Issued: August 24, 2004

# CLIMAS
## Southwest Climate Outlook

## August 2004 Climate Summary

**Hydrological Drought** – Hydrological drought continues for much of the Southwest.

- Storage has decreased in many reservoirs in Arizona and New Mexico.
- Lake Powell and Lake Mead are at their lowest levels in over 30 years.
- Far eastern New Mexico is no longer in short-term drought.

**Precipitation** – Precipitation for the water year remains below 90 percent of average through mid-August for much of the Southwest. Eastern New Mexico experienced wetter-than-average conditions over the past 45 days.

**Temperature** – New Mexico and eastern Arizona have been generally cooler than average over the past 30 days. Temperatures for the remainder of Arizona were slightly above average.

**Climate Forecasts** – Seasonal forecasts indicate slightly increased probabilities of above-average temperatures for the Southwest through January 2005. Climate forecasts are predicting slightly increased probability of wetter-than-average conditions for the Southwest during the winter.

**El Niño** – Conditions in the Pacific Ocean hint at the onset of a weak El Niño during the next several months.

**The Bottom Line** – Hydrological drought is expected to persist in Arizona through late autumn, while parts of New Mexico may see limited improvement.

The climate products in this packet are available on the web:
http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html



## In this issue:



The Southwest Climate Outlook is published monthly by the Climate Assessment for the Southwest Project at the University of Arizona. This work is funded, in part, by the U.S. Bureau of Reclamation and the Technology Research Initiative Fund of the University of Arizona Water Sustainability Program.

The University of Arizona®

## Arizona Drought Plan

Arizona has drafted its first drought plan and submitted it to the public for comment. The plan emphasizes ongoing drought monitoring, preparedness, and mitigation, in addition to well-coordinated drought emergency response. The drought planning process has been guided by experts from the National Drought Mitigation Center, with an emphasis on public participation at open Drought Task Force meetings during the past year.

The draft drought plan and accompanying statewide conservation strategy document can be downloaded from the URL below. Comments can be submitted via e-mail (dtf@adwr.state.az.us). In addition, public comment on the plan will be sought throughout September at workshops (dates at left). The public comment period ends September 24.

http://www.water.az.gov/gdtf/

**Public Meetings**
Prescott – 9/8
Show Low – 9/9
Safford – 9/14
Nogales – 9/15
Yuma – 9/21
Kingman – 9/22

All meetings are from 4–7 p.m.

# Forecasters expect below-normal East Pacific hurricane activity despite likely El Niño development this season

BY MELANIE LENART

When it comes to social impacts of climate, few phenomena can top hurricanes. Charley's visit to Florida earlier this month left at least 25 people dead as it flattened a 10-mile wide area north of Fort Myers. The damage is still being tallied.

Here in the West, we may be landlocked, but we're not immune to the effects of hurricanes. In fact, the remnants of tropical storm Norma killed 23 people in Arizona in 1970, a relatively dry year in the Southwest, when more than 11 inches of rainfall flooded a high-elevation campground about 60 miles northeast of Phoenix.

Still, most hurricanes that form off western North America travel westward, heading harmlessly across the Pacific. As a result, they have not received the attention given their Atlantic brethren, which regularly batter East Coast towns from Texas to New England. It wasn't until 1965 or so that reliable hurricane data became available for researchers who monitor East Pacific hurricanes, while Atlantic hurricane data was considered reliable a couple of decades earlier.

A growing awareness of the importance of hurricanes and tropical storms for potential rainfall in the Southwest and Mexico when they do turn landward, however, helped inspire researchers at the National Oceanic and Atmospheric Administration (NOAA) to release an experimental East Pacific Hurricane Outlook this year and last year.

The 2004 Hurricane Outlook calls for a below-average to normal season for the East Pacific, with only about a 10 percent chance of activity being greater than the average, explained Muthuvel Chelliah, the Climate Prediction Center (CPC) scientist who led the effort to produce the East Pacific forecasts. The experimental outlook, a collaborative effort among NOAA scientists working for the CPC, the National Hurricane Center, and the Hurricane Research Division, will go operational next year.

The 2004 outlook projects the formation of 13 to 15 East Pacific tropical storms, with about six to eight of these becoming hurricanes. Two to four of the latter are expected to become major hurricanes. The average since 1970 is 15 storms, with nine becoming hurricanes (winds of 74 miles per hour or greater) and four reaching major hurricane status (winds of 111 mph or greater). As of August 20, five of the seven tropical depressions that formed in the East Pacific became named tropical storms by reaching speeds of 39 miles per hour or greater, and two of these intensified to hurricane strength.

Arizona gets hit directly from a named tropical storm about twice every nine years, and receives rainfall from systems that started their existence as tropical depression or greater about every two years, according to calculations by Tucson National Weather Service meteorologist Erik Pytlak.

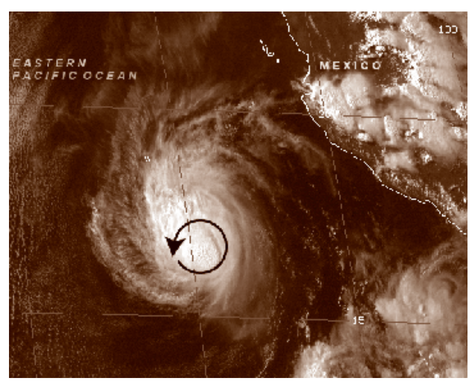
The resulting rainfall generally is welcome in the Southwest, outside of dangerous floods. For instance, the remnants of Tropical Storm Olivia dropped 3 to 5 inches of rain around the southern border of Arizona and New Mexico in mid-October of 2000, buffering the area from some of the widespread drought impacts for about a year, U.S. Drought Monitor archives state.

At this point, at least, the forecasts do not attempt to predict the number of storms that might turn landward, so desirable rainfall or even devastation could occur even during a below-normal year if one particular hurricane moved inland, Chelliah noted. Also, he cautioned that the numbers are rough estimates based upon the more accurate Accumulated Cyclonic Energy (ACE) index, which is similar to the Hurricane Destruction Potential used by Colorado State Professor William Gray and his colleagues who forecast Atlantic hurricane activity. These indices are more accurate than hurricane counts because their values encompass tropical storm systems as well, and take into account variations in intensity and duration of storms.

"It's fairly difficult to predict the exact number of storms or hurricanes because a couple of 6- or 12-hour storms that soon fizzle out will throw off the numbers," Chelliah explained. "How would one of those compare to a storm that lasted for three days and battered the shores and wouldn't go away?"

The destruction in Florida from Charley was in some ways foreseen by CPC climate forecasters, who had predicted an above-normal hurricane season in the Atlantic. But the last minute veering of the hurricane into Punta Gorda defied expectations by weather forecasters that it would strike Tampa Bay, which illustrates the erratic nature of individual hurricanes.

**continued on page 3**




The cyclonic nature of tropical storms and hurricanes is illustrated here by a satellite image of Tropical Storm Agatha on May 22 of this year in the East Pacific. In the northern hemisphere, winds circulate counter-clockwise at the surface. Image courtesy of the National Oceanic and Atmospheric Administration.

## Hurricanes, continued

Although the Atlantic hurricane outlook is updated during the season, the East Pacific outlook team does not plan to update their forecast, originally released in mid-June. In part, this is because the East Pacific season peak runs July–September, about a month earlier than the Atlantic season peak of August–October. Also, the June forecast ranges already took into consideration the likelihood that an El Niño might develop later this summer, Chelliah said.

If the ongoing trend continues, the start of an El Niño could be made official by the end of August, perhaps in time to affect the tail-end of the peak Pacific hurricane season in September. The CPC identifies an El Niño based on a three-month running mean of above-average sea surface temperature in a specific region of the equatorial central Pacific, an index that Chelliah was involved in devising with colleagues. (For more on the index they developed, Niño-3.4, see their 1997 paper in the journal *Atmosphere-Ocean*).

"El Niño and its counterpart La Niña definitely have a signature on the Atlantic and Pacific hurricane activity," Chelliah noted.

Chelliah and his colleague Gerald Bell, who heads the Atlantic hurricane forecast team, developed a global spatial model allowing them to depict when conditions are favorable for hurricane activity based on two dominant predictors. One has an El Niño/La Niña signature that can change from year to year, and the other reflects a longer-term pattern they dubbed the tropical multidecadal mode.

The multidecadal mode captures spatial patterns of atmospheric activity in the tropics that can hold for a couple of decades or more, and which appear related to a variety of factors, including sea surface temperatures in the tropical

**continued on page 4**

# Hurricanes vs. Monsoons

by Melanie Lenart

The cyclonic precipitation that comes from hurricanes differs slightly from two other types of precipitation, namely the convective precipitation that is most dramatically represented by thunderstorms and monsoon systems, and the orographic precipitation promoted by mountains. These categories overlap and intermingle. Still, it can be useful to differentiate these three basic ways of initiating snow and rain.

Convective forces fuel the North American monsoon and its more famous Asian counterpart commonly known as the Indian monsoon. The monsoon season starts after the land surface has become warmer than surrounding water bodies. The change in heat gradient launches a change in wind direction, so prevailing winds transport moisture from the sea to land during the summer monsoons. The ongoing heating of the land also promotes the convective lifting of clouds, as heat rises.

Convective precipitation also occurs when clouds are lifted up by a warm front colliding with a cold front, and within a hurricane system. However, the collision of two frontal systems often sets in motion a pattern known as cyclonic precipitation, so named because the winds circle a low-pressure zone in the center.

Hurricanes, the most powerful form of cyclonic precipitation, do not have fronts. They have warm, low-pressure cores. The more dramatic the air pressure difference between the center of the storm and the encircling air, the greater the wind strength and therefore potential destructive force of the storm. Hurricanes themselves don't survive the inland trek into the Southwest—a hurricane's eye soon collapses once it leaves the energy-providing warmth of high sea surface temperatures. But the cyclonic storms they generate can survive to influence rainfall patterns here, particularly during the fall.

The relevant (East Pacific) hurricane season and the monsoon season both tend to peak around August in the Southwest. The hurricane season potentially stretches from mid-May through November, while the monsoon season typically extends from mid-July through mid-September depending on location in the Southwest, although stronger monsoons tend to start earlier and last longer.

On its own, convective precipitation tends to spawn relatively short-lived thunderstorms in spotty local events at a scale that is difficult to predict, especially in space. Cyclonic precipitation, which typically contains bands of thunderclouds, tends to operate at larger scales in space and time. An average hurricane measures about 350 miles across. Cyclonic storms may take days to pass over a region, with rainfall occurring continuously or least sporadically during their passage.

Orographic precipitation tends to be fairly predictable in space because it is associated with a specific mountain range or plateau. Orographic influences come in a variety of forms, all of them associated with changes in topography on the landscape. Mountains can mechanically force precipitation by channeling air and cloud parcels upward over its bulk, and differential heating of mountainsides facing the sun can contribute to convection. Mountain ranges can also shape precipitation events by slowing the movement of cyclonic systems and fronts.

# Hurricanes, continued

northern Atlantic (see their article in the *Journal of Climate*, May 2004).

Many researchers have noted a strong tendency for East Pacific hurricane formation rates to be higher when Atlantic hurricane formation rates are lower, as during a multidecadal phase from about 1970 through 1995. That phase seems to have reversed, starting with a strong Atlantic season in 1995.

Similarly, El Niño conditions tend to suppress the formation of Atlantic hurricanes, and in the most recent decades a reduction in Atlantic hurricane activity tends to be associated with an increase in Pacific hurricane action and vice versa, Chelliah said. La Niña conditions, the opposite of El Niño, do the approximate reverse, he said.

In the Southwest, El Niño's effect on tropical storms is not clear-cut, although CLIMAS Program Manager Gregg Garfin found evidence that tropical storms in Arizona and New Mexico tend to last longer during strong El Niño years than during La Niña years.

CPC Director Jim Laver noted that stronger storms and hurricanes are more likely to survive the long trek to the Southwest from the birthing ground off Baja California, the most prolific spawning ground for hurricanes in the world.

"The air is already laden with moisture, having come in off the ocean, so for some period of time you have a chance of getting it into the Southwest," he said.

Garfin's finding of longer lasting tropical storms in the Southwest during strong El Niño years fits in well with the expectation for more Pacific hurricane activity during such years. However, the El Niño currently developing might not be strong, Laver cautioned.

"This one we're starting will most likely be a garden variety – either a weak or moderate El Niño," he said. It might impact this year's East Pacific hurricane season, which extends from about mid-May through November, but probably only in a comparatively weak or moderate way, he indicated.

Other influences on hurricane activity remain more mysterious at this time. Unfortunately, the reliable record for Pacific hurricanes is too short when it comes to clearly distinguishing the many potential climatic influences on hurricane formation rates, particularly when some of them have phases that can span several decades.

In more general terms, though, sea surface temperature, wind shear, and location on the globe are the most important factors influencing hurricane formation. Sea surface temperatures must reach at least 26 degrees Celsius (roughly 79 degrees Fahrenheit) in order to yield hurricanes. In addition, the system must be in the right place at the right time.

Hurricanes can form only in certain regions, between about 6 degrees and 30 degrees latitude in either hemisphere. Nearer the equator, there's not enough Coriolis force generated from the Earth's spin to maintain their required motion. Further north than about 30 degrees latitude, wind shear becomes an issue.

The timing, too, depends largely on wind shear, which relates to how surface winds are behaving in relation to those higher in the troposphere. If there's a lot of vertical wind shear, which gets more pronounced as upper and lower winds move in different directions, potential storms will not be able to launch or maintain the prerequisite cyclonic motion.

To illustrate, Laver likened hurricane action to a spinning top. Wind shear, in this metaphor, would act as pressure that tips the top in one direction, reducing its ability to maintain its structure.

Other factors that affect the hurricane's ability to maintain its internal spin include the temperature and humidity in the higher reaches of its vertical span, and the smoothness of the surface over which they travel. Hurricanes generally deteriorate rapidly once they hit land.

"When a system hits land, several things can happen," Laver explained. "The source of moisture becomes more limited. Also the friction of the land, and the unevenness of the terrain, breaks up the eye of the hurricane. The system doesn't maintain an eye very long once it hits land. The instability continues enough to create the rain and showers, but it no longer has the look of an organized circular system."

Unfortunately for those who happen to live in the path of an incoming hurricane, the disintegration of the system takes time, and the resisting friction that eventually disrupts its passage can come from homes and trees as well as terrain. One hurricane can contain enough energy to light up the continent for a year, if its power could be tapped.

So in the Southwest, we can count ourselves lucky for rarely having to face the wrath of hurricanes directly – even though it comes at the cost of not having as much information on the hurricanes that can affect us.

*Melanie Lenart is a postdoctoral research associate with the Climate Assessment for the Southwest.*

## Resources on the Web

For more information on the East Pacific hurricane forecast, visit:
http://www.cpc.ncep.noaa.gov/products/Epac_hurr/Epac_hurricane.html

For information on how tropical storms have affected the Southwest, see
http://www.ispe.arizona.edu/climas/forecasts/articles/tropical_Aug2002.pdf

# Temperature (through 8/18/04)

**Sources: Western Regional Climate Center, High Plains Regional Climate Center**

The temperatures during the current water year are mainly above average (Figure 1a). The lone exception is an area in northeastern New Mexico. Southwestern Arizona continues to have the warmest conditions relative to average, with temperatures in excess of 3 degrees Fahrenheit above average. The average temperatures for that area are at least 74 degrees F (Figure 1b). A rapid decrease in average water year temperature occurs from southwestern Arizona to the higher elevations in the north-central part of the state. The previous 30 days have been cooler than average for much of the Southwest (Figure 1c). The eastern third of New Mexico was between 2 and about 7 degrees F below average. According to the Albuquerque National Weather Service (NWS) office, a series of cold fronts pushed through the eastern part of the state throughout July and kept temperatures down. Through the first half of August, Clayton, New Mexico, is more than 4 degrees F cooler than average, while Roswell is 2.5 degrees F below average (Albuquerque NWS). Phoenix, Arizona, has had slightly below-average temperatures since mid-July (Phoenix NWS).

## 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.

Figures 1c and 1d are experimental products from the High Plains Regional Climate Center.

## On the Web:

For these and other temperature maps, visit:
http://www.wrcc.dri.edu/recent_climate.html and
http://www.hprcc.unl.edu/products/current.html

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

**Figure 1a.** Water year '03–'04 (through August 18, 2004) departure from average temperature.

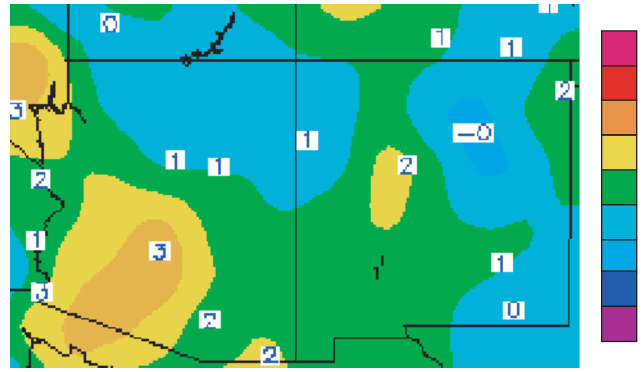



**Figure 1b.** Water year '03–'04 (through August 18, 2004) average temperature.

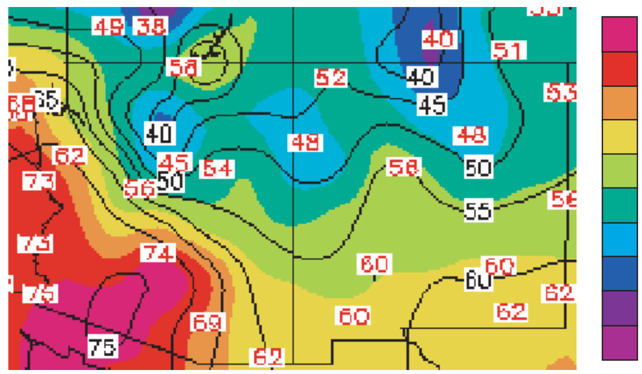



**Figure 1c.** Previous 30 days (July 20–August 18, 2004) departure from average temperature (interpolated).

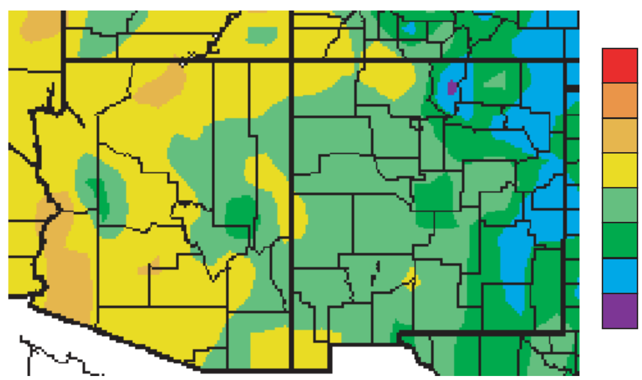
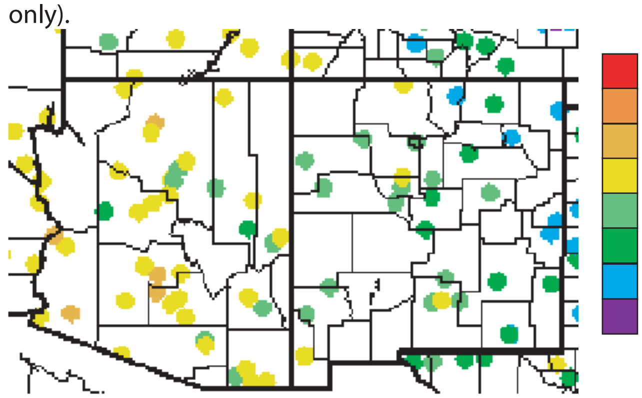



**Figure 1d.** Previous 30 days (July 20–August 18, 2004) departure from average temperature (data collection locations only).



# Precipitation (through 8/18/04)

**Source: High Plains Regional Climate Center**

The average percentage of precipitation since October 1, 2003 in the Southwest ranges from about 25 percent along the Colorado River and in east-central New Mexico to more than 150 percent in various locations (Figure 2a). Most of the region has received between 50 and 90 percent of average rainfall. The previous 30 days were wetter than average in northwestern and east-central Arizona and over a large proportion of New Mexico (Figure 2c). The combination of the cold fronts that passed through New Mexico, in association with adequate atmospheric moisture, promoted the development of precipitation. This rainfall has helped decrease drought intensity, and in some cases completely eliminate drought conditions, in the eastern half of the state (see Figures 3 and 4). On July 23, the first major thunderstorms of the monsoon affected Albuquerque. Some portions of the city received up to 2.15 inches of rain during one thunderstorm, causing flooding, automobile accidents, and electrical problems—including one power outage that affected 23,000 homes (*Albuquerque Journal*, July 24). Patagonia Lake, the largest lake in southern Arizona, rose by 1.5 feet mid-July as monsoonal thunderstorms provided much-needed rainfall (KOLD-TV, July 20, 2004).

## Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2003 we are in the 2004 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 '03–'04 through August 18, 2004 percent of average precipitation (interpolated).

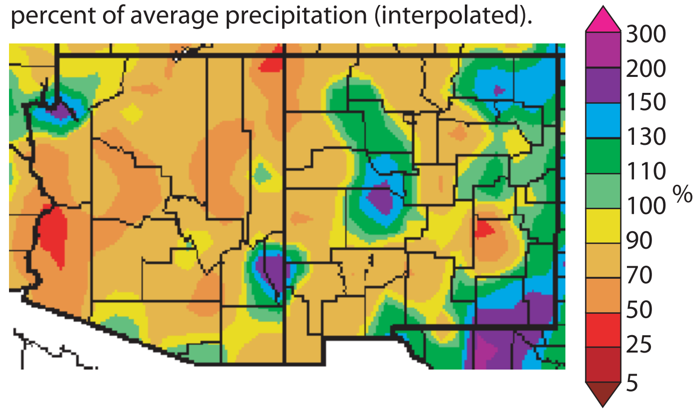



**Figure 2b.** Water year '03–'04 through August 18, 2004 percent of average precipitation (data collection locations only).

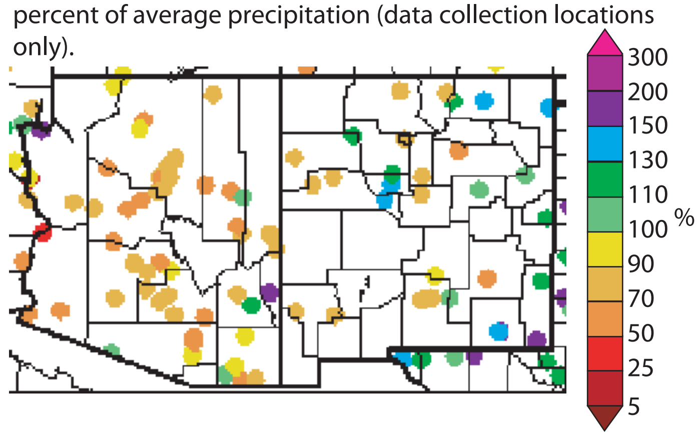



**Figure 2c.** Previous 30 days (July 20–August 18, 2004) percent of average precipitation (interpolated).

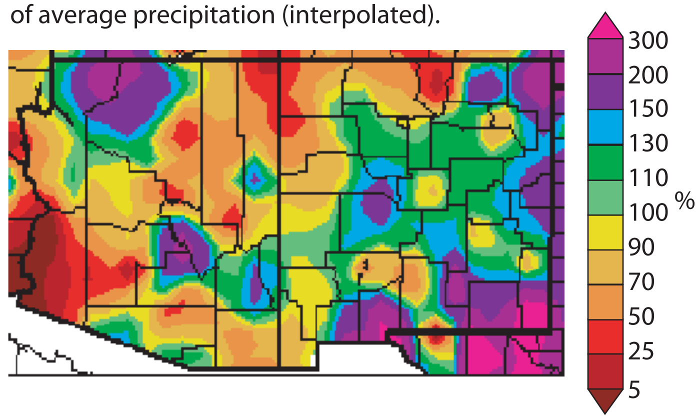
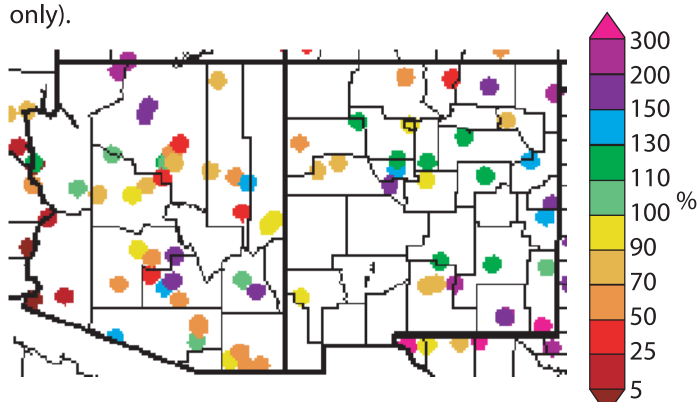



**Figure 2d.** Previous 30 days (July 20–August 18, 2004) percent of average precipitation (data collection locations only).



# U.S. Drought Monitor

**(released 8/19/04)**

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

Drought intensity has shown little change for much of the Southwest (Figure 3). Intensity has increased along the lower Colorado River and near the Four Corners. Decreased drought intensity is confined to the Kaibab Plateau in north-central Arizona and eastern and far northern New Mexico. Parts of eastern New Mexico have been eliminated from all drought categories due to wetter-than-average conditions in July (Albuquerque National Weather Service).

The amount of pasture and range lands in poor or very-poor condition in New Mexico has also decreased (not shown). Arizona experienced another 6 percent increase. Compared to 2003, the percentage of poor and very-poor pasture and range lands is up five percent in Arizona and down 47 percent in New Mexico. Pasture and range land in good or excellent condition only stands at 26 percent in both states.

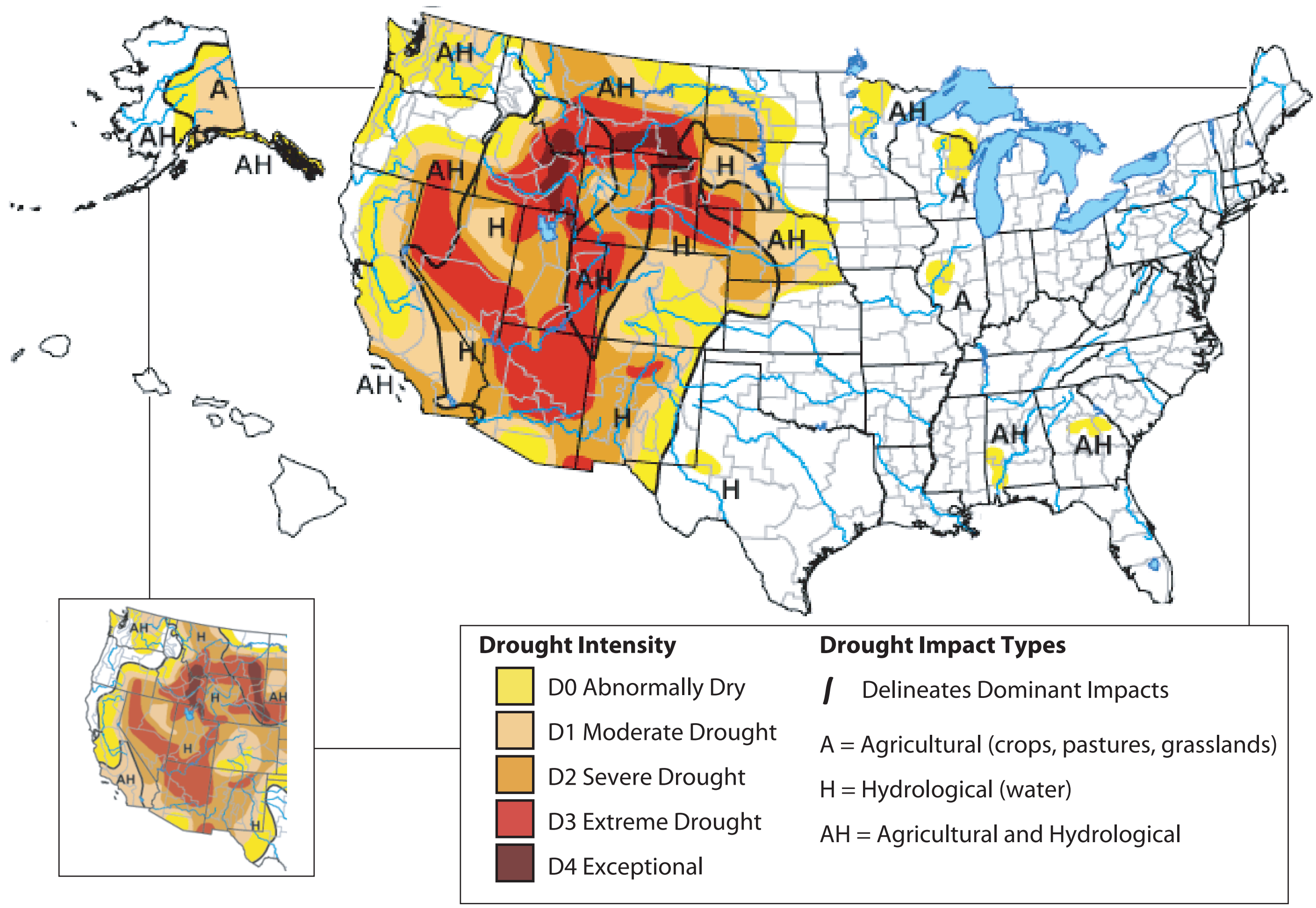
The drought has raised serious concerns about water availability from the Colorado River for the seven states who rely on the river for water supply. These states are being forced to develop emergency plans to ease the tensions and are expected to reconvene later this year for further discussions.

## 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 Rich Tinker from NOAA/NWS/NCEP/CPC.

**Figure 3.** Drought Monitor released August 19, 2004 (full size) and July 15, 2004 (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

# New Mexico Drought Status
## (through 8/13/04)

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

After a dry spell in late June and early July, many locations in New Mexico experienced a wetter than average end of July (Albuquerque National Weather Service [NWS]). Short-term drought conditions in much of the western two-thirds of the state continue at warning or emergency levels (Figure 4a). Some areas in north-central and west-central New Mexico are now at alert status. The eastern and much of the southern tier of the state range from normal to alert status. Higher moisture levels, several cold fronts, and the remnants of a tropical depression combined to provide above-average precipitation in the east (Albuquerque NWS). Long-term drought conditions have remained largely unchanged, except for three river basins. The drought intensity has increased from alert to emergency status in the northern Rio Grande Basin, while the San Francisco and Mimbres river basins have seen slight improvements from emergency to warning status (Figure 4b).

Water rights issues continue to make the news in New Mexico. The *Cibola County Beacon* (August 11) reports that property owners in Cibola County  are protesting the quantity of water allocated to the Acoma and Laguna Pueblos. Interstate river compacts—agreements concerning water delivery from one state to another—are the cause of quarrels in the Rio Grande and Pecos river basins (*Santa Fe New Mexican*, August 12). If New Mexico fails to meet delivery obligations to Texas, water officials say that federal courts could take charge of water management in the state.

## Notes:

The New Mexico drought status maps are produced monthly by the New Mexico Drought Monitoring Workgroup. 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 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 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 New Mexico drought status map, visit:
http://www.nm.nrcs.usda.gov/snow/drought/drought.html

Information on Arizona drought can be found at:
http://www.water.az.gov/gdtf/

**Figure 4a.** Short-term drought map based on meteorological conditions as of August 13, 2004.

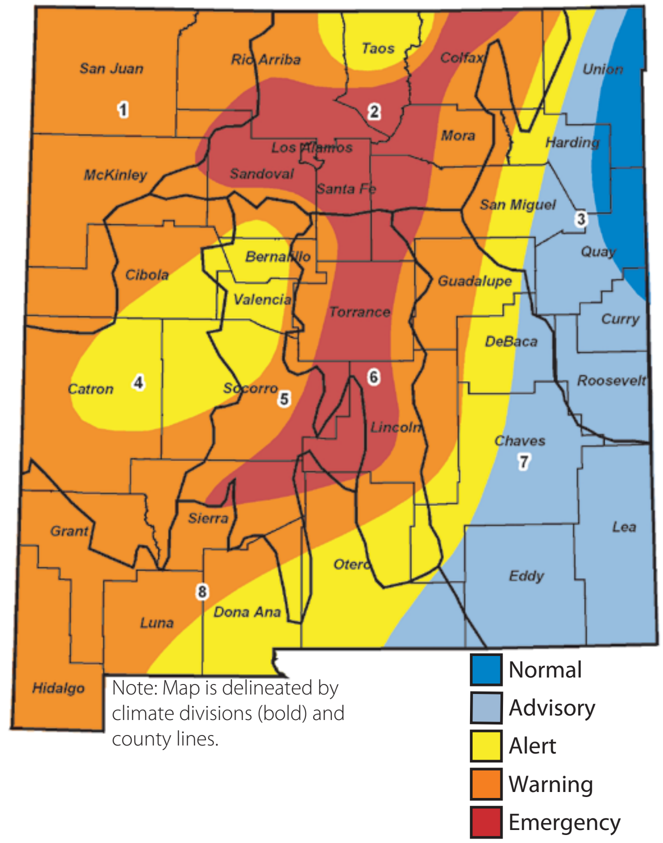
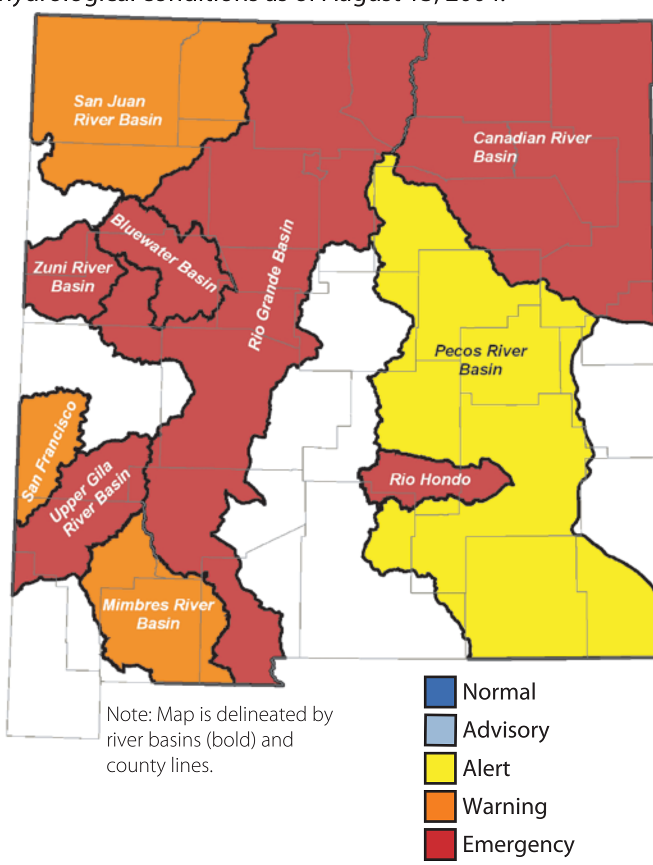



**Figure 4b.** Long-term drought map based on hydrological conditions as of August 13, 2004.



# Arizona Reservoir Levels

**(through 7/31/04)**

**Source: National Water and Climate Center**

During July, the storage in nearly every reservoir decreased from June levels (Figure 5). Show Low Lake and Lyman Reservoir experienced the greatest reductions (4 percent). The storage at San Carlos Lake decreased by approximately 1,100 acre-feet. The *Eastern Arizona Courier* (August 3) reports that San Carlos Apache Tribal Chairwoman Kathy W. Kitcheyan has asked President George W. Bush and Arizona Governor Janet Napolitano to declare the reservation a federal disaster area in addition to establishing a minimum capacity of 75,000 acre-feet in the San Carlos Reservoir. If the request is granted, the reservation would be entitled to federal disaster and drought relief. The tribe is also concerned about looting from grave sites and religious areas that have been submerged until recently and about major fish kills, which could negatively impact local wildlife and pose public health risks.

Lake Powell has slumped below 10 million acre-feet for the first time since May 1970, while Lake Mead is under 14 million acre-feet for the first time since June 1964, according to the Natural Resources Conservation Service. At Lake Mead, crews are lowering the intake pipe, which draws water for Las Vegas and other southern Nevada cities, by 50 feet due to water quality and availability concerns (*Arizona Republic*, July 25). The *Las Vegas Review-Journal* (August 8) reports that the low storage has affected local businesses and the National Park Service. Marinas have lost income, and some have relocated to new areas on the lake. When the reservoir level dropped to 1180 feet above sea level earlier this year (approximately 54 feet above the current level), the Park Service had to spend $6 million to extend roads, boat ramps, and utility lines. They approximate that each subsequent 20-foot decrease will cost an additional $6 million.

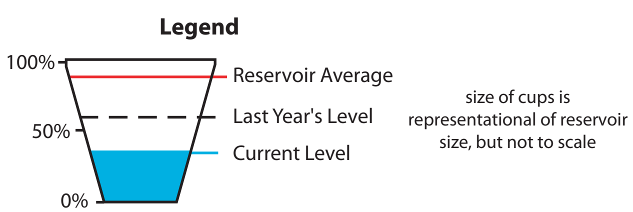
## Notes:

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 (red line) and the 1971–2000 reservoir average (dotted line).

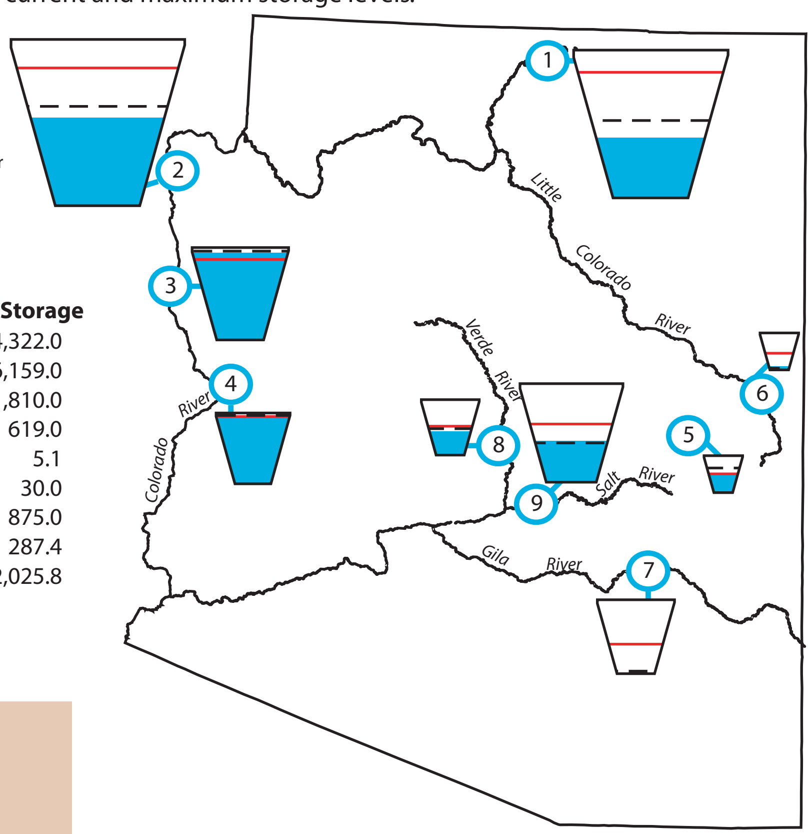
The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir.

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 (tpagano@wcc.nrcs.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 5.** Arizona reservoir levels for July 2004 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 | 41% | 9,914.0 | 24,322.0 |
| 2. Lake Mead | 53% | 13,924.0 | 26,159.0 |
| 3. Lake Mohave | 94% | 1,706.7 | 1,810.0 |
| 4. Lake Havasu | 96% | 594.9 | 619.0 |
| 5. Show Low Lake | 49% | 2.5 | 5.1 |
| 6. Lyman Reservoir | 10% | 3.1 | 30.0 |
| 7. San Carlos | 2% | 20.2 | 875.0 |
| 8. Verde River System | 43% | 124.4 | 287.4 |
| 9. Salt River System | 42% | 845.3 | 2,025.8 |




**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 7/31/04)**

**Source: National Water and Climate Center**

Reservoirs in the Land of Enchantment generally experienced a better month than those in Arizona, in terms of change in capacity. Most of them are near or above their level from last year as well (Figure 6). Of the locations in the north-central and eastern parts of the state, where more rain was received in July, only Lake Avalon showed an increase in capacity (44%). Some of the reservoirs exhibited substantial decreases. For example, the capacity in Costilla, Conchas, and Sumner lakes decreased between 9 and 23 percent.

In view of the low capacities in New Mexico's reservoirs, the ongoing drought, and apprehension about future water shortages, the state announced a request for proposals for methods to promote water conservation and develop new water supplies (*New Mexico Business Weekly*, July 21). At a meeting between United States and Mexican border governors in early August, water cooperation issues were raised. One document—the Rio Grande Compact—between New Mexico, Colorado, and Texas involves water storage and supply along the Rio Grande. The *Free New Mexican* (August 12) reports that New Mexico is prohibited from holding water in "upstream reservoirs" if Elephant Butte Lake contains less than 400,000 acre-feet or approximately 20 percent of its maximum storage. The lake is currently near 143,700 acre-feet (7 percent of maximum). New Mexico State Parks announced on August 11 that Sumner Lake State Park reopened for boating and other water activities. The lake had been closed to boating since June 21, but recent precipitation has increased levels deemed safe for boating.

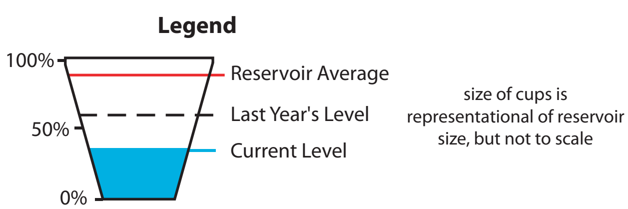
## Notes:

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 (red line) and the 1971–2000 reservoir average (dotted line).

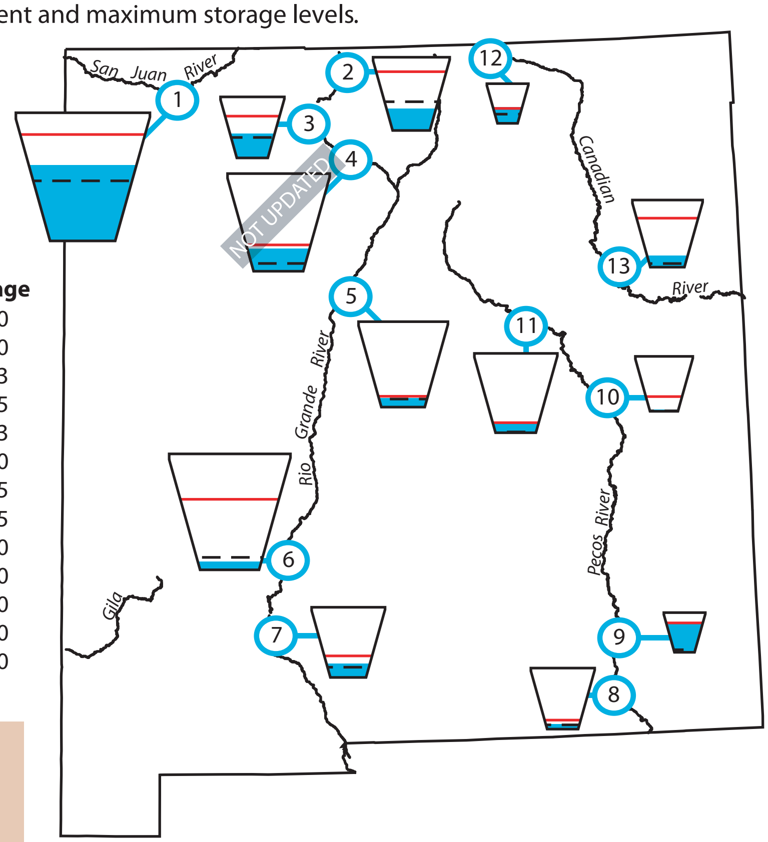
The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir.

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 (tpagano@wcc.nrcs.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 6.** New Mexico reservoir levels for July 2004 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 | 59% | 995.4 | 1,696.0 |
| 2. Heron | 30% | 118.8 | 400.0 |
| 3. El Vado | 40% | 73.6 | 186.3 |
| 4. Abiquiu NOT UPDATED | 23% | 130.1 | 554.5 |
| 5. Cochiti | 10% | 50.1 | 502.3 |
| 6. Elephant Butte | 7% | 143.7 | 2,065.0 |
| 7. Caballo | 20% | 66.5 | 331.5 |
| 8. Brantley | 8% | 11.6 | 147.5 |
| 9. Lake Avalon | 72% | 4.3 | 6.0 |
| 10. Sumner | 3% | 2.8 | 102.0 |
| 11. Santa Rosa | 11% | 49.0 | 447.0 |
| 12. Costilla | 40% | 6.4 | 16.0 |
| 13. Conchas | 17% | 43.5 | 254.0 |




## 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 Fire Summary

### (updated 8/23/04)

**Source: Southwest Coordination Center**

There have been more than 2,900 wildland fires in Arizona and New Mexico through mid-August (Figure 7a). Arizona has had more human-caused fires (923) than the total number of fires (human- and lightning-caused combined) in New Mexico (852). The total acres burned in the Southwest stood at 299,485 acres as of August 23, of which Arizona accounts for more than 216,500 acres. Both figures are slightly above the historical averages. Locations of large (greater than 100 acres) wildland fires from January 1 through August 23 are shown in Figure 7b. The greatest concentration of fires is in central and east-central Arizona near the Mogollon Rim and other high-elevation areas. The dangers left in the aftermath of large fires are of concern. The Burned Area Emergency Response team, a group of scientists who studies and works in areas where fires have occurred, believe that runoff in the area of the Nuttall Fire Complex may increase by up to 400 percent in some areas (*Eastern Arizona Courier*, July 28). Higher runoff tends to result in more and faster soil erosion. A large portion of the plants that once secured the soil with their roots can be destroyed by fire, which leads to little or no soil support. Runoff from heavy rains then creates higher rates of erosion. The potential for destructive landslides is of special concern in areas with steep slopes. Runoff on Mount Graham recently led to clean-up efforts by Safford Highway Maintenance, as rock and logs crossed several roadways, although no damage was reported (*Eastern Arizona Courier*, August 9).

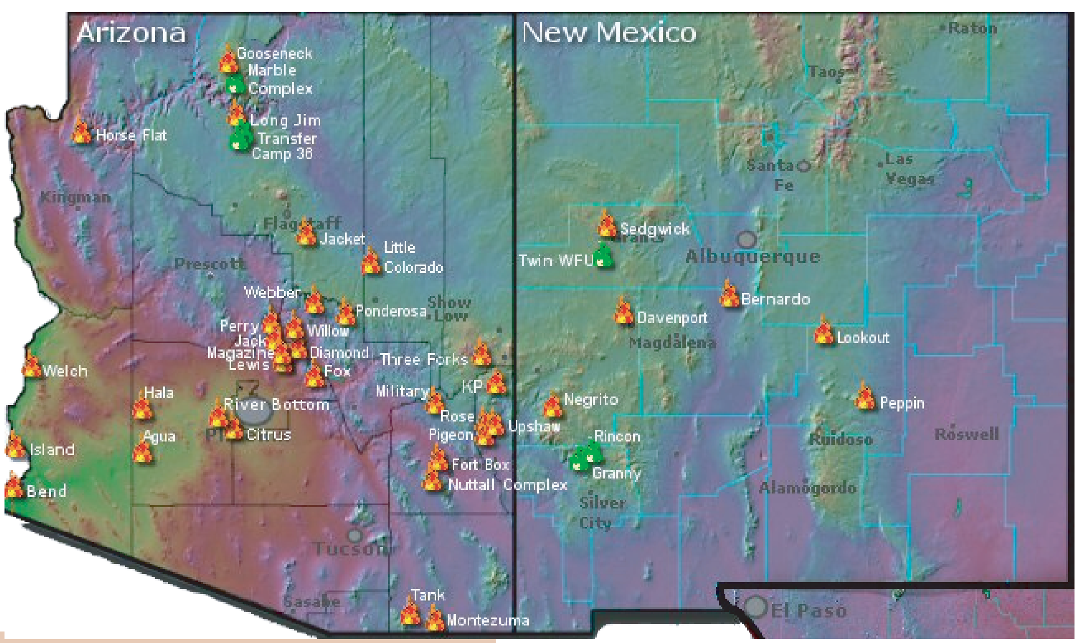
## Notes:

The fires discussed here are "large" fires, defined as those covering 100 acres or more, which have been reported by federal, state, or tribal agencies during 2004. The figures include information both for current fires and for fires that have been suppressed. Figure 7a shows a table of year-to-date fire information for Arizona and New Mexico. Prescribed burns are not included in these numbers. Figure 7b indicates the approximate location of past and present fires, both wildfires and prescribed burns. The orange fire symbols indicate wildfires ignited by humans or lightning. The green fire symbols are prescribed fires started by fire management officials. The name of each fire is provided next to the symbol.

**Figure 7a.** Year-to-date fire information for Arizona and New Mexico as of August 23, 2004.

| Location | Human Caused Fires | Human caused acres | Lightning caused fires | Lightning caused acres | Total Fires | Total Acres |
|---|---|---|---|---|---|---|
| Arizona | 923 | 44,858 | 1,211 | 171,758 | 2,134 | 216,616 |
| New Mexico | 285 | 17,091 | 567 | 65,778 | 852 | 82,869 |
| Total | 1,208 | 61,949 | 1,778 | 237,536 | 2,986 | 299,485 |

**Figure 7b.** Year-to-date wildland fire location. Map depicts large fires of greater than 100 acres burned as of August 23, 2004.




## On the Web:

These data are obtained from the Southwest Area Wildland Fire Operations website:

http://www.fs.fed.us/r3/fire/swapredictive/swaintel/daily/ytd-daily-state.htm
http://www.fs.fed.us/r3/fire/swapredictive/swaintel/daily/ytd-large-map.jpg

# Monsoon Summary (through 8/18/04)

**Source: Western Regional Climate Center**

Most of the Southwest has received between 1.0 and 3.5 inches of precipitation since July 1 (Figure 8a). Extreme south-central and east-central Arizona and the eastern slopes of the New Mexican mountains have recorded at least 5 inches. Areas that are relatively drier include the northern border between Arizona and New Mexico and the Colorado River valley. The departure from average precipitation shows that a large portion of the region is within 1.5 inches of July through August 18 average rainfall (Figure 8b). In terms of percent of average precipitation, the region is generally less than 90 percent (Figure 8c). The areas that have experienced above-normal percentage of average precipitation follow the same pattern that is seen in departure from average precipitation in Figure 8b. Since the average rainfall in these areas is low, a change relative to average amounts appears as a large percentage increase. The lower Colorado River valley stands out at around 25 percent of average precipitation. The monsoon officially began in Tucson on July 11, which is the tenth latest onset on record. According to the National Weather Service, Tucson, Arizona is 2 inches below average, but Sierra Vista, Arizona is nearly 3 inches drier than average for the monsoon season. Some locations in southeastern Arizona have received above-average rainfall; one such location is Clifton, which has recorded approximately twice its seasonal precipitation.

**Figure 8a.** Total precipitation in inches July 1–August 18, 2004.

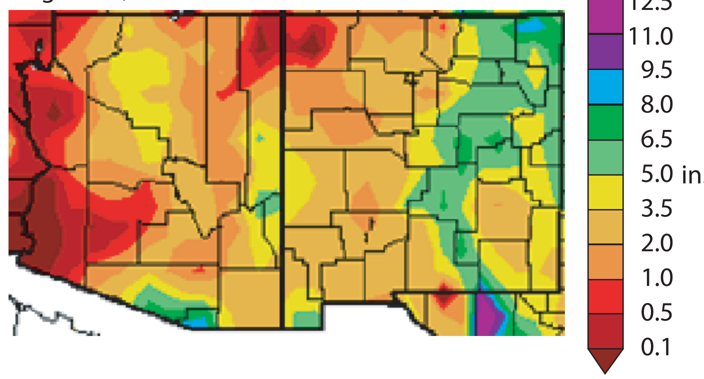



**Figure 8b.** Departure from average precipitation in inches July 1–August 18, 2004.

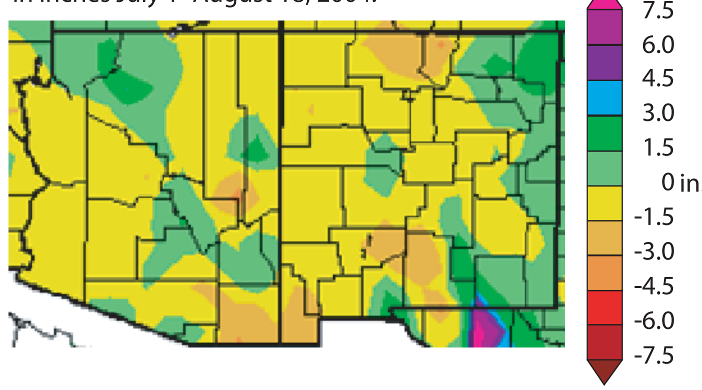
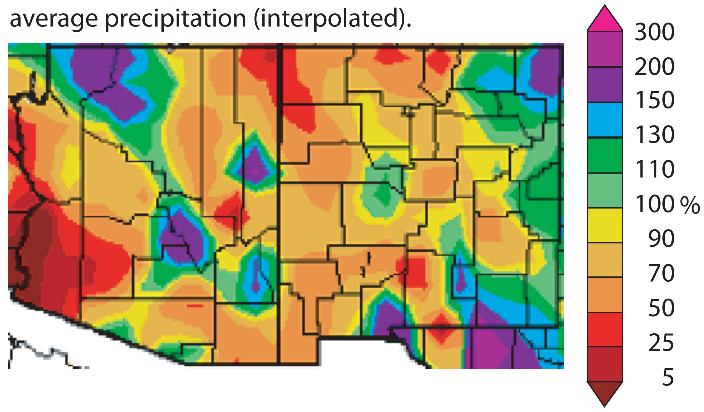



**Figure 8c.** July 1–August 18, 2004 percent of average precipitation (interpolated).




## 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-8c) 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 has not yet been subjected to rigorous quality control.

# Temperature Outlook
## (September 2004–February 2005)
**Source: NOAA Climate Prediction Center**

The NOAA-Climate Prediction Center (CPC) indicates slightly increased chances of above-average temperatures for much of the southwestern United States through January 2005 (Figures 9a–c). Judgment is withheld for the entire state of New Mexico and the eastern third of Arizona in the outlook for December through February (Figure 9d). This period also indicates that much of the West has slightly increased chances of warmer-than-average conditions. The forecasts issued by the International Research Institute for Climate Prediction (IRI; not shown) are similar for the first, second, and last periods (Figures 9a, 9b, 9d). However, IRI shows an extensive region with increased chances of above-average temperatures in the northern Great Plains. These forecasts are based mainly on long-term temperature trends, especially in the Southwest, and indications from statistical forecast tools.

### 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 September–November 2004.

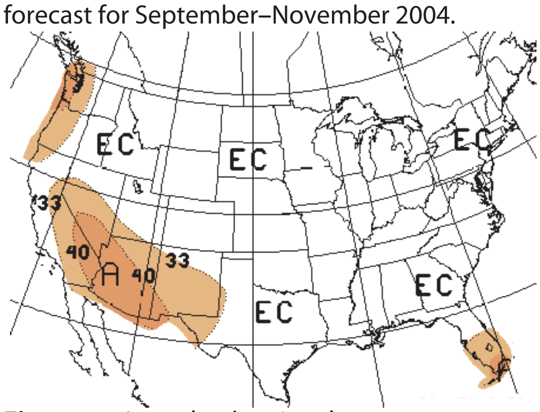



**Figure 9b.** Long-lead national temperature forecast for October–December 2004.

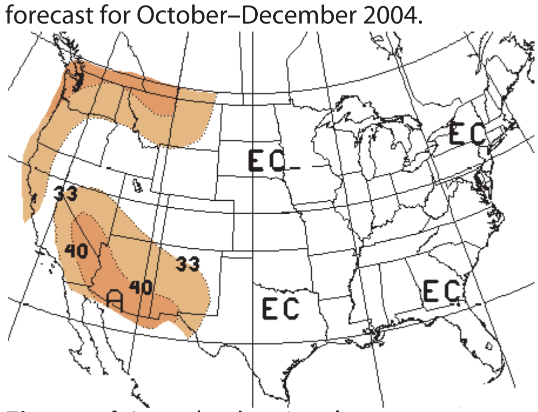



**Figure 9c.** Long-lead national temperature forecast for November 2004–January 2005.

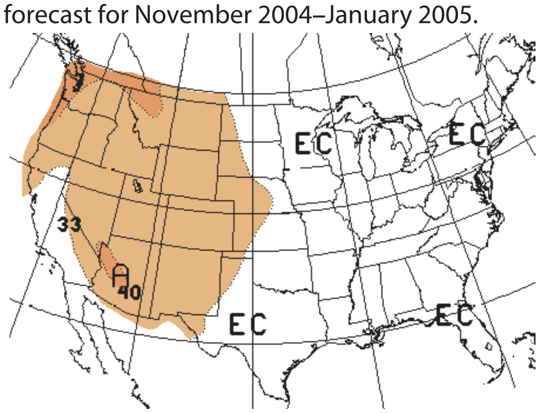
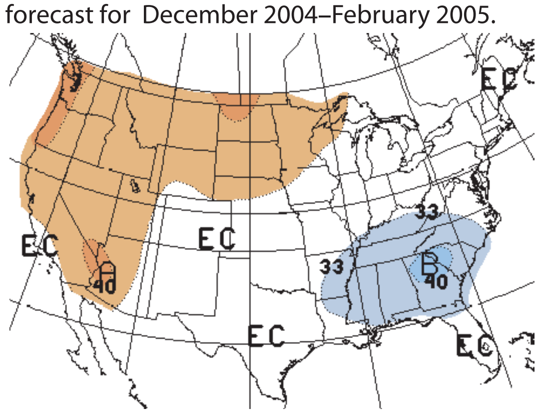



**Figure 9d.** Long-lead national temperature forecast for  December 2004–February 2005.




A= Above: 40.0–49.9%; 33.3–39.9%

B= Below: 33.3–39.9%; 40.0–49.9%

EC= Equal chances. No forecasted anomalies.

### On the Web:
For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

# Precipitation Outlook
## (September 2004–February 2005)
**Source: NOAA Climate Prediction Center**

The NOAA-CPC and International Research Institute for Climate Prediction (IRI; not shown) precipitation outlooks withhold judgment for the Southwest for September–December. During October 2004–January 2005, both forecasts indicate El Niño-related slightly increased chances of above-average precipitation in Arizona and New Mexico though differ in the expected spatial extent. For November–January NOAA-CPC predicts slightly increased chances of above-average precipitation across Arizona and western New Mexico (Figure 10c). From December–February, much of Arizona is predicted to have slightly increased chances of wetter-than-average conditions (Figure 10d). IRI October 2004–January 2005 forecasts show increased chances of wetter-than-average conditions across the southern two-thirds of New Mexico, as well as in Arizona.

### 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 September–November 2004.

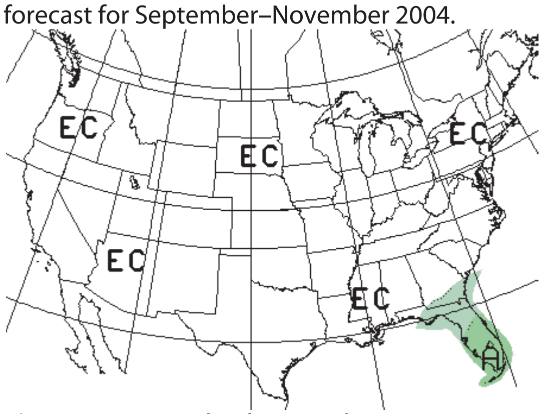



**Figure 10b.** Long-lead national precipitation forecast for October–December 2004.

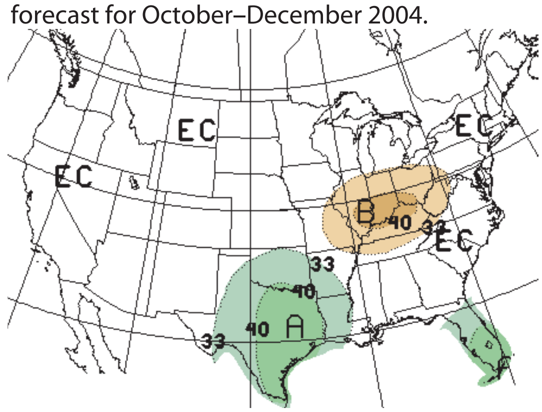



**Figure 10c.** Long-lead national precipitation forecast for November 2004–January 2005.

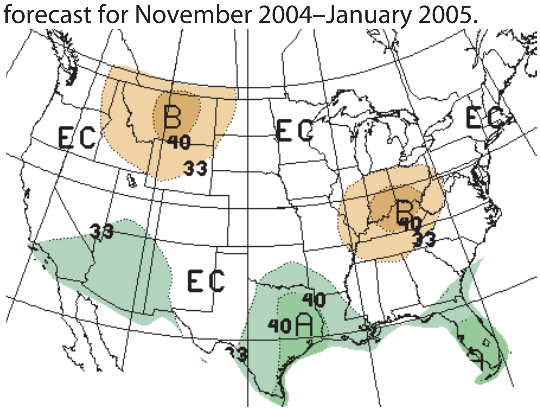
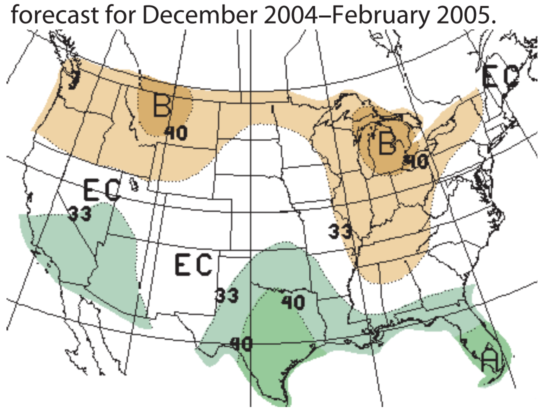



**Figure 10d.** Long-lead national precipitation forecast for December 2004–February 2005.




A= Above: 40.0–49.9%; 33.3–39.9%

B= Below: 33.3–39.9%; 40.0–49.9%

EC= Equal chances. No forecasted anomalies.

### On the Web:
For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

# Seasonal Drought Outlook

**(through November 2004)**

**Sources: NOAA Climate Prediction Center**

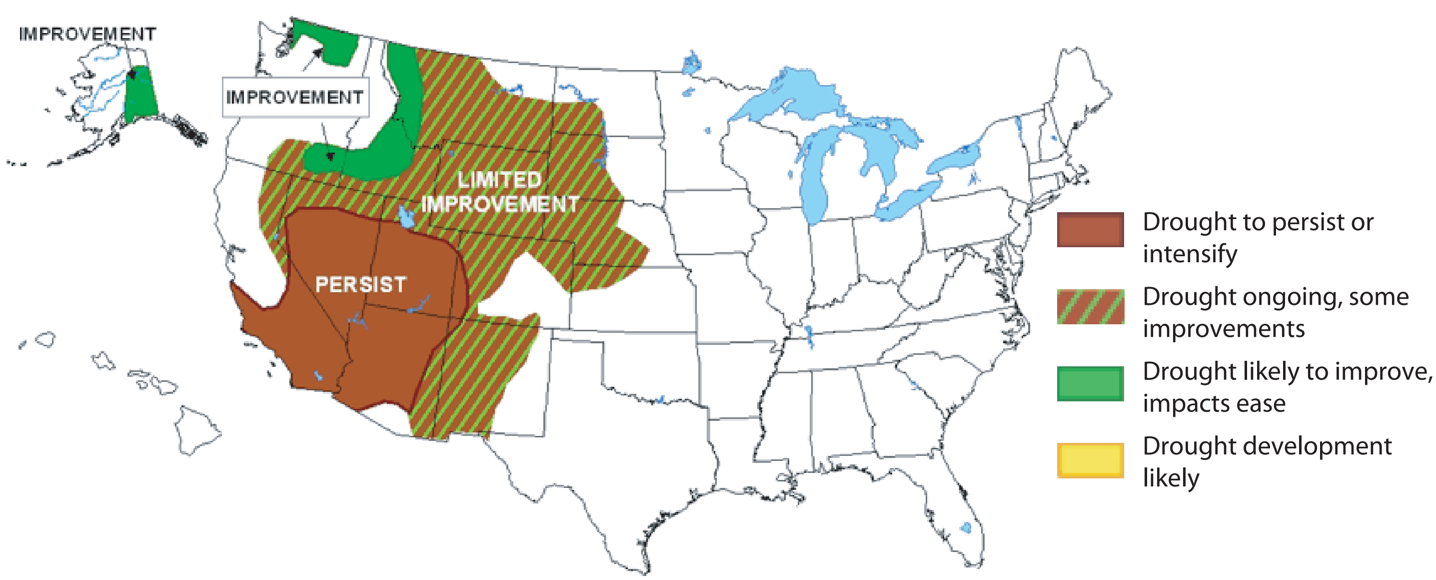
Impacts of the drought are predicted to improve in the northwestern United States, while limited improvements are forecast for much of the remainder of the West (Figure 11). Drought intensity in southern California, Nevada, Utah, Arizona, and parts of Colorado and New Mexico are expected to persist. A continuation of the drier-than-average conditions would likely fuel debates about allocation of water in the Colorado River, as farmers near Yuma, Arizona, and in the Imperial Valley in southeastern California have been fighting to keep their share. The *Arizona Republic* (July 25) reports that farmers in the region have been accused of wasting too much water and have felt pressure from large southern California cities and Department of Interior officials. The U.S. Bureau of Reclamation is working with the farmers to help with more efficient use of the water. Many farmers are willing to do their part, but they argue that others have to contribute to water conservation efforts as well.

Albuquerque recently began construction on a water-diversion project that will provide 70 percent of the city's water needs once completed in 2006 (*New Mexico Business Weekly*, August 10). The water will be taken from the Rio Grande instead of continuing to pump from an underground aquifer, which has not been refilling at the same rate as water has been removed. Elsewhere, Nevada officials have submitted an appeal for agricultural disaster relief to state Governor Kenny Guinn and Agriculture Secretary Ann Veneman after reviewing crop damage assessment reports from county emergency boards (The *Casper Star-Tribune*, August 17). If the designation is granted, farmers and ranchers may apply for low-interest loans if they meet eligibility standards. As this climate outlook is headed for release, the *New York Times* (August 22) reports that the seven Colorado River Basin states are negotiating a change in the Law of the River, in order to avoid conflict between the upper and lower basin states. Such a move would be unprecedented. The suggested changes would attempt to stabilize the level of Lake Powell, while decreasing the level of Lake Mead.

**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 November 2004 (release date August 19, 2004).




**On the Web:**

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

# Wildland Fire Outlook

**Sources: National Interagency Coordination Center, Southwest Coordination Center**

Portions of Arizona and Nevada have a greater-than-average large wildland fire potential due to the ongoing dry conditions. Much of the Southwest is expected to have moderate potential for large (greater than 100 acres) fire development; the exception is northwestern Arizona, where the likelihood is high to very high (Figure 12b). The moisture (both higher humidity and precipitation) that much of the region experiences during the monsoon typically does not have a significant impact on this area. While the precipitation received during the monsoon is below average overall, the increased atmospheric moisture can increase fuel moisture in plants. Higher fuel moisture essentially means that fires do not ignite or spread as quickly. Short dry periods and windy conditions are sometimes sufficient to promote drying though. *Time* (August 9) reports that the fires and acreage burned in Southern California thus far are well above last year's totals, and that several additional fires the size of the Nuttall Complex (eastern Arizona) or the Peppin Fire (southeastern New Mexico) may turn 2004 into one of the top fires years in the western United States. The potential for large (greater than 100 acres) wildland fires is below-average in part of the Mid-Atlantic and eastern Great Lakes states through the end of August (Figure 12a). East-central Alaska, Northern Minnesota, the northwestern United States, and the West Coast also have a greater-than-average large wildland fires potential due to the ongoing dry conditions. The seasonal drought outlook (Figure 11) shows that the drought in these areas is expected to persist, although some locations may experience limited improvement.

**Figure 12a.** National wildland fire potential for fires greater than 100 acres (valid August 1–31, 2004).

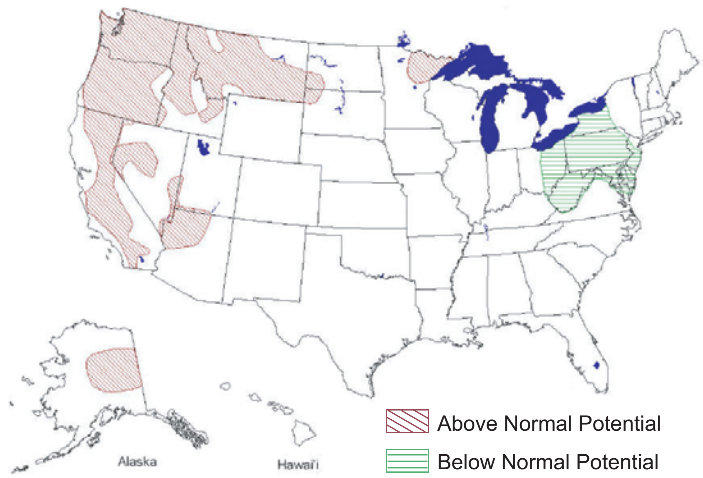
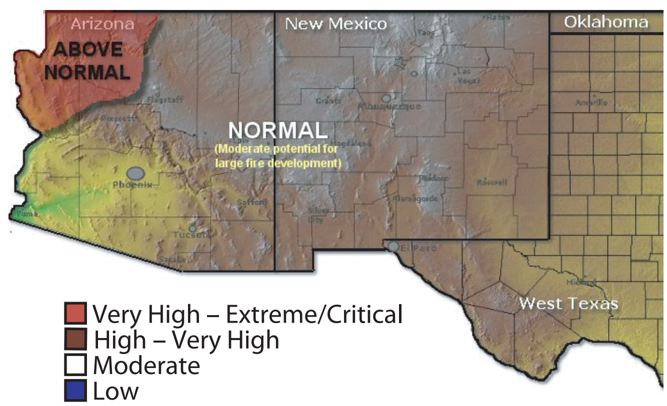



**Figure 12b.** Southwest monthly fire danger outlook (valid August 1–31, 2004).




## Notes:

The National Interagency Coordination Center at the National Interagency Fire Center produces monthly (Figure 12a) wildland fire outlooks. These forecasts consider climate forecasts and surface-fuels conditions in order to assess fire potential for fires greater than 100 acres. They are subjective assessments, based on synthesis of regional fire danger outlooks. The Southwest Coordination Center produces more detailed monthly subjective assessments of fire danger for Arizona, New Mexico, and west Texas (Figure 12b).

## On the Web:

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

Southwest Area Wildland Fire Operations (SWCC) web page:
http://www.fs.fed.us/r3/fire/

# El Niño Status and Forecast

**Sources: NOAA Climate Prediction Center, International Research Institute for Climate Prediction**

The International Research Institute for Climate Prediction (IRI) probabilistic ENSO forecast shows a 50 percent chance of El Niño conditions in the equatorial Pacific Ocean through late November (Figure 13a). The likelihood decreases slightly throughout the winter to near 40 percent by January–March, as the probability of neutral conditions increases. On average, there is only a 25 percent chance of El Niño developing during any given year. The NOAA-Climate Prediction Center (CPC) predicts that, based on recent oceanic and atmospheric trends in the Pacific Ocean, El Niño conditions will develop during the next three months. CPC reports that about half of their models forecast El Niño conditions, while the remaining models point toward near-neutral conditions. The Southern Oscillation Index (SOI), which measures the atmospheric strength of ENSO (Figure 13b), displays a slight trend toward the development of El Niño conditions; however, IRI reports that the atmosphere is not yet engaged in classic El Niño behavior. NOAA-CPC believes that any impacts to North America will be minor throughout the remainder of the summer and most of autumn (*Reuters*, August 19). According to CPC, weak El Niños slightly increase the chances of above-average precipitation in the Southwest, but they do not decrease the chances of below-average precipitation. El Niño is normally the strongest during the winter.

As demonstrated in the July 2002 CLIMAS Southwest Climate Outlook, weak-to-moderate El Niños can result in widely varying precipitation impacts in the Southwest. Other information on El Niño, how it works, and its effects on the Southwest can be found in past CLIMAS Southwest Climate Outlooks on the web at: http://www.ispe.arizona.edu/climas/forecasts/archive. Select July 2002 and February 2003 for detailed El Niño discussions.

## Notes:

Figure 13a 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.

Figure 13b shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through July 2004. 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.

## 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 13a.** IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released August 19, 2004). Colored lines represent average historical probability of El Niño, La Niña, and neutral.

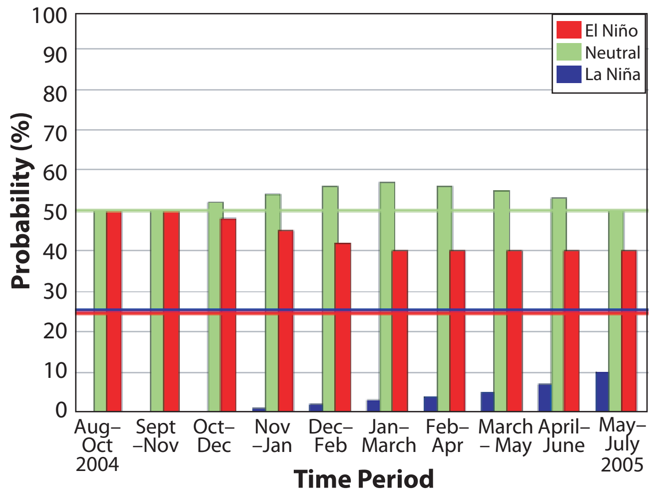
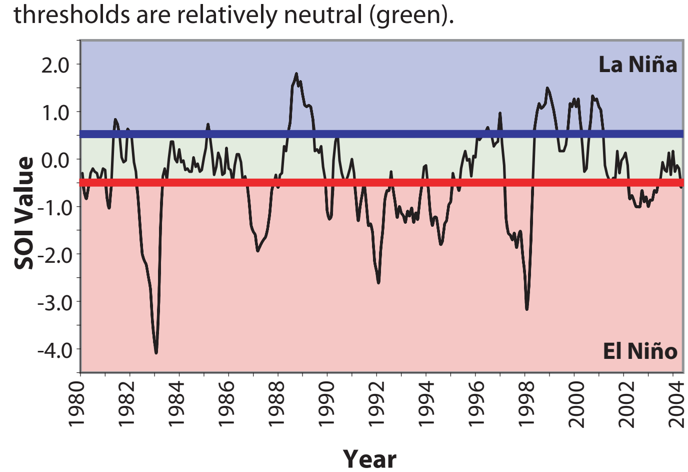



**Figure 13b.** The standardized values of the Southern Oscillation Index from January 1980–July 2004. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).



# Temperature Verification
**(May–July 2004)**

**Source: NOAA Climate Prediction Center**

The May through July forecast issued by the NOAA-Climate Prediction Center (NOAA-CPC) did not indicate increased chances of below-average temperatures for the continental United States (Figure 14a). Much of the West Coast and the southern tier of the United States were predicted to have increased chances of above-average temperatures, with the highest likelihood in southwestern Arizona. Areas that experienced below-average temperatures from May through July were the central third of the United States (up to 4 to 6 degrees Fahrenheit below average in the extreme northern Great Plains), the Great Lakes region, and New England (Figure 14b). Most of the central United States was only two to four degrees F below average. The remainder of the country generally had slightly above-average temperatures (0 to 4 degrees Fahrenheit). The NOAA-CPC forecasts verified best in the Southeast and Pacific Northwest, while the cooler-than-average conditions in the central U.S. and into New England were not indicated. Except for east-central and west-central Arizona, the Southwest had near-average temperatures.

**Figure 14a.** Long-lead U.S. temperature forecast for May–July 2004 (issued April 2004).

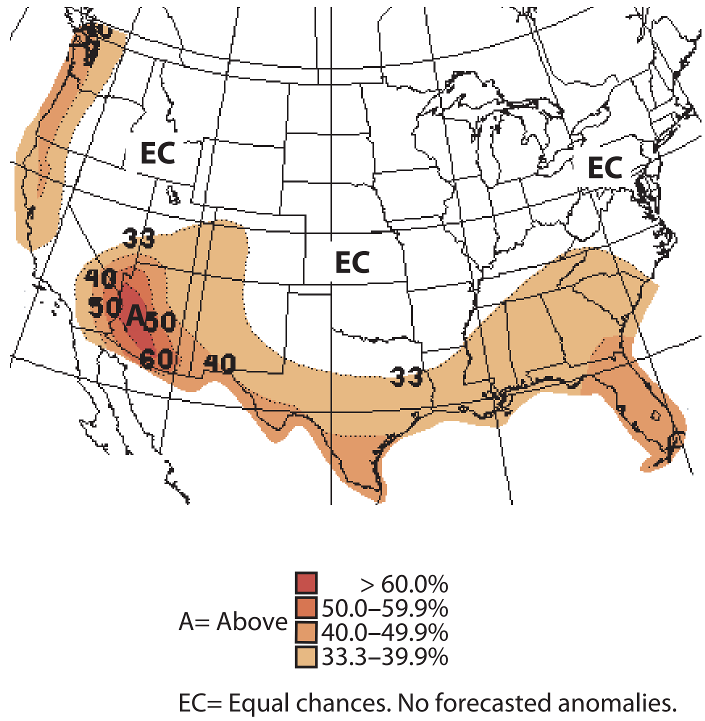
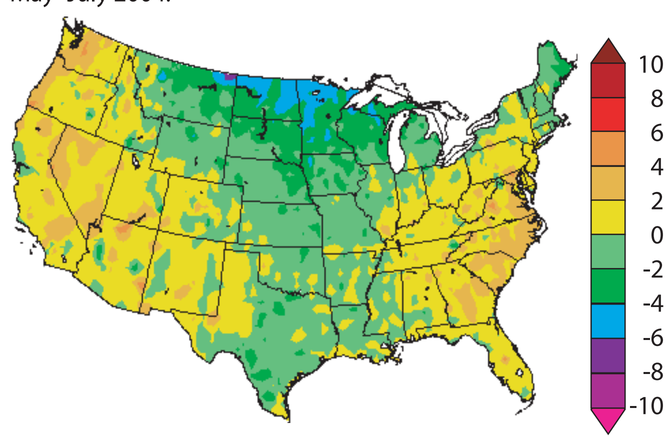



**Figure 14b.** Average temperature departure (in degrees F) for May–July 2004.




## Notes:

Figure 14a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months May–July 2004. This forecast was made in April 2004.

The May–July 2004 NOAA CPC 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. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps described below.

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 14b shows the observed departure of temperature (°F) from the average for May–July 2004.

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

## On the Web:

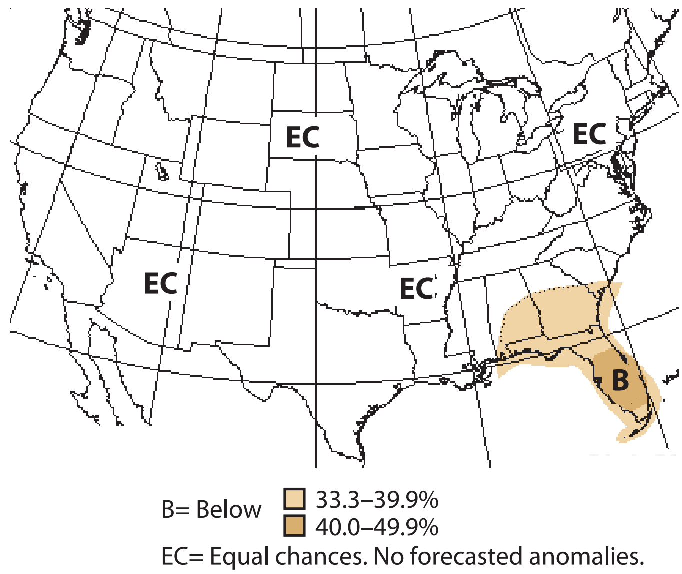
For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

# Precipitation Verification
## (May–July 2004)

**Source: NOAA Climate Prediction Center**

The NOAA-Climate Prediction Center did not forecast any precipitation anomalies for the majority of the continental United States for May through June (Figure 15a). The lone exception was the southeastern portion of the country, which had increased chances of below-average rainfall, particularly over southern Florida. The observed precipitation for this region turned out to be near normal or slightly above average during the May–July period. Much of the western United States experienced below-average precipitation during this period (Figure 15b). The driest areas included California, Nevada, western Arizona, and along the borders of Utah, Colorado, Arizona, and New Mexico, where 50 percent or less of the average May through July precipitation fell. May and June are typically dry in the Southwest, although July can be quite wet. Precipitation for the three month period was only about 60 percent of average for the region. The northern Rocky Mountains and the eastern half of the U.S. were near to well-above average. The most notable wet areas were the states along western coast of the Gulf of Mexico and in the Great Lakes.

**Figure 15a.** Long-lead U.S. precipitation forecast for May–July 2004 (issued April 2004).




## Notes:

Figure 15a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months May–July 2004. This forecast was made in April 2004.

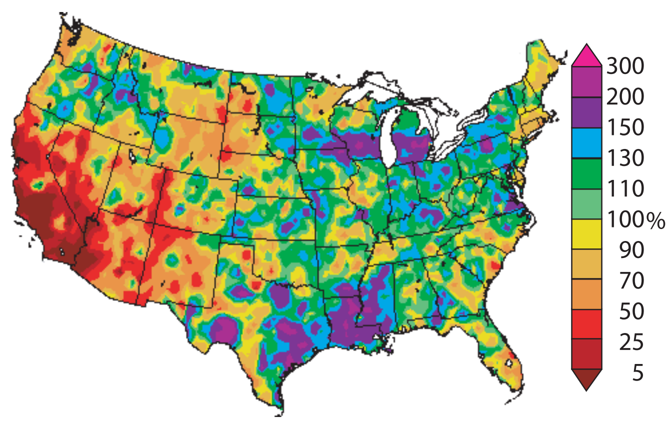
The May–July 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps described below.

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 15b shows the observed percent of average precipitation observed May–July 2004.

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 15b.** Percent of average precipitation observed from May–July 2004.




## 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

# Monsoon Bursts and Breaks

**Source: National Climatic Data Center and National Weather Service**

The summer monsoon is the main precipitation source for much of western Mexico and the Southwest United States, delivering up to 70 percent of the annual precipitation in Mexico and 40–50 percent in parts of Arizona and New Mexico. The coverage of the precipitation can vary significantly, with some locations receiving much rain and others very little.

There are periods known as "breaks" when atmospheric moisture is insufficient for thunderstorm or precipitation development due to large-scale pressure systems bringing dry air to the region (Figure 16b). Based on data from 1977–2001, Tucson typically has four breaks annually, each lasting for four days on average (Figure 16a). Periods when moister air enters the region are known as "bursts." They occur when the weather pattern favors southerly or southeasterly winds, and thunderstorms become more widespread. The moist air persists for a longer duration than breaks—about 13 days on average (Figure 16a), although three weeks is not unusual.

Monthly precipitation amounts in Tucson during the 1981 monsoon show how breaks and bursts affect rainfall. The monsoon began on June 25 according to the Tucson National Weather Service office. In July, 6.17 inches of precipitation (much above average) was recorded. Most of this period (July 6–31) was characterized by high humidity. In contrast, August contained several breaks of 2–5 days duration, and the monthly precipitation was only 0.80 inch (much below average).

In an annual comparison, 9.85 inches of rain were recorded during the monsoon at Tucson in 1990 (3.8 inches above average) with only two breaks (July 28–30 and August 20–26). Five breaks, each from 2–10 days in duration, occurred in 1991. The total precipitation for that summer was 4.15 inches (3.9 inches below average). Thus, the number of breaks can play a significant role in the amount of precipitation during the monsoon.

## On the Web:

For more information on bursts and breaks visit:
National Climatic Data Center
http://www.ncdc.noaa.gov

Tucson National Weather Service
http://www.wrh.noaa.gov/tucson/
and http://www.wrh.noaa.gov/tucson/monsoon/monsoon.html

Flagstaff NWS website
http://www.wrh.noaa.gov/Flagstaff/science/monsoon.htm

## Notes:

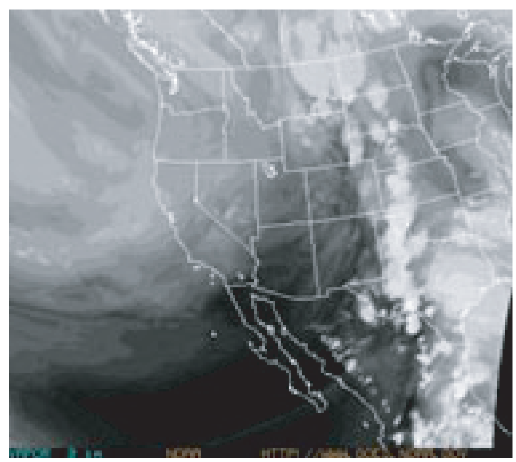
Portions of the information on this page are being used for current research at the University of Arizona and will be submitted to a climate science journal for review. Therefore, the conclusions remain proprietary and are not intended for use by others without the permission of Rick Brandt (rbrandt@u.arizona.edu).

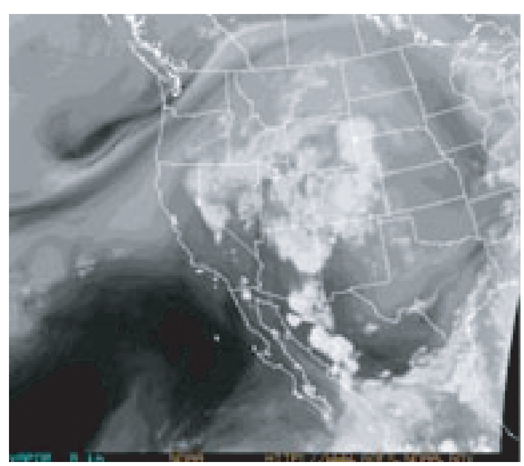
The satellite images in Figures 16b are from the Flagstaff NWS website. They show the amount of water vapor in the atmosphere. Dark regions indicate dry air, while light regions are locations of much moisture. The whitest areas are thunderstorms. The top image shows a lack of clouds and thunderstorms in our region during a break. The bottom image shows thunderstorms in eastern and northern Arizona and northwestern Mexico during a burst.

**Figure 16a.** Break and burst statistics for 1977–2001 in Tucson.

| | Break | Burst |
|---|---|---|
| Average duration (in days) | 3.9 | 12.8 |
| Maximum duration (in days) | 17 | 71 |
| Minimum duration (in days) | 1 | 1 |
| Average number | 4.2 | 5.2 |
| Maximum number | 8 | 9 |
| Minimum number | 1 | 1 |

**Figure 16b.** Water vapor satellite images of a break (top) and a burst (bottom).





# Albuquerque NWS Website

**Source: National Weather Service, Albuquerque**

Each National Weather Service (NWS) office has a website where the public can obtain forecasts, warnings, observations, and climate data. Some offices also provide links to summaries of weather during past months and highlight research that is performed by the meteorologists in that office. This month, we focus on a few pages of interest from the Albuquerque NWS.

Summaries of weather during past months can be viewed using one of two methods: (1) selecting the link at the top of the homepage under the heading "Latest News" or (2) scrolling down to the "Climate" section in the menu in the left-hand column and selecting the "Monthly Highlights" link. The first method will take you directly to the most recent monthly summary, while the second method allows you to choose a summary for any month in the past four years. Typically, one or two significant weather events, like severe thunderstorms or heavy rain, are discussed with accompanying weather radar images and tables of weather events (Figure 17a and 17b). Also, graphs of daily temperature and precipitation for Albuquerque are provided and briefly analyzed (Figure 17c).

Research performed by office meteorologists is available by selecting "Local Research" under "Additional Info" on the left-hand side of the homepage. This link contains both technical and non-technical studies (some as web pages and others as downloadable files) and is divided into five sections: "Recent Additions," "Climate Studies," "Seasonal," "Local Interest," and "Miscellaneous Summaries." For example, "Climate Studies" includes research about teleconnections, such as the effect of the El Nino-Southern Oscillation on precipitation, while growing season information is available in the "Seasonal" section. "Local Reviews" mainly focuses on the Albuquerque area, and "Miscellaneous Summaries" examines statewide weather events.

## Notes:

The two sections of the Albuquerque NWS website discussed here are also available by typing the following addresses directly into the address bar on your Internet window: http://www.srh.noaa.gov/abq/climate/Monthlyreports/monthly.htm for monthly highlights and http://www.srh.noaa.gov/abq/research/feature.htm for local research. Readers are also encouraged to explore the other pages on the Albuquerque NWS website. To search the web pages of any of the 124 NWS offices in the U.S. and U.S. territories, go to http://weather.gov/organization.php and click on the link for the location of interest.

### On the Web

Albuquerque NWS homepage
http://www.srh.noaa.gov/abq/

**Figure 17a.** Weather radar image of thunderstorms near Albuquerque on July 23, 2004.

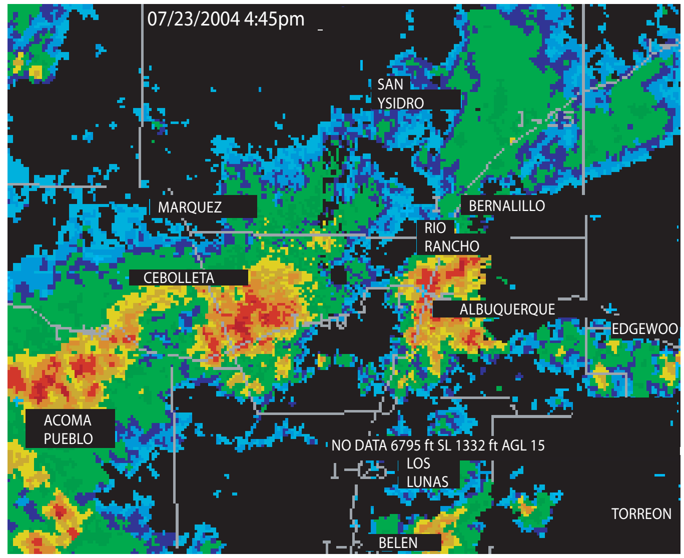



**Figure 17b.** Summary table of rainfall in Albuquerque during a strong July thunderstorm.

| Rainfall Across Albuquerque July 23, 2004 | |
|---|---|
| Location | Rainfall (inches) |
| Girard/Kathryn | 2.30 |
| San Pedro/Lomas | 1.53 |
| Albuquerque Sunport | 1.19 |
| Four Hills | 0.71–0.90 |
| Louisiana/San Antonio | 0.80 |
| Montgomery/Morris | 0.77 |
| Comanche/Wyoming | 0.68 |
| Constitution/Wyoming | 0.68 |
| Lomas/Tramway | 0.55 |
| Indian School/Morris | 0.52 |

**Figure 17c.** Graph of minimum temperatures in Albuquerque that compares the July 2004 measurements (vertical bars) with daily average values (horizontal line).