Issued: November 21, 2006

Southwest Climate Outlook

THE UNIVERSITY OF ARIZONA.

Source: Melanie Lenart

Photo Description: CLIMAS reasearch associate Melanie Lenart took this shot of a while traveling in New Mexico in October 2006. This double rainbow appeared shortly after a rainstorm.

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 information in this packet is available on the web: http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html

November Climate Summary

Drought – During this normally dry time of year in the Southwest, drought conditions have remained mostly unchanged since last month.

- In the short-term, most of Arizona is only abnormally dry and much of New Mexico is drought-free.
- Future drought conditions and long-term relief will depend mainly on winter snow and rain.

Temperature – Since the start of the water year on October 1, temperatures have generally been near average.

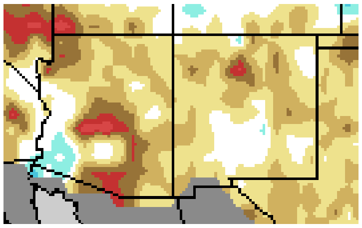
Precipitation – Northern areas of Arizona and portions of western New Mexico have experienced above-average precipitation since the beginning of the water year due to a series of early October storms.

Climate Forecasts – Experts predict equal chances of above-average, below-average, or average temperatures and increased chances of above-average precipitation through the upcoming winter and spring.

El Niño – Sea surface temperatures have continued to warm across the equatorial Pacific with the current El Nino episode. Moderate El Nino conditions are expected to persist through the winter months into the spring.

The Bottom Line – A strong monsoon season and several October storms have contributed to cooler temperatures and an improvement in drought conditions in the Southwest. Future improvements will depend on winter precipitation, which is forecast to be above average through the winter due to current El Niño conditions.

New soil moisture product from UW



The University of Washington's Experimental Surface Water Monitor is a new online product that provides fine spatial scale soil moisture and snow water equivalent maps for the United States. As the Southwest lacks soil moisture and spatially-continuous snowpack estimates, this product helps provide physically-based estimates. The maps are created daily from the output of a sophisticated hydrologic model that is driven by real-time observations from approximately 2,130 stations across the country. The maps present the data in terms of percentiles (rankings) or in terms of the categories used by the U.S. Drought Monitor. The product allows the user to see modeled soil moisture changes in one-day, one-week, two-week, and one-month increments, as well as fourteen-day animations for the western U.S. and Mexico. The website also includes an extensive archive of monthly maps going back to 1915. This product is experimental, so take a look and give the product developers your feedback!

For more info visit: http://www.hydro.washington.edu...

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Global warming could affect groundwater recharge

By Melanie Lenart

Less than a week after record streamflow filled the six-lane-highway sized Rillito River with churning brown water, barely a puddle remained visible in the Tucson stretch near River and Park. A logjam piled up against a bridge bore silent testimony to the late July flood, which seemed to have passed on (Figure 1). Actually, some of it had passed underground. Judging from previous events, remnants of the floodwaters continued to trickle toward the water table about 120 feet below the barely moist surface.

Figure 1. Tucson resident Robert Segal stands by debris collected by supports of the First Avenue bridge where it crosses the Rillito River. The July 31 high waters that carried the logs had moved downstream or underground by August 5, when this picture was taken.

Groundwater reservoirs remain mysteriously out of sight, making fluctuations of these important sources of southwestern water difficult to measure. It's even more challenging to project how they might fare as climate changes with the ongoing global warming.

Recent research shows that groundwater replenishment in the Southwest depends largely on floods, especially winter floods. This, in turn, means the fate of El Niño and snow cover likely hold the key to how groundwater recharge rates will change as the climate warms. The fate of El Niño as climate continues to warm remains unclear. Snow cover changes are more predictable. The changes they will wreak on groundwater recharge is less predictable, but not encouraging.

Short-term recharge

"The thing that really drives groundwater recharge are these large storm events," which typically occur in winter, explained John Hoffmann, brandishing a graph showing episodes of groundwater recharge along the Rillito from one of his studies. The U.S. Geological Survey hydrologist pointed to the boost in aquifer levels during the winter of 1998, when the Rillito flowed for a month straight.

"That sustained flow provided an opportunity for focused recharge," Hoffmann added during a conversation in his Tucson office that also included Stan Leake, a hydrologist who has considered how climate change might impact groundwater recharge processes. Like the 2006 flood, a 1999 summer flood during the study disappeared more quickly, providing less time for recharge (Figure 2).

Riverbeds focus recharge in space as well as time, Leake explained. Unlike most of the southwestern lowlands, riverbeds do not contain a layer of caliche. Composed of calcium carbonate—roughly the same material as concrete—caliche blocks the downward flow of water. Caliche forms when the carbonate in rainfall joins with the calcium in the soil, often combining as the water evaporates back up through the soil horizon.

Along with riverbeds, mountain fronts also serve as major recharge sites. The alluvial fans of sediment spreading across the foothills can soak up the melted snow streaming down from the peaks as well as the monsoonal rainfall of summer that the mountains help spur. Just how much recharge occurs along mountain fronts versus in riverbeds depends on the region and the climate that year, noted James Hogan, the assistant director of SAHRA, a University of Arizona consortium of water researchers. His work in the San Pedro Basin of southeastern Arizona suggests the recharge occurring in riverbeds can range from zero, such as during a dry year such as 2002, up to 40 percent during a year with a strong monsoon, such as 1999.

Like the oil and natural gas contributing to global warming, groundwater exists in the porous spaces of rocks and sediments. Also like these fossil fuels, groundwater may have moved into its belowground location thousands or even tens of thousands of years ago. That's why some geologists like to refer to it as "fossil water" and speak of "mining" groundwater. The latter refers to taking out more groundwater from an aquifer than can be recharged on average in the time frame considered.

Although the Southwest contains massive amounts of fossil water, mining

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Groundwater, continued

it can cause the ground to subside—a potential disaster from a homeowner's point of view. In Tucson, subsidence has caused three to four feet drops in some areas around the central area.

So far, the subsidence hasn't caused widespread damage to homes and roads—but it could in the future if water mining continues unabated, explained Tim Thomure, the lead hydrologist for the Tucson Water Department. That's why the department has been promoting the use of renewable water supplies to replace groundwater mining.

'Artificial' recharge

Along with surface water supplied by rivers, renewable sources can include the water that measurably replenishes the aquifer. In Tucson's case, it also includes some of the city's Colorado River allocations now deployed in the Avra Valley artificial recharge project. It's called artificial because the water source is not local precipitation. But the recharge project is helping officials and researchers better understand recharging processes, whatever the water source.

"Your key point is you have to get through the surface—your top 10 to 20 feet," Thomure explained during a recent interview. Once it filters down that far, it should be safe from evaporation, as long as plants can't reach it. Then it has time to move around pockets of clay or other impermeable barriers on its long journey to the water table, which can take a year at the Avra Valley site. The artificial recharge project is highlighting another value of floods. Floods tend to scour channels, clearing out debris and organic matter from the riverbed. In the artificial recharge arena, officials must find ways to mimic the cleansing action of floods or clogged pores can impede their efforts.

Without floods, an impenetrable layer of mud or algae can build up on the channel bottom. Scouring the riverbed with heavy equipment can help, but creates potential erosion problems. Where the recharge source involves wastewater effluent, the high nitrogen levels boost algae growth so much that workers have to allow the sediments to dry out every day or two.

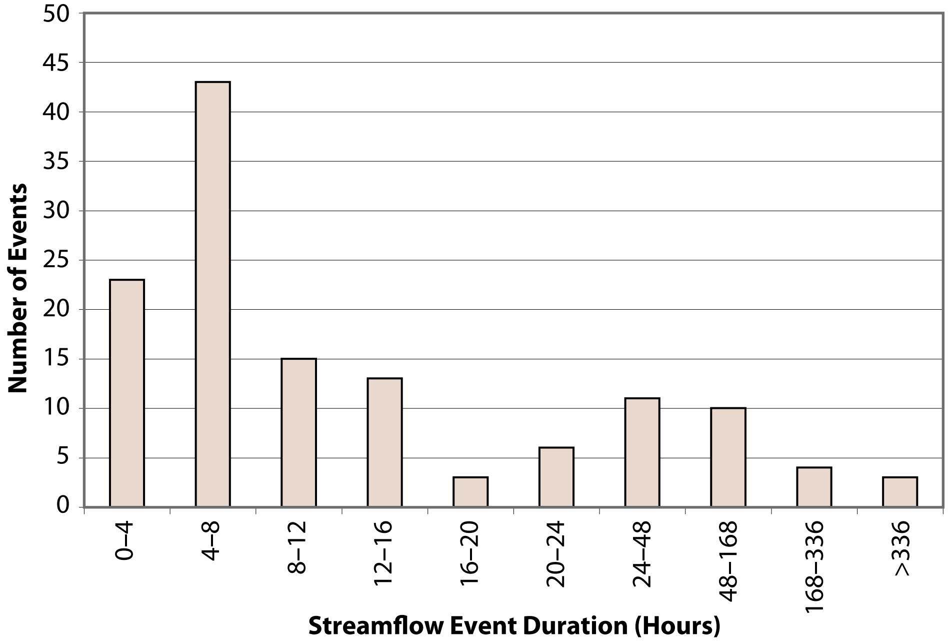

Figure 2. The number of hours during which waters soaked the Rillito River, an ephemeral stream, rarely lasted more than a day (24 hours) between 1990 and 2002 at USGS site 9485700. Graphic adapted from a figure published in the August 5, 2006, issue of *Water Resources Research* (Volume 42, number 8, page W08405-7).

Long-term recharge

To consider the long-term flow of groundwater, researchers favor using isotopes. For the past 15 years, University of Arizona (UA) geologist Christopher Eastoe has been employing isotopes from carbon, oxygen, hydrogen, and sulfur along with tritium to explore the sources and flow patterns of groundwater in the Tucson Basin.

Using equipment at the UA campus, Eastoe can compare chemical patterns in groundwater patterns to those in rainfall. For instance, the ratio of slightly heavier oxygen atoms—known as isotopes in this context—to the more common variety can reveal whether their H_2O source fell during summer or winter.

This chemical detective work has allowed him to identify groundwater signatures that point to their sources—in space as well as time. His paper on the topic, along with others including one on James Hogan's research mentioned above, can be found in the book *Groundwater Recharge in a Desert Environment* (American Geophysical Union, 2004).

Winter storms rule

Eastoe's work over the years, with others, has highlighted the importance of winter precipitation for groundwater recharge.

"We have almost no influence of summer rain in the (Tucson) basin regarding recharge," judging from the isotopic signature in the top 600 feet of the water table, Eastoe said in November. This fits with the observations that winter storms tend to be larger and linger longer on the landscape, while summer storms tend to come in flashier local events and evaporate quickly.

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Groundwater, continued

"To the extent that you keep the water in the river for three months rather than three days, there's far more potential for recharge," noted Katharine Jacobs, executive director of the Arizona Water Institute.

Although Eastoe is still pulling together other research, preliminary results indicate the tendency for winter precipitation to drive groundwater recharge probably holds for many basins throughout the Southwest. He noted that graduate researcher Arun Wahi's work shows the telltale signs of winter-dominated groundwater inputs even in the basin underlying the San Pedro River, where monsoon rain comprises about two-thirds of precipitation in a typical year.

USGS hydrologist Don Pool's research also supports the interpretation that winter storms drive recharge. He found the high-flow events that are good for recharge were more likely to occur during El Niño events at the three stretches he considered: the San Pedro River at Charleston and Tucson's Rillito and Sabino creeks (*Water Resources Research*, November 2005). La Niña conditions almost always meant low winter/spring river flows. However, about a third of the remaining years corresponded to years with high waters on at least one of the rivers.

El Niño years tend to boost winter and spring rainfall in the Southwest, with little direct impact on summer and fall precipitation. During El Niño events, warm water drifts to the eastern side of the Pacific Ocean Basin, often pulling the jet stream south into saguaro territory. During La Niña years, cooler eastern Pacific temperatures help create a ridge that deflects the jet stream and its associated rainfall.

Impacts of changing climate

El Niño events have become more frequent and pronounced since the mid-1970s, although a lengthy La Niña event from 1998–2002 helped provoke the southwestern drought. Global warming accelerated during the same three decades, but Climatologists are reluctant to use this as evidence that El Niño events will dominate future climate.

El Niño can fall into decades-long patterns from other causes besides global warming, as evidence from past climates show (*Southwest Climate Outlook*, January 2006). Computer models considering how this crucial pattern might shift with additional warming show a wide array of results (*Advances in Geosciences*, 2006). Scientists disagree on exactly how the ocean fluctuates from El Niño to La Niña and back, much less on how the mechanisms behind the fluctuations will change as oceans warm (*International Journal of Climatology*, April 2006).

The fluctuations, which affect precipitation patterns throughout the world, depend on differences in temperature between the western and eastern Pacific, not merely the temperatures themselves. While it's straightforward to project an upward climb in overall temperatures for both land and sea, it's more challenging to predict how the dynamics will play out.

The fate of snow cover, on the other hand, is easier to project because it relates directly to the warming. As temperatures rise, snowline creeps up the mountaintops. Snow cover shrinks in time, too, as warm temperatures extend their reach forward into autumn and backwards into spring.

Already researchers have been documenting a trend for more precipitation falling as rain rather than snow over the past half century throughout much of the West (*Journal of Climate*, September 2006). These changes are bringing a documented shift forward in time for the peak river flow that comes with spring thaw (*Journal of Climate*, April 2005). This has some researchers worried about the fate of groundwater recharge.

"As we change toward more rain away from snow, that has the potential to decrease the amount of recharge," Leake said. In higher mountain ranges of the Southwest, the melting of snow creates steady springtime river flows that recharge aquifers in the valleys below, he added.

USGS researcher Michael Dettinger expressed similar thoughts. "As the snowline retreats to cover smaller and smaller areas, and as the snowpack itself declines because of more rain and less snow and more intermittent melting… it seems really likely that recharge will decline in many parts of the Southwest," he said during a telephone conversation.

Warming temperatures also can turn some winter storms into the flashier events usually associated with the Southwest summer. He recalled a May 2005 storm around California's Yosemite Valley. Warm temperatures allowed the rain to cover a much larger area than typical for that time of year, with snowfall limited to elevations above about 10,000 feet. As a result of the extensive area involved, a mere one inch of rainfall resulted in a flashy valley-wide flood.

Floods like this can provide some recharge, much as the here-and-gone Rillito flood this summer did. But it's unlikely to provide the same groundwater boost as it would have if the same amount of precipitation had fallen as snow and then gradually melted over time in the spring. If winter storms start acting like summer storms, groundwater aquifers could pay the price.

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

Temperature (through 11/15/06)

Source: High Plains Regional Climate Center

Temperatures have generally been near average across most of the Southwest since the beginning of the new water year on October 1 (Figures 1a–1b). A few stations in west-central Arizona and west-central New Mexico were considerably cooler than surrounding locations, with temperature departures ranging from 2 to 6 degrees Fahrenheit below the long-term average. Most other areas were close to average with temperature departures ranging between -2 and 2 degrees F. Average temperatures ranged from the mid-30 degrees F at higher elevations in northern New Mexico and Arizona to the mid 70 degrees F across the low desert regions of southern Arizona. Observations for the past 30 days depict a very similar picture, given the overlap with the current water year data (Figures 1c and d). Some warmer-than-average locations in southern Arizona and southern New Mexico stand out with temperature departures ranging from 1 to 3 degrees F.

Overall, the statewide average temperature for Arizona was 61.2 degrees F with a ranking as the forty-eighth coolest October in 112 years according to the NOAA National Climatic Data Center. The New Mexico observed statewide average temperature of 54 degrees F, which was also slightly cooler than average (-0.4 degrees F), made it the forty-ninth coolest October.

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 '06–'07 (through November 15, 2006) average temperature.

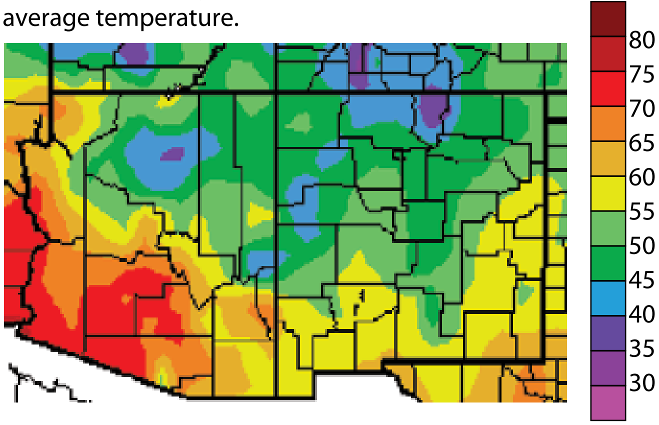


Figure 1b. Water year '06–'07 (through November 15, 2006) departure from average temperature.

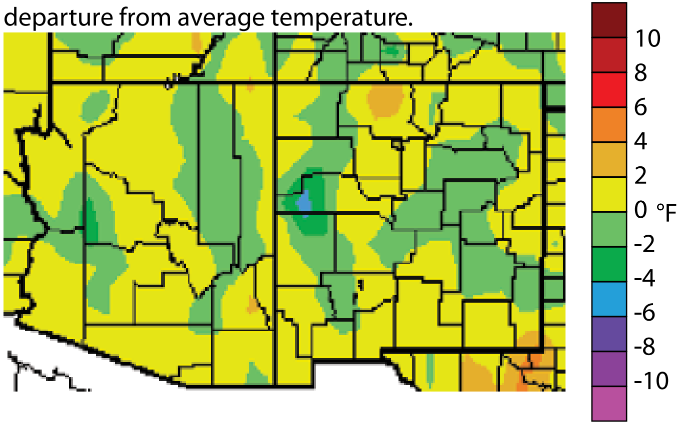


Figure 1c. Previous 30 days (October 17–November 15, 2006) departure from average temperature (interpolated)

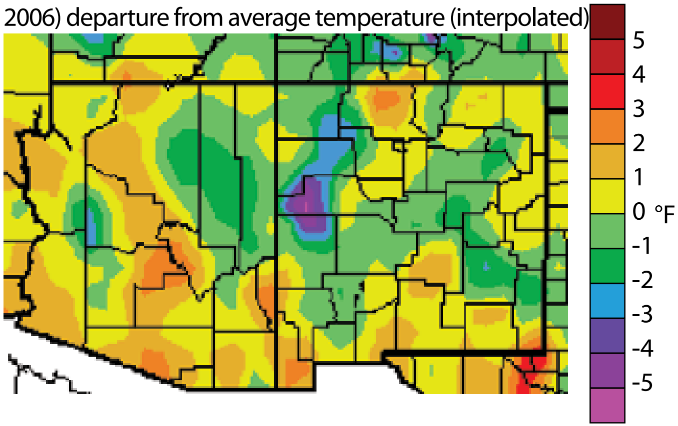
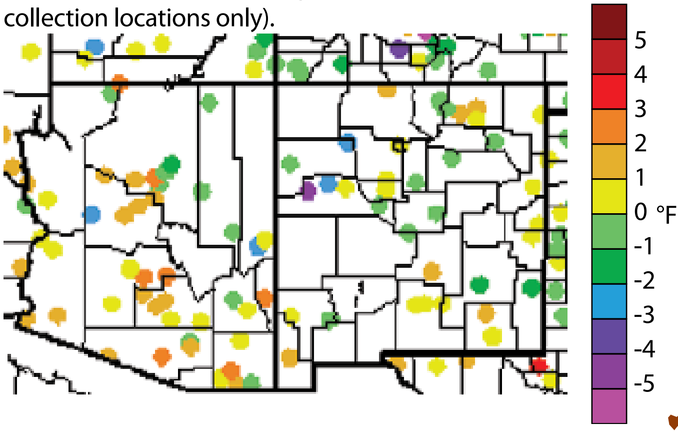


Figure 1d. Previous 30 days (October 17–November 15, 2006) departure from average temperature (data collection locations only).



Precipitation (through 11/15/06)

Source: High Plains Regional Climate Center

Water year precipitation totals are slightly above average across northern Arizona and eastern New Mexico (Figures 2a and 2b), due solely to precipitation accompanying a series of storm systems that crossed the region in early October. Several low pressure systems tapped moisture from the Pacific Ocean between October 5 and 10, bringing significant rainfall to parts of New Mexico and snow to higher elevation areas in northern Arizona and northern New Mexico. Above-average precipitation from these storms is evident on the water year map with percent of average precipitation exceeding 150 percent in some areas. Conditions were generally drier than average across the Southwest during the past 30 days (Figures 2c and 2d). Areas of southern New Mexico picked up precipitation with the passage of a storm system on October 19, which helped push 30-day precipitation totals up to 70–90 percent of average. Southwest Arizona stands out with precipitation totals exceeding 300 percent of average during the period. A storm system crossing Arizona on October 24 produced widespread rainfall across areas of western Arizona that are normally dry this time of year. Yuma picked up 0.20 inches of rainfall that day—the only measurable precipitation it received all month. Statewide average rainfall for October was 1.84 inches for New Mexico and 1.35 inches for Arizona. Both amounts were above average (0.68 inches above average for New Mexico and 0.43 inches above average for Arizona) with respect to 1901–2000.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2006, we are in the 2007 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 '06–'07 through November 15, 2006 percent of average precipitation (interpolated).

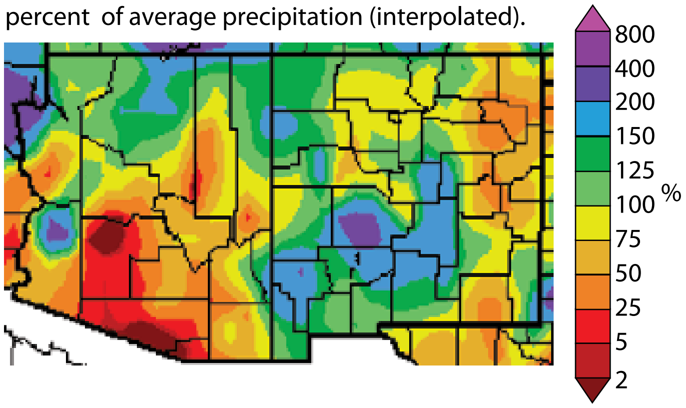


Figure 2b. Water year '06–'07 through November 15, 2006 percent of average precipitation (data collection locations only).

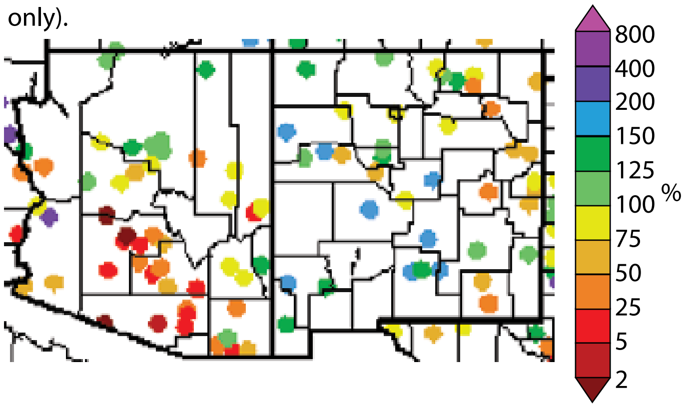


Figure 2c. Previous 30 days (October 17–November 15, 2006) percent of average precipitation (interpolated).

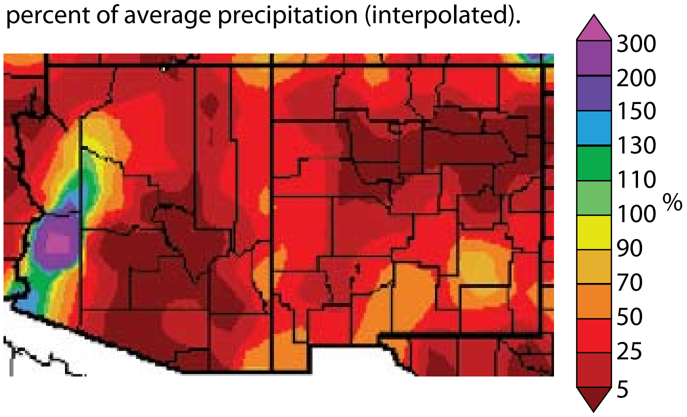
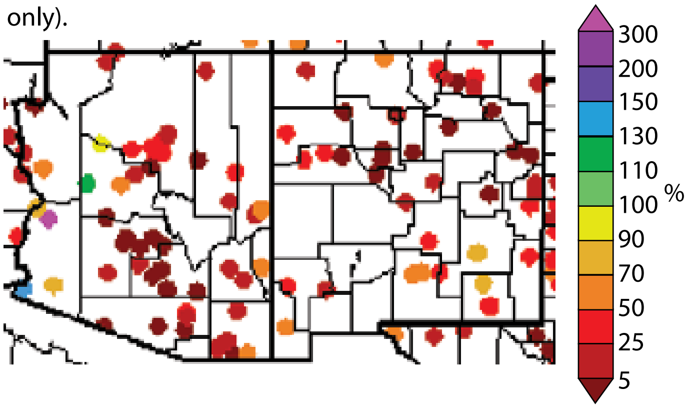


Figure 2d. Previous 30 days (October 17–November 15, 2006) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 11/16/06)

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

The US Drought Monitor depicts some level of drought for virtually all of Arizona and parts of northern New Mexico (Figure 3). Extreme drought conditions persist in northeastern Arizona, while most of the rest of the state and northern New Mexico is in moderate drought or has abnormally dry conditions. Although the summer monsoon season brought above-average rainfall to most of the region and improved short-term drought conditions, long-term precipitation deficits from the previous winter account for the persistent drought.

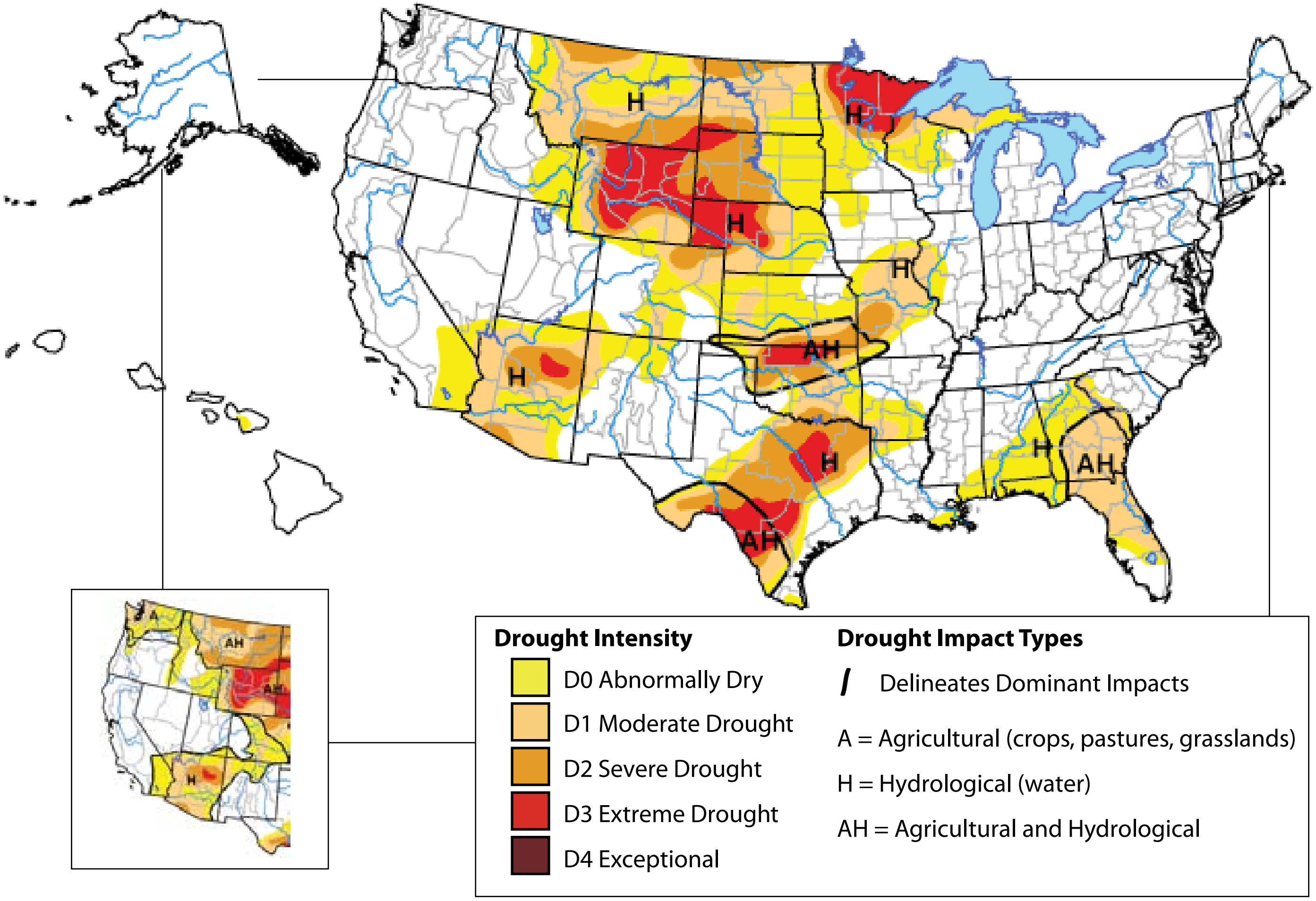
Drought status in the Southwest has remained relatively stable in the last month due to recent, typically dry conditions for this time of year. Drought status through the winter will primarily depend on the amount of snowfall received at higher elevations. Winter precipitation and snowpack are extremely important in the Southwest in terms of replenishing surface water supplies. Elsewhere in the country, extreme drought persists in large parts of Wyoming, Nebraska, Texas, Oklahoma, and Minnesota. Large parts of the Central Plains and South are also experiencing abnormally dry conditions or are in moderate drought.

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 November 16, 2006 (full size) and October 19, 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 10/31/06)

Source: Arizona Department of Water Resources

Since last month, short-term drought conditions in Arizona have improved somewhat while long-term conditions have remained the same. In northern and western Arizona, short-term drought conditions have improved from moderate drought to abnormally dry in the Verde River, Agua Fria, and Lower Gila River watersheds due to the last of the monsoon storms during the first half of September. The rest of the state remains abnormally dry except for areas of moderate drought in the Upper Colorado and Bill Williams River watersheds (Figure 4a).

Long-term conditions have remained the same relative to last month (Figure 4b). Long-term drought conditions are most apparent in the eastern and southeastern parts of the state, while the southwestern watersheds have returned to normal status and the northern part of the state remains abnormally dry. Although the recent above-average monsoon rains have improved short-term conditions, it is insufficient to overcome several years of accumulated long-term precipitation deficits.

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 October 2006.

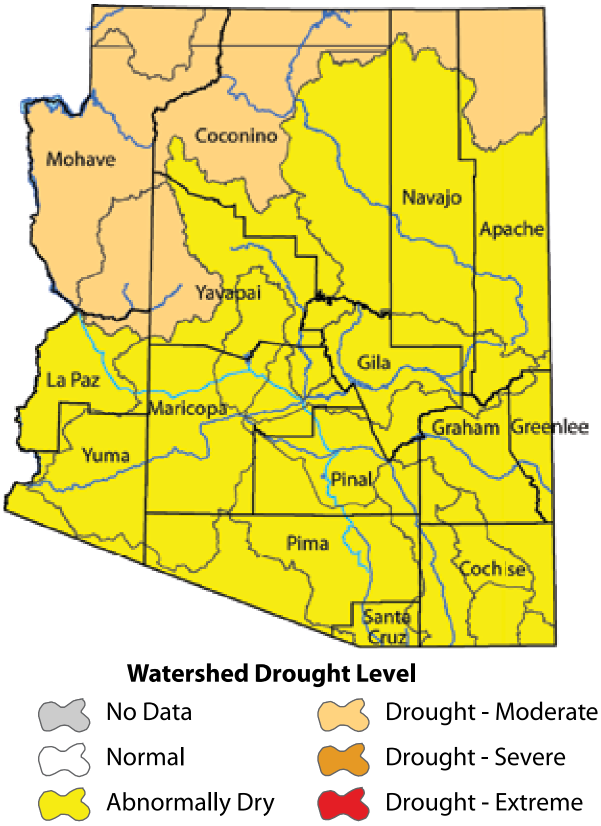
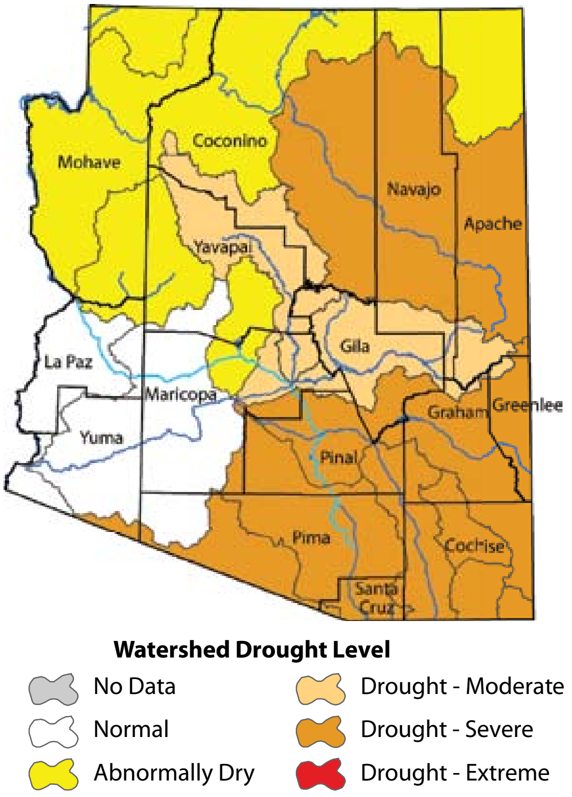


Figure 4b. Arizona long term-drought status for October 2006.



New Mexico Drought Status

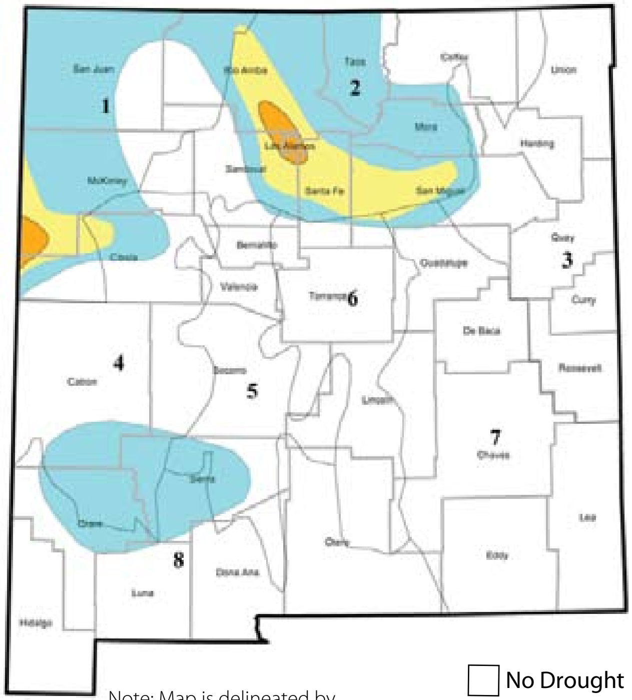
(through 10/31/06)

Source: New Mexico Natural Resources Conservation Service

Short-term drought status in New Mexico has improved somewhat since last month and most of the state is now drought-free (Figure 5a). Northern and northeastern portions of the state remain in advisory status, while there are localized areas of warning status near Los Alamos and along the Arizona border in McKinley and Cibola counties. Portions of Catron, Sierra, and Grant counties are also under advisory status. Due to heavy summer precipitation, most of the state has come out of drought status relative to last winter and spring.

Long-term drought status is unchanged since last month, with most of the eastern and southern parts of the state in alert status. Northwestern and southwestern parts of the state remain in long-term advisory status (Figure 5b).

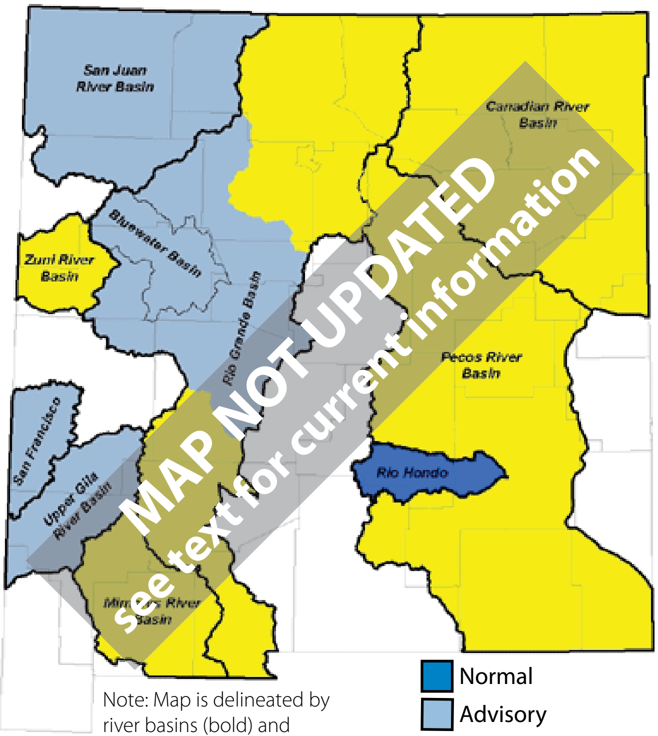
Figure 5a. Short-term drought map based on meteorological conditions for October 2006.



Note: Map is delineated by climate divisions (black) and county lines (grey).

⬜ No Drought
🟦 Advisory
🟨 Alert
🟧 Warning
🟥 Emergency

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



Note: Map is delineated by river basins (bold) and county lines.

🟦 Normal
🟦 Advisory
🟨 Alert
🟧 Warning
🟥 Emergency

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

Arizona Reservoir Levels

(through 10/31/06)

Source: National Water and Climate Center

During October 2006, the Four Corners region received substantial precipitation. According to Tom Ryan of the U.S. Bureau of Reclamation, these downpours resulted in record-breaking daily flows on Colorado River tributaries and unprecedented increases in the elevation of Lake Powell during October. Lake Powell storage rarely increases during October. Since last month, the combined storage in Lake Powell and Lake Mead increased 1 percent. Some of the smaller interior Arizona reservoirs also logged increases during the last month (Figure 6). However, storage in the Salt and Verde river basin systems declined by several percent. During this time of year, storage usually declines until replenished by winter precipitation and spring snowmelt.

The Arizona Statewide Water Advisory Group (SWAG) has been meeting to address the need for better water conservation in rural areas, and to discuss potential changes to Arizona water policy. According to an article in the *Daily Courier* (October 28), some stakeholders in the central uplands and Mogollon Rim country of Arizona have reported to SWAG and Arizona Department of Water Resources director Herb Guenther that existing state law constrains the ability of municipalities to manage development based on water availability. Under existing state law, developers need to ascertain whether a one hundred-year water supply exists for their developments. However, in rural areas developers can proceed with projects, even if an adequate one hundred-year supply is not available. The SWAG recommends two actions for Payson and the Rim Country: development of Blue Ridge reservoir water to supplement groundwater supplies, and financial assistance through a Water Development Fund.

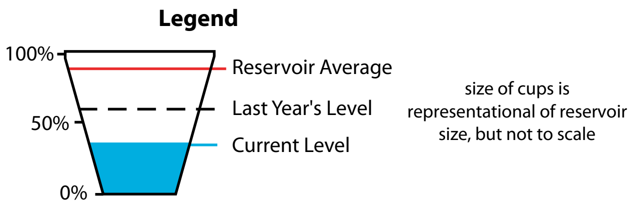
Notes:

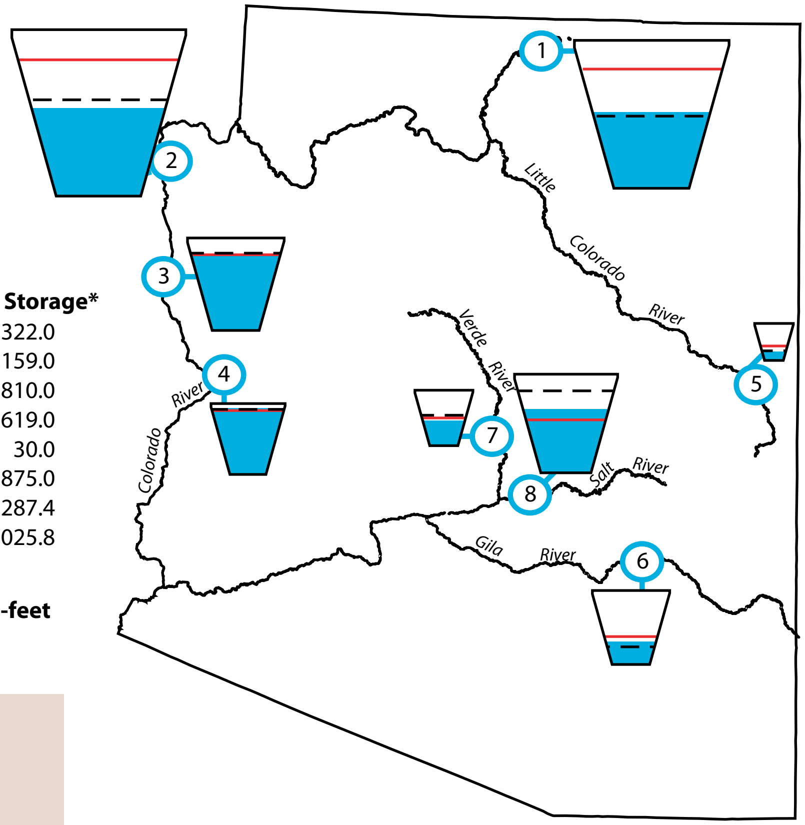
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 October 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	52%	12,526.0	24,322.0
2. Lake Mead	53%	13,964.0	26,159.0
3. Lake Mohave	81%	1,467.5	1,810.0
4. Lake Havasu	93%	577.2	619.0
5. Lyman Reservoir	24%	7.3	30.0
6. San Carlos	31%	268.8	875.0
7. Verde River System	45%	129.0	287.4
8. Salt River System	65%	1,319.7	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 10/31/06)

Source: National Water and Climate Center

Reservoir storage in the majority of New Mexico's reservoirs increased during October. Large amounts of precipitation received during early October and mid-October in the Four Corners region created record runoff and streamflow in the San Juan and several other regional rivers. Navajo Reservoir, New Mexico's largest, increased by over 6 percent (103,000 acre feet); Elephant Butte increased by over 2 percent (43,600 acre feet). Storage decreases, typical for this time of year, occurred primarily in eastern New Mexico (Figure 7).

Secretary of Interior Dirk Kempthorne seeks to settle more tribal water rights claims during the next year, including settlements with the following pueblos: Nambé, Pojoaque, San Ildefonso, and Tesuque (www.uswaternews.com). Kempthorne is also working with the seven Colorado River Basin states, and with Mexico to resolve shortage sharing agreements (*Ely Times*, November 6).

New Mexico Governor Bill Richardson has declared "The Year of Water" as the theme for the 2007 New Mexico legislative session. Among the initiatives proposed by Governor Richardson are $5 million for the Strategic Water Reserve, as well as projects that acknowledge the close link between water efficiency and energy efficiency. The 1,000 Friends of New Mexico, New Mexico Acequia Association, and other groups are encouraging Year of Water initiatives that protect riparian values, and that assure one hundred-year water supplies for new residential developments (*Las Cruces Sun-News*, October 27).

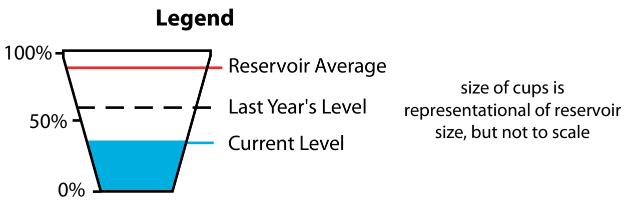
Notes:

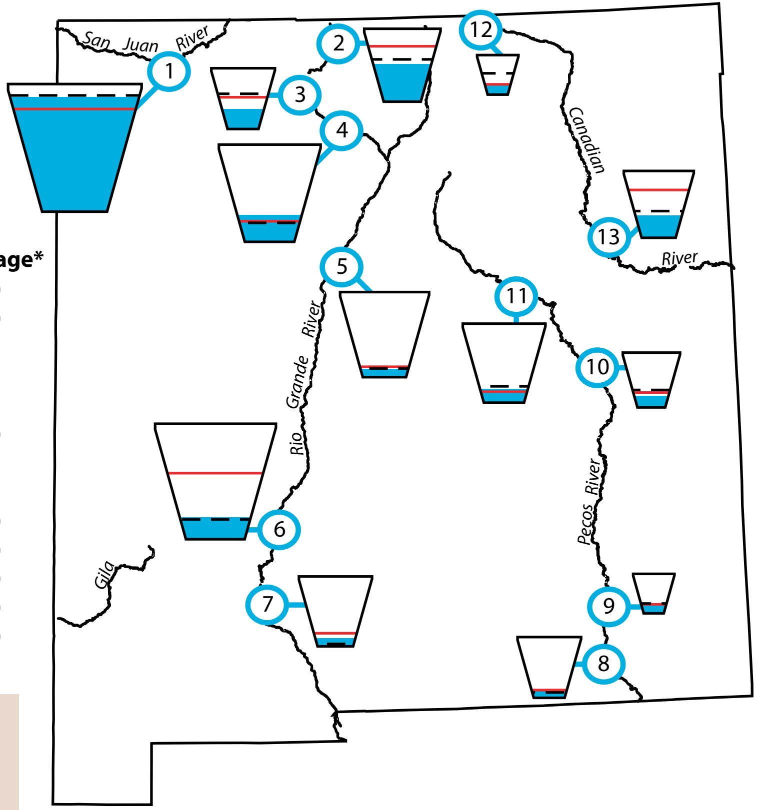
The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total 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 October 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	90%	1,522.8	1,696.0
2. Heron	52%	208.9	400.0
3. El Vado	33%	61.2	186.3
4. Abiquiu	28%	154.2	554.5
5. Cochiti	10%	49.0	502.3
6. Elephant Butte	19%	395.2	2,065.0
7. Caballo	12%	39.3	331.5
8. Brantley	12%	17.7	147.5
9. Lake Avalon	22%	1.3	6.0
10. Sumner	21%	21.7	102.0
11. Santa Rosa	18%	79.7	447.0
12. Costilla	29%	4.6	16.0
13. Conchas	34%	85.5	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

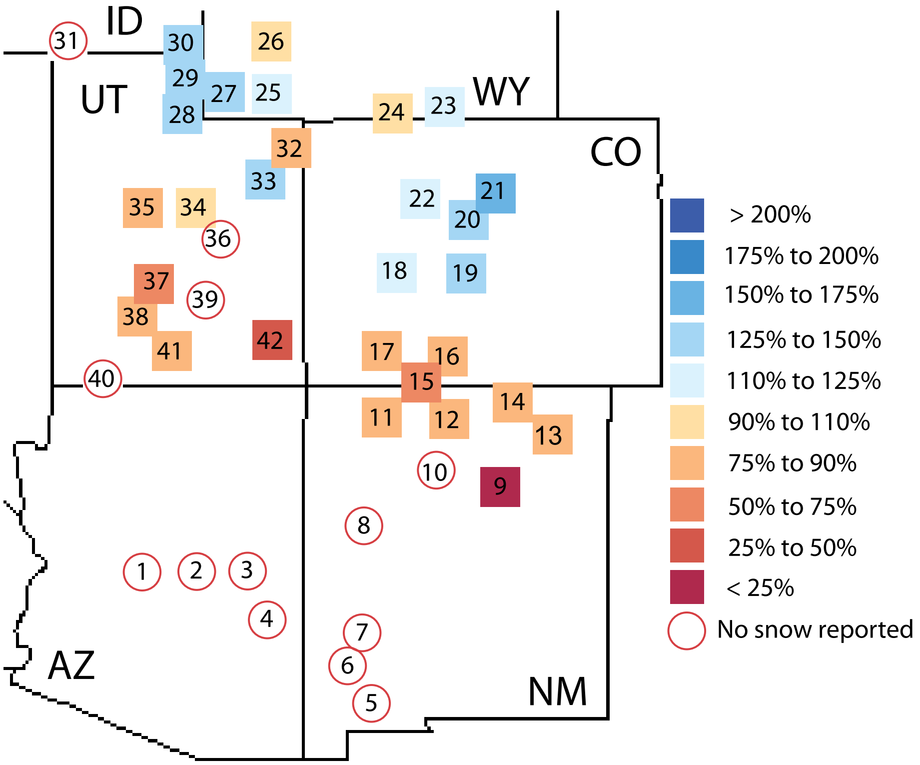
Southwest Snowpack

(updated 11/16/06)

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

The early snowpack in the Southwest shows encouraging signs in parts of the Upper Colorado River Basin (Figure 8). Water year snow water equivalent (SWE) at SNOTEL sites in the western slope of the Colorado Rocky Mountains, southwestern Wyoming, and southeastern Utah are at far higher levels than they were in November 2005. However, the Lower Colorado River Basin and middle Rio Grande Basin of New Mexico have received little or no snow, and snow levels in the Upper Rio Grande Basin are below average for this time of year.

Figure 8. Average snow water content (SWC) in percent of average for available monitoring sites as of November 16, 2006.



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

Speakers at the New Mexico drought summit, including CLIMAS lead investigator Jonathan Overpeck and Martin Hoerling of the NOAA Earth System Research Lab, presented climate model projections of 5-degree Fahrenheit temperature increases across the Southwest during the next fifty years (*Albuquerque Journal*, October 31). Observed climate records show that increased temperatures during the last 50 to 100 years have generated earlier streamflow runoff and lower snowpack across much of the western United States. In fact, a recent paper by USGS and Scripps Institution of Oceanography scientists shows that since 1949 more western U.S. precipitation is falling as rain instead of snow (Knowles and colleagues, *Journal of Climate*, September 16, 2006). The trends toward the combination of reduced winter snowfall and higher winter rainfall are a response to warming across the region, with the most significant reductions occurring as a result of warmer minimum temperatures on wet days. These trends were most pronounced in March.

On the Web:

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

For a numeric version of the map, visit:
http://www.wrcc.dri.edu/snotelanom/basinswen.html

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

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.

Figure 8 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.

Temperature Outlook

(December 2006–May 2007)

Source: NOAA Climate Prediction Center (CPC)

Temperature forecasts from the NOAA-Climate Prediction Center (CPC) call for equal chances of above-average, below-average, or average temperatures through April 2007 (Figures 9a–9c) and for increased chances of above-average temperatures through May 2007 (Figure 9d) in the Southwest. The greatest likelihoods for warmer-than-average temperatures through April 2007 are in the Pacific Northwest, northern plains, and upper Midwest. Most of the southern part of the country is forecast to have below-average temperatures through the upcoming winter and spring. The forecast for March–May 2007 calls for increased chances of warmer-than-average temperatures for most of the West, including most of Arizona and northwestern New Mexico. These forecasts are a departure from previous months' forecasts which predicted increased chances for above-average temperatures in the Southwest and may be related to current El Niño conditions.

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 December 2006–February 2007.

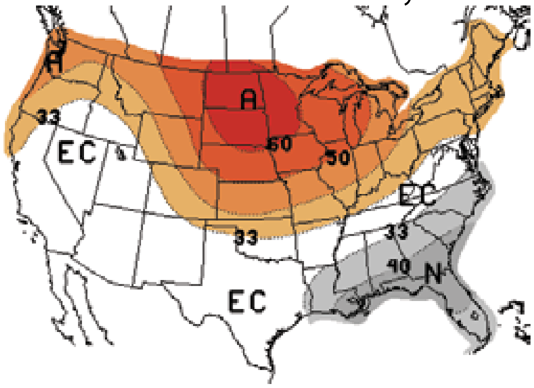


Figure 9b. Long-lead national temperature forecast for January–March 2007.

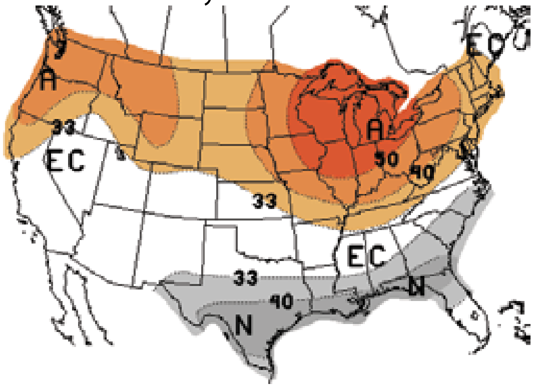


Figure 9c. Long-lead national temperature forecast for February–April 2007.

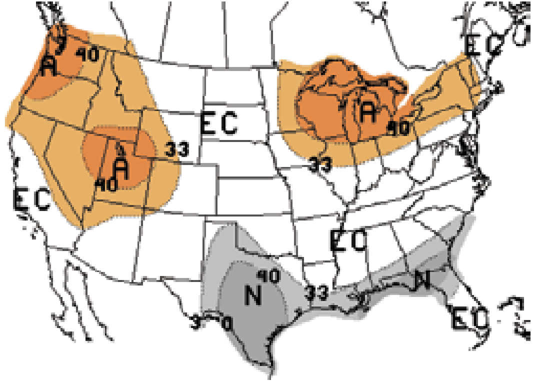
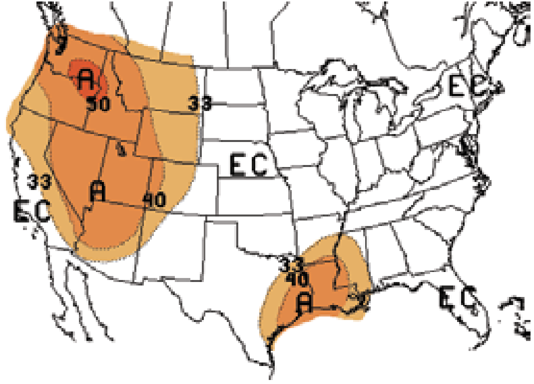


Figure 9d. Long-lead national temperature forecast for March–May 2007.



N= Near Normal
- ▨ 33.3–39.9%
- ▨ 40.0–49.9%

A= Above
- ▨ 60.0–69.9%
- ▨ 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

(December 2006–May 2007)

Source: NOAA Climate Prediction Center (CPC)

Most of the southern U.S., including the Southwest, is forecast to have increased chances for above-average precipitation through May 2007 (Figures 10a–10d). This is good news for the Southwest, where many areas are still in drought status from the previous record-dry 2005–2006 winter.

Through the upcoming winter and spring, the Northwest and Midwest are forecast to have drier-than-average conditions. These forecasts are representative of the current El Niño conditions. During El Niño events, the Southwest typically experiences above-average precipitation while the Northwest generally receives below-average rainfall. During La Niña events, such as last winter, the pattern is reversed and the Southwest is typically dry and the Northwest wet.

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 December 2006–February 2007.

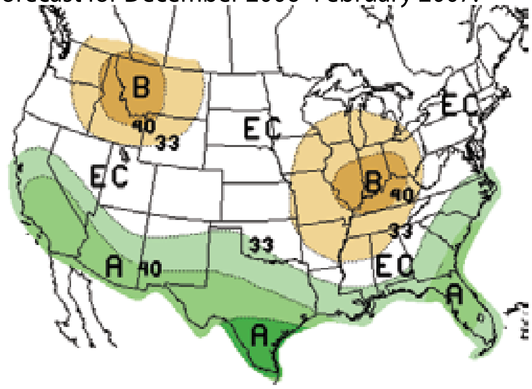


Figure 10b. Long-lead national precipitation forecast for January–March 2007.

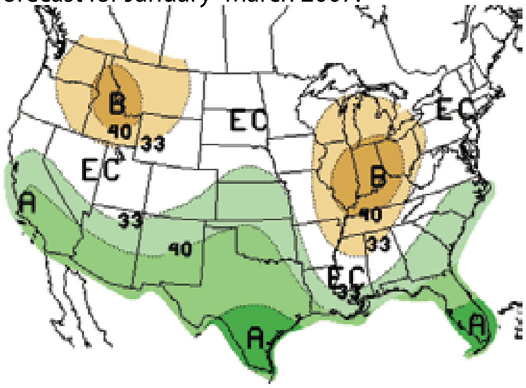


Figure 10c. Long-lead national precipitation forecast for February–April 2007.

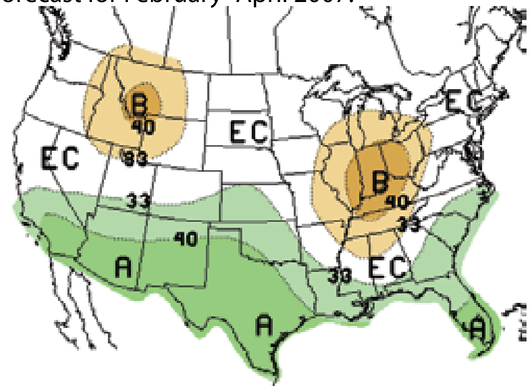
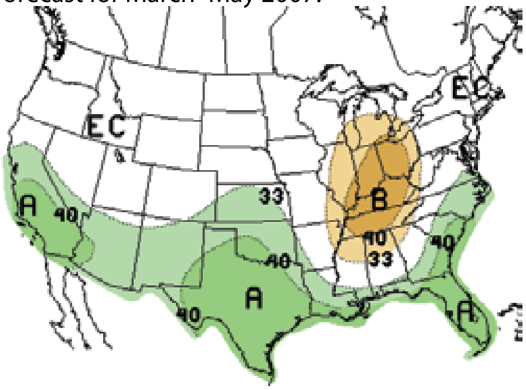


Figure 10d. Long-lead national precipitation forecast for March–May 2007.



A= Above
🟩 50.0–59.9%
🟩 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 February 2007)

Source: NOAA Climate Prediction Center (CPC)

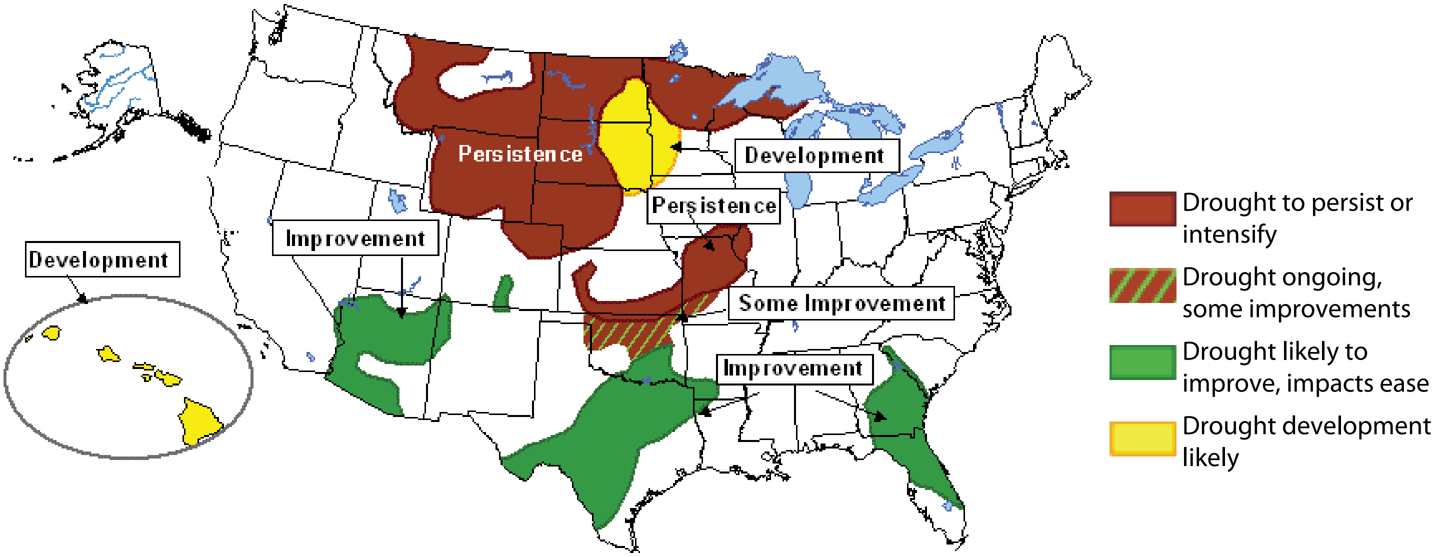
The U.S. drought outlook calls for improvements in drought conditions in most of Arizona and northwestern New Mexico (Figure 11). Despite above-average summer rainfall, these areas are still feeling the effects of several years' worth of accumulated long-term precipitation deficits. Forecast improvements are due to expected above-average rainfall related to current El Niño conditions in the tropical Pacific.

Drought improvements are also expected in the southern U.S. in central Texas, Georgia, and Florida. In the north central areas of the country, including Montana, Wyoming, the Dakotas, Nebraska, Minnesota, and northern Wisconsin, drought conditions are expected to persist or develop. These areas were affected severely by drought and high temperatures during the summer and are forecast to have increased chances for below-average precipitation through winter and spring 2007 (see Figures 10a–10d).

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 February 2007 (release date November 16, 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)

The current El Niño episode continued to intensify over the past month, with Southern Oscillation Index (SOI) values now down to -1.7. This indicates a growing atmospheric response to the warmer-than-average sea surface temperature (SST) patterns in the equatorial Pacific Ocean. A broad area of warm SSTs, 1 degree Celsius above-average, now extends from the South American coast along the equator to just past the international date line (180 degrees E longitude). SSTs are over 2 degrees C above average in some locations, reflecting the growing intensity of the event.

SOI values have been consistently negative since last spring, when a brief and relatively weak La Niña episode brought exceptionally dry weather to the 2005–2006 winter season. El Niño conditions officially returned in early October with the persistence of above-average SSTs across the eastern Pacific. The NOAA Climate Prediction Center reports that warmer-than-average water temperatures extend down several hundred meters in the region of El Niño ocean warming (known as the warm pool), which indicates that El Niño conditions may intensify slightly through the winter season and continue at moderate levels into the spring.

The ENSO forecast produced by the IRI indicates that the probability of continued El Niño conditions exceeds 90 percent through the winter season of 2006–2007. Neutral conditions are expected to return by late spring 2007. The current moderate-intensity El Niño event is expected to bring above-average precipitation to the Southwest.

Notes:

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

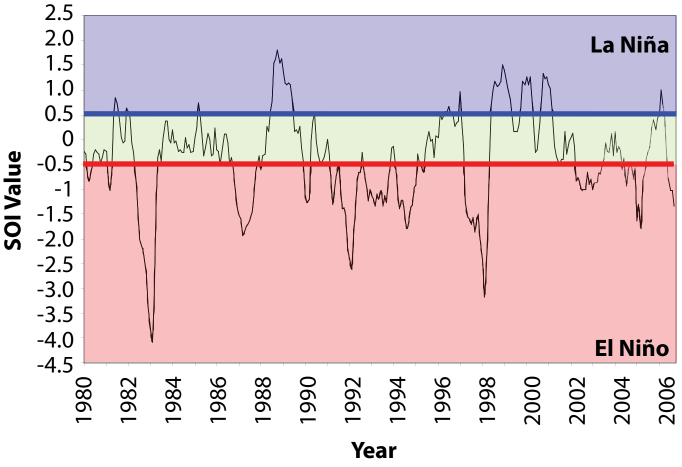
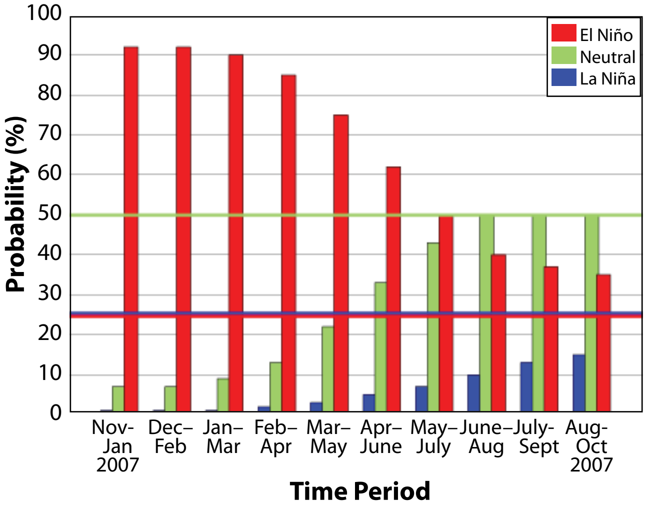


Figure 12b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released November 16, 2006). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification

(August–October 2006)

Source: NOAA Climate Prediction Center (CPC)

The temperature outlook for August–October 2006 from the NOAA-CPC predicted increased probabilities of above-average temperatures for most of the conterminous United States, based primarily on multi-decade temperature trends. Forecasters reserved judgment for Pacific Northwest and portions of the East (Figure 13a). Predicted probabilities for above-average temperatures were greatest for the Southwest, in particular over western Arizona and southern Nevada. In contrast to the forecast, observed temperatures were 1–4 degrees F below average in the Southwest (Figure 13b). Maximum temperatures were suppressed, primarily due to the cooling effects of abundant summer precipitation. According to the National Weather Service, September 2006 had the fewest days with maximum temperatures above 100 degrees F since 1996 in Tucson. Maximum temperatures were below average each month during the verification period, and August 2006 recorded record-low maximum temperatures at the Albuquerque airport. In the rest of the United States, there was agreement with the outlook for New England and Texas, where observed temperatures were generally 0–3 degrees Fahrenheit above average. The summer of 2006 concluded with a persistent heat wave across the southern Great Plains and Southeast, providing some agreement with the seasonal temperature outlook. The northern Great Plains were 1–4 degrees Fahrenheit below average, in contrast to predictions.

Notes:

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

Figure 13a. Long-lead U.S. temperature forecast for August–October 2006 (issued July 2006).

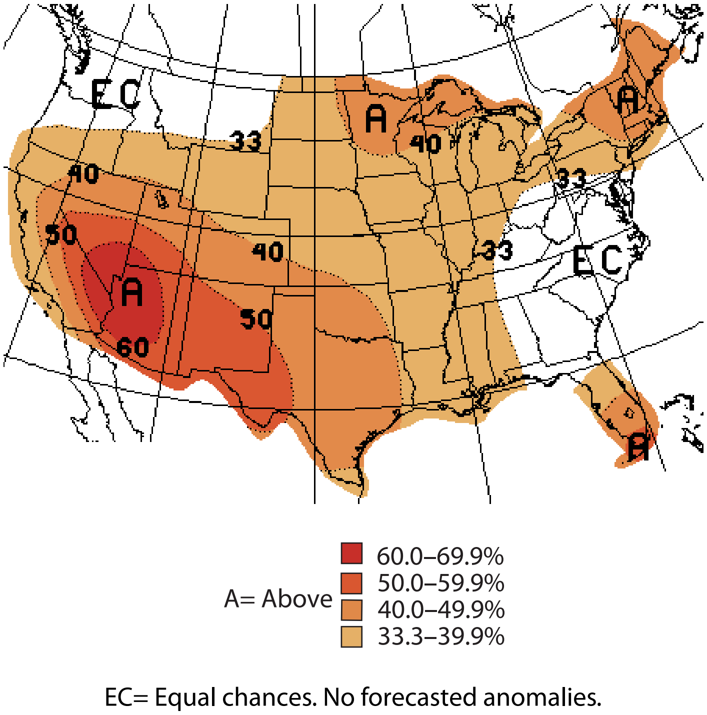
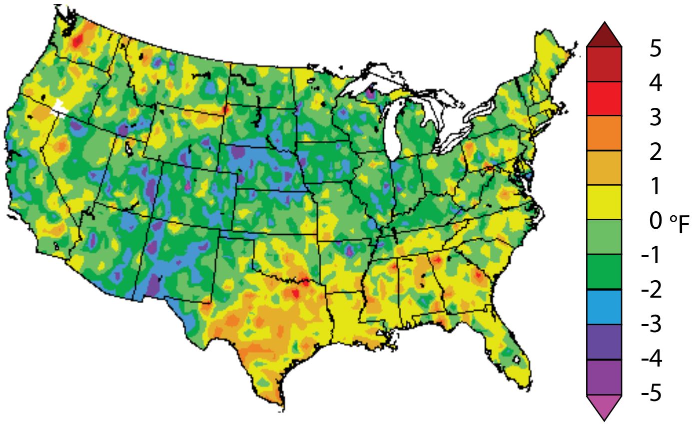


Figure 13b. Average temperature departure (in degrees F) for August–October 2006.



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

(August–October 2006)

Source: NOAA Climate Prediction Center (CPC)

The precipitation outlook from the NOAA-CPC for August–October 2006 predicted increased probabilities of below-average precipitation in the southern Great Lakes, northern California and northern Nevada, and increased probabilities of above-average precipitation for Florida and along the southern Atlantic coastline (Figure 14a). Forecasters called for equal chances of below-average, average, or above-average precipitation for the rest of the nation. Observed precipitation matched the forecast very well in northern California and Nevada, where precipitation was 5–50 percent of average. The forecast increased chances of below-average precipitation in this region was primarily based on long-term trends in the region. In contrast to the forecast, observed precipitation for southern Michigan and northern Indiana was 90–130 percent of average. In Florida and the southern Atlantic Coast precipitation was 50–100 percent of average with the exception of Miami (130 percent of average). Forecasts for the region were based on trends toward above-average precipitation and anticipation of an active Atlantic hurricane season. From August through mid-September, the Southwest monsoon remained extremely powerful over New Mexico and parts of Arizona, with observed precipitation ranging from 130 to more than 300 percent of average.

Figure 14a. Long-lead U.S. precipitation forecast for August–October 2006 (issued July 2006).

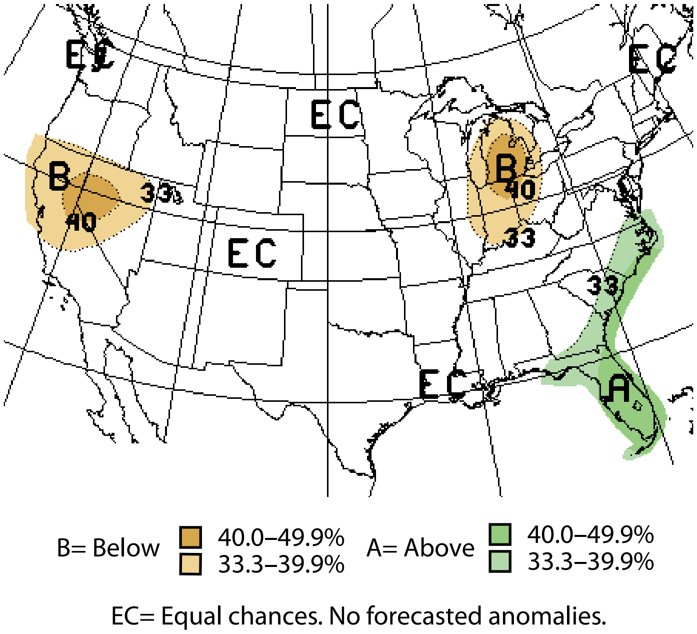
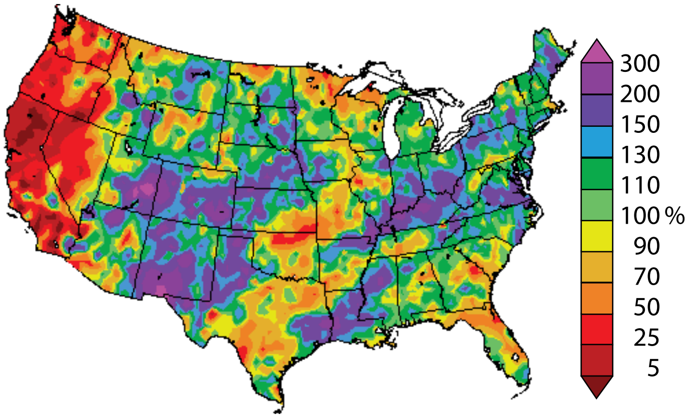


Figure 14b. Percent of average precipitation observed from August–October 2006.



Notes:

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