Issued: September 27, 2006

# Southwest Climate Outlook

The University of Arizona.

*Source: Barbara Morehouse, UA Institute for the Study of Planet Earth*

**Photo Description:** Lake Powell is one of Arizona's largest reservoirs and is essential to the state's water supply. It is currently at less than 50 percent of capacity. This photo was taken last month and shows Lake Powell's "bathtub ring," the line between the lighter colored rock and dark red rock is the high water mark. It was taken from the water on the western side of the reservoir between Navajo Generating Station and Natural Bridge National Monument.

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: knelson7@email.arizona.edu

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The record-breaking monsoon season of 2006 did much to ease short-term drought conditions in the Southwest, but it also caused considerable flood damage in many localities in Arizona and New Mexico. President Bush signed disaster declarations for both states...

# September Climate Summary

**Drought –** The record monsoon rains have brought significant short-term drought relief to the Southwest, particularly in New Mexico. Longer-term relief will be dependent on adequate winter rain and snow.

- Drought conditions are expected to continue to improve in New Mexico and some improvement is likely in Arizona.
- Reservoirs in Arizona and New Mexico were partly replenished by the abundant monsoon rains.

**Temperature –** Since the start of the water year on October 1, 2005 temperatures over most of the Southwest have been above average.

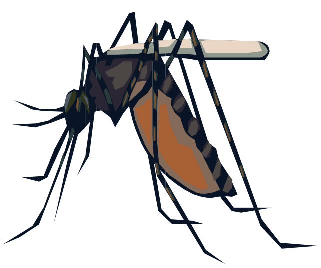
**Precipitation –** Since the start of the monsoon season precipitation has been well above average across most of the Southwest. Heavy rainfall has caused extensive flooding in many areas in Arizona and New Mexico.

**Climate Forecasts –** Experts predict increased chances of warmer-than-average temperatures and above-average precipitation for most of the Southwest during the upcoming winter.

**El Niño –** El Niño conditions have developed and are expected to continue into early 2007.

**The Bottom Line –** Some drought relief has occurred due to the abundant rain since the start of the monsoon season, but that relief may be limited to short-term impacts due to the accumulated effects of long-term, multi-year precipitation deficits.

# Mosquitoes and the monsoon



The monsoon season has done much to alleviate drought conditions in the Southwest, but it has also aided the mosquito populations here, increasing the risk of contracting West Nile virus. Mosquitoes need standing water for their eggs and larvae to mature, so the more rain during the monsoon, the more places that can breed mosquitoes. Ponds, puddles, stock tanks, clogged drain gutters, outdoor pots for plants, old tires, kid's toys, and even empty boats in the yard make ideal places for the mosquito population to blossom rapidly. Years with relatively weak monsoons tend to produce fewer mosquitoes compared to years with strong monsoons like 2006. Since West Nile virus made its appearance in Arizona in 2003, more than 500 people have become infected. Most people develop no symptoms, or only mild flu-like symptoms, but the disease can be more serious especially to the elderly. Twenty people in Arizona have died of the disease, including two in 2006.

For more information visit http://www.azdhs.gov ...



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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 for the Study of Planet Earth, 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.

# Population growth, warming, and water supply

## Water for the ongoing influx of people in the Southwest will come at a cost

By Melanie Lenart

Expanding cities and warming climate merge dramatically in the Southwest to boost water demand. The combined effect of rising population, temperature and water use, meanwhile, threatens to take a toll on quality of life.

"We have put ourselves on a trajectory to make this a hotter, drier place," keynote speaker Grady Gammage cautioned during a June workshop in Phoenix, called "Providing water to Arizona's growing population: How will we meet the obligation?" A lawyer, Gammage helped secure regional water supplies by serving on the Central Arizona Project (CAP) board of directors for 12 years before taking his current post at the Arizona State University's (ASU) Morrison Institute.

While many workshop speakers expressed confidence that Arizona could find water to support the ongoing influx of people, their words supported Gammage's premise that residents would pay a price for continued population growth.

Higher water bills clearly will be coming down the pipeline in many cities, with current as well as future residents anteing up. Declining water quality could represent another cost as water managers consider saltier sources.

Shrinking rivers also follow rising water demand, as acknowledged by speakers at the June workshop, organized by The University of Arizona's Water Resources Research Center, and at an August event in Tucson. Another cost of the growing population and the water policy it will inspire will be measured in degrees.

Temperatures had already reached 110 degrees on the morning of the first day of the workshop, as the sun was reaching its annual peak in intensity on the summer solstice. Unrestrained population growth will make Arizona cities hotter for several reasons, Gammage suggested, naming more xeriscaping, agricultural water buy-outs, and city infill.

Xeriscaping—using desert vegetation in landscaping—uses less water, but it also does less to cool residential areas than lush grass and trees. Shifting agricultural allotments permanently to cities will reduce the region's ability to weather drought years by temporarily turning off the supply to agriculture. This increases the chances for urban water use restrictions. Promoting the infill of population within city centers saves on pipelines and other infrastructure, but makes cities even hotter as heat-trapping concrete replaces cooler open spaces.

The "urban heat island effect"—a result of concrete, buildings, and asphalt covering open land—worsens as cities become more densely populated. For instance, temperatures in Tempe (near Phoenix) increased by about 10 degrees Fahrenheit over the last century, ASU researchers have found, with about two-thirds of the difference related to the urban heat island effect and the remainder linked to global warming. The population of metropolitan Phoenix roughly doubled in three decades to top 1.4 million in 2005.

Residents who bought homes in 2005 in Arizona's central area—Maricopa, Pinal and Pima counties—can expect the surrounding population to nearly double again by the time they pay off a conventional mortgage in 2035. Their roughly 9.6 million neighbors in the merging three-county urban sprawl will contribute to a projected near doubling of water demand during that same time frame, as described in a discussion paper drafted for the workshop.

The central Arizona region can support only about 8.5 million people with the water considered "currently secured," according to the paper's preliminary analysis led by ASU researcher Jim Holway, a former assistant director with the Arizona Department of Water Resources. Beyond that population level, projected for about 2020, the supply would depend on securing additional sources such as agricultural water and wastewater effluent (Figure 1).

Additional water sources are "likely" to become available, including from the Colorado River allocations to agriculture, but are not secured at this point. Water managers are pursuing the prospect of treating wastewater effluent, among other sources, to keep up with the growing demand for potable water (For more information: http://sustainability.asu.edu/gios/waterworkshop.htm).

Projections for global warming, meanwhile, indicate regional temperatures could continue to rise throughout the century by perhaps a degree Fahrenheit a decade. That's the rate already registering in Arizona since about the mid-1970s, based on data from the Western Regional Climate Center. It's several times faster than the average rate for the world as a whole.

Higher temperatures boost water demand, especially in summer when residents run evaporative swamp coolers and water wilting plants. An average household in Tucson, for example, uses a third more water during the warm months of May through October than in cooler months.

Global warming causes other regional climate changes as well. Along with temperatures, it increases evaporation rates, rainfall variability and the risk of heat waves and drought.

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# Water supply, continued

"We're going to have to prepare for more intense droughts than we've had in the past," acknowledged Steve Olson, executive director of the Arizona Municipal Water Users Association that covers metropolitan Phoenix. By one climate change assessment that models a slight drop in Colorado Basin precipitation along with an ongoing temperature rise, the river could run short about a quarter of the time in the coming century (*Climatic Change*, March 2004).

"I think the climate is going to change. We need to be able to react to what that change might be." Tucson Water Director David Modeer said.

Modeer and other water managers for Tucson have been alerting residents to the potential need to start converting wastewater effluent into drinking water within the next decade. Pima County residents must decide in the next few years whether to accept what some critics characterize as a "toilet to tap" plan.

It may be a tough sell. Tucson residents twice voted against even allowing Colorado River water directly into their drinking water, citing water quality issues. Residents finally agreed in 2000 to accept a blend of CAP water with groundwater. The Tucson Water Plan indicates they'll soon be asked to consider a saltier blend, with a greater share of Colorado water.

Tucson renewable groundwater could sustainably support a population of roughly 375,000—less than half the current population of the city's metropolitan area. In theory, Tucson's allotment of Colorado water could supply another 1 million people at current use rates. That would assume that drought doesn't limit the supply, and the city retains its entire share for residential use.

Currently, about 70 percent of Arizona's water, and 80 percent of its Colorado River allocations, goes to support agriculture on private and tribal lands.

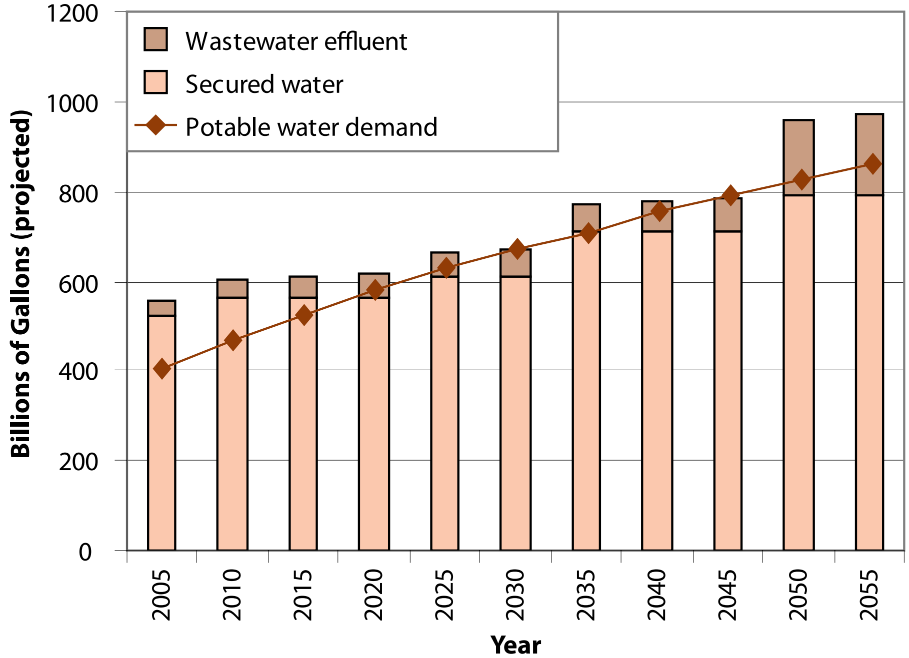


**Figure 1.** The population of central Arizona is projected to exceed the "secured supply" of renewable water by about 2020 given current population growth. Water managers are pursuing the prospect of treating wastewater effluent, among other sources, to keep up with the growing demand for potable water.

"Ultimately, urban and rural Arizona are competing for the same water supplies," Gammage told the group, some of who needed no reminding.

"We're a target and we know it," said Roger Gingrich, Yuma's water resources coordinator. He noted that Yuma lettuce growers supply the country, helping Arizona's third largest metropolitan area earn $1 billion a year from crops. The resources, including water, supporting this industry would not be given away lightly, he indicated.

"It's more, what are you willing to pay? When it comes to water, you'll be paying a lot," he said. Noting that bottled water sells in stores for more than $1 a gallon, he tallied the price for an acre-foot of water at about $365,000. Gingrich was speaking mostly with tongue in cheek, but he said he was serious in conveying that farmers would not sell water at the going rate. Currently, Tucson residents pay about $15 for their first 11,200 gallons of water a month. At this rate, water costs about $450 an acre-foot.

Arizona residents would pay an estimated $3,000 an acre-foot for desalinated water in a plan proposed by CAP Deputy General Manager Larry Dozier. The desalination approach he outlined would boost an average water bill to $150 to $200 a month, he said.

It would involve erecting a desalination plant and an electrical plant to power it on the Gulf of California in Mexico, given the approval of Mexico's burgeoning tourism industry on the gulf. The desalinated ocean water could help cover the million acre-feet of Colorado River water promised to Mexico, Dozier said, freeing up more of the river's share for Arizona.

Arizona's share of the Colorado could then support future development. Under current law, developments can go up in Arizona even where water supplies are deemed "inadequate" to supply homes for the century or more they may exist. Also, landowners currently can withdraw unlimited quantities of

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## Water supply, continued

groundwater from below their land, with some caveats, even if doing so dries up nearby rivers and neighbors' wells.

In a day of interactive sessions during the June workshop, people suggested policy makers should consider the property rights of existing residents before permitting new developments. Participants also stressed the need to protect rivers when evaluating the potential impacts of new developments.

Southwestern rivers that once flowed year-round have been reduced to intermittent streams in areas where growing populations increasingly tap into groundwater or surface flows, such as Tucson's Santa Cruz River.

Even the San Pedro River has been faltering in recent years, with population growth in Sierra Vista and Benson as well as drought reducing stream flow. About seven miles northeast of Sierra Vista, the San Pedro dried up for 12 days in the summer of 2005—for the first time at least since continuous monitoring began there in 1930. It almost repeated its disappearing act in late June, but reaped the benefits of an early start to the monsoon season.

The impact on the San Pedro from water withdrawals depends in part on where wells go, explained hydrologist John Hoffman of the U.S. Geological Survey. To illustrate, Hoffman showed a map of the San Pedro River where it flowed through Arizona northeast of the Huachuca Mountains and explained the modeled impacts of 50 years of pumping 33 millions of groundwater—an amount that would support less than a thousand people a year at current use rates.

Wells located around the river near Fort Huachuca's eastern edge would draw about 95 percent of their supply from water that would otherwise feed the San Pedro River, Hoffman's preliminary map indicated. In contrast, wells located west of the river near the Huachuca's southern boundary would draw only about 30 percent of their supply from water that would otherwise go to the stream.

The area's newest spate of wells are going in exactly where Hoffman's analysis shows they would do the most damage, pointed out Patrick Graham of The Nature Conservancy, alluding to some of the development occurring in the budding towns of Hereford and Palominas right along the river.

"Groundwater supports those rivers. While there's not a legal recognition, it's a fact," Graham said. Many states, including Arizona, fail to consider the impact groundwater withdrawals have on nearby rivers, as Robert Glennon describes at length in his book *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters*.

Graham compared groundwater basins to bathtubs, noting that rivers flow only when the basins are full enough to overflow into channels. Yet surface waters serve millions of birds as "nature's highways, hospitals, hotels, and restaurants," he said. Conservationists consider the San Pedro especially crucial as an oasis for migratory birds, as it encompasses the northern limits for some tropical species and the southern edge for some species traveling from cooler climates.

Tourism and recreation also thrive due to surface water, such as the inner tubing industry on Phoenix's Salt River.

Concern for rivers and their functions drew a crowd of about 250 people to an August talk in Tucson by Jackie King. A researcher from South Africa, King assesses ecological, social, and economic values of river systems around the world and how they change with development.

Noting that Arizona policy encourages population growth, she outlined how

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## A natural source of water

By Melanie Lenart

Homeowners can turn their yards into oases by capturing rainwater and recycling household water, explained Brad Lancaster, author of *Rainwater Harvesting for Drylands*.

He describes harvesting principles that allow plants to thrive and thus cool the area around homes, a form of climate control that becomes more crucial with temperatures rising and populations growing.

"We're truly desertifying our so-called desert," Lancaster said during a talk this year at The University of Arizona's Water Resources Research Center. "Here's where the rivers are today," he added, showing a slide of a Tucson street flooded by monsoon rains.

Paved streets, concretized river banks, and hard bare soil all channel water away before it can soak into the ground—sometimes whisking it out of town even before it can recharge groundwater aquifers, he noted.

A permaculturist based in Tucson, Lancaster learned some of his techniques in Zimbabwe, which has a semi-arid climate similar to that in the Southwest. There, a man he calls Mr. Phiri taught him how to "plant water before planting trees" and other lessons. These include:

- Start by observing your landscape during rains, noticing how water moves and collects. Then revise after noticing what does and doesn't work.
- Start at the top of your "watershed," which on a residential lot may be a roof. Capture and/or

**continued on page 6**

## Water supply, continued

researchers could assess some of the benefits and costs of proposed water withdrawals to encourage more informed policy decisions (*River Research and Applications*, Fall 2003).

Using extensive data on historical, present-day, and future river flow patterns and location of riparian plants, researchers could project how proposed withdrawals might impact water quality, wildlife, and tourism, for example.

"If you take half your diet away, you will change. If you take half the river water away, it will change," King told the crowd gathered at The University of Arizona. Later she reminded, "Good quality of life doesn't just mean a nice house and food in the fridge."

King noted that her approach includes working with various interest groups and individuals. With her recommended approach, scientists restrict their role to evaluating and presenting data, leaving policy decisions to the governments and stakeholders involved.

In the concluding remarks at the June conference, Kathy Jacobs encouraged water managers and the research community to explain the impact of decisions so policy makers could avoid working "in a vacuum." A onetime water manager, Jacobs now directs the tri-university Arizona Water Institute.

Water managers need to create a better link between water availability and population growth management, Gammage suggested, adding, "I don't think water managers can continue the attitude of 'We're the plumbers. You tell us what we need to do and we'll do it.' "

*Melanie Lenart is a postdoctoral research associate with the Climate Assessment for the Southwest (CLIMAS). The SWCO feature article archive can be accessed at the following link: http://www.ispe.arizona.edu/climas/forecasts/swarticles.html*

## Natural source, continued

direct gutter water toward plants or into a storage tank.

- Start small. Use simple strategies that slow and spread the flow of water across the land, giving it time to seep down into soil.

- Maximize ground cover, especially living ground cover. Plants and mulch help soils quickly soak up water, so it won't be available for mosquito breeding.

"If nothing else, raise your pathways and patios and sink your planting areas," Lancaster suggested. That way plants will receive some of the water running off the impermeable surfaces.

**Figure 2.** Brad Lancaster in front of the cistern that stores rainwater in his yard. Photo credit: Melanie Lenart

During an early September tour of his yard, he pointed out a 1,200 gallon cistern—now full—that stores water channeled from his roof (Figure 2). A spigot on the side yields some of its contents with a turn of the faucet. A driveway and a strategically sliced curb pull in some of the street's flow during monsoon rains, where native plants benefit from the spillover. Corrugated zinc on the roof of his workshop drains water in rivulets into an area sprouting orange and fig trees.

The thriving saplings also receive water every time Lancaster washes a load of clothes. Recycled water draining from showers, washing machines, and other household pipes is known as greywater.

Arizona has begun encouraging residents to use greywater for landscaping, as long as they avoid draining from kitchen sinks or, of course, toilets. In 2007, the state will start providing up to $1,000 in tax credits per household to help reimburse residents who set up greywater-harvesting systems.

When employing greywater, Lancaster recommends using liquid detergents rather than powders, which use salt as filler. Also, unlike rainwater, greywater should not be stored in a tank. Lancaster encourages people to deposit it directly into mulched and vegetated soil.

Water harvesting can make a crucial difference when living in any desert. Lancaster's mentor, Mr. Phiri, became a role model for his village in Zimbabwe after turning a barren wasteland into a productive farm over the years.

"There are other people in his village literally dying of thirst in drought years, and he is raising fish," Lancaster said. "And they could be doing the same."

*More information about the tax credit program, suitable detergents for greywater systems, and Lancaster's book can be found at his website: http://www.harvestingrainwater.com.*

# Temperature (through 9/20/06)

**Source: High Plains Regional Climate Center**

Since the start of the water year on October 1, 2005, temperatures across most of the Southwest have been 0–4 degrees Fahrenheit above average (Figure 1b). Average temperatures have ranged from the low 70s F in much of southwest Arizona to the high 30s F in higher elevations of northern New Mexico and Arizona (Figure 1a). Over the last 30 days temperatures generally have been below average, ranging from 0 to 4 degrees F below average over most of Arizona and New Mexico, and even cooler in parts of southwestern New Mexico (Figure 1c–d). Much of western and southwestern New Mexico was from 4 to 6 degrees F below average, as were some other small areas in both states. Some areas in western and southwestern New Mexico were up to 8 degrees F below average. In New Mexico, September brought some early fall cool temperatures. According to the National Weather Service in Albuquerque, several locations in New Mexico saw the first freezing temperatures of the season from September 17 through September 19. The freeze was early in parts of the Rio Grande Valley, setting a record for the earliest freeze in Los Lunas, and tying the record in Española.

## 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/products/current.html

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

**Figure 1a.** Water year '05–'06 (through September 20, 2006) average temperature.

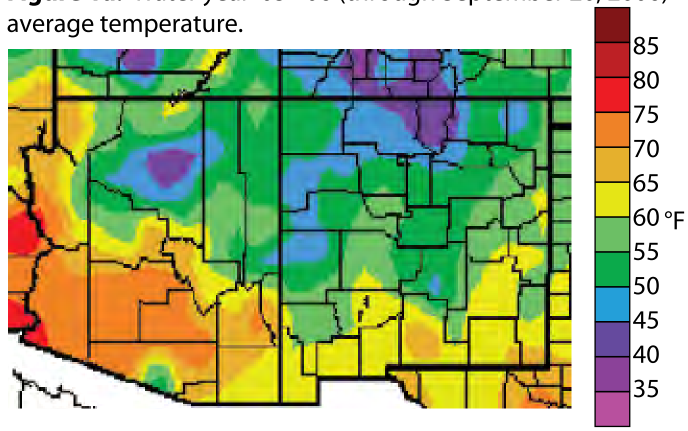



**Figure 1b.** Water year '05–'06 (through September 20, 2006) departure from average temperature.

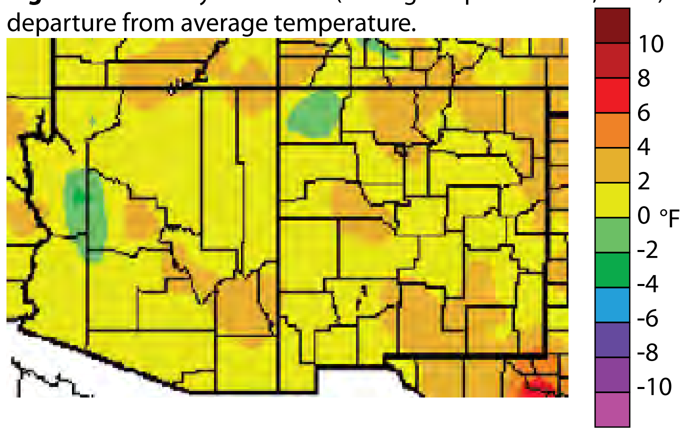



**Figure 1c.** Previous 30 days (August 22–September 20, 2006) departure from average temperature (interpolated).

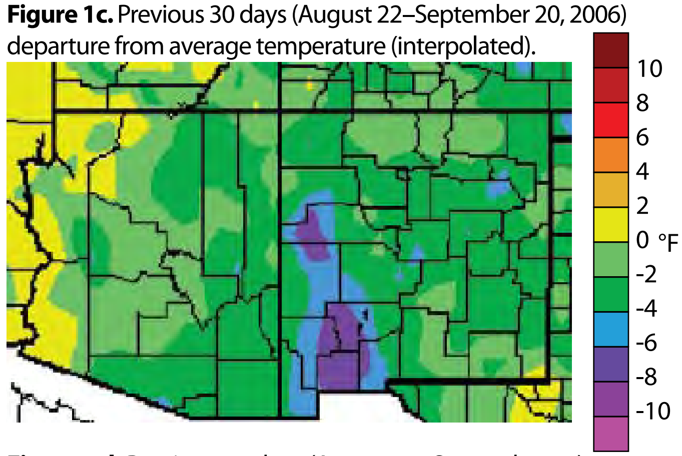
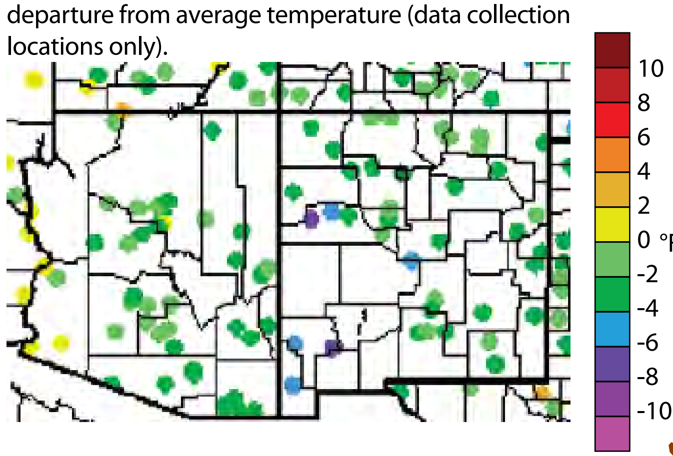



**Figure 1d.** Previous 30 days (August 22–September 20) departure from average temperature (data collection locations only).



# Precipitation (through 9/20/06)

Source: High Plains Regional Climate Center

Despite the abundant rain received during the monsoon season, precipitation across most of the region remains below average since the start of the water year on October 1, 2005 (Figures 2a–b). Much of northern and eastern New Mexico and virtually all of Arizona have received below normal rain and snow. Much of Arizona and parts of New Mexico have received less than 70 percent of average precipitation, with some areas getting less than 50 percent of average, particularly in parts of central and western Arizona. Precipitation totals for the water year have been above average in much of southern New Mexico, thanks to the abundant rain received during the record-breaking monsoon season. Precipitation in much of southeastern New Mexico has been up to 130 percent of average for the water year, and up to 200 percent of average in the Rio Grande valley near the Mexican border. During the last 30 days rainfall has been above average along most of the southern part of the region, particularly in New Mexico, and in parts of northern Arizona and New Mexico, but below average in an irregular band extending across the region from northwestern Arizona through central Arizona and New Mexico to northeastern New Mexico (Figure 2c–d).

## Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2005, we are in the 2006 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/products/current.html

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 '05–'06 through September 20, 2006 percent of average precipitation (interpolated).

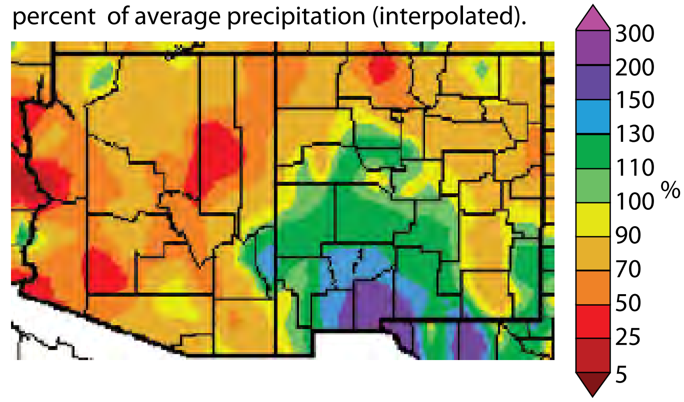



**Figure 2b.** Water year '05–'06 through September 20, 2006 percent of average precipitation (data collection locations only).

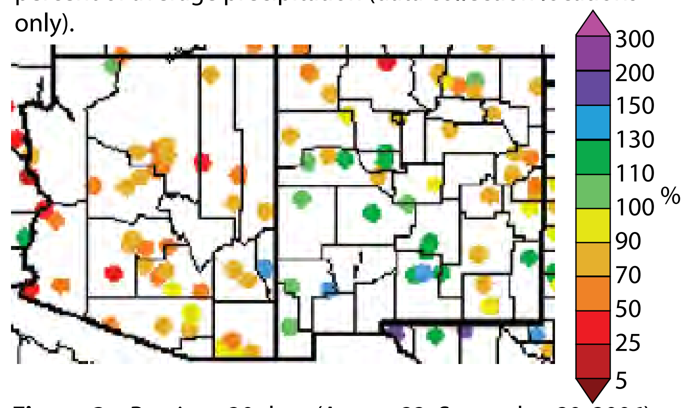



**Figure 2c.** Previous 30 days (August 22–September 20, 2006) percent of average precipitation (interpolated).

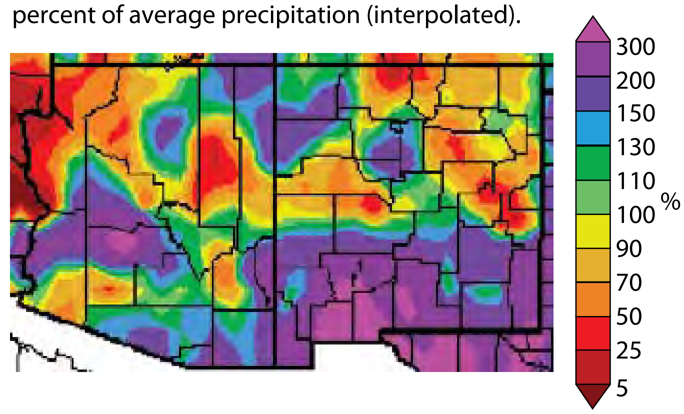
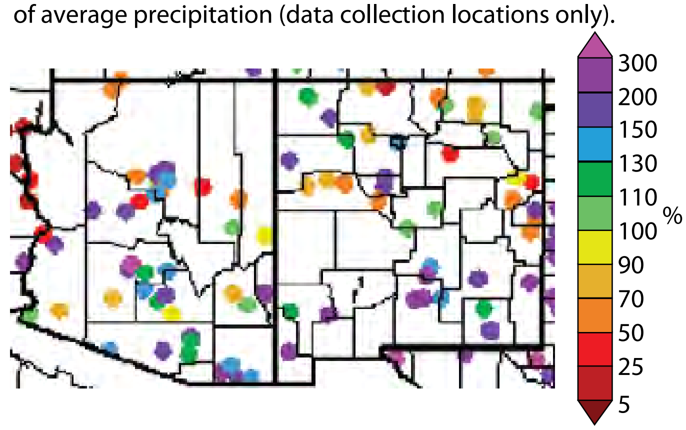



**Figure 2d.** Previous 30 days (August 22–September 20) percent of average precipitation (data collection locations only).



# U.S. Drought Monitor

**(released 9/21/06)**

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

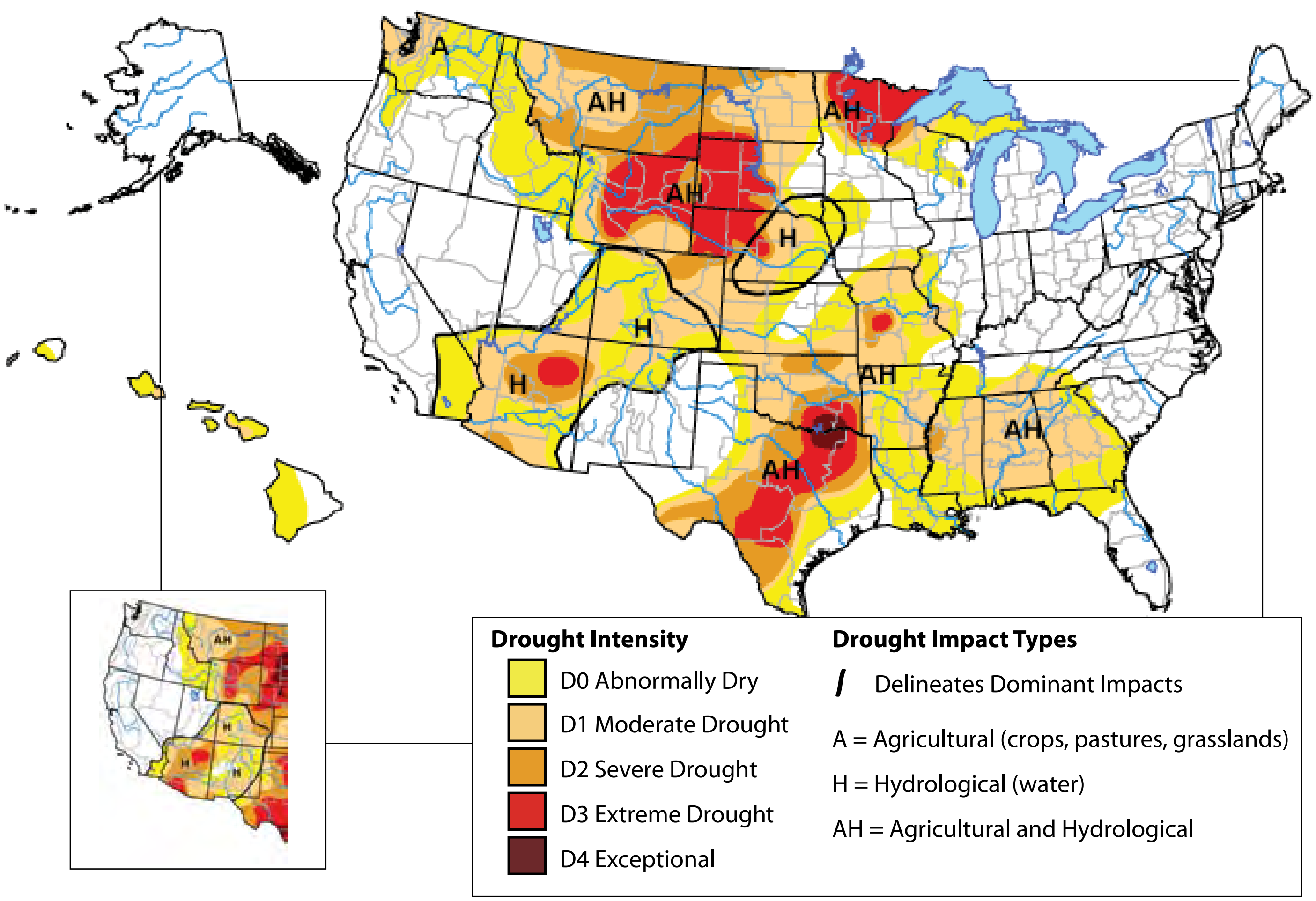
The U.S. Drought Monitor shows improvement across most of the Southwest, particularly in New Mexico, where the monsoon rains have brought relief to most of the state (Figure 3). Thanks to the record-breaking rains in New Mexico, only the northwestern and north-central parts of the state remain in moderate drought or abnormally dry condition. The rains have also improved conditions considerably in Arizona, where severe drought is now limited to an area in the northeastern part of the state, and in a small area along the Mexican border in southwestern Arizona. An area of extreme drought still persists in northeastern Arizona, but much of the area that was in severe drought has improved to moderate drought status. Due to long-term precipitation deficits, nearly all of Arizona remains in some level of drought or abnormally dry condition, except for the extreme southeastern part of the state near the New Mexico border. Elsewhere in the nation the drought picture has also generally improved, easing from Texas to the Southeast, and in the northern Great Plains, where exceptional drought is now limited to part of the Texas-Oklahoma border. Drought has expanded slightly in Minnesota, and dryness has developed in the Pacific Northwest.

## 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 the several agencies; the authors of this monitor are Ned Guttman and Liz Love-Brotak, NOAA/NESDIS/NCDC.

**Figure 3.** Drought Monitor released September 21, 2006 (full size) and August 17, 2006 (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

**(through 9/30/06)**

**Source: Arizona Department of Water Resources**

Short-term drought conditions have continued to improve dramatically throughout most of Arizona due to the persistent and abundant monsoon season rains (Figure 4a). Severe drought, which covered most of the state last month, is now limited to the Agua Fria and Bill Williams watersheds in central and western Arizona. The Gila and San Simone watersheds in southeastern Arizona have improved from extreme to moderate status. Most of southern Arizona is in moderate drought status, except for the San Pedro River and Lower Colorado River watersheds, which have improved to abnormally dry. Despite the improvements, the entire state remains in some level of short-term drought or abnormal dryness.

The long-term drought picture continues to show most of the eastern part of Arizona in severe drought status, abnormal dryness in the north and northwest, and generally no long-term drought in southwestern Arizona (Figure 4b). There has been almost no change in long-term drought status since last month, except that conditions in the San Pedro River watershed have improved from extreme to severe drought status, while the Wilcox Playa watershed has deteriorated from severe to extreme status. Soil moisture conditions in Arizona have continued to improve since last month, with 58 percent of the pasture and range land rated in "poor" to "very poor" condition, down from 73 percent last month. Despite the improvement, only 17 percent is in "good" or "excellent" condition. This time one year ago only 44 percent of the pasture and range land was in "poor" to "very poor" condition.

## Notes:

The Arizona drought status maps are produced monthly by the Arizona Drought Preparedness Plan Monitoring Technical Committee. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 4a shows short-term or meteorological drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known as hydrological drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfall (e.g., many months to years) on water supplies (i.e., streamflow, reservoir and lake levels, and groundwater). These maps are delineated by river basins (wavy gray lines) and counties (straight black lines).

## On the Web:

For the most current Arizona drought status maps, visit:
http://www.azwater.gov/dwr/Content/Hot_Topics/Agency-Wide/Drought_Planning/

**Figure 4a.** Arizona short term drought status for September 2006.

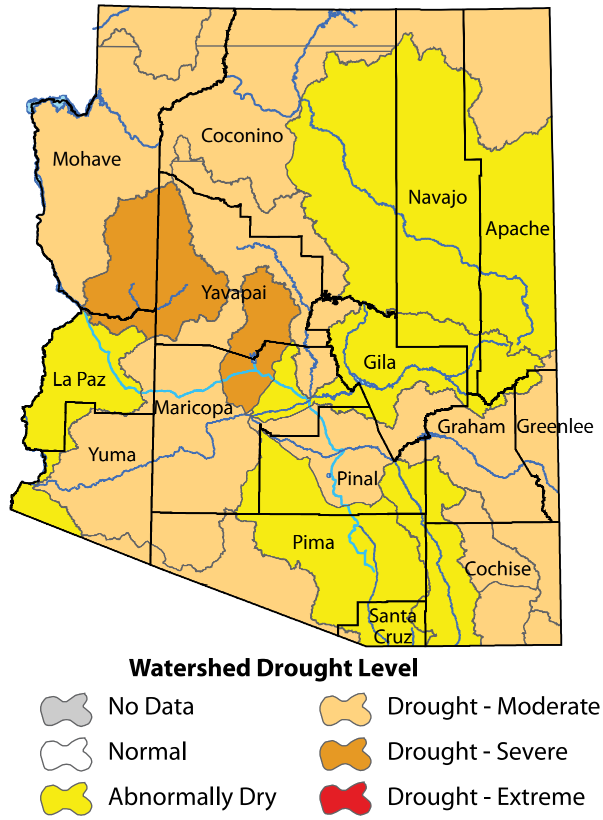
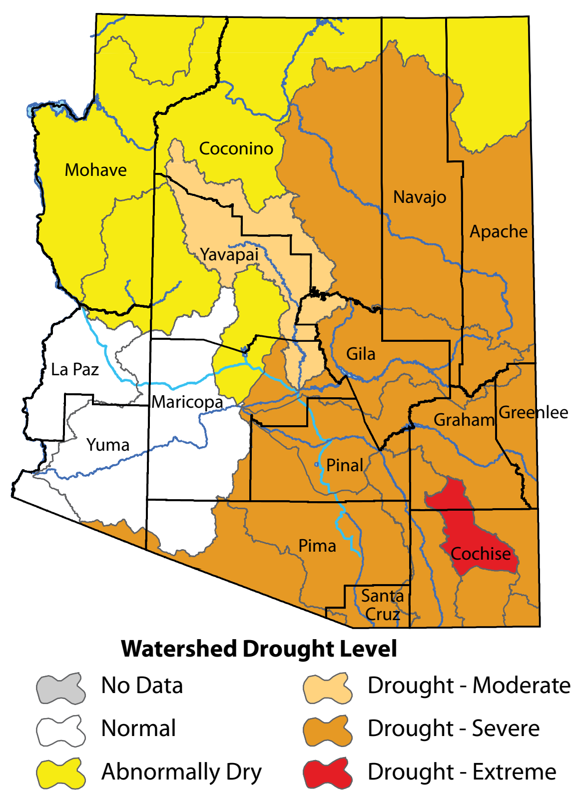



**Figure 4b.** Arizona long term drought status for September 2006.



# New Mexico Drought Status

## (through 08/31/06)

**Source: New Mexico Natural Resources Conservation Service**

The short-term drought status in New Mexico has continued its dramatic improvement since last month (Figure 5a), thanks to the record-breaking monsoon rains. All of the emergency drought conditions have disappeared in the state, and warning drought status lingers only in part of north-central New Mexico and in some small areas in western and southwestern New Mexico. August precipitation was 184 percent of average in New Mexico, making the month the wettest August on record. Consequently, much of the short-term drought has been relieved throughout the state.

The long-term drought status map (Figure 5b) also shows considerable improvement, with most of the eastern and southern part of the state in alert status and most of western New Mexico in advisory status. Soil moisture conditions in New Mexico have improved substantially since last month, with only 17 percent of the pasture and range land in “poor” or “very poor” condition, down from the 34 percent reported last month. As of mid-September, 60 percent of the pasture and range land was in “good” or “excellent” condition, compared to only 3 percent in early June. Despite the welcome easing of drought conditions, the lingering impacts of the long-term drought will likely require significant winter precipitation and spring snowmelt runoff before they are ameliorated, according to the National Weather Service Albuquerque Office.

## Notes:

The New Mexico drought status maps are produced monthly by the New Mexico State Drought Monitoring Committee. When near-normal conditions exist, they are updated quarterly. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 5a shows short-term or *meteorological* drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some “normal” or average amount) over a relatively short duration (e.g., months). Figure 5b refers to long-term drought, sometimes known as *hydrological* drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfalls (e.g., many months to years) on water supplies (i.e., streamflow, reservoir and lake levels, groundwater). This map is organized by river basins—the white regions are areas where no major river system is found.

**On the Web:**

For the most current meteorological drought status map, visit:
http://www.srh.noaa.gov/abq/feature/droughtinfo.htm

For the most current hydrological drought status map, visit:
http://www.nm.nrcs.usda.gov/snow/drought/drought.html

**Figure 5a.** Short-term drought map based on meteorological conditions for August 2006.

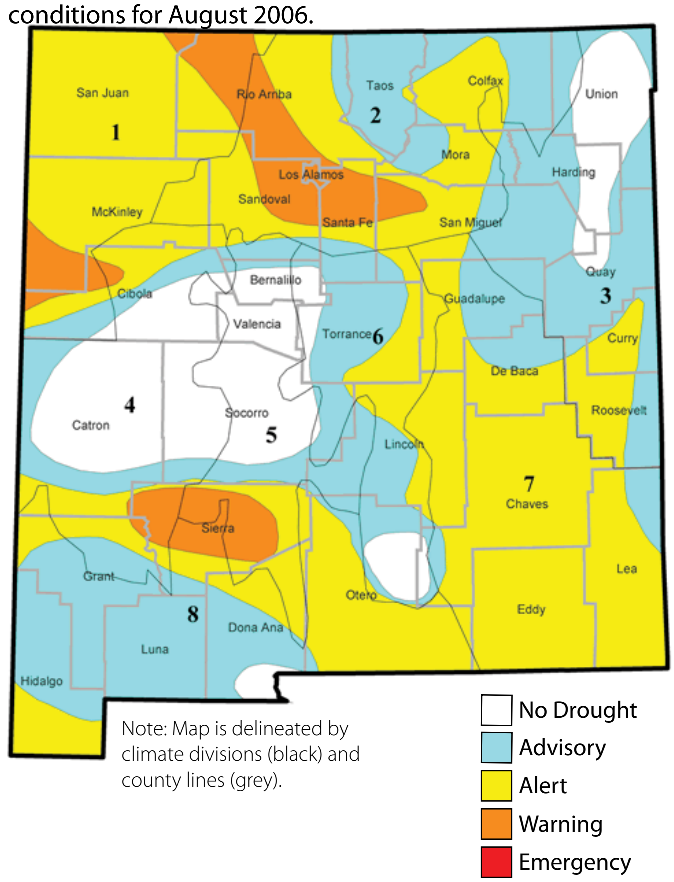
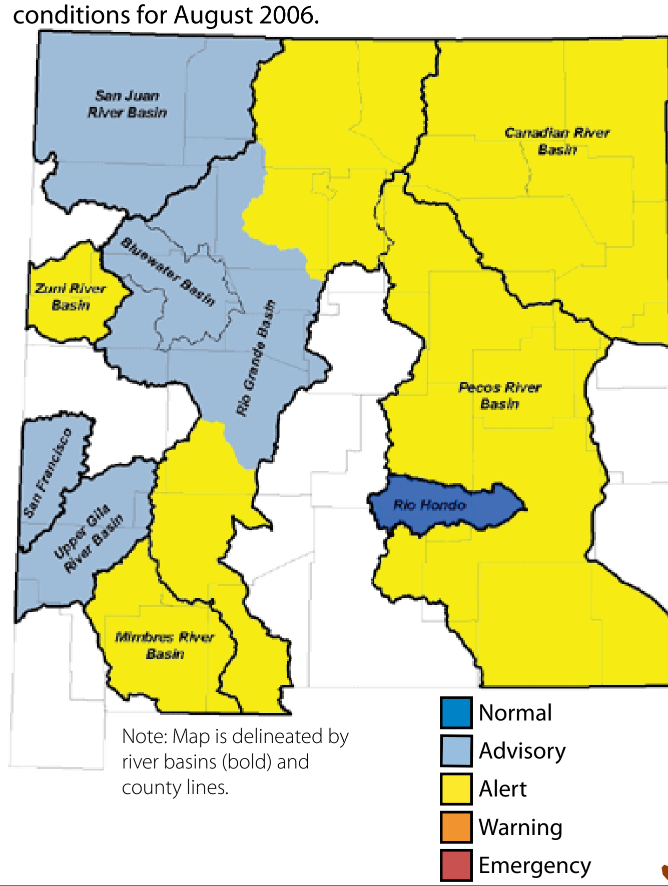



**Figure 5b.** Long-term drought map based on hydrological conditions for August 2006.



# Arizona Reservoir Levels

**(through 8/31/06)**

**Source: National Water and Climate Center**

The abundant rainfall brought by this year's monsoon season has helped raise the water storage levels in several Arizona reservoirs, an event most often caused by winter precipitation rather than summer rains (Figure 6). The total in-state storage rose from 48 to 54 percent of capacity since last month. Storage in the Salt River system increased by about 3 percent of capacity, and the Verde system rose 6 percent. Storage has tripled in the San Carlos Reservoir on the Gila River, which had been down to 8 percent last month, and has now filled to 24 percent of its capacity. Reservoir managers had feared that San Carlos Reservoir could dry up by the end of the summer, leaving farmers in the area without a dependable source of water, according to the *Tucson Citizen* (August 29). On the Colorado River, Lake Powell declined by approximately 2 percent, while Lake Mead rose slightly by approximately one percent. The total Colorado River storage is at about 53.5 percent of capacity, having declined by less than one percent since last month.

Storage on the Colorado River remains only slightly less than one year ago, when it was at 57 percent of capacity. But the almost complete lack of rain and snowpack over the past winter has caused significant depletion of the in-state water storage. Winter rain and snow are usually the biggest contributors to the replenishment of reservoirs in the Southwest, with summer rainfall usually contributing only minor amounts of runoff. According to the *Tucson Citizen* (August 29), officials at the Salt River Project said that runoff from the summer precipitation this year has exceeded winter runoff for only the ninth time since record-keeping began just over a century ago.

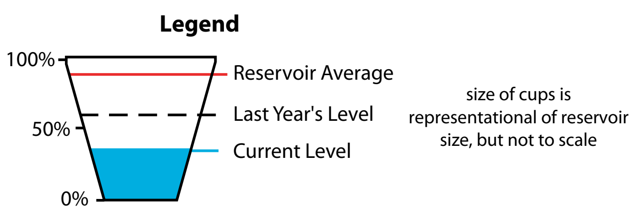
## Notes:

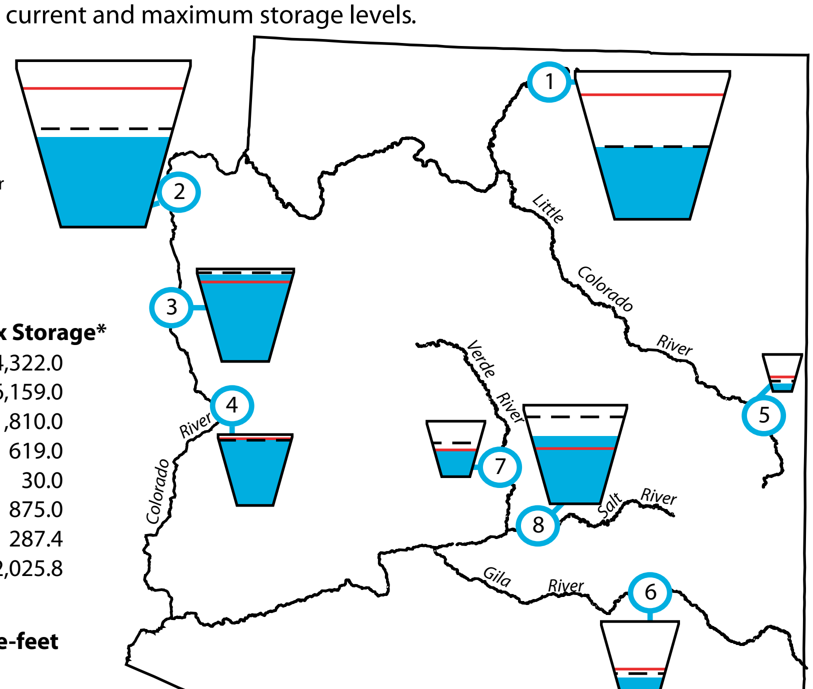
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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.

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. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) or Larry Martinez, Natural Resource Conservation Service, 3003 N. Central Ave, Suite 800, Phoenix, Arizona 85012-2945; 602-280-8841; Larry.Martinez@az.usda.gov).

**Figure 6.** Arizona reservoir levels for August 2006 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir, while the table also lists current and maximum storage levels.




| Reservoir Name | Capacity Level | Current Storage* | Max Storage* |
|---|---|---|---|
| 1. Lake Powell | 49% | 12,017.0 | 24,322.0 |
| 2. Lake Mead | 54% | 14,005.0 | 26,159.0 |
| 3. Lake Mohave | 94% | 1,705.8 | 1,810.0 |
| 4. Lake Havasu | 94% | 579.6 | 619.0 |
| 5. Lyman Reservoir | 21% | 6.2 | 30.0 |
| 6. San Carlos | 24% | 212.8 | 875.0 |
| 7. Verde River System | 49% | 139.6 | 287.4 |
| 8. Salt River System | 68% | 1,379.1 | 2,025.8 |

*** 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 8/31/06)**

**Source: National Water and Climate Center**

The record-breaking summer rainfall in New Mexico has helped stream inflow and replenishment for most of the reservoirs in the state (Figure 7). Total storage in New Mexico has improved significantly, from 33 percent of capacity last month to about 37 percent at the end of August. The most dramatic improvements were in the southern part of the state, where rainfall totals were well above average (see Figure 2c–d). Elephant Butte, the largest reservoir in the state, had been down to only 9 percent of capacity a month ago, but now has almost doubled its storage to 16 percent. The same intense rainfall that brought widespread flooding in the lower Rio Grande Valley also provided significant inflow to Caballo Reservoir downstream of Elephant Butte, raising the storage of Caballo from 14 to 19 percent. Significant inflow also occurred on the Pecos, raising storage levels on all the major reservoirs, especially on Santa Rosa, which more than doubled in storage, from only 6 percent of capacity to 14 percent. Most reservoirs in the state showed at least some gain in storage, but Costilla Reservoir on the upper Rio Grande fell by 6 percent of capacity, while Navajo Reservoir on the San Juan River fell by less than one percent. Cochiti and El Vado on the Rio Grande held steady at 10 and 30 percent, respectively.

According to the National Weather Service Albuquerque Office, much of the short-term drought that began in October 2005 has been relieved, but lingering impacts of the long-term multiyear precipitation will require significant winter precipitation and spring snowmelt runoff to be alleviated. Elephant Butte Reservoir was at 132 percent of average in early 2000, but is now at only 27 percent of average, even after partial replenishment by the summer rains.

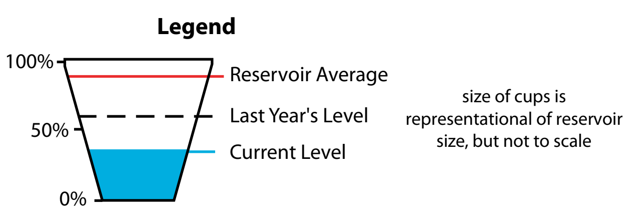
## Notes:

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.

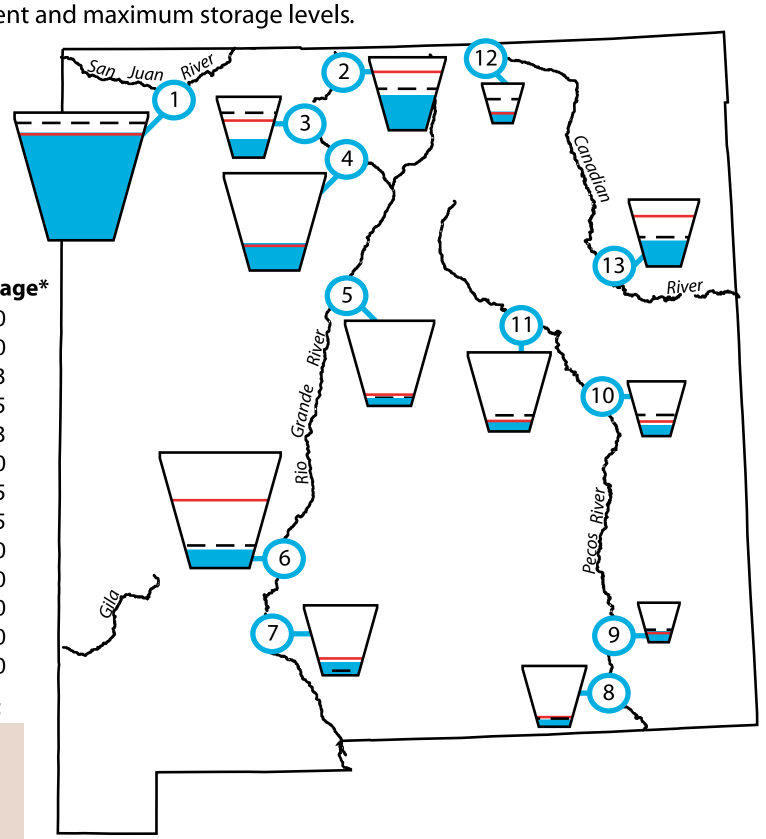
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) or Dan Murray, NRCS, USDA, 6200 Jefferson NE, Albuquerque, NM 87109; 505-761-4436; Dan.Murray@nm.usda.gov).

**Figure 7.** New Mexico reservoir levels for August 2006 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir, while the table also lists current and maximum storage levels.




| Reservoir Name | Capacity Level | Current Storage* | Max Storage* |
|---|---|---|---|
| 1. Navajo | 84% | 1,417.4 | 1,696.0 |
| 2. Heron | 48% | 191.9 | 400.0 |
| 3. El Vado | 30% | 56.0 | 186.3 |
| 4. Abiquiu | 28% | 157.7 | 554.5 |
| 5. Cochiti | 10% | 48.2 | 502.3 |
| 6. Elephant Butte | 16% | 331.6 | 2,065.0 |
| 7. Caballo | 19% | 64.3 | 331.5 |
| 8. Brantley | 12% | 18.0 | 147.5 |
| 9. Lake Avalon | 28% | 1.7 | 6.0 |
| 10. Sumner | 20% | 20.6 | 102.0 |
| 11. Santa Rosa | 14% | 64.8 | 447.0 |
| 12. Costilla | 30% | 4.8 | 16.0 |
| 13. Conchas | 38% | 95.5 | 254.0 |

*** 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

# Monsoon Summary
**(through 9/19/06)**

**Source: Western Regional Climate Center**

The record-breaking monsoon season of 2006 did much to ease short-term drought conditions in the Southwest, but it also caused considerable flood damage in many localities in Arizona and New Mexico. President Bush signed disaster declarations for both states. Federal disaster aid is being provided in several areas, including the lower Rio Grande region in New Mexico and Pinal and Pima counties in Arizona, and to several Indian tribes in Arizona. Since July 1, most of the Southwest has received above-average precipitation, with areas in southwestern New Mexico and central and southeastern Arizona receiving more than 300 percent of average rainfall (Figure 8c). In contrast, some areas in northern New Mexico and in western and northeastern Arizona received from 0 to 6 inches less than average rainfall (Figure 8b). Rainfall amounts were generally greater in New Mexico and southeastern Arizona, ranging from more than 22 inches in southern New Mexico to less than 0.5 inches in parts of western and northeastern Arizona (Figure 8a). According to the National Weather Service Albuquerque Office, August 2006 was the wettest August in 112 years statewide in New Mexico. July–August 2006 was also the wettest July–August period in 112 years, and June–August was the third-wettest such period. Largely as a result of the monsoon rains, much of the Southwest has seen improvements in short-term drought status.

**Figure 8a.** Total precipitation in inches July 1–September 19, 2006.

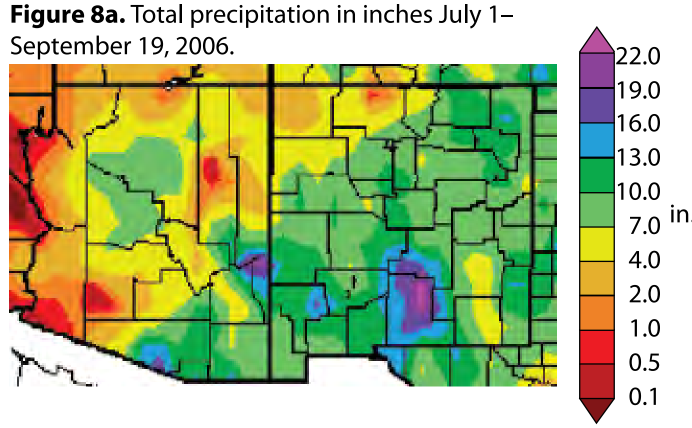



**Figure 8b.** Departure from average precipitation in inches July 1–September 19, 2006.

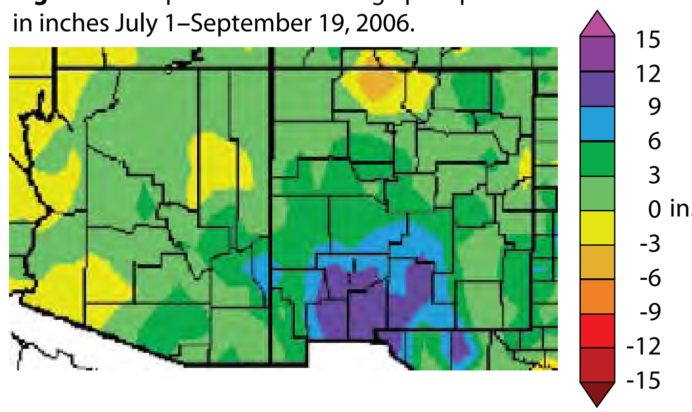
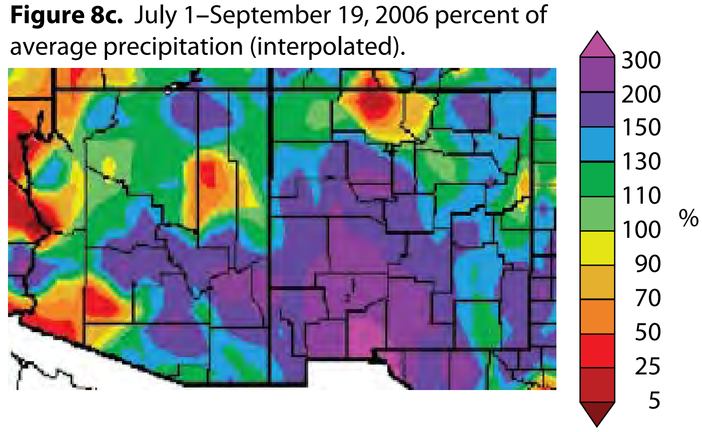



**Figure 8c.** July 1–September 19, 2006 percent of average precipitation (interpolated).




## Notes:

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. Departure from average precipitation is calculated by subtracting the average from the current precipitation.

The continuous color maps (Figures 8a–c) 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 data used to create these maps is provisional and have not yet been subjected to rigorous quality control.

## On the Web:

These data are obtained from the Western Regional Climate Center: http://www.wrcc.dri.edu

# Temperature Outlook

## (October 2006–March 2007)

**Source: NOAA Climate Prediction Center (CPC)**

The NOAA-CPC temperature outlook calls for increased chances of above-average temperatures for the Southwest through March 2007 (Figures 9a–d). The outlook for October–December is for warmer-than-average temperatures for most of the West and Great Plains, except for the southern California coast. The area with the highest probabilities for warmer-than-average temperatures (greater than 50 percent) is centered over northwestern Arizona and southern Nevada. As the season progresses into winter and early spring, the outlook for warmer-than-average temperatures extends northeast to cover most of the nation except for the Gulf Coast and southern Atlantic Coast states. An area centered over northern Florida and adjacent parts of the Southeast is expected to have increased chances for near normal temperatures (greater than 33 percent) for November–February.

### 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 the reliability (i.e., 'skill') of the forecast is poor; 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 October–December 2006.

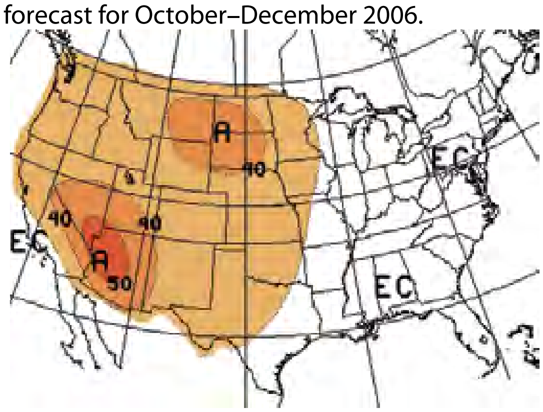



**Figure 9b.** Long-lead national temperature forecast for November 2006–January 2007.

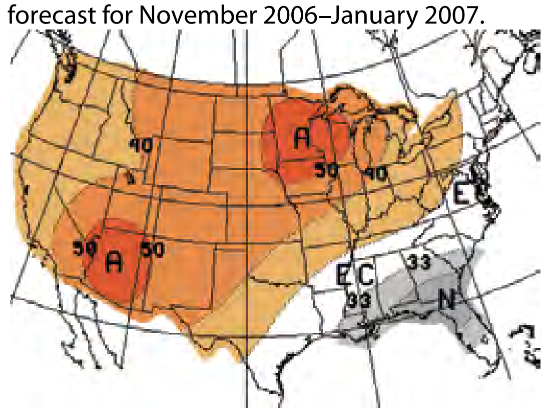



**Figure 9c.** Long-lead national temperature forecast for December 2006–February 2007.

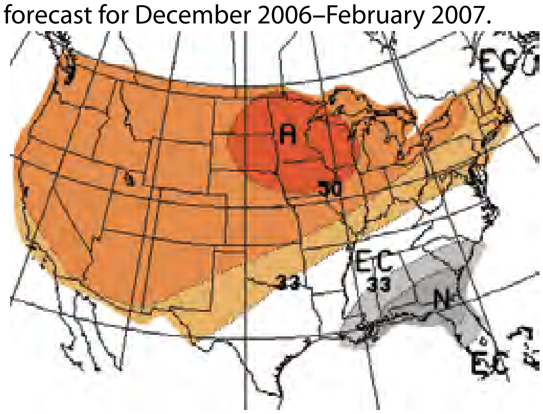
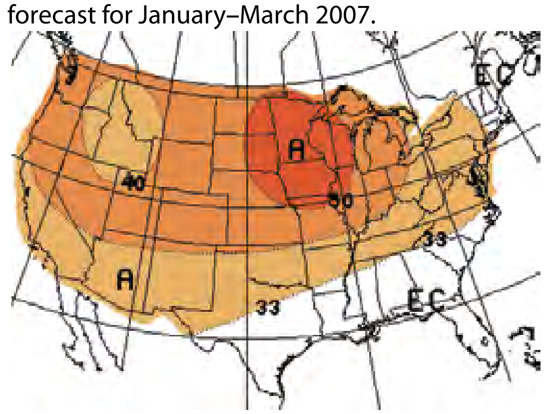



**Figure 9d.** Long-lead national temperature forecast for January–March 2007.




N= Near Normal: 33.3–39.9%; 40.0–49.9%

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

EC= Equal chances. No forecasted anomalies.

### On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(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
## (October 2006–March 2007)

**Source: NOAA Climate Prediction Center (CPC)**

Long-lead precipitation outlooks from the NOAA-CPC call for increased chances of above-average precipitation in southern New Mexico during October–December, and for wetter-than-average conditions to extend westward and northward during the winter and early spring to include the entire Southwest (Figure 10a–d). The area of greatest probability of above-average precipitation (greater than 40 percent) is expected to be along the Mexican border, gradually moving from southern Texas in the fall towards the West to include much of southern New Mexico and southern Arizona by mid-winter and early spring. Wetter-than-average conditions are also expected to develop in Florida starting in November, and below-average precipitation is expected to prevail in the Pacific Northwest and parts of the Midwest and Southeast throughout the fall, winter, and early spring.

### 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 the reliability (i.e., 'skill') of the forecast is poor; 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 October–December 2006.

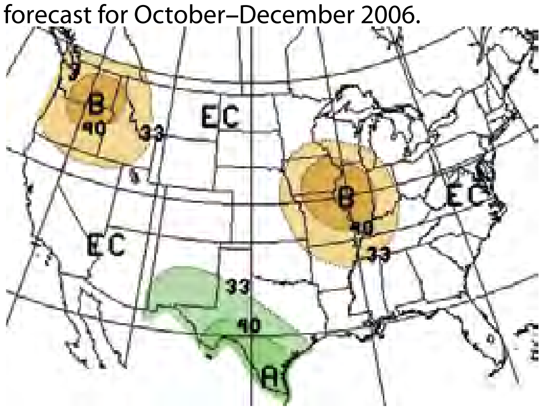



**Figure 10b.** Long-lead national precipitation forecast for November 2006–January 2007.

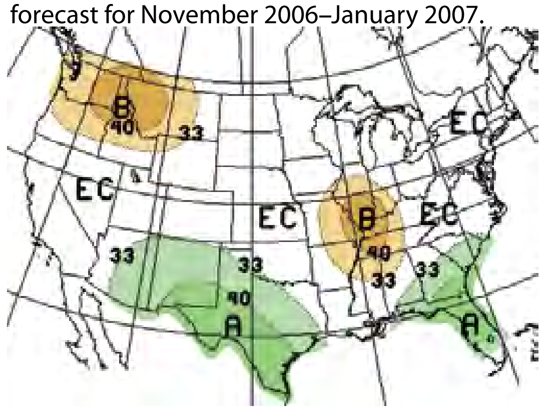



**Figure 10c.** Long-lead national precipitation forecast for December 2006–February 2007.

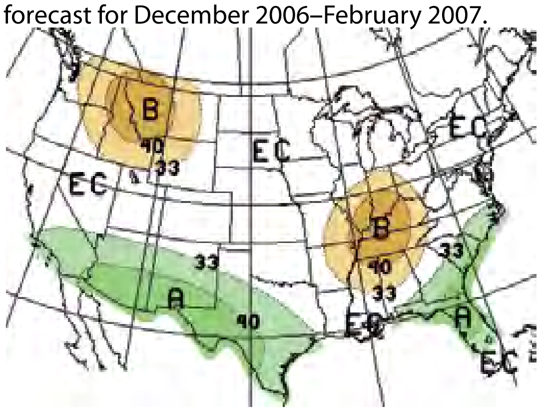
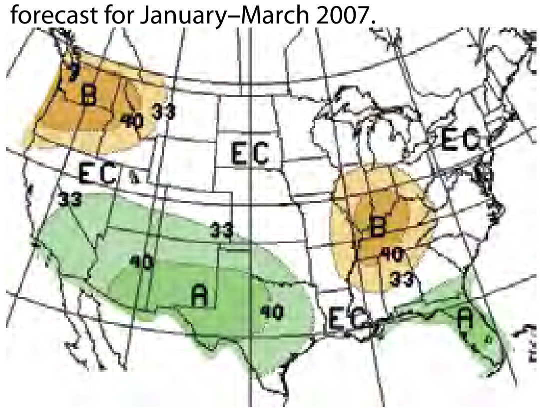



**Figure 10d.** Long-lead national precipitation forecast for January–March 2007.




A= Above: 40.0–49.9%; 33.3–39.9%

B= Below: 33.3–39.9%; 40.0–49.9%

EC= Equal chances. No forecasted anomalies.

### On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(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 December 2006)

**Source: NOAA Climate Prediction Center (CPC)**

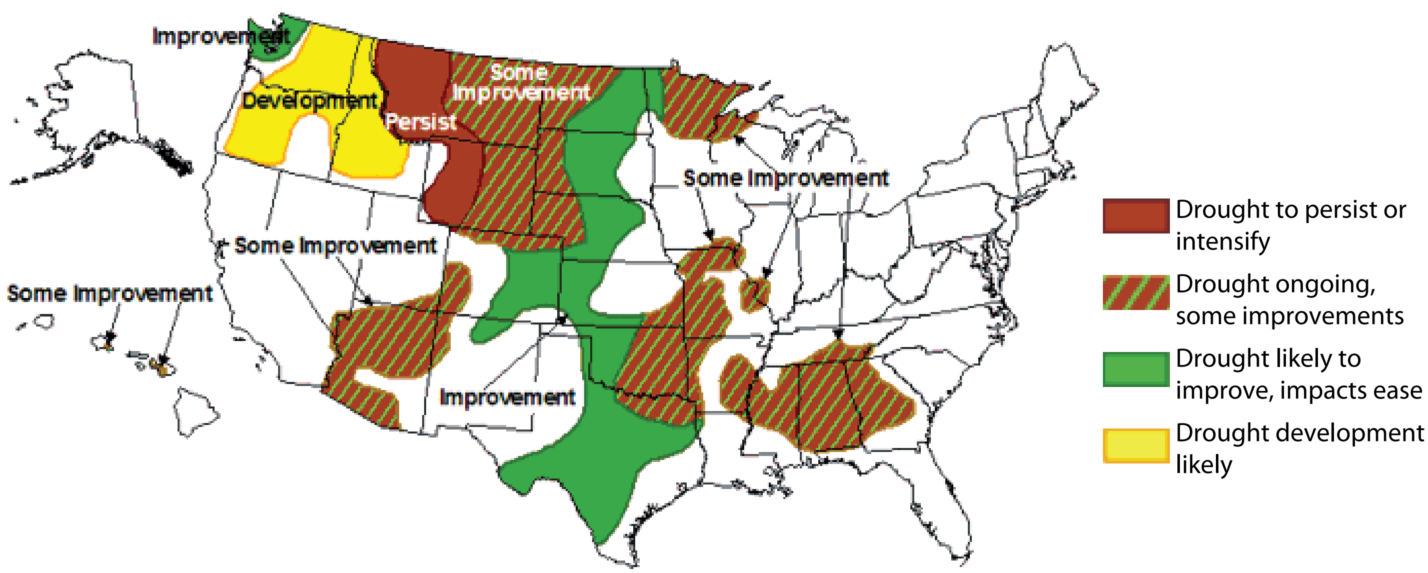
The U.S. drought outlook through December 2006 calls for drought conditions to improve in northern New Mexico and to show some improvement in Arizona (Figure 11). Abundant rain during the record monsoon season has already brought much drought relief to the Southwest, particularly in New Mexico. Nevertheless, the relief may be limited due to the accumulated effects of long-term, multi-year precipitation deficits, depending on the amount of rain and snow we receive this winter. The outlook for increased chances of warmer-than-average temperatures in the Southwest during the fall and winter (Figures 9a–d) means that evaporation rates may increase, lessening the benefits of the summer rains and increasing the likelihood of further deterioration of drought conditions in the long term.

On the other hand, El Niño conditions have recently developed in the tropical Pacific and are expected to persist into early 2007. This makes it very unlikely that the Southwest will experience a repeat of the almost total absence of precipitation received during the winter of 2005–2006, according to the NOAA-CPC. The long-range outlook is for increased chances of above-average precipitation for the Southwest during the winter and early spring, raising hopes that at least some longer-term drought relief may be experienced during the upcoming winter. Elsewhere in the nation, drought improvement is expected in the Great Plains from West Texas northward into South Dakota, and some improvement is expected from northern Texas to parts of the Midwest and much of the Southeast. Some improvement is also likely from northern Colorado northeast through the upper Great Plains and to the Canadian border in the upper Midwest. Drought is expected to persist in western Wyoming and in Montana, and eastward along the Canadian border. Drought is also likely to persist in parts of east Texas and southeastern Oklahoma and is expected to develop over a large part of the Pacific Northwest.

**Notes:**

The delineated areas in the Seasonal Drought Outlook (Figure 11) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

**Figure 11.** Seasonal drought outlook through December 2006 (release date September 21, 2006).




**On the Web:**

For more information, visit:
http://www.drought.noaa.gov/

# El Niño Status and Forecast

**Sources: NOAA Climate Prediction Center (CPC), International Research Institute for Climate Prediction (IRI)**

El Niño conditions have developed in the tropical Pacific Ocean and are expected to continue into early 2007. Positive equatorial sea surface temperature (SST) anomalies have been observed across most of the equatorial Pacific since early September, with departures exceeding 2 degrees Fahrenheit in the central Pacific. SST departures in all of the Niño regions are currently greater than 1 degree F. In August the Southern Oscillation Index (SOI) was negative for the fourth consecutive month, with the three-month running mean now at –1.0 (Figure 11a). Beginning in February the basin-wide upper ocean heat content increased, and positive anomalies have been observed since early April. Weaker-than-average equatorial winds also have been observed across most of the equatorial Pacific since early July. According to CPC, these collective oceanic and atmospheric anomalies are consistent with the development of warm-episode (El Niño) conditions in the tropical Pacific. Most of the other ENSO model forecasts (not shown) are also favoring El Niño conditions into early 2007. The recent weaker-than-average easterly winds over the central equatorial Pacific and the warming trends in observed oceanic conditions support those forecasts. The probabilistic forecast issued by the IRI is in agreement, predicting an approximately 60 percent chance of El Niño conditions through March 2007, followed by a return to ENSO-neutral conditions later in the spring or early summer (Figure 12b). According to the CPC, typical El Niño effects are likely to develop over North America during the upcoming winter season, including warmer-than-average conditions over the northern and western United States. Historically, El Niño conditions are associated with increased amounts of winter precipitation in the Southwest leading to the CPC long-range forecast for greater-than-average precipitation.

## Notes:

Figure 12a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through August 2006. 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.

Figure 12b shows the International Research Institute for Climate Prediction (IRI) probabilistic El Niño-Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

## On the Web:

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

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

**Figure 12a.** The standardized values of the Southern Oscillation Index from January 1980–August 2006. 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).

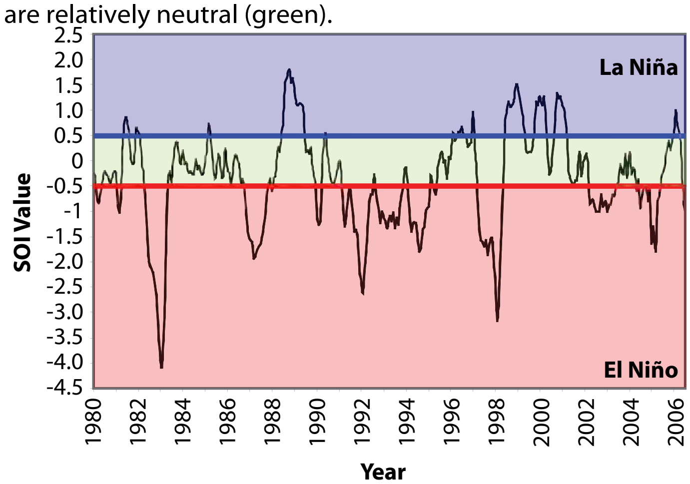
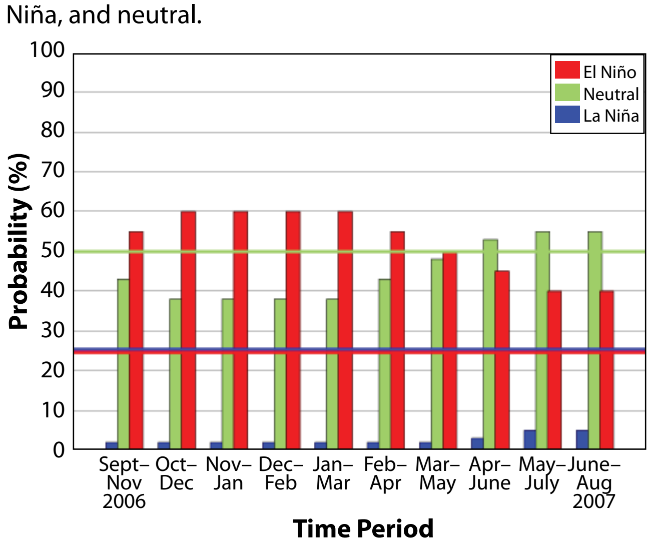



**Figure 12b.** IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released September 21, 2006). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



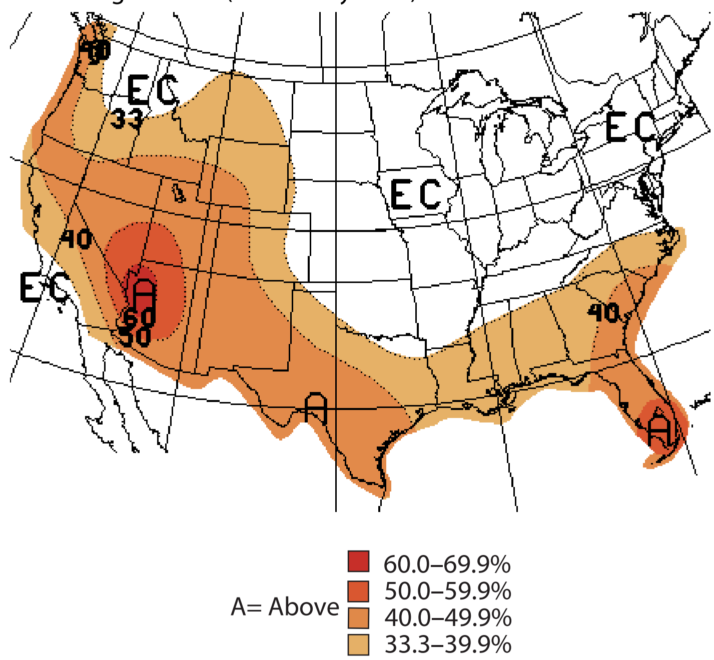
# Temperature Verification

## (June–August 2006)

**Source: NOAA Climate Prediction Center (CPC)**

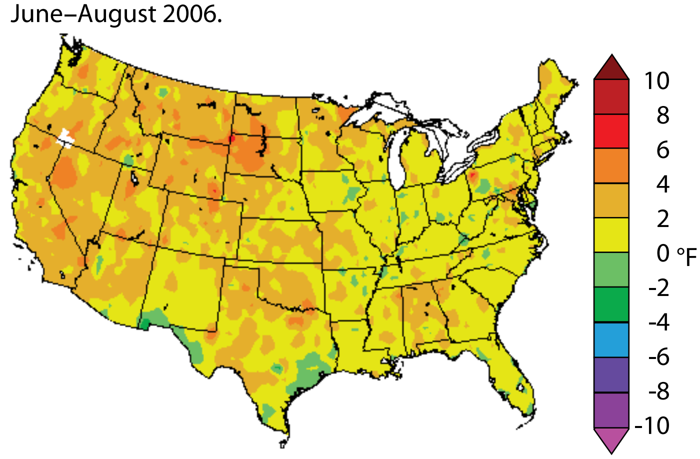
The long-range outlook for June–August 2006 from the NOAA-CPC predicted above-average temperatures in the West and along the far southern tier of states in the East. The anomaly covered much of the West from the West Coast to the Rocky Mountain states, and extended along the Gulf Coast to include Florida and parts of the southern Atlantic Coast (Figure 13a). The area of highest probability (greater than 60 percent) was over western Arizona and southern Nevada. Another area of high probability (greater than 50 percent) was centered over southern Florida. No areas of cooler-than-average temperature were included in the outlook. Observed temperatures were in good agreement with the outlook for above-average temperatures in the West and along the southern coastline, generally ranging from 0–4 degrees Fahrenheit above average, although some small areas along the Texas Coast and the southwestern borders of New Mexico and Texas were 0–2 degrees F below average.

**Figure 13a.** Long-lead U.S. temperature forecast for June–August 2006 (issued May 2006).




EC= Equal chances. No forecasted anomalies.

**Figure 13b.** Average temperature departure (in degrees F) for June–August 2006.




## Notes:

Figure 13a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months June–August 2006. This forecast was made in May 2006.

The outlook predicts 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.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is 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. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 13b shows the observed departure of temperature (degrees F) from the average for the June–August 2006 period. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps. The temperature departures do not represent probability classes as in the forecast maps, so they are not strictly comparable. They do provide us with some idea of how well the forecast performed. In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

## 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.html

# Precipitation Verification

## (June–August 2006)

**Source: NOAA Climate Prediction Center (CPC)**

The long-range outlook from the NOAA-CPC for June–August 2006 called for below-average precipitation in the Northwest, and for wetter-than-average conditions in Florida and southern Georgia. Equal chances for above-average, average, or below-average precipitation was predicted for the Southwest and the rest of the nation. In the Northwest, the area of highest probability (greater than 40 percent) was centered over northern Idaho and adjacent parts of Montana, Washington, and Oregon. Southern Florida was the area of highest probability (greater than 40 percent) of above-average rainfall. Observed precipitation matched the forecast fairly well in the Northwest, where precipitation ranged mostly from 25 to 90 percent of average, although some small areas received up to 110 percent of average. The outlook performed less well in Florida, where only some coastal areas in southern and central Florida experienced up to 130 percent of average rainfall, while drier-than-average conditions prevailed over most of the peninsula.

**Figure 14a.** Long-lead U.S. precipitation forecast for June–August 2006 (issued May 2006).

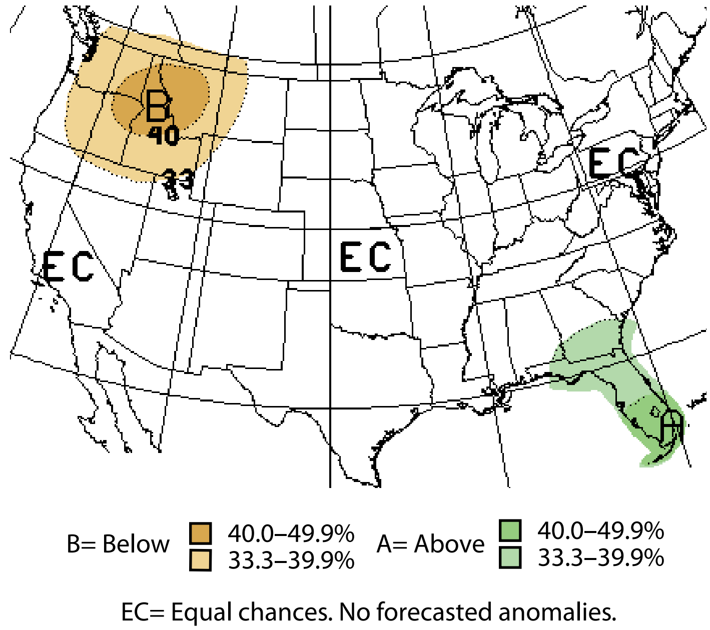
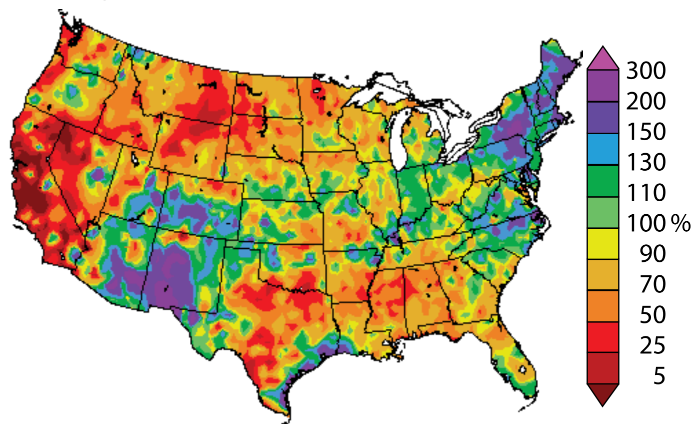



**Figure 14b.** Percent of average precipitation observed from June–August 2006.




## Notes:

Figure 14a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months June–August 2006. This forecast was made in May 2006.

The outlook predicts 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. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is 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. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 14b shows the observed percent of average precipitation for June–August 2006. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps. The observed precipitation amounts do not represent probability classes as in the forecast maps, so they are not strictly comparable, but they do provide us with some idea of how well the forecast performed.

In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

## 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.html