Issued: September 27, 2007

Southwest Climate Outlook

THE UNIVERSITY OF ARIZONA.

Source: Steve Novy, Institute for the Study of Planet Earth

Photo Description: This photo of a horned toad was taken last month in Tucson, Arizona. For more information on the horned toad visit: http://www.desertmuseum.org/books/nhsd_horned_lizard.php.

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

In this issue...

ARIZONA COOPERATIVE EXTENSION
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CLIMAS

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Water Sustainability
THE UNIVERSITY OF ARIZONA.

September Climate Summary

Drought – There has been little change in drought conditions across Arizona since last month. Moderate to severe drought continues across much of the state with west-central areas experiencing the worst conditions. Most of New Mexico remains drought free, but central and northeastern parts of the state are being monitored for developing drought conditions due to several months of below-average precipitation.

Temperature – Temperatures were generally above-average across both Arizona and New Mexico. Most locations observed monthly average temperatures that were 2–5 degrees F above average.

Precipitation – Precipitation amounts were spotty across Arizona over the past thirty days, but generally below average. Most locations saw less than 75 percent of average precipitation for the period. Portions of southwestern and north-central New Mexico observed 100–200 percent of average precipitation over the same period. Central and northeastern New Mexico saw much below-average precipitation.

Climate Forecasts – Temperature forecasts continue to predict above-average temperatures across Arizona and New Mexico through the fall and into the winter season. The precipitation outlook also continues to paint Arizona and New Mexico with a below-average fall and winter precipitation forecast due to developing La Niña conditions in the Pacific Ocean.

The Bottom Line – Waning monsoon precipitation over the past month has done little to improve drought conditions across Arizona, while another month of below-average precipitation across portions of New Mexico is prompting concern about drought conditions developing. The continuation of above-average temperatures and a developing La Niña event could mean more dry and warm conditions through the fall and into the winter season.

New minimum low of Arctic sea ice

Climate change was in the news again, with the National Snow and Ice Data Center (NSIDC) reporting a new minimum low extent of Arctic sea ice of 1.59 million square miles, based on data since 1979. Ice extent is the total area covered by some amount of ice, including open water between ice floes, according to the NSIDC. The 2007 minimum sea ice extent was approximately 460,000 square miles less than the previous low, set in 2005. That decrease is equivalent to roughly the size of Texas and California combined. Several Arctic science specialists speculated that this year's low was unmatched by any low during the twentieth century, including during an exceptionally warm period in the 1930s. The summer ice retreat season left Canada's Northwest Passage open for weeks.

For more information visit http://nsidc.org/...

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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.

Cooling systems affect resources, climate, and health

By Arunima Chatterjee and Melanie Lenart

Residential cooling and heating account for about 56 percent of the total energy consumed in the typical home in the United States, according to a 2005 U.S. Department of Energy report. In the Southwest, this energy is increasingly going toward air-conditioning rather than the traditional evaporative coolers, known as swamp coolers. The shift has implications for energy use, water use, and climate.

Energy vs. Water

Strictly in terms of energy use, the ongoing shift from swamp coolers to air conditioners has its costs. Air conditioners generally use two to four times more electricity than swamp coolers. For a typical 2,000-square-foot Tucson residence, the electricity used by a swamp cooler can be as low as 250 kilowatt-hours in an average month, while an air conditioner consumes about 850 kilowatt-hours. In Tucson, this translates to a monthly electrical cost of $25 compared with $85.

But a scarcity of water in the Southwest makes the comparison more complex, posing a challenge in determining the conservation strategy that can yield optimum savings for both energy and water. T. Lewis Thompson of the Environmental Research Laboratory (ERL) at The University of Arizona found that during summer conditions in Tucson (May–September), a swamp cooler working at 75 percent efficiency uses an average of 150 gallons of water per day, while air-conditioning units do not directly use water. The generation of electricity, however, requires water, a behind-the-scenes use that is easily overlooked.

Hydropower, which supplies about 12 percent of Arizona's electricity, consumes about 65 gallons of water per kilowatt-hour generated because of high regional evaporation rates where it is generated, according to research at the National Renewable Energy Laboratory led by Paul Torcellini. This value considers the total water evaporated from the reservoirs serving Hoover and Glen Canyon dams and the amount of electricity generated. They estimate that the coal-fired plants that supply most of Tucson's electricity consume about half a gallon of water for each kilowatt-hour of electricity produced.

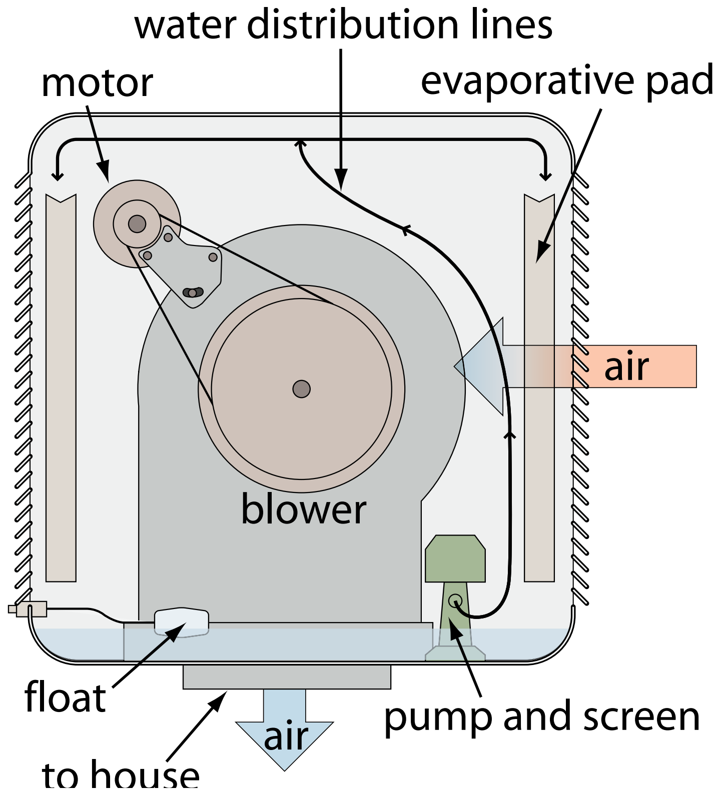

Figure 1. Swamp coolers typically consist of a box with vented sides. A fan draws ambient air through vents and through pads that are kept moist by a water supply, pump, and distribution lines. The cooled, moist air is then delivered to the building via a vent in the roof or wall. *Credit: Mike Buffington, Southwest Hydrology*

Applying the coal plant standard to the cooling of a 2,000 square-foot home, the ERL analysis found that monthly water consumption for an air-conditioning system is about 425 gallons, while an evaporative cooler requires about 4,620 gallons, including direct and indirect usage for both. The source of energy used to power air conditioning is critical to this analysis, however. If the same calculations are made using hydropower, an air conditioner uses 55,250 gallons of water per month compared with an evaporative cooler's 20,745 gallons. Overall, the water used directly by swamp coolers represents 5 percent or less of a household's annual water use, based on a study of several southwestern cities by the non-profit group Southwest Energy Efficiency Project (SWEEP).

Evaporative cooling works best in the dry months of summer. During the monsoon, when outside air is already moist, the effectiveness of swamp coolers is limited. One benefit of air conditioning is its ability to cool to a thermostatically controlled temperature regardless of the humidity. At some level, though, the cooling of a home usually equates to a warming of the planet, with air conditioners doing more damage than swamp coolers when the electricity source, such as coal or oil, produces greenhouse gases.

Climate Considerations

The collective choice of cooling equipment can affect the local climate as well as the global one. While air conditioners merely eject heat from the interior of a home or office into the outside air, swamp coolers can actually contribute to cooling the environment, indoor and outdoor. An evaporative cooler pulls

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Cooling systems, continued

air through moist pads, lowering the incoming air by as much as by 30 degrees (Figure 1). Because people cooling their homes with swamp coolers must leave some windows open, some of this cooled air permeates outdoors.

A typical swamp cooler converts about 1 billion joules of energy a day from heat into other types of energy, including kinetic and latent energy. As heat, this amount of energy could warm a six-foot deep, twelve-by-twelve-foot pool by 20 degrees Fahrenheit. Meanwhile, a typical air conditioner ejects about 63 million joules of energy per hour into the outside air, or a billion joules for every 16 hours of operation.

Arizona State University (ASU) researchers were surprised to find daytime temperatures in parts of metropolitan Phoenix were no higher, and in some cases actually lower, than those in the surrounding desert despite the expected urban heat island effect. They surmised that their results reflected the evaporative cooling from pools, urban lakes, landscaped vegetation, and perhaps even swamp coolers. Joseph Zehnder, a researcher who worked on this topic while at ASU, noted that the ongoing shift from swamp cooling to air conditioning may eventually reduce some of that daytime cooling.

Once the sun goes down, the desert cools down more quickly than the city, which is carpeted by heat-trapping pavement and vegetation. Some Phoenix-area urban temperatures averaged up to 20 degrees F warmer than those in the nearby desert, so in this case the

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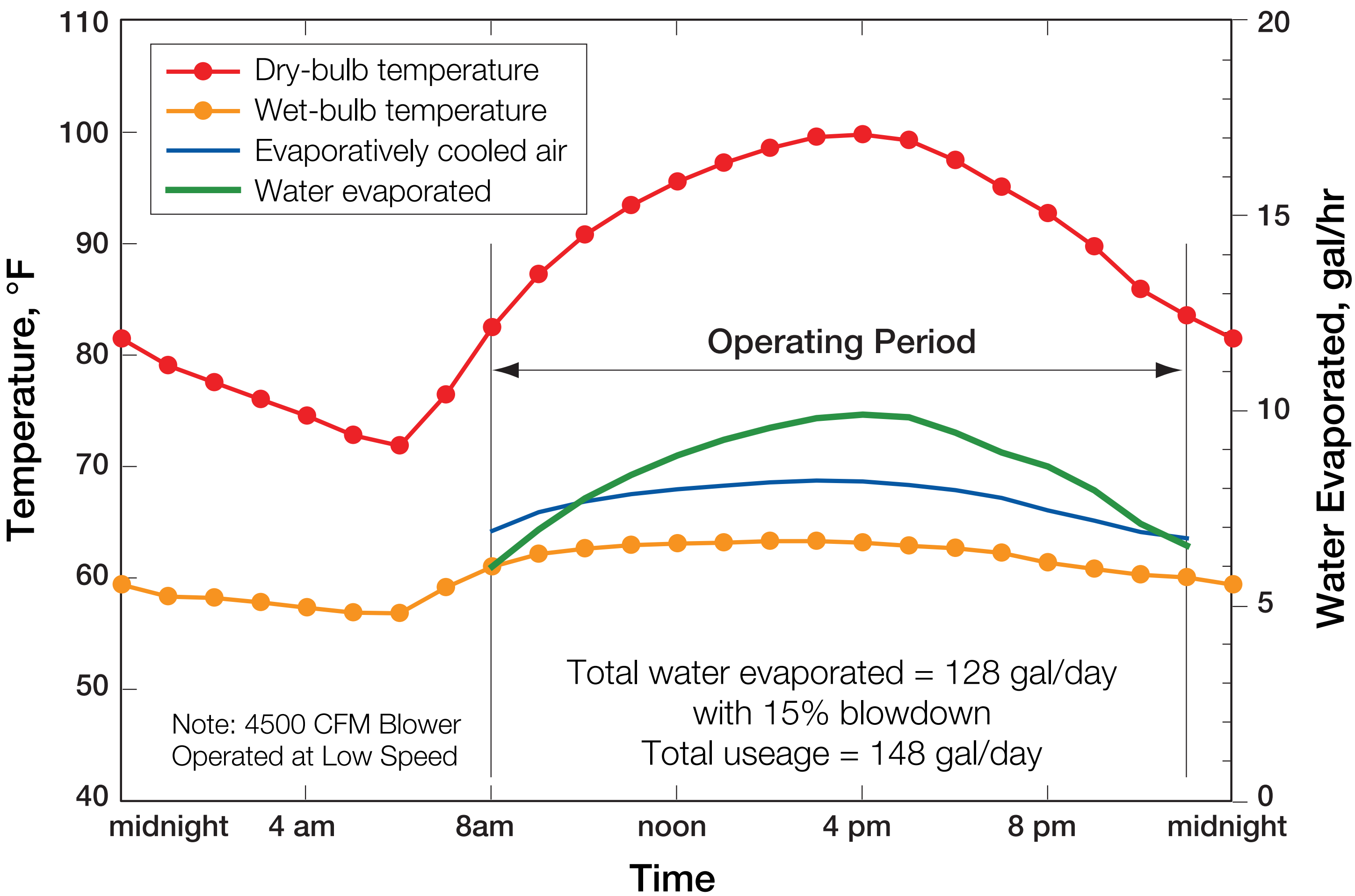

Figure 2. Evaporative coolers work by converting some of the heat energy in air into latent heat and kinetic energy that is trapped in the process of evaporation of water. A modern swamp cooler with an 85 percent efficiency can cool 100 degrees F daytime air down to about 68 degrees F. In the process, it uses about 145 to 150 gallons of water a day, assuming it operates on low during the day and is turned off at night. This data is for Tucson in June 2006. *Credit: T. Lewis Thompson of The University of Arizona Environmental Research Laboratory*

Cooling systems, continued

urban heat island effect operates mainly at night.

Health

When it comes to health issues, central air-conditioning may not be the best choice. Evaporative cooling contributes to better indoor air quality. The moist pads through which the outside air flows act as effective air filters, trapping dust and pollen. Since the pads are continually moistened, trapped particles are flushed out with the water cycle. Evaporative cooling also adds moisture to the air, which helps keep wooden furniture, fabrics, and plants from drying out along with skin, eyes, and throats.

Swamp coolers actually work best when given plenty of ventilation to the outside air. This system thus provides an ongoing stream of fresh air, as long as outside air is not contaminated from a nearby wildfire or excessive pollution levels.

Air-conditioners, in contrast, are more efficient when recirculating indoor air. Thus air-conditioning systems can magnify indoor pollution, especially in households that permit smoking. Even in non-smoking households, central air-conditioning units can pull in contaminants from walls and concentrate volatile organic compounds from carpets, cosmetics, and cleaning products, among other materials.

Researcher Michael Lebowitz and his colleagues at the UA College of Medicine conducted a series of studies on how indoor air quality varies with factors including type of cooling equipment. They concluded that sensitive populations, such as asthmatics and people with cardio-vascular problems, should only use central air-conditioning if the units have a high-efficiency filter, such as a High Efficiency Particulate Air (HEPA) filter. Otherwise, they should use swamp cooling supplemented with window-mounted air-conditioners as needed.

Alternative Options

Many factors influence total water consumption in an evaporative cooling system, including residential design, location of the cooler, and the use of vegetation and other features to cool air before it enters the cooling system. The cooling efficiency of such a swamp cooler can increase dramatically by sensible cooling of the air before it goes through the moist pads of the cooler. Sensible cooling can be achieved by strategic landscaping, rock beds, and water channels.

On a typical summer day in Tucson, air entering an evaporative cooler with 75 percent efficiency at a temperature of 100 degrees F can exit with an air temperature of 75 degrees F. Many newer evaporative cooling systems have an 85 percent efficiency (Figure 2).

For residences at the design stage, cool towers are a way of using the principle of downdraft evaporative cooling. Cool towers usually have a wet pad in the top of the tower. The cool air is heavier than warm air and sinks by means of gravity, creating its own airflow and eliminating the need for blowers or fans. The only power required is for a 12-volt pump to circulate water over the cooler pads. Generally, cool towers without fans are 20 to 30 feet tall and between 6 and 10 feet wide. These systems require 100 to 150 watts and cool 1,000 to 2,500 square feet.

The need to consider energy as well as water demand for cooling options seems likely to increase during this century. The Intergovernmental Panel on Climate Change projects that average summer temperatures in the Southwest will rise by at least several degrees in decades to come, and even more if society fails to stabilize greenhouse gas emissions. As temperatures rise, individuals will continue to seek a cool indoor refuge from outdoor heat—a cycle that could force society to seek energy- and water-saving solutions to cooling.

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T. Lewis Thompson of The University of Arizona Environmental Research Laboratory also contributed to the analysis.

A slightly shorter version of this article ran in Southwest Hydrology's September-October issue on water and energy, available at http://www.swhydro.arizona.edu/.

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Temperature (through 9/24/07)

Source: High Plains Regional Climate Center

The very warm period in late summer contrasts with much cooler-than-average temperatures across eastern and southwestern New Mexico for the water year, which began October 1, 2006 (Figures 1a–b). Even Arizona, which had a warmer-than-average spring and summer, had water year temperatures up to 3 degrees Fahrenheit below average in the west- central region. In New Mexico, the cooler-than-average temperatures may well be due to a relatively wet spring and early summer. For the water year, northern Arizona was generally about 2 degrees F above average while much of southern Arizona was less than 1 degree F above average.

Temperatures during the past thirty days have been well above average across both Arizona and New Mexico (Figures 1c–d). The hottest area was the western two-thirds of Arizona, which was 1–5 degrees above average. New Mexico's temperatures were only 2–4 degrees F above average in most places. The coolest area in the two states was southwestern New Mexico, which was 2 degrees F below average.

Figure 1a. Water year '06–'07 (through September 24, 2007) average temperature.

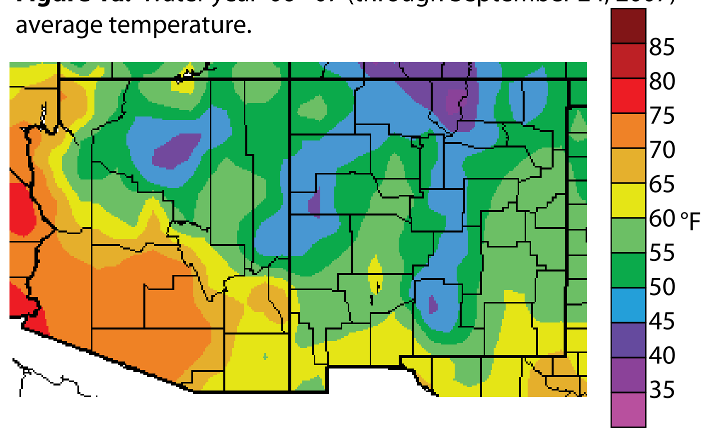


Figure 1b. Water year '06–'07 (through September 24, 2007) departure from average temperature.

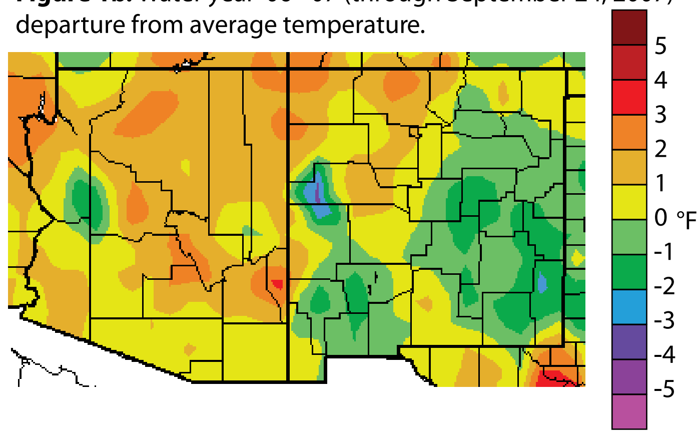


Figure 1c. Previous 30 days (August 26–September 24, 2007) departure from average temperature (interpolated).

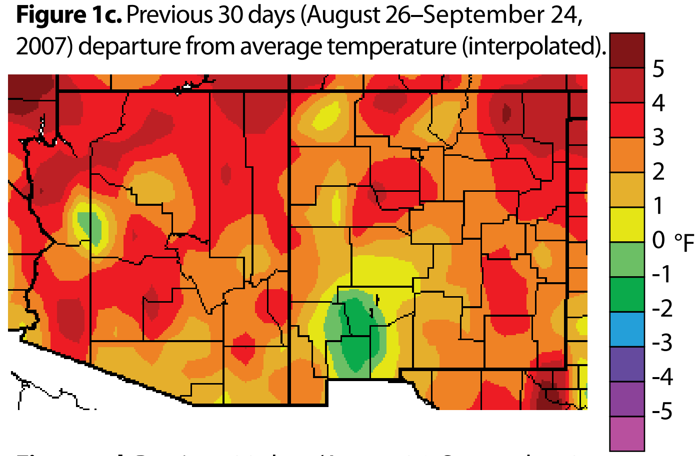
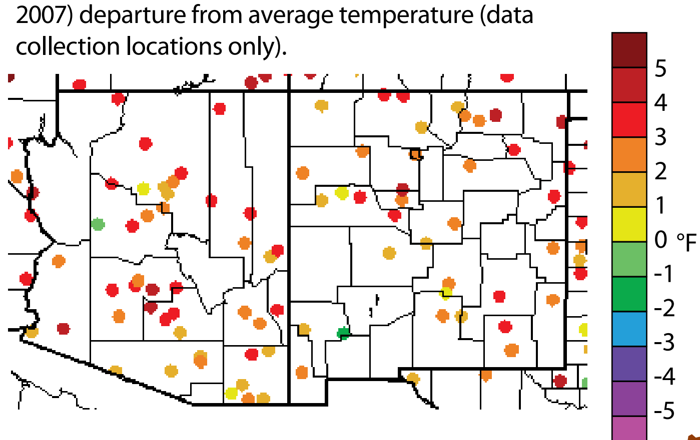


Figure 1d. Previous 30 days (August 26–September 24, 2007) departure from average temperature (data collection locations only).



Notes:

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

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

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

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

On the Web:

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

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

Precipitation (through 9/24/07)

Source: High Plains Regional Climate Center

For the 2007 water year, which ends September 30, most of New Mexico, except the northeastern corner, and only small sections of Arizona received above-average precipitation (Figures 2a–b). The western half of Arizona had less than 70 percent of average precipitation for the year, sparking a worsening of drought conditions everywhere except the southeast corner of the state.

The end of the summer precipitation season brought significant precipitation to southwestern New Mexico, ranging from 100 to 400 percent of average, mostly due to moisture from Hurricane Dean at the end of August (Figures 2c–d). Arizona missed out on the tropical moisture from Dean, and had a drier-than-average month and summer. Only the White Mountains in east-central Arizona, the highest elevations near Flagstaff, and the Yuma area in the southwestern corner of the state had above-average precipitation. Yuma had 1.79 inches of rain on September 2—just over half of its yearly average of 3.41 inches—as a result of moisture from Hurricane Erin. Unfortunately, most of the south-central desert areas of Arizona and the eastern third of New Mexico received less than 50 percent of average precipitation. Compared to 2006, this was a dry summer for both states. An early cold front on September 16–17 brought widespread precipitation to both states.

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/maps/current/

For National Climatic Data Center monthly precipitation and drought reports for Arizona, New Mexico, and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2003/perspectives.html#monthly

Figure 2a. Water year '06–'07 (through September 24, 2007) percent of average precipitation (interpolated).

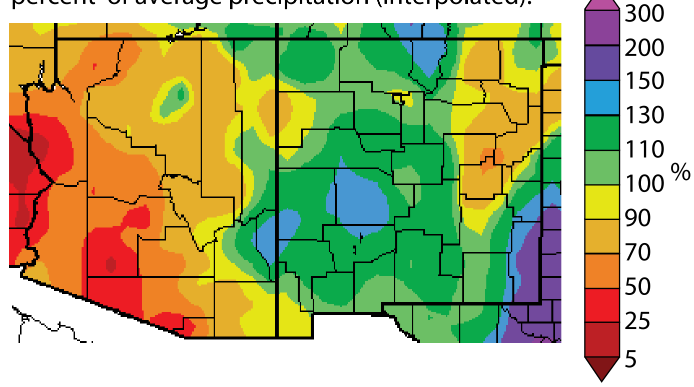


Figure 2b. Water year '06–'07 (through September 24, 2007) percent of average precipitation (data collection locations only).

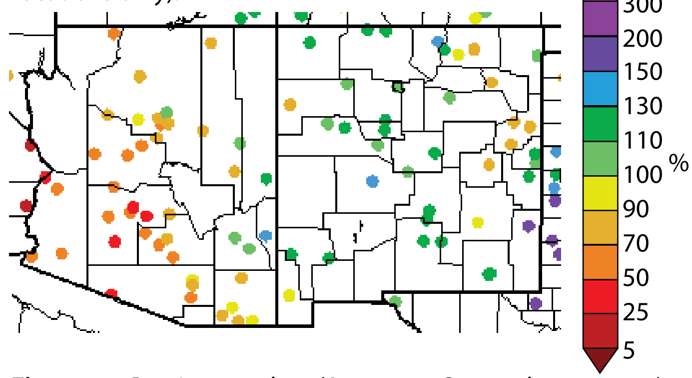


Figure 2c. Previous 30 days (August 26–September 24, 2007) percent of average precipitation (interpolated).

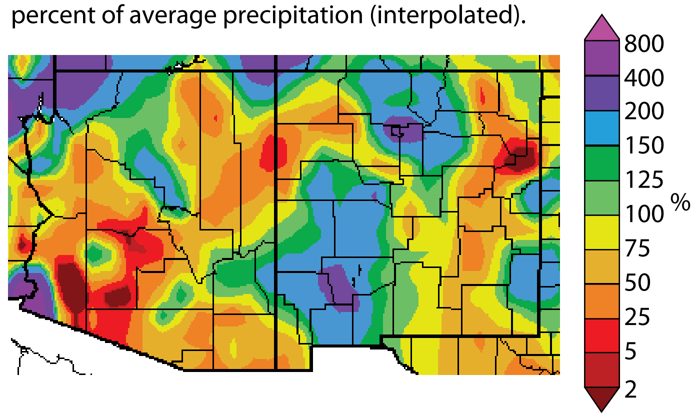
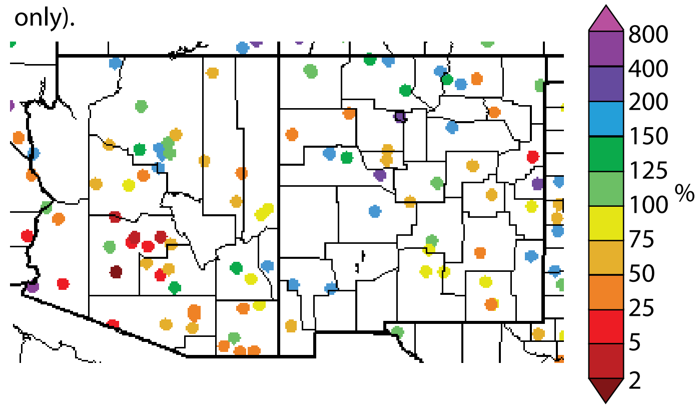


Figure 2d. Previous 30 days (August 26–September 24, 2007) percent of average precipitation (data collection locations only).



U.S. Drought Monitor
(released 9/20/07)

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

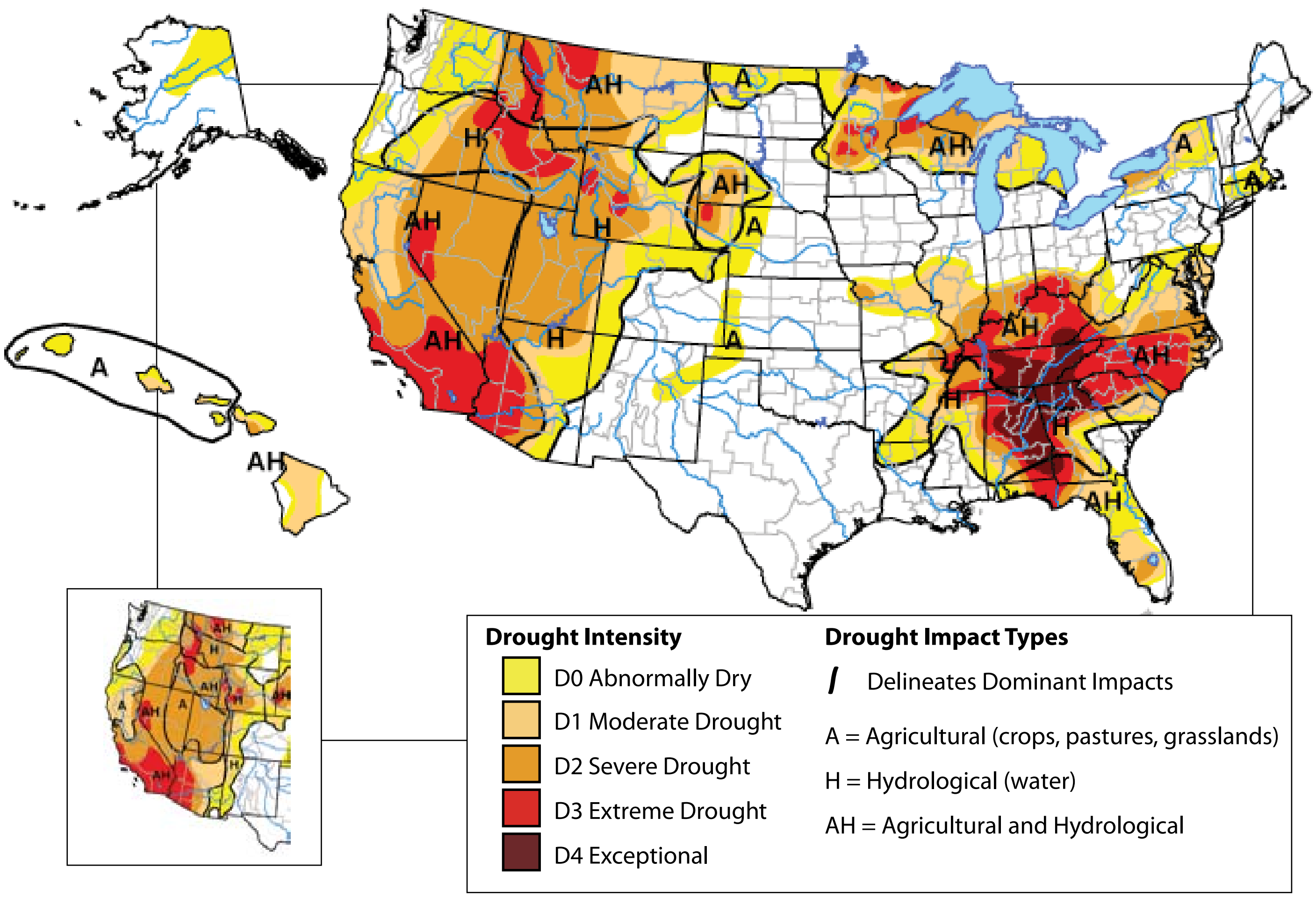
The National Drought Monitor shows some improvement in drought conditions from last month's map (Figure 3). A large portion of northeast Arizona and northwest New Mexico were upgraded from moderate drought to abnormally dry status. Drought monitoring discussions indicate that this improvement stems from average to above-average short-term precipitation amounts across the region associated with the North American monsoon. Very few other changes in drought status were made across the Southwest, with much of Arizona remaining in advanced stages of drought and most of New Mexico remaining drought free. Currently more than 88 percent of Arizona is under some type of drought designation. Western Arizona is bearing the brunt of the intense drought conditions with much of the region classified as experiencing extreme drought. The abnormally dry drought designation has been introduced to a small portion of northeast New Mexico, due to below-average precipitation in August and early September.

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 author of this monitor is David Miskus, JAWF/CPC/NOAA.

Figure 3. Drought Monitor released September 20, 2007 (full size) and August 16, 2007 (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 7/31/07)

Source: Arizona Department of Water Resources

There were no changes in Arizona's August drought status maps since the July update. Conditions have held steady across the state with all areas experiencing some type of drought. West-central portions of the state are experiencing the most intense short-term drought conditions. Short-term drought status in the Bill Williams watershed is holding at the extreme classification again. Conditions also remain bleak in the Verde and Agua Fria watersheds, with drought status remaining at severe. Below-average summer precipitation across these areas has done little to improve short-term drought conditions that formed with below-average precipitation last winter. The rest of the state continues to experience moderate drought conditions. Southeast Arizona is in the best shape at abnormally dry to normal drought status. Severe drought conditions are more extensive across the state and longer timescales, as represented in the long-term drought status map (Figure 4b). Continued long-term patterns of below-average precipitation and streamflows across portions of Arizona indicate severe drought conditions in the Little Colorado, Verde, Agua Fria, Santa Cruz, and San Simon watersheds.

Drought impact reports from Yavapai County continue to support the severe to extreme drought conditions present in the Bill Williams and Verde watersheds. August reports indicate that many trees along the Verde River are showing signs of water stress, with leaves yellowing and falling off. Increased mortality in some non-native trees lacking drought adaptations is also being observed across the region.

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 July 2007.

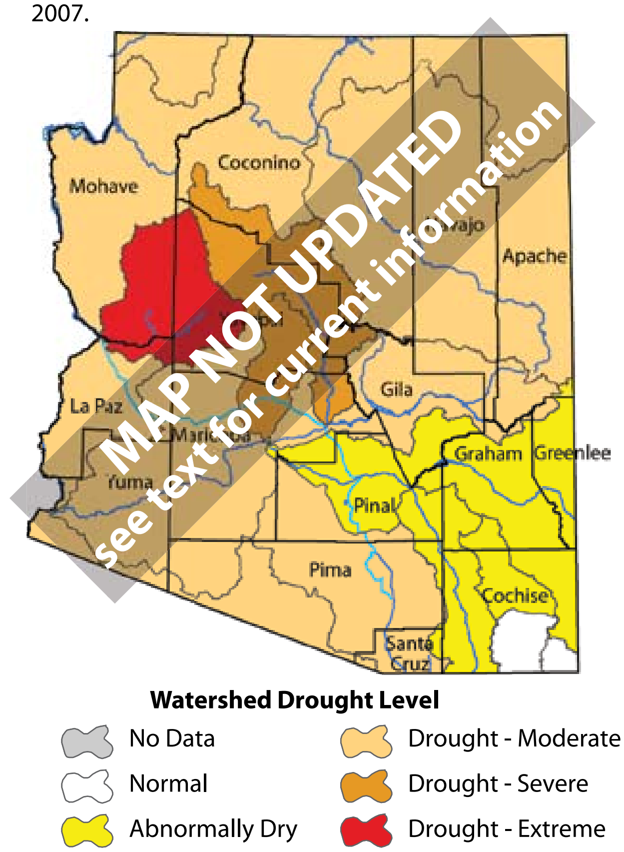
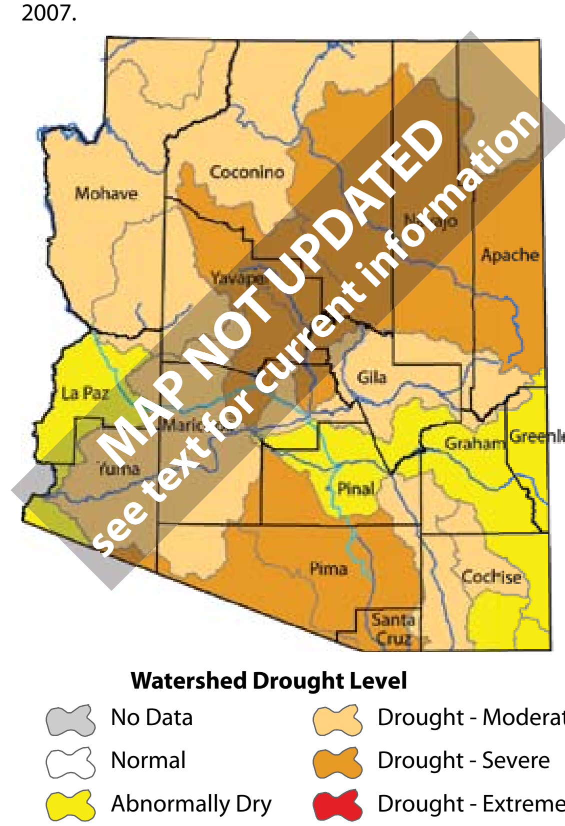


Figure 4b. Arizona long-term drought status for July 2007.



New Mexico Drought Status

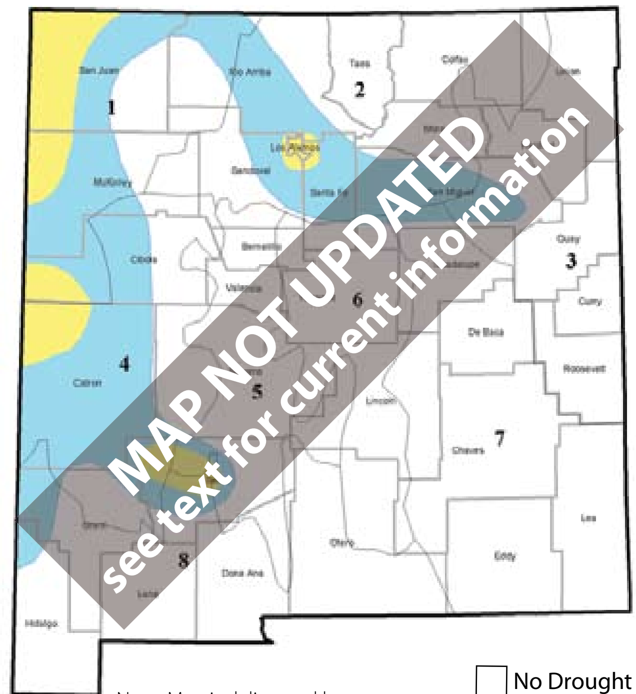
(through 9/30/07)

Source: New Mexico Natural Resources Conservation Service

Some changes in drought status occurred across New Mexico since last month's New Mexico Drought Status report. Much of the state was drought free with the exception of some far western counties that showed advisory to alert levels in August. The September report shows that drought conditions have moved from western to northeastern portions of the state. Above-average rainfall in the western border counties of McKinley, Cibola, and Catron eliminated short-term drought conditions, improving the status to no drought. The recent spell of below-average precipitation in August continuing into September has led to the introduction of advisory to alert drought status to counties like Torrance, Guadalupe, and De Baca in the central region and Union County in the far northeastern corner of the state. These regions have seen less than 50 percent of average rainfall over the past 60 days, according to reports compiled by the Western Regional Climate Center.

Scientists at the New Mexico State University Agricultural Experiment Station in Clovis are working to breed a more drought-tolerant peanut crop to grow in the state (*Portales News Tribune*, September 3). Eastern New Mexico is home to extensive Valencia peanut farms and is the largest supplier of the variety in the country. High prices and increasing demand are spurring new cultivation, including moving fields from cotton production to peanut production.

Figure 5. Short-term drought map based on meteorological conditions for August 2007.



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

- No Drought
- Advisory
- Alert
- Warning
- Emergency

Notes:

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

Figure 5 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).

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 8/31/07)

Source: National Water and Climate Center

Levels increased in Lyman Lake, San Carlos Reservoir, and the Verde River Basin as a result of summer monsoon precipitation (Figure 6). Levels of other Arizona reservoirs declined during the last month. The combined levels of Lake Powell and Lake Mead declined slightly during the last month, as did reservoir levels in the Salt River watershed. Reservoir storage in Lake Powell and Lake Mead has decreased during the past eight years. Inflow to Lake Powell for the 2007 water year is projected to be 69 percent of average, according to Tom Ryan of the Bureau of Reclamation. The water surface elevation of Lake Powell will likely decrease between now and March 2008.

In water-supply news, an invasive mollusk, the quagga mussel, was reported in the Central Arizona Project canal (*Arizona Republic*, September 15). While the mussels pose no health threat to drinking water, their populations can expand exponentially, clogging pipes and pumps and threatening native ecosystems.

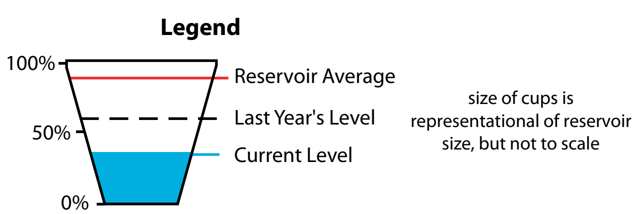
Notes:

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. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

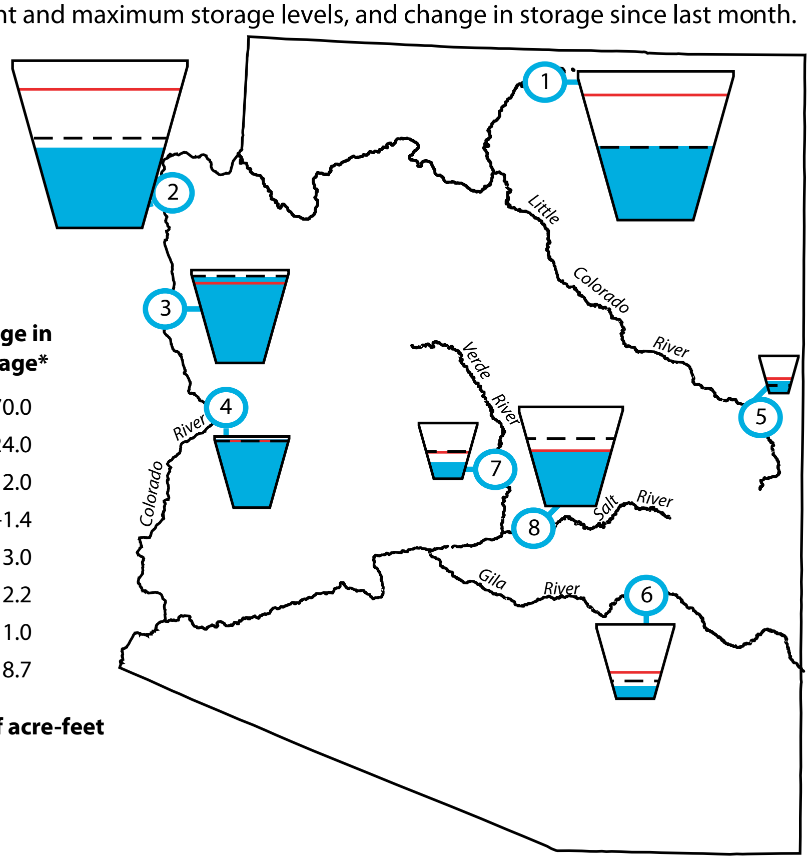
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) 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 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Lake Powell	50%	12,095.0	24,322.0	-370.0
2. Lake Mead	48%	12,578.0	26,159.0	24.0
3. Lake Mohave	93%	1,683.7	1,810.0	-12.0
4. Lake Havasu	95%	585.4	619.0	-1.4
5. Lyman Reservoir	31%	9.2	30.0	3.0
6. San Carlos	17%	147.0	875.0	2.2
7. Verde River System	30%	86.9	287.4	11.0
8. Salt River System	57%	1,162.4	2,025.8	-18.7

*** 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 8/31/07)

Source: National Water and Climate Center

Storage in most New Mexico reservoirs declined since last month. In particular, the Elephant Butte, Caballo, Conchas, Santa Rosa, and El Vado reservoirs each declined by more than 10 percent (Figure 7). Irrigators in the Elephant Butte Irrigation District (EBID) received only 25 percent of the allotment that they received in 2004; the last day for EBID water deliveries is October 12 (*Associated Press*, September 19). In water-supply news, twice as many water rights may be promised on the lower Rio Grande than there is water available (*Santa Fe New Mexican*, September 15). The water rights issue has come to the forefront in many Rio Grande communities due to rapid growth and development, as well as the need for the state engineer to quantify Middle Rio Grande water rights, including new rights to brackish groundwater. Mining of deep groundwater could potentially impact upper aquifer water sources.

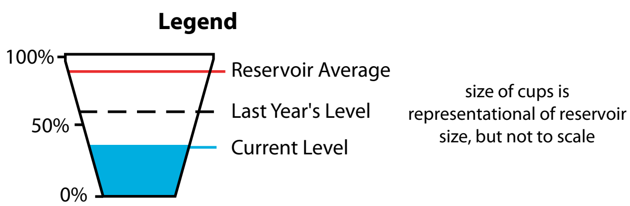
Notes:

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. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

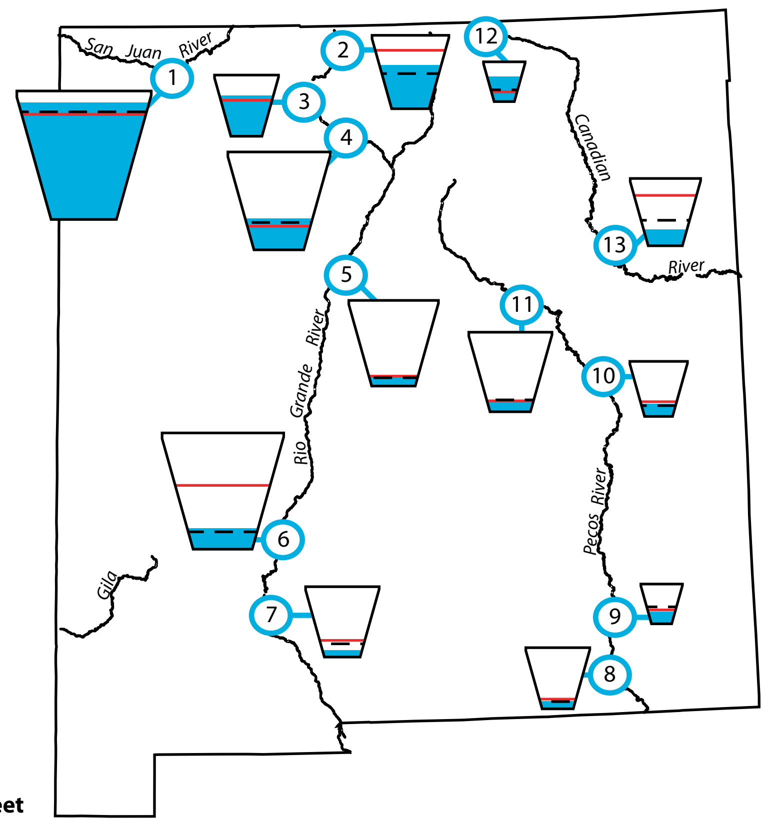
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) 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 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	91%	1,550.9	1,696.0	-26.1
2. Heron	59%	235.4	400.0	-0.7
3. El Vado	66%	129.3	195.0	-21.2
4. Abiquiu	32%	175.3	554.5	1.5
5. Cochiti	11%	54.4	491.0	3.5
6. Elephant Butte	18%	396.6	2,195.0	-67.4
7. Caballo	10%	33.0	332.0	-25.3
8. Brantley	13%	18.5	147.5	-6.2
9. Lake Avalon	30%	1.2	4.0	-0.2
10. Sumner	23%	23.7	102.0	-1.5
11. Santa Rosa	14%	60.1	438.3	-9.0
12. Costilla	63%	10.1	16.0	-2.4
13. Conchas	24%	62.1	254.2	-9.7

*** 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 9/18/2007)

Source: Western Regional Climate Center

Monsoon activity quieted during the end of August and into September. Nevertheless, parts of the region, notably western New Mexico, received copious rainfall from hurricane remnants and atmospheric circulation patterns that allowed moisture to penetrate to the north-central and central part of the state (Figure 8a). The retreating monsoon was relatively inactive across Arizona during this time period, as high pressure dominated much of the region.

In general, the 2007 monsoon season delivered average to above-average precipitation to southeastern and north-central Arizona and southwestern New Mexico (Figures 8b–c). As is typical of the North American monsoon, rainfall patterns varied greatly, even within small regions. This year, the erratic monsoon skipped most of central and southwestern Arizona, including Phoenix. The monsoon also missed northeastern New Mexico, where most locations received less than half of their average summer precipitation. The Tucson National Weather Service office reported that weather observation stations at Organ Pipe National Monument and Oracle received well below their average summer precipitation totals.

During the main monsoon moisture surge between July 21 and August 6, most locations in the region recorded rainfall. Late July and early August thunderstorms produced severe flooding in the Tucson area and flash flooding in Zuni Pueblo in northwestern New Mexico. Strong winds and lightning snapped power lines, causing power outages in parts of Tucson several times during the summer.

Figure 8a. Total precipitation in inches July 1–September 18, 2007.

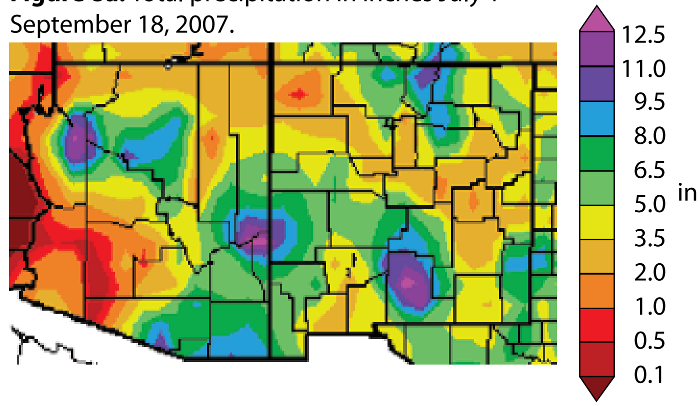


Figure 8b. Departure from average precipitation in inches July 1–September 18, 2007.

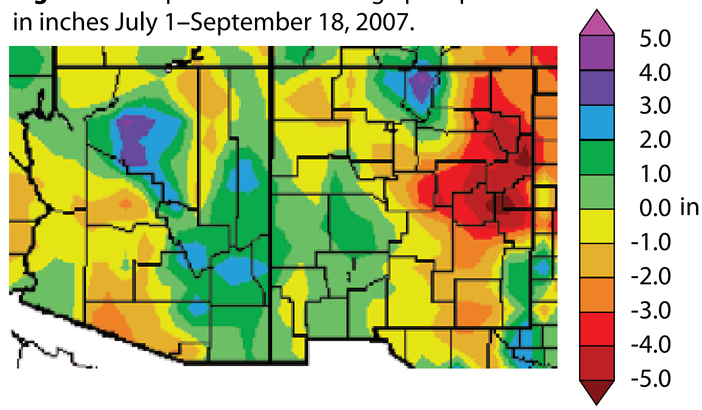
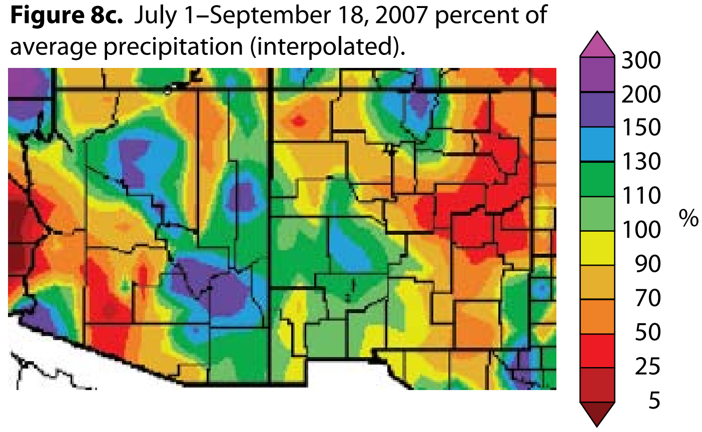


Figure 8c. July 1–September 18, 2007 percent of average precipitation (interpolated).



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 2007–March 2008)

Source: NOAA Climate Prediction Center (CPC)

This month's NOAA-CPC long-lead temperature forecasts predict an increased likelihood of above-average temperatures across most of the southern two-thirds of the conterminous U.S. through March 2008 (Figures 9a–d). Greatly increased chances of above-average temperatures are predicted for Arizona beginning with the November–January forecast. The area of increased chances of above-average temperatures spreads across New Mexico, Texas, and into the Gulf states by early spring 2008 due to a combination of long-term temperature trends and the development of a La Niña episode in the tropical Pacific Ocean. Warmer-than-average conditions across the southern tier of the United States frequently accompany La Niña episodes.

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 2007.

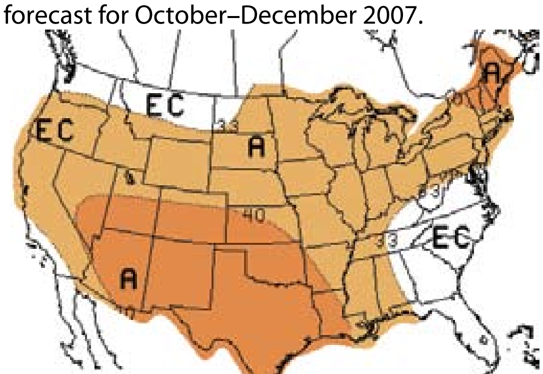


Figure 9b. Long-lead national temperature forecast for November 2007–January 2008.

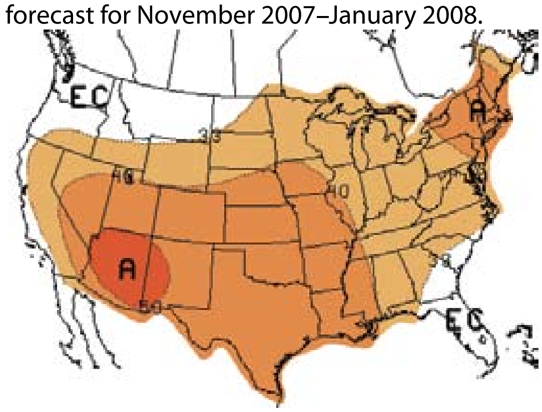


Figure 9c. Long-lead national temperature forecast for December 2007–February 2008.

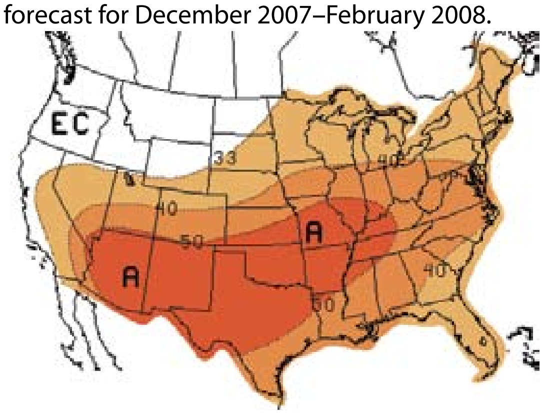
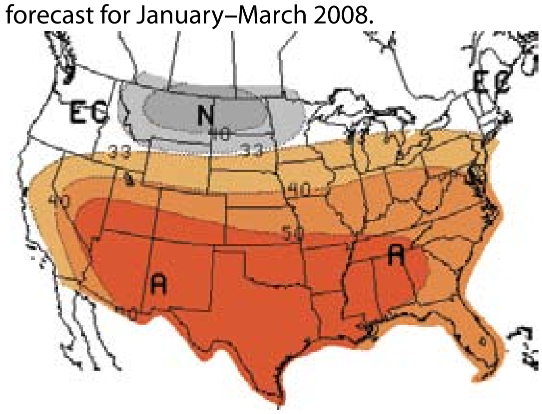


Figure 9d. Long-lead national temperature forecast for January–March 2008.



N=Near Normal: 40.0–49.9%, 33.3–39.9%

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 2007–March 2008)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC forecasts for October 2007–March 2008 indicate an increased probability of below-average precipitation in the Southwest, especially in central and southern Arizona (Figures 10a–d). This signal spreads to the Gulf and southern Atlantic Coast states for the November 2007–March 2008 forecasts. An increased chance of above-average precipitation is indicated for the Pacific Northwest and Northern Rockies through most of this period and for portions of the Midwest beginning in December 2007. Expectations for a dry winter in the Southwest and a wet one in the Northwest reflect widespread predictions that La Niña conditions will continue to develop over the next several months (see Figures 12a–b).

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 2007.

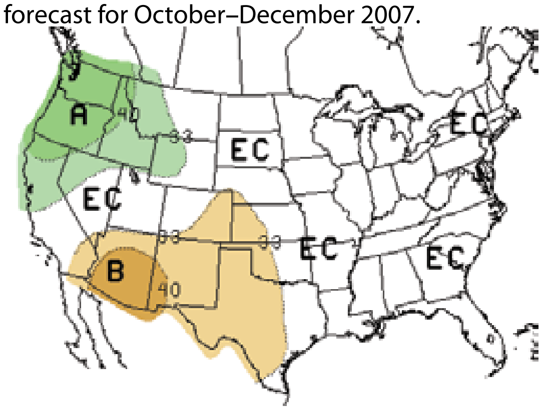


Figure 10b. Long-lead national precipitation forecast for November 2007–January 2008.

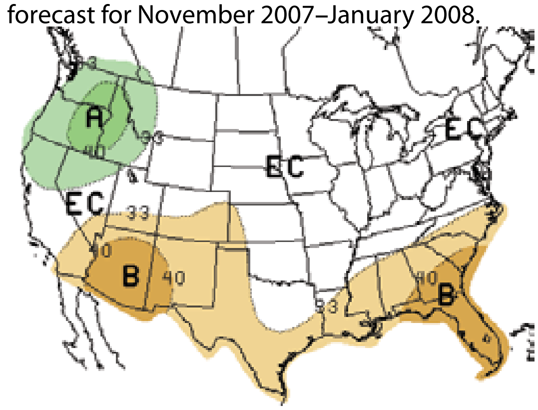


Figure 10c. Long-lead national precipitation forecast for December 2007–February 2008.

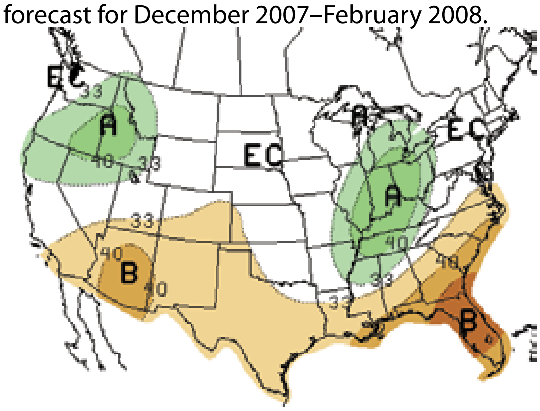
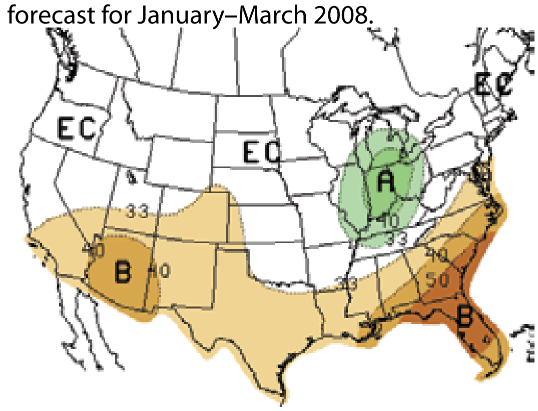


Figure 10d. Long-lead national precipitation forecast for January–March 2008.



A= Above
- 40.0–49.9%
- 33.3–39.9%

B= Below
- 33.3–39.9%
- 40.0–49.9%
- 50.0–59.9%

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 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC projects that drought conditions will persist throughout much of western and northern Arizona (Figure 11). With the exception of parts of north-central Arizona, this region experienced a dry 2006–2007 winter and below-average summer precipitation. The assessment by NOAA forecasters takes into account the entrenched drought conditions in this area, as well as the recent intensification and expected persistence of La Niña conditions. La Niña episodes typically bring dry conditions to the Southwest.

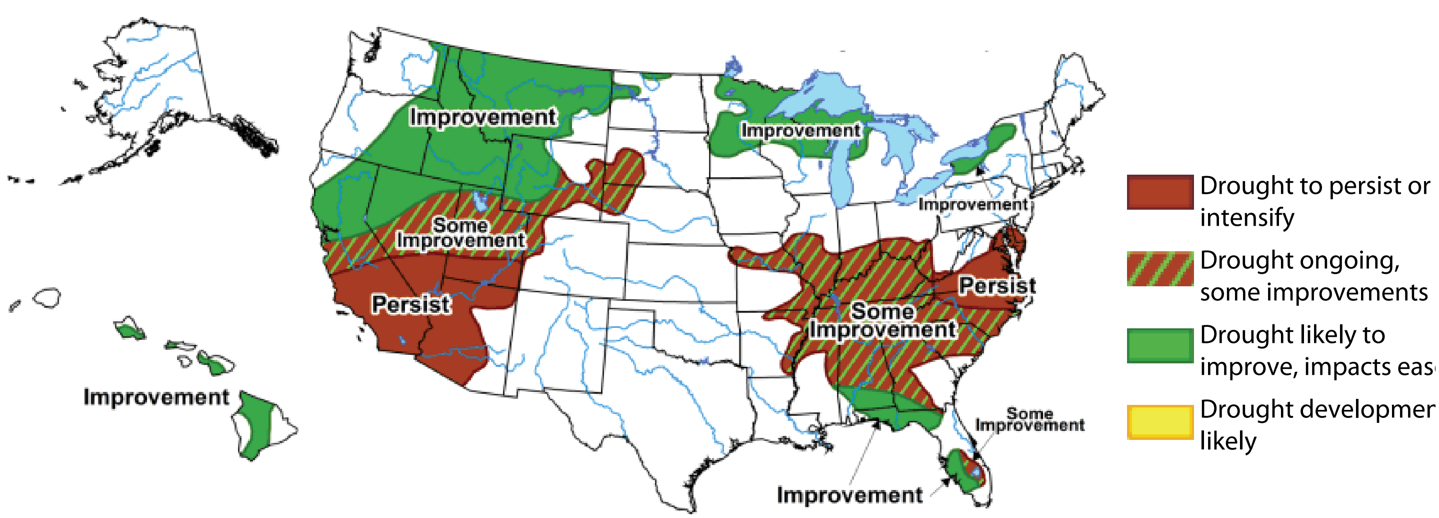
The proposed Navajo-Gallup Water Supply Project, an $800 million project to bring surface water from the San Juan River to northwestern New Mexico, has been the focus of intense discussions about water rights and future water supplies for the Navajo Nation and the city of Gallup, New Mexico. In recent years, well levels in Gallup have been declining by 22 feet per year, and with continued drought, the city could experience shortages during the period of peak summer water demand as soon as 2014 (*Gallup Independent*, August 31). While the water supply project legislation is being considered by Congress, the city of Gallup has been exploring tapping into a deep groundwater aquifer nearby; Navajo Nation hydrologists are concerned about the sustainable use of the groundwater resource. In the interim, the Navajo Nation and Gallup have renegotiated a memorandum of understanding for a 500 acre-foot water swap that would benefit both parties (*Gallup Independent*, September 11).

Cloudcroft, New Mexico, a resort town of 750, whose population grows by several thousand on weekends, will be one of the first towns in the nation to develop a wastewater treatment system to deliver drinking-quality treated effluent to its residents (*High Country News*, September 17). Cloudcroft's 9,000 foot elevation, recent drought, and the tremendous demand for water by visitors render treated effluent as the only feasible option to sustain the town's tourism-based economy.

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 2007 (released September 20, 2007).



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 and Society (IRI)

The NOAA Climate Prediction Center (NOAA-CPC) reports a La Niña event will be official at the end of September with the inclusion of data from this past month (Figure 12a). Trends in sea surface temperatures (SSTs) across the equatorial Pacific Ocean have hinted at the development of La Niña conditions since March. The highly variable weather conditions in the spring and summer may have limited the rapid development of La Niña, but the tell-tale signs of a La Niña event have become stronger this past month. Below-average SSTs now extend out to the International Date Line from the South American coast. The easterly winds across the Pacific have also strengthened and convection is suppressed across the eastern Pacific. These observations highlight the connections developing between the ocean and atmosphere that are necessary to sustain or possibly strengthen the current event. The official NOAA-CPC threshold for a La Niña event to occur is when the three-month average SST in a specific region in the eastern Pacific is more than one-half of one degree below the long-term average. July and August have both crossed this threshold. September will make it the requisite three months.

Statistical and dynamical models have had trouble tracking this event over the past couple of months but appear to be coming into agreement on short-term expected conditions through the fall. The International Research Institute (IRI) reports that a majority of models point toward the continuation of weak La Niña conditions, if not a slight strengthening, through the fall and into the winter season (Figure 12b). The IRI forecast indicates a 65 percent chance of La Niña conditions developing and continuing through this fall. It is unclear how long this event may linger into spring 2008. Models are giving mixed projections, so confidence is low in this forecast period. Nonetheless, it is expected that weak to moderate La Niña conditions may impact winter weather across the Southwest, potentially bringing below-average precipitation.

Figure 12a. The standardized values of the Southern Oscillation Index from January 1980–August 2007. 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).

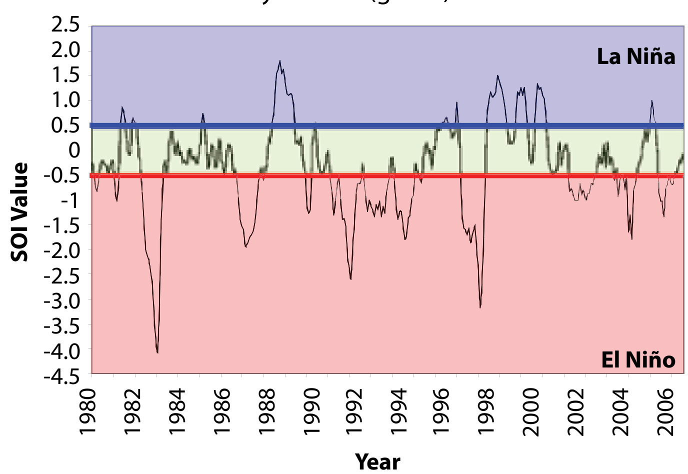
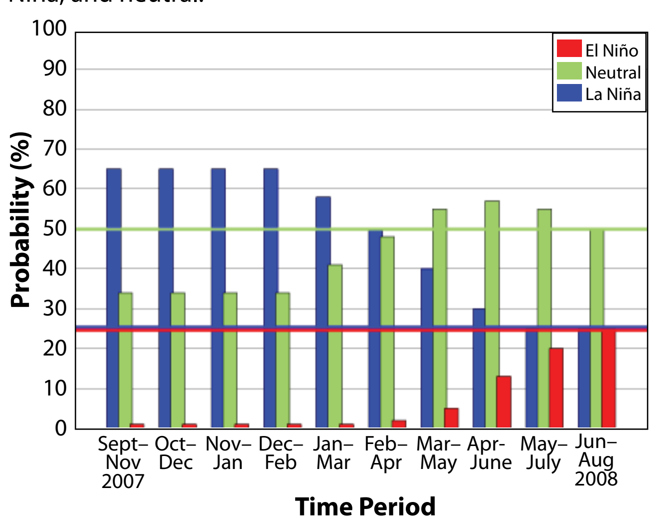


Figure 12b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released September 20, 2007). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Notes:

Figure 12a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through August 2007. 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/

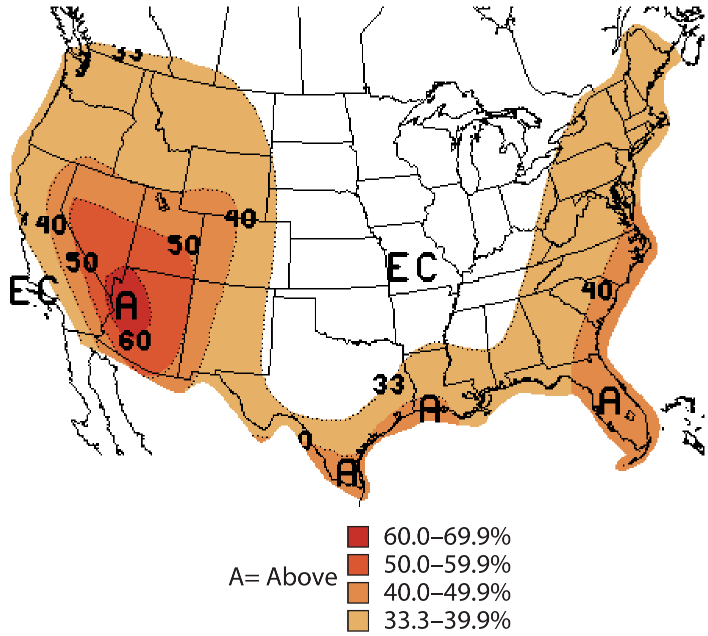
Temperature Verification

(June–August 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC seasonal temperature outlook for June–August 2007 predicted an increased likelihood of above-average temperatures across most of the West and the Atlantic Coast states (Figure 13a). An especially strong signal indicated above-average temperatures in Arizona, southern Utah, and southern Nevada. Observed temperatures for that period were somewhat above average at 0-4 degrees F across most of the country, with the greatest departures observed, as expected, in the western states (Figure 13b). Similarly, most of the Southwest saw temperatures within -2 to 4 degrees F of the long-term average. Across large areas of Texas and Oklahoma, temperatures were 0-4 degrees F below normal, most likely in association with widespread June rainfall and floods. The forecast had indicated an equal chance of below-average, average, and above-average temperatures for that region.

Figure 13a. Long-lead U.S. temperature forecast for June–August 2007 (issued May 2007).



EC= Equal chances. No forecasted anomalies.

Notes:

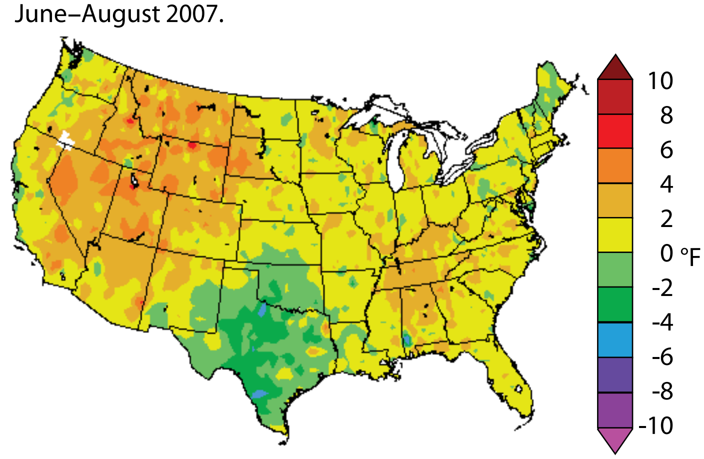
Figure 13a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months June–August 2007. This forecast was made in May 2007.

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 2007 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 13b. Average temperature departure (in degrees F) for June–August 2007.



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

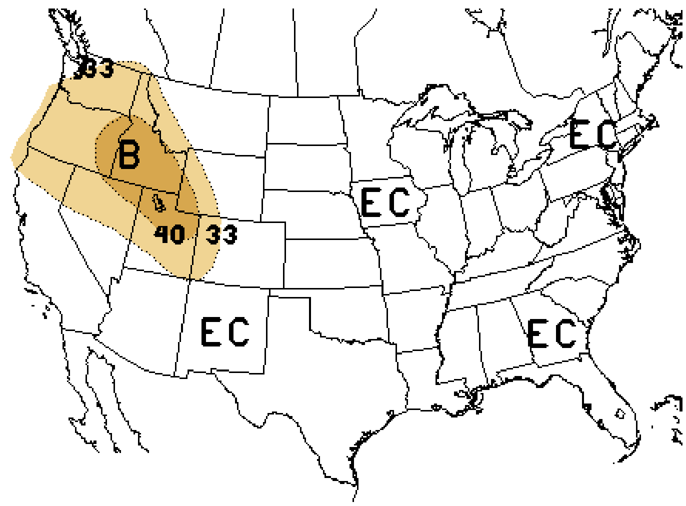
Precipitation Verification

(June–August 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC seasonal precipitation outlook for June–August 2007 indicated equal chances of below-average, average, and above-average precipitation across most of the United States. The exception was the Pacific Northwest, where an increased probability of below-average precipitation was anticipated (Figure 14a). The pattern of observed precipitation was somewhat mixed in the Northwest; coastal areas received near- or slightly above-normal precipitation, but some inland areas received as little as 5–25 percent of normal precipitation (Figure 14b). The southwestern states saw a similarly varied picture, where localized areas received anywhere from 5 to 300 percent of normal precipitation. The dry spots were largely in eastern New Mexico and portions of southwestern Arizona, while eastern, north-central, and extreme southwestern Arizona saw the greatest departure above the long-term average. However, some of these precipitation figures were likely the result of one or two major monsoonal precipitation events and some late August precipitation in southwestern New Mexico from Hurricane Dean. On the national scale, most of California remains in meteorological drought, with large swaths of the state experiencing less than 5 percent of normal precipitation. Texas and much of the central Plains remained well above average, due to copious May–June precipitation.

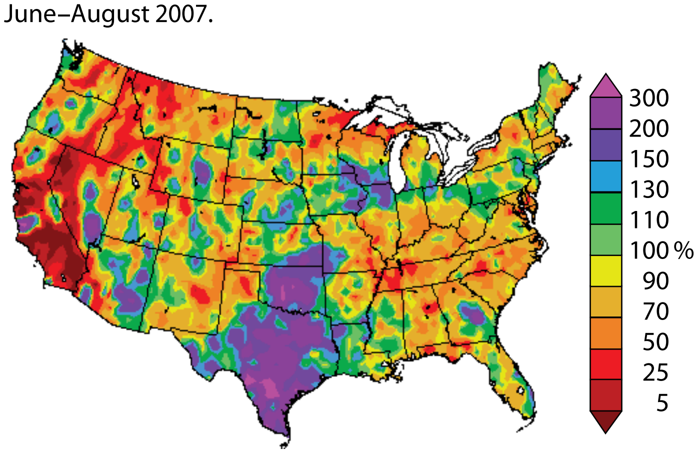
Figure 14a. Long-lead U.S. precipitation forecast for June–August 2007 (issued May 2007).



B= Below 40.0–49.9% 33.3–39.9%

EC= Equal chances. No forecasted anomalies.

Figure 14b. Percent of average precipitation observed from June–August 2007.



Notes:

Figure 14a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months June–August 2007. This forecast was made in May 2007.

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 2007. 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