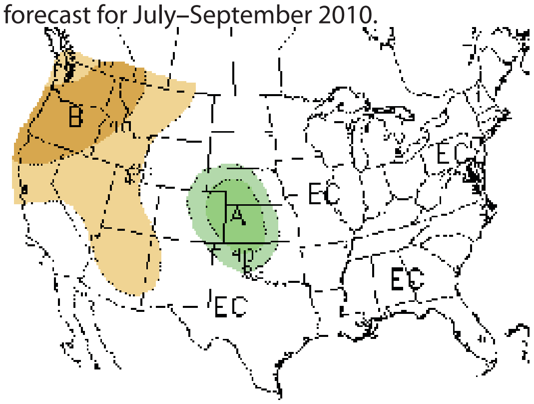
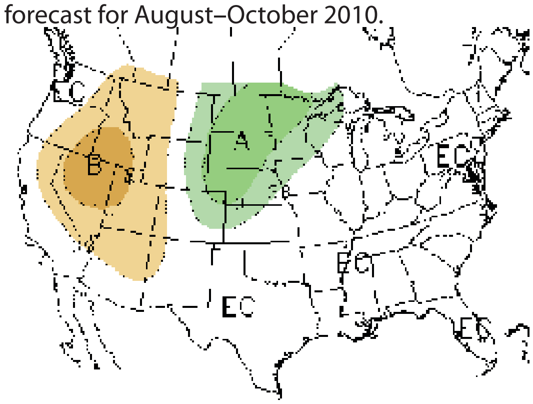


Figure 10d. Long-lead national precipitation forecast for August–October 2010.



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 July)

Source: NOAA-Climate Prediction Center (CPC)

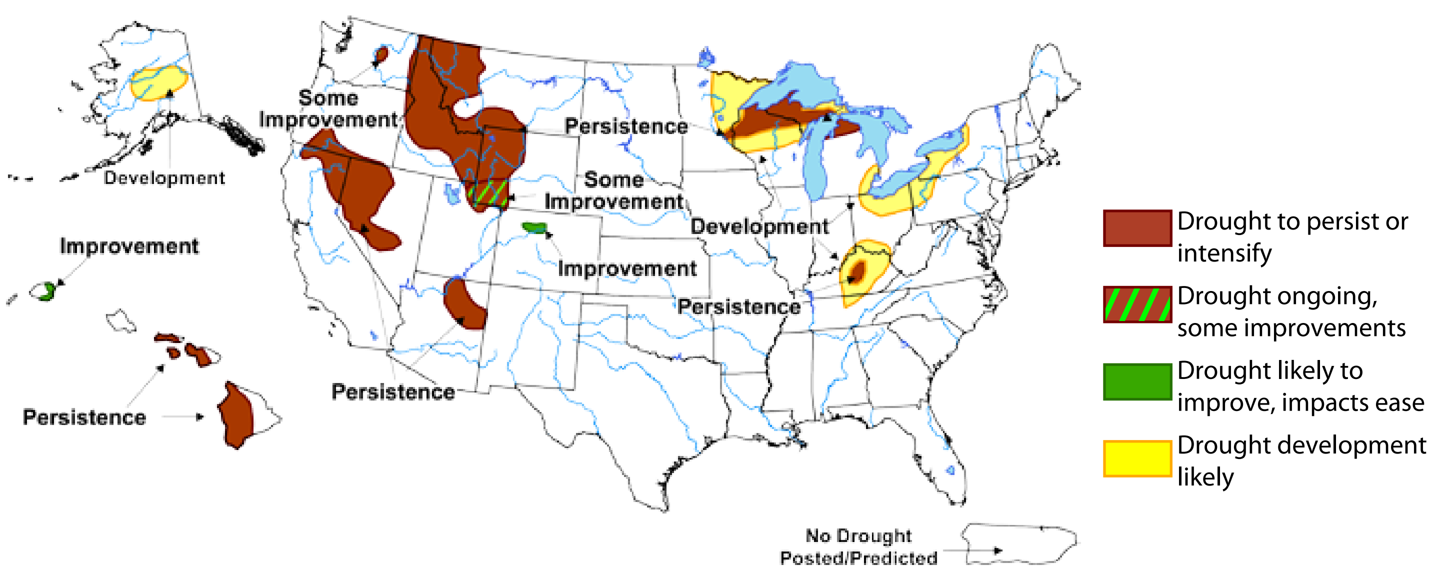
This summary is excerpted and edited from the April 15 Seasonal Drought Outlook technical discussion produced by NOAA–CPC and written by forecasters Andrew Loconto and Doug Lecomte

In recent weeks, a series of disturbances has moved across the western and southwestern portion of the U.S. However, most of the heaviest precipitation associated with these storm systems has not fallen across the Great Basin and the Four Corners region. This is reflected in two-week and 30-day percent-of-average precipitation totals falling below 100 percent. However, Natural Resources Conservation Service SNOTEL percent of average snow water equivalent (SWE) values for northeast Arizona are above average, due to a southern storm track during the winter months (consistent with El Niño winters), leading to a significant snowpack. As the Great Basin/Four Corners region is entering its climatological dry season, precipitation amounts from operational models through early May do not indicate substantial precipitation is likely from any storm(s). Soil moisture forecasts through the two-week period also show near- to below-average soil moisture for the Great Basin/Four Corners region, though some increase in soil moisture for both areas is hinted at by a few of the seasonal soil moisture tools. Drought persistence is forecast for the drought areas in northern California, Nevada, southern Oregon, and Arizona (Figure 11). Forecast confidence for California, Nevada, southern Oregon, and the Four Corners region is moderate.

In the rest of the West, during April, moderate to severe hydrological drought has persisted across the northern Rockies and the upper Midwest. Though precipitation is expected through much of the remainder of April for the northern Rockies, drought persistence is indicated for Idaho and western Montana due to forecasts of poor streamflows and soil moisture values into the May–July season. Some improvement is indicated in southwest Wyoming, and improvement is indicated for northern Colorado. This is due to more favorable forecasts of soil moisture combined with slightly more favored prospects for precipitation through the latter part of April into May.

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 July (released April 15).



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)

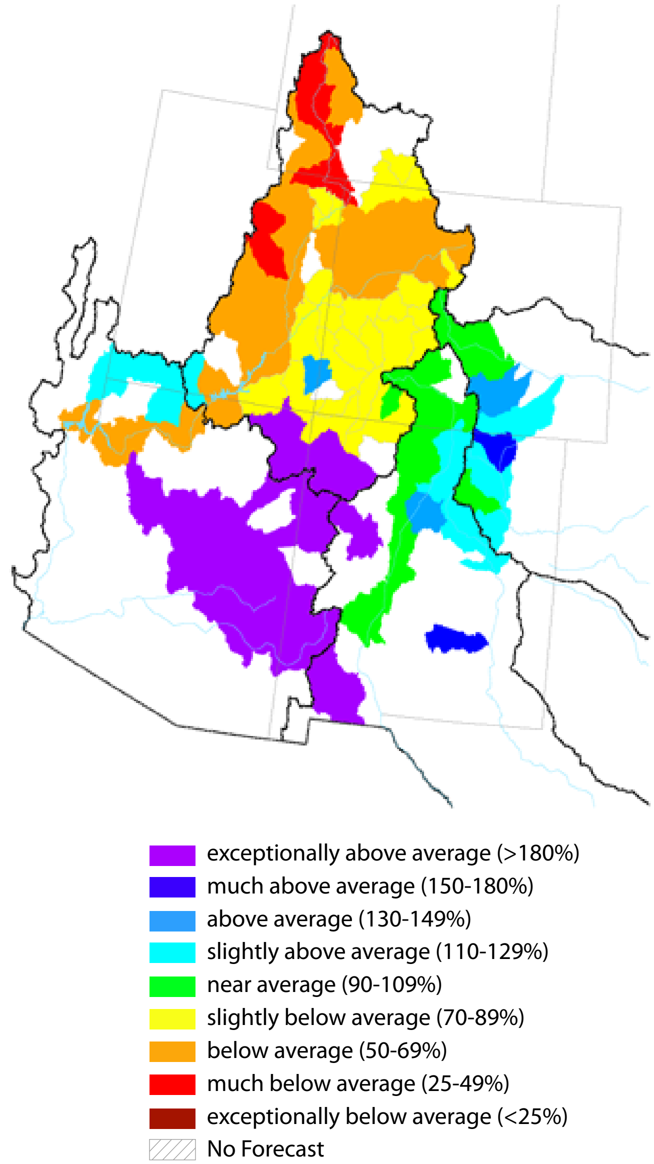
Source: National Water and Climate Center

The April 1 streamflow forecast for the Southwest shows a wide range of projected flows, divided primarily along the geographic boundary for the Upper and Lower Colorado river basins (CRBs). There is at least a 50 percent chance that streamflow in most Upper CRB sub-basins will be below average; thus, predicted inflow to Lake Powell is 63 percent of the 1971–2000 average for the April–July forecast period (Figure 12). 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 April–May Salt River flows will be close to 200 percent of average. A flow of more than 300 percent of average is predicted for the Chuska and Little Colorado river basins.

Forecasts for most New Mexico basins show at least a 50 percent chance of average to above-average flows. A notable exception is the San Juan River Basin, for which forecasts indicate a 50 percent chance of lower-than-average flows at most forecast points (i.e., measurement gage sites). Canadian River Basin forecasts indicate at least a 50 percent chance of April–June flows exceeding 125 percent of average at most forecast points in the basin.

In water news, the U.S. Army Corps of Engineers has given a poor condition rating to 1950s-era levees, which could result in flood insurance premium hikes (Associated Press, March 27). An Albuquerque Metropolitan Arroyo Flood Control Authority official said that it is very likely that all Albuquerque levees on the Rio Grande will be decertified by the Federal Emergency Management Agency (FEMA) by 2012.

Figure 12. Spring and summer streamflow forecast as of April 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 April, 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
(May–July 2010)

Sources: National Interagency Coordination Center, Southwest Coordination Center

The National Interagency Fire Center (NIFC) forecast shows below-normal fire potential for most of the Southwest during April (Figure 13). NOAA–Climate Prediction Center forecasts for April depict slightly higher chances of above-average precipitation and slightly higher chances of below-average temperatures across most of the region, both of which impact fire potential. These precipitation and temperature forecasts are a likely result of the ongoing El Niño event.

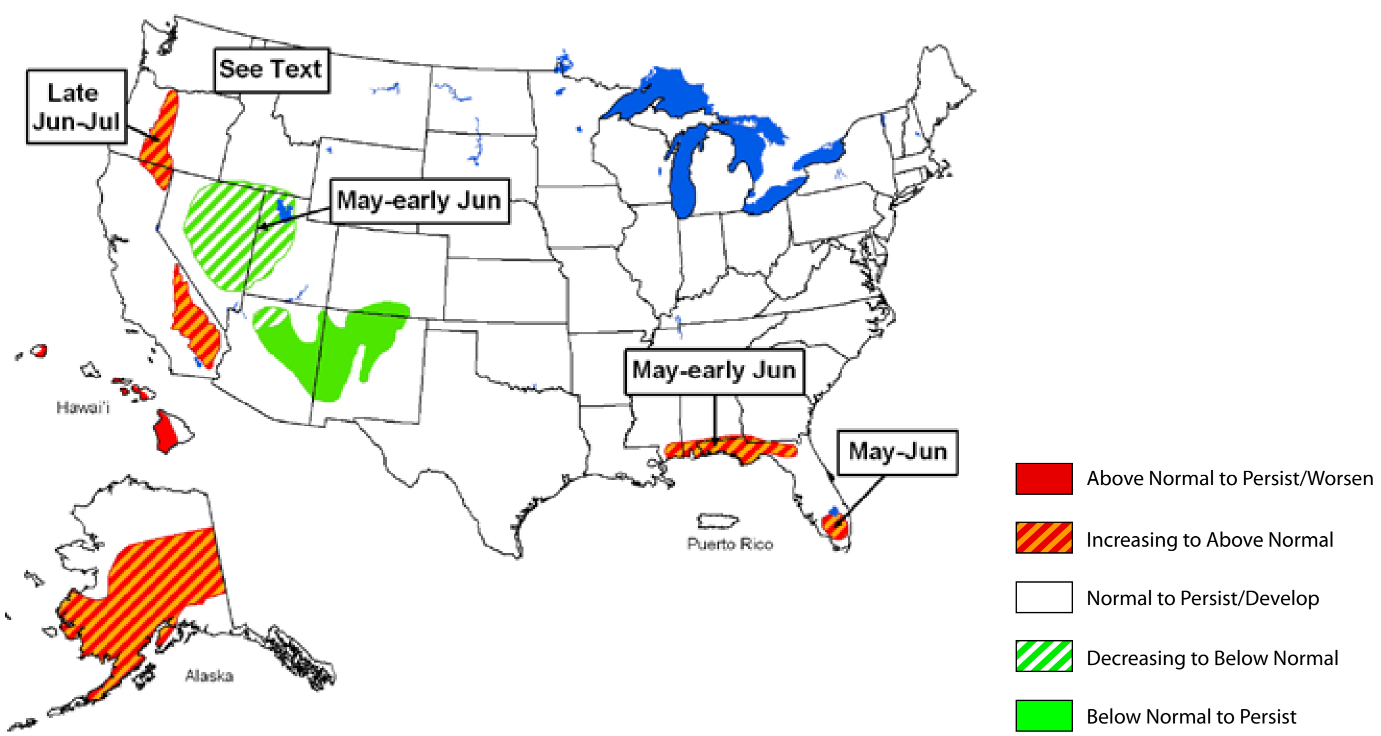
Looking ahead to May through July, NIFC's seasonal outlook shows normal significant fire potential across most of the Southwest, with below-normal fire potential for the central portions and the higher elevations of the region. Factors influencing this forecast include large regional snowpack amounts ranging from 100 to 200 percent of average, continued periodic storms through the spring months, and above-average levels of fuel moisture. Despite these wet conditions, a few wind episodes with periods of warmer and drier weather in spring and early summer will keep fire potential at normal levels, especially in grassland areas.

During the month of March, no fires greater than 100 acres were reported in Arizona, while four were reported in New Mexico. Historically for March, Arizona averages one fire greater than 100 acres and New Mexico averages four.

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 13. National wildland fire potential for fires greater than 100 acres (valid May–July 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)

The 2009–10 El Niño event is finally winding down after a strong six-month run. The International Research Institute for Climate and Society (IRI) reports that sea surface temperatures (SSTs) in the central and eastern Pacific fell from 1.14 degrees Celsius above-average in mid-March to 0.8 degrees C above-average in mid-April, just warm enough to hold on to weak El Niño status. The atmosphere also has started to notice the shift in SST patterns across the Pacific. The Southern Oscillation Index rose slightly from -2.1 in February to -1.4 in March, indicating a weakening atmospheric connection to the El Niño pattern (Figure 14a). This trend continued since late March, with the NOAA–Climate Prediction Center (NOAA–CPC) noting in early April that "atmospheric conditions are no longer consistent with El Niño." The hot-spot of above-average SSTs in the central Pacific that drove the strong atmospheric response and wet teleconnection pattern across the southwestern U.S. from January through March quickly dissipated and disconnected from the atmosphere in late March. IRI notes that the current event lasted a bit longer into the spring than most but is on schedule to wind down over the next month or two.

With the above-average SST pattern breaking down quickly across the Pacific, most forecast models point towards the return of ENSO-neutral conditions by mid-summer. IRI's forecasts show the probability of El Niño conditions continuing over the next three months at only 38 percent, while the probability of neutral conditions returning is 57 percent (Figure 14b). The chance of neutral conditions returning rises through the summer, while the chance of El Niño conditions continuing drops. The threat of a double-year El Niño event, which was a concern in previous months, also appears to have dramatically diminished.

Figure 14a. 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).

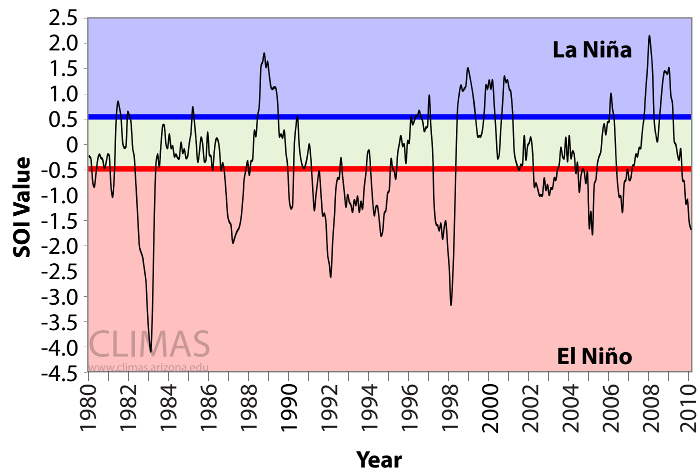
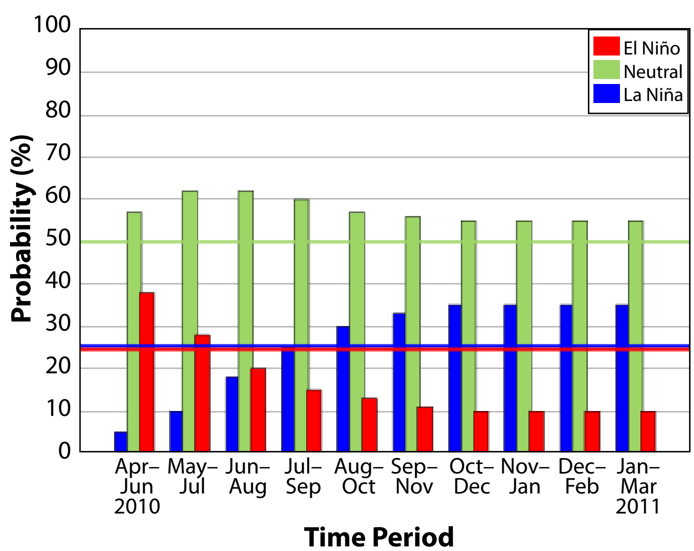


Figure 14b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released April 15). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Notes:

The first figure shows the standardized three month running average values of the Southern Oscillation Index (SOI) from April 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
(May–October 2010)

Source: Forecast Evaluation Tool

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

Comparisons of observed temperature for May–July to forecasts issued in April for the same period suggest that in southern and western Arizona forecasts have been better than an equal chances forecast (Figure 15a). Forecast skill—a measure of the accuracy of the forecast—is highest in the southeast corner of Arizona and is less accurate in New Mexico than in Arizona. Skill for the two-month lead time forecasts for the period June–August has a similar pattern as the May–July period (Figure 15b). The three- and four-month lead time forecasts historically have been more accurate than equal chances in all of Arizona with relatively high skill score values, suggesting that forecasts for these periods are more likely to occur (Figures 15c–d). Forecasts for New Mexico for these periods, on the other hand, do not have the same skill and have been less accurate then 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 15a. RPSS for May–July 2010.

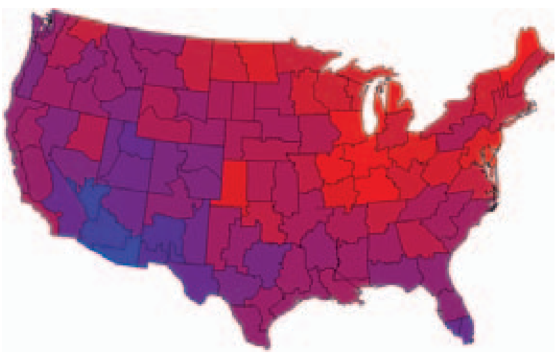


Figure 15b. RPSS for June–August 2010.

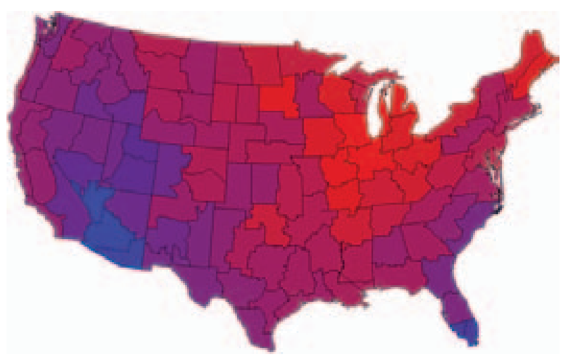


Figure 15c. RPSS for July–September 2010.

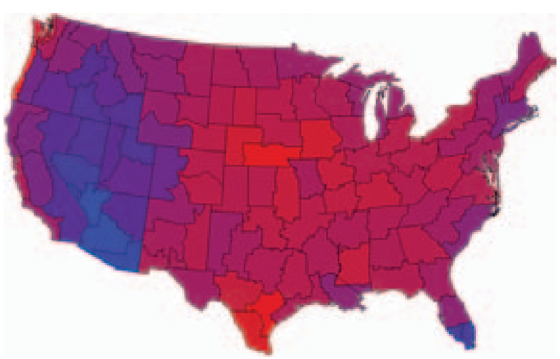
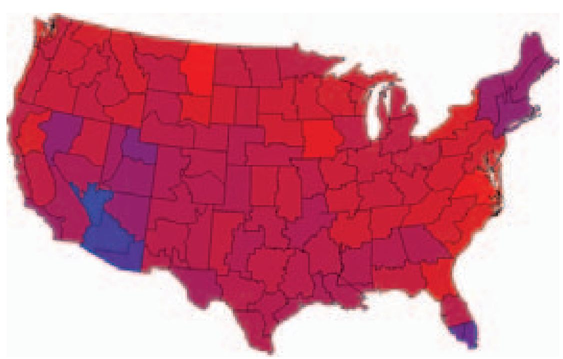
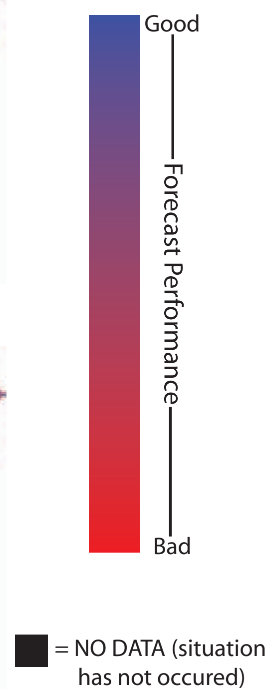


Figure 15d. RPSS for August–October 2010.





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
(May–October 2010)

Source: Forecast Evaluation Tool

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

Comparisons of observed precipitation for May–July to forecasts issued in April for the same period suggest that forecasts are only slightly better than forecasting equal chances for all of Arizona and New Mexico (Figure 16a). Forecast skill—a measure of the accuracy of the forecast—is highest in the northwest corner of Arizona and eastern New Mexico, but only marginally better than equal chances. Skill for the two-month lead time forecasts historically have been similar to equal chances in most of both states, with the exceptions of southern New Mexico, where forecasts have been slightly better than equal chances, and northern Arizona, where forecasts have been less accurate than equal chances (Figure 16b). The three- and four-month lead time forecasts have not performed better than equal chances in most of both states, particularly in western New Mexico for the July–September period (Figures 16c–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 16a. RPSS for May–July 2010.

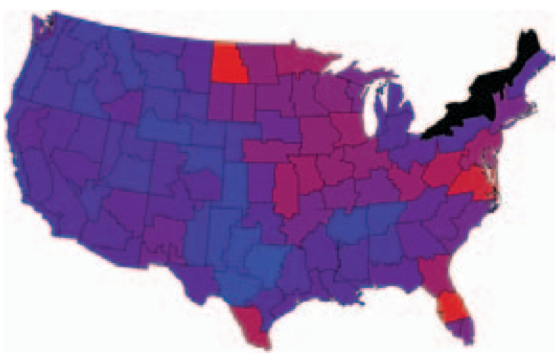


Figure 16b. RPSS for June–August 2010.

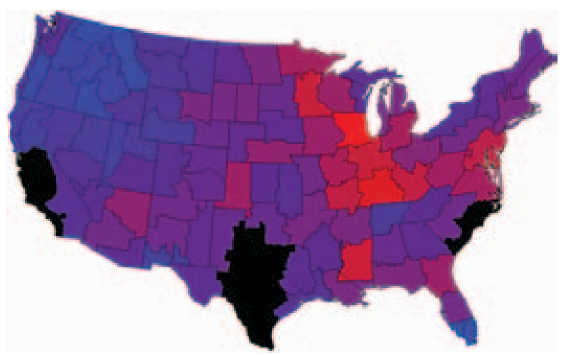


Figure 16c. RPSS for July–September 2010.

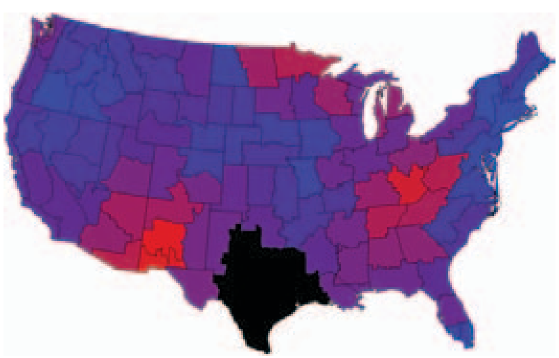
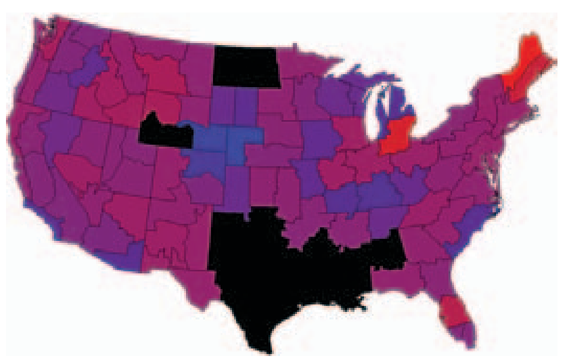
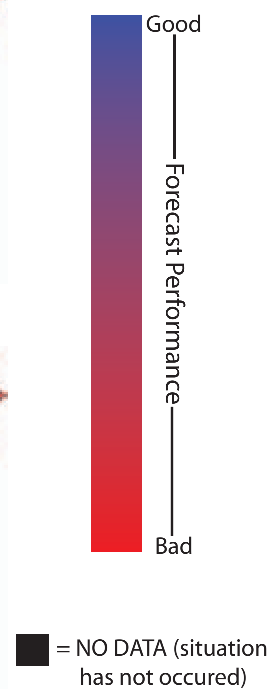


Figure 16d. RPSS for August–October 2010.





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