CLIMAS
Southwest Climate Outlook

September 2004 Climate Summary

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

- Agricultural drought status has been added to some portions of Arizona and New Mexico.
- Far eastern New Mexico remains free of all drought categories.
- Storage in many reservoirs in Arizona and New Mexico continues to decrease.

Precipitation – Precipitation for the water year is below average for most of Arizona and New Mexico. Monsoonal rains have been rare since mid-August. Precipitation from the remnants of Hurricane Javier did help the Southwest, but the climate products capturing this event will appear in next month's outlook.

Temperature – The Southwest was generally cooler than average over the past 30 days.

Climate Forecasts – Seasonal forecasts indicate slightly increased probabilities of above-average temperatures for much of Arizona through March. Increased chances of cooler-than-average conditions are predicted for eastern New Mexico through January. There are no predicted anomalies in precipitation until the December–February period.

El Niño – A weak El Niño is in progress, and it is expected to strengthen slightly in the next several months. Effects of this event may not be seen until late winter or early spring.

The Bottom Line – Hydrological drought is expected to persist in Arizona through December, while 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

Developing El Niño

The NOAA Climate Prediction Center expects that an El Niño will develop in the next three months, based on current tropical Pacific Ocean sea surface temperatures. The impact that this event will have in the Southwest is yet to be determined. A more southerly track of storms during El Niño conditions can tap into tropical moisture in the eastern Pacific Ocean, which tends to result in wetter-than-average winters for the Southwest. A wet winter may improve, but not completely alleviate, dry conditions in the region.

For detailed discussions of El Niño's effect on the Southwest check out the this month's feature article and focus page.

See pages 2 and 21 for more on El Niño...

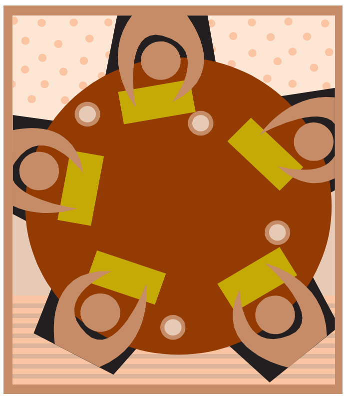
In this issue:

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®

Climate experts discuss Southwest drought

The following is an abbreviated portion of a roundtable discussion on drought held on September 10, 2004. Some definitions and explanations are included within the discussion (in italics). Please see the CLIMAS online glossary (http://www.ispe.arizona.edu/climas/forecasts/glossary.html) for terms that are not defined here.



Roundtable Participants

Julia Cole, PhD, associate professor, Geosciences, University of Arizona

David Gutzler, PhD, professor, Earth and Planetary Sciences, University of New Mexico

David Meko, PhD, associate research professor, Laboratory of Tree-Ring Research (LTRR), University of Arizona

Klaus Wolter, PhD, meteorologist, Climate Diagnostic Center, Boulder and research associate, University of Colorado

Melanie Lenart, PhD, *roundtable moderator* research associate, Climate Assessment for the Southwest, University of Arizona

Lenart: Well, thank you so much everybody for participating in this roundtable discussion on drought. Let me just give you a little background before we begin. A version of this discussion will be published in our September packet of the Southwest Climate Outlook. We publish this every month, and it began as an El Niño-Drought initiative that we launched in the summer of 2002. At that time, an El Niño year was forecast and CLIMAS thought it would be worthwhile to alert people to the concept that just because an El Niño winter was forecast, that doesn't mean the drought will end. It looks like we're in a similar situation again with an El Niño winter forecast while we're in the grip of intense drought in the Southwest. So, because all of you have some expertise with El Niño, drought and generally the monsoon as well, we thought you'd be an ideal group of people to address this topic for us. Let's get down to business now and get the scoop on where we're at with this drought. Do we have a mega-drought on our hands now—maybe even a drought so severe that it comes around every 500 years, like some media reports maintain?

Meko: Looking at those [tree-ring] reconstructions back to, say, 1500, the current drought is not a 1-in-500 year event. There may be a handful of droughts that were as severe. It depends really on how you summarize statistically the severity of the drought, but say if you took five-year moving averages that embrace the current dry period, there are other droughts in the past 500 years that exceed it. It's a bad drought, but it's maybe one of a half a dozen.

Wolter: It certainly hasn't lasted as long as some of the megadroughts of the past.

Gutzler: And it seems to me that that's probably the most meaningful measure of severity of a long-term drought, more so than whether one particular year is astoundingly dry compared to previous records. And by that standard, we're still, in many cases, in a hydrological drought in the Southwest. In New Mexico, anyway, we haven't reached the [longest] duration of sub-normal precipitation years yet—in fact, we'll come in above average this year according to much of the state. You know, the 1950s drought was six or seven years long and this one, arguably, is four. So, we're not to that standard yet, in New Mexico at least, although it's important to add there that over the last year or two, the center of the Southwest drought seems to have shifted westward somewhat. So that, where New Mexico might have been in the middle of it a year or two ago, it looks like the central part of the severe drought has moved farther west toward Arizona. Now, it's important to keep in mind that there are different aspects of drought. And so, what we're talking about here, is precipitation over the last year, and that has not been enough to fill up reservoirs or make streamflows anywhere near normal, so that from a hydrological perspective, despite relatively abundant rains recently, we're still locked in a very severe hydrologic drought in, say, the Río Grande valley. And it's certainly true farther west. Again, we have to make a distinction between the precipitation that's falling locally and what fills up the major rivers, for which we care a lot of about the precipitation that falls closer to where Klaus is sitting up in the headwaters regions in Colorado. But in New Mexico, over much of the state—and especially over much of the central and eastern parts—near-normal or even, to some extent, above-normal precipitation has extended back into last winter.

Lenart: And this brings up the point that people have emphasized, about how you can still have a good year of rainfall and snowfall within a drought. Does anyone want to address that? Getting back to the long-term drought question, does it seem like we could be coming out of it or do you think that we'll still be in it for another five or 10 years?

Wolter: I think with the drought, until you're really out of it, until the reservoirs are full again, you don't know. I think Kelly Redmond has a great phrase that getting out of a drought is like removing a fishhook: you know, you have to be very careful.

continued on page 3

Roundtable, continued

Lenart: So, that would be your criterion for recognizing that we're out of the drought, when the reservoirs are full again?

Wolter: Well, that's certainly the easiest. It's a very reasonable and easy to gauge. Obviously, in terms of ecosystems and the like, one would like to assess that too, but I'm not that quick to do that. It's very complex and I think there's some debate, really, on how to define the end of the drought.

Cole: Reservoir filling, in a sense, is a nice integrator because it doesn't respond to those little blips you would probably see in a climate data record, and that you certainly see in a paleodata record *(a record that goes back beyond instrumental records).*

Wolter: I guess a caveat is that you have to look at reservoirs that take more than one year's runoff to fill up.

Meko: Yeah, with some of these reservoirs, it really depends on how wet conditions get in individual years. Water managers talk about it taking decades of normal rainfall to refill, say, Lake Powell, but if you have extremely wet years, like we had in the 1980s, it can refill reservoirs fairly fast. You can have a tremendously wet year and refill the reservoirs and alleviate hydrologic drought in that way, but that still probably wouldn't alleviate environmental drought as far as stress on trees and on forests go because it's just rapid runoff to them.

Lenart: Do you want to talk about your preliminary findings at all on the Salt River? This seems like a good context for that.

Meko: With the Salt River project, some work that Katie Hirschboeck [also of the LTRR] and I are doing, we're looking at the joint drought occurrence on the Upper Colorado River Basin and the Salt River drainages in Arizona. And just looking at the Salt River flow itself, which is kind of a really nice hydrologic indicator of moisture conditions, integrating conditions over a mountainous area in eastern Arizona, during the last few years, there were a couple of very low years: 2002 and 2000 were lower than anything in the previous record of Salt River.

Cole: And that's instrumental data?

Meko: That's instrumental data, yeah. That's definitely disturbing to water managers to see that. Now, if you go to longer periods, it also all depends on how you analyze the drought, but if you go to five-year moving averages or 10-year moving averages, then it's still no more severe than the 1950s drought yet. So, you know, if this thing lasts a few more years, yeah, then it's going to start reaching at least all-time severity in the instrumental record.

Lenart: Okay, and what about this, do you think it will last? Klaus, maybe you can fill us in on some of the most current El Niño forecasts?

Wolter: Well, before I get to that, one comment. I'm not sure whether that applies to any other region, but here in the Colorado Front Range, over the last year, we have definitely seen that the general public…actually consumed consistently less water. It was like 27 percent less than they expected from the normal statistics. And it was partially because they had very severe restrictions [on using water], partially because it was expensive, costlier than usual, but we also happen to have had a very wet, consistently cloudy, cool summer. So they were actually able, last year, with a near-normal snowpack, to refill the reservoirs even though all the public predictions were, "Oh, it will take at least three years of near-normal [precipitation] to do that." So, I'm really not sure if this applies anywhere else, but this is actually an example where the human factor played a role. [Regarding the El Niño forecast,] there are quite a few people there who have actually come out publicly, saying there's no way there's going to be an El Niño this year. Famous last words…So it basically kicked in at the beginning of July and, the way it's looking right now, is going to continue. Incidentally, two year ago, you mentioned that earlier, the 2002–2003 El Niño, it was actually still a little bit warmer too [regarding sea surface temperatures in the region of the tropical Pacific known as Niño-3.4, Figure A]. I'm just pointing out that if you, and NOAA is kind of committed to this, if you use Niño-3.4 as your benchmark to define El Niño, that index, that particular index, has one of the strongest signals right now. So, in terms of how you speak about this event, if you go with the official NOAA definition, we already have a moderate event.

Cole: Regarding the current El Niño, although [sea surface] temperatures in the Pacific are warming up, there does not seem to be much response in the atmosphere, and the atmosphere's response in the Pacific is what drives the connections to climate in North America. Klaus, can you comment on why you think that's happening and whether you think that's going to make a big difference for its impact on U.S. climate, particularly Southwest climate?

Wolter: Well, I can get to the point right away. Arizona, for instance, the way I understand Arizona teleconnections to ENSO [the El Niño-Southern Oscillation], it has a very reliable, very robust wet signal in the winter if El Niño is very strong. So, if you take the top five or six events, it's almost a one-to-one relationship. As soon as you go below those strong events, it really, I wouldn't say it falls apart, but becomes much weaker. In fact, if you look at different model projections for the next six

continued on page 4

Roundtable, continued

months, the amount of moisture that comes into southern California and Arizona really depends on the degree of warming in the eastern Pacific, which has been on the cool side so far. So, for you guys, it makes a huge difference. I'm actually still running my own forecasts. I have carried a shift in the odds towards wet, not a big shift, but, you know, 5 to 10 percent in Arizona the last two months and that stayed. As best as I can tell, at least for the early winter, there definitely are better-than-normal odds for wet fall. My forecast for January through March continues this trend towards wetness in Arizona, while remaining undecided for New Mexico.

Gutlzer: I believe that's consistent, qualitatively at least, with what the Climate Prediction Center is calling for. They have called for some slight chance of "better than climatology" *(better than average)* for a wetter than normal winter across much of the Southwest.

Lenart: David Gutzler, I wonder if you could give us a little bit of information, getting away from the official forecast, from your research on how El Niño relates to some of the decadal-scale oceanic variability and what that might mean for us this winter?

Gutlzer: One of the uncertainties in making these El Niño-based forecasts is that not all El Niños are alike and, although we don't understand in a theoretical way what determines the differences in teleconnections and precipitation from one year to the next very well, there are some hints in the data that there may be long-term modulations in how El Niño affects storm tracks, for example. So, there are several people, and I'm one of them, who have looked at whether decadal-scale oceanic variations could modulate the predictability of precipitation in the Southwest based on El Niño. There's some indication that, back in the '50s and '60s when conditions were relatively drier across the Southwest, that El Niño provided somewhat less of a basis for predicting a wet winter and spring across the Southwest than in the subsequent decades after the Pacific Decadal Oscillation—the PDO—shifted in the late '70s. So, there may be some basis for saying that during some decades, El Niño reliably produces wet, cold-season precipitation in the Southwest, whereas in other decades that forecast is less reliable.

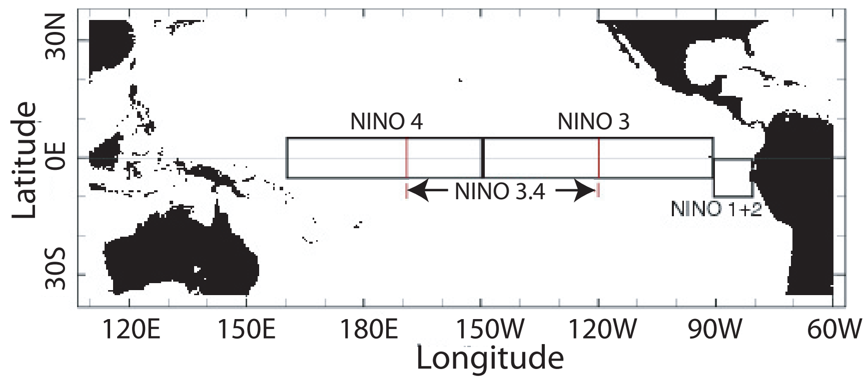


Figure A. ENSO observation areas in the equatorial Pacific region used to determine El Niño conditions by the National Oceanic and Atmospheric Administration.

Lenart: And what kind of a decade are we in now?

Gutlzer: Well, now there's yet another source of uncertainty. It's actually difficult to define what the state of the Pacific Decadal Oscillation is now because it has flip-flopped on shorter time scales itself. So there was some indication, that, a few years ago, after the 1997–1998 El Niño event, the Pacific Decadal Oscillation made a shift back to its so-called "negative" phase, which is what things were like in the 1950s and '60s. But it's hovered around zero back and forth since then. If you look at the index itself that we use, it's back positive, which is the wet phase for the Southwest. But, because it's flip-flopping a bit, it's a little hard to tell how that's working.

Cole: I had a comment on the Pacific Decadal Oscillation, too. First, there is a paper out recently that actually looked at the precipitation correlations in the Southwest with El Niño during PDO warm and cool phases. This is something that David Brown and Andrew Comrie here at the UA did [published in the May 2004 issue of *Geophysical Research Letters*]. They found that when they looked at the cool phase of the Pacific Decadal Oscillation, which was the period like we had in the '50s, that if you have warm El Niño-like conditions in the fall, you actually had drier conditions in the following winter during the cool phases of the Pacific Decadal Oscillation. And only when you went into the warm phase of the Pacific Decadal Oscillation, did you see this more canonical *(typical)* connection with warmer El Niño conditions being associated with wetter conditions here. And I had never heard that before, but it struck me as interesting because it goes exactly against what we've all been assuming about El Niño in the Southwest.

Gutzler: Melanie, this all pertains to drought because one of the mechanisms that some of us think about for really breaking a long-term drought is to have a really wet year, especially a wet winter to drive a big snowpack at the headwaters of the rivers and just fill up the reservoirs and drench the Southwest. In recent decades, we've come to think that the way to do that is with a big El Niño. So, one thing that people look at…was a big El Niño in 1957, which was near the end of that drought period. What we're starting to learn is that there are these modes of variability that make it difficult for the climate system to produce a big El Niño-driven wet year in ways that we still don't understand well

continued on page 5

Roundtable, continued

enough to make confident predictions. This does not look like its going to be an especially strong El Niño event compared to the really big ones like '97–98 or '82–83, when we really had tremendous warm anomalies in the ocean (*i.e., unusually warm sea surface temperatures in the region that indicates an El Niño*).

Meko: A comment on the El Niño and the drought. We could look back at just a few years in Arizona at the severe drought '94 through '96 and then coming into the El Niño of '97. And I guess there are a couple ways to look at it. You could say that the '97 El Niño ended that short drought of a few years or maybe it's just a little El Niño in a blip that's breaking a drought up into two—now we're just in the second phase of that drought.

Wolter: Did you actually have drought conditions in '94–95?

Meko: We had a severe drought in '94. We had one of the driest years down here in winter of '95–96.

Wolter: Yeah, I mention that because there was an El Niño in late '94 going into early '95 and, at this time of the year, it was actually stronger than the one [El Niño] we have right now. In Colorado, it ended up being quite wet. Actually, one of the hallmarks, I think, of the weaker El Niños is that you don't get precipitation anomalies quite as coherent and connected as with the bigger events.

Lenart: Julia, did you want to add something to this discussion?

Cole: Yeah, just that the discussion of the Pacific Decadal Oscillation always has me a little bit uneasy because I feel like this is a phenomenon that has been recognized for all of about 10 to 15 years. The PDO itself has time scales that are quite long—20 or 30 years between being in one mode or another—and yet we're talking about it as if we understand it as a natural mode of the system. And I worry about that, primarily because when we look at paleoclimate records that are sensitive to that system in the 20th century and try to understand how it's behaved prior to the 20th century, we find that those records don't give us answers that we might feel comfortable with. An example of that is, when you look at different people's reconstructions of the Pacific Decadal Oscillation before about 1910, they simply don't agree. And these are reconstructions developed using the best available records for 20th century sensitivity, which match the 20th century very well, but they simply don't carry back in time looking like a coherent system. So I worry that we're hanging a lot on the PDO issue without really knowing what it's all about and the fact that, for five years, it's kind of been flip-flopping back and forth right now and, some people have argued, shows characteristics of being both strongly positive and strongly negative. It makes me think that it might not be very helpful for prediction.

Meko: I'd like to make a comment about the importance of the seasonality of the rainfall in this area and the drought. Winter drought is not always occurring at the same time as summer drought, but sometimes they do occur in the same year and the stress on ecosystems, in particular, might depend on that strongly, that if you get failure of the summer rains and the winter rains, that is really going to hurt, say, tree growth. And we saw a lot of die-back of trees in the 1950s. That seemed to coincide with a failure of summer and of winter rains. So, it depends on the season and we might have to look at the cold season and warm season rains separately in summarizing drought for some purposes. Well, this year in particular, it seems the monsoon's not very good so far. I mean, we've had a very dry rainfall total from the cold season and it's at best spotty. We've had some summer rains, but in a lot of places it's 75 percent of normal or less for the summer. Those circumstances are really going to stress the trees in the mountains in Arizona.

Gutzler: As David Meko mentioned, it seems to me that, thinking back about drought, a really stressful drought period is one in which you have year-round dryness. That is one of the things that tended to characterize the big Southwest drought of the '50s and that, by definition almost, was a period of time when the sort of out-of-phase relationship we see between winter precipitation and summer precipitation broke down. So, in wetter periods, there does seem to be some tendency for wet winters to be followed by dry summers and the other way around. Which, again almost by definition, would tend to mitigate drought somewhat since we get most of our precipitation in the summer. If you have this flip-flop between winter and summer it's tough to have terribly long, persistent anomalies because one dry season gets followed by a wet season. One of the major puzzles for drought dynamics, from my perspective, is what breaks this down, what makes a wet anomaly or a dry anomaly persist across the seasonal cycle because, as Julia suggested, a lot of our understanding of how these teleconnection-driven anomalies work is mostly a cold season picture. There's not a good, strong correlation between El Niño indices and summer precipitation. So, what is it that makes dry conditions persist from winter to summer? We simply don't know that. So understanding dynamically how that process works seems to me would help us go a long way toward understanding the dynamics of long-term drought. That's hardly an answer; I'm just posing a question.

Lenart: Does anybody else want to add anything to that? Ok, well let's call that a wrap then. Thanks again for participating.

Temperature (through 9/15/04)

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

Water year temperatures continue to be above average across much of the Southwest (Figure 1a). The warmest locations are near Lake Mead and in the low deserts of southwestern Arizona, where average temperatures are in excess of 70 degrees Fahrenheit (Figure 1b). Slightly cooler-than-average conditions persist in north-central New Mexico. Arizona and New Mexico experienced predominately below-average temperatures over the past 30 days (Figure 1c). Scattered locations in both states were up to 4 to 6 degrees cooler than average. The North Rim of the Grand Canyon was the main exception with temperatures 2 to 4 degrees above average.

The Tucson National Weather Service (NWS) reports that the average summer temperature for Tucson is 0.3 degrees warmer than average through the end of August, placing it as the 23rd warmest summer since records have been kept. In addition the maximum, minimum, and average temperatures for the year in Tucson are above average. This month, a series of cold fronts again moved into New Mexico, helping to keep much of the state cooler than average (Albuquerque NWS). The average temperature for August was nearly 1.5 degrees below the 1971–2000 average.

Notes:

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

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

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

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 September 15, 2004) departure from average temperature.

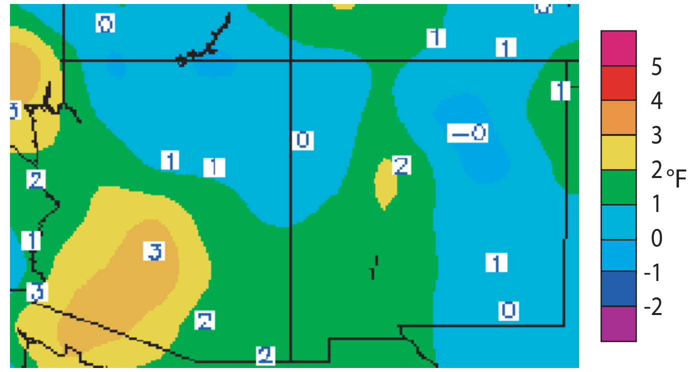


Figure 1b. Water year '03–'04 (through September 15, 2004) average temperature.

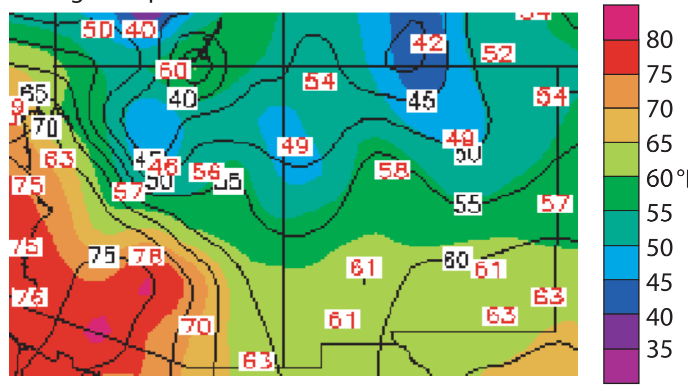


Figure 1c. Previous 30 days (August 17–September 15, 2004) departure from average temperature (interpolated).

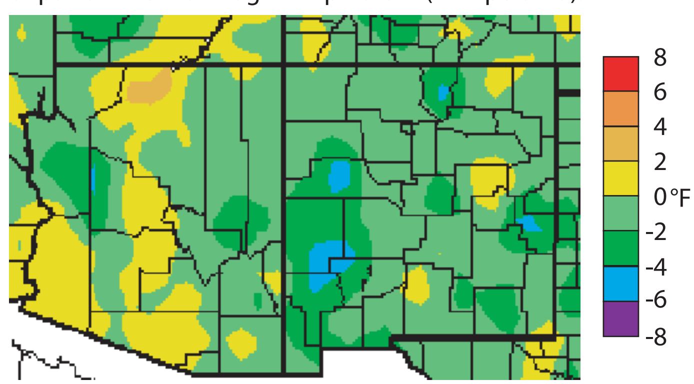
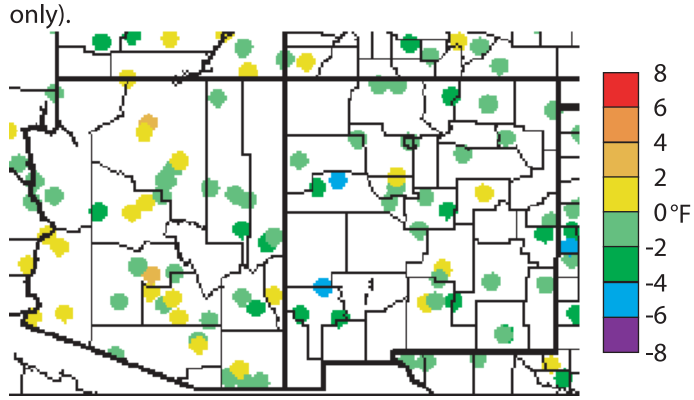


Figure 1d. Previous 30 days (August 17–September 15, 2004) departure from average temperature (data collection locations only).



Precipitation (through 9/15/04)

Source: High Plains Regional Climate Center

A bleaker picture is evident this month in water year precipitation (Figure 2a). A dry monsoon in the Southwest has increased the area covered by below-average precipitation and reduced the amount of above-average precipitation in other locations. Western, central, and northeastern Arizona and portions of central New Mexico are now at 70 percent or less of average water year precipitation. The past 30 days are a dramatic change from last month and are further evidence of the low precipitation totals during the monsoon (Figure 2c). Only a few areas in southwestern New Mexico and southeastern and northeastern Arizona received above-average precipitation. Much of the remainder of the Southwest experienced 50 percent or less of average precipitation. Remnants of Hurricane Javier supplied some areas with significant rainfall, but this event is not reflected in this month's climate products.

According to the National Weather Service (NWS) as of September 15, Tucson was experiencing the 8th driest summer on record with just 1.81 inches of precipitation recorded at the official rain gauge at Tucson International Airport through the end of August. Water year rainfall is nearly 4 inches below average. Annual and water year precipitation are slightly above average when calculated for the entire state of New Mexico (Albuquerque NWS). Individual regions range from 75 percent to approximately 140 percent of average values.

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 September 15, 2004 percent of average precipitation (interpolated).

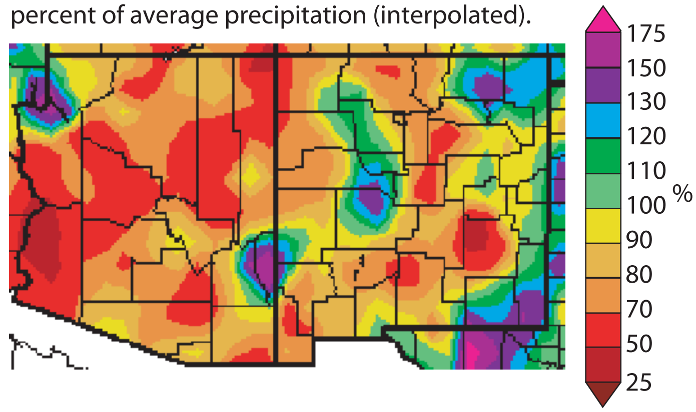


Figure 2b. Water year '03–'04 through September 15, 2004 percent of average precipitation (data collection locations only).

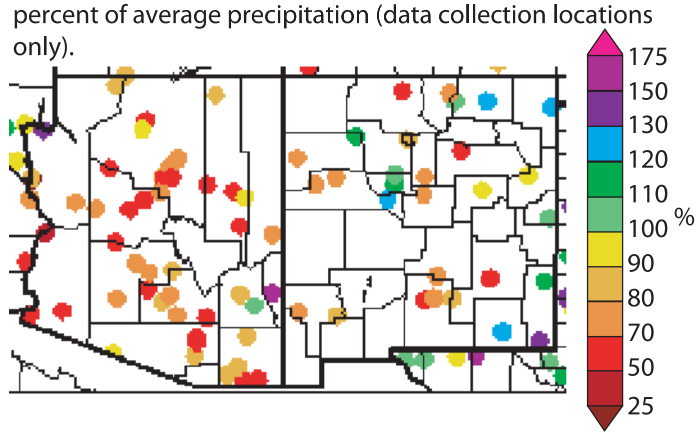


Figure 2c. Previous 30 days (August 17–September 15, 2004) percent of average precipitation (interpolated).

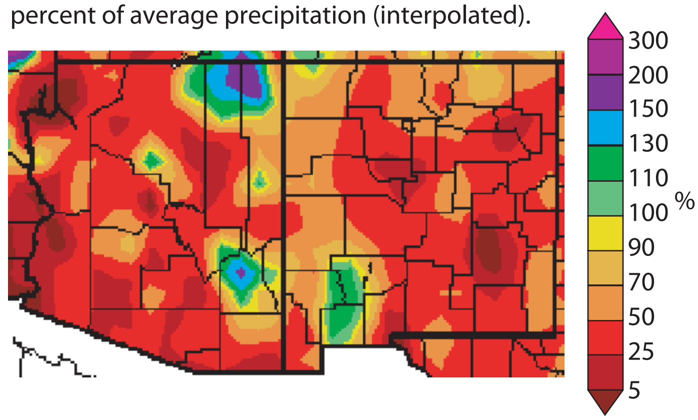
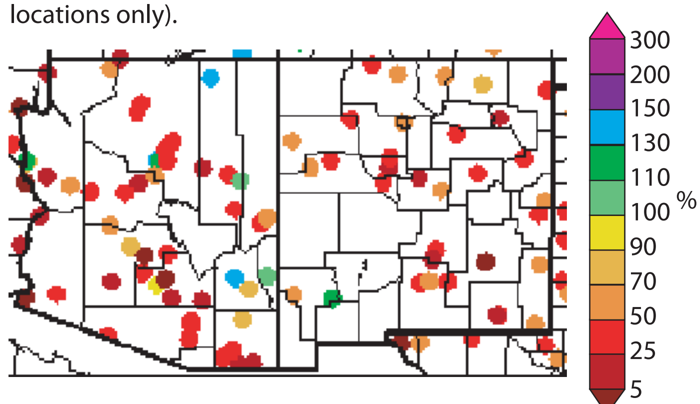


Figure 2d. Previous 30 days (August 17–September 15, 2004) percent of average precipitation (data collection locations only).



U.S. Drought Monitor
(released 9/16/04)

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

The Pacific Northwest, central Colorado, and sections of the eastern United States show decreased drought intensity, but the same cannot be said for Arizona and New Mexico (Figure 3). Extreme southeastern and northeastern New Mexico have been removed from abnormally dry status, but much of the remainder of the Southwest continues to experience severe or exceptional drought conditions. The Albuquerque National Weather Service reports that the northeastern and southeastern plains have received above-average precipitation for 2004, but these areas are drier than average over the past 1–5 years.

Pasture and range land conditions in Arizona and New Mexico illustrate the difference between these two states. In Arizona, 57 percent of the pasture and range lands are in poor to very poor condition (up 1 percent from mid-August and 16 percent since last year) compared to only 15 percent in New Mexico (down 21 percent from mid-August and 61 percent since last year).

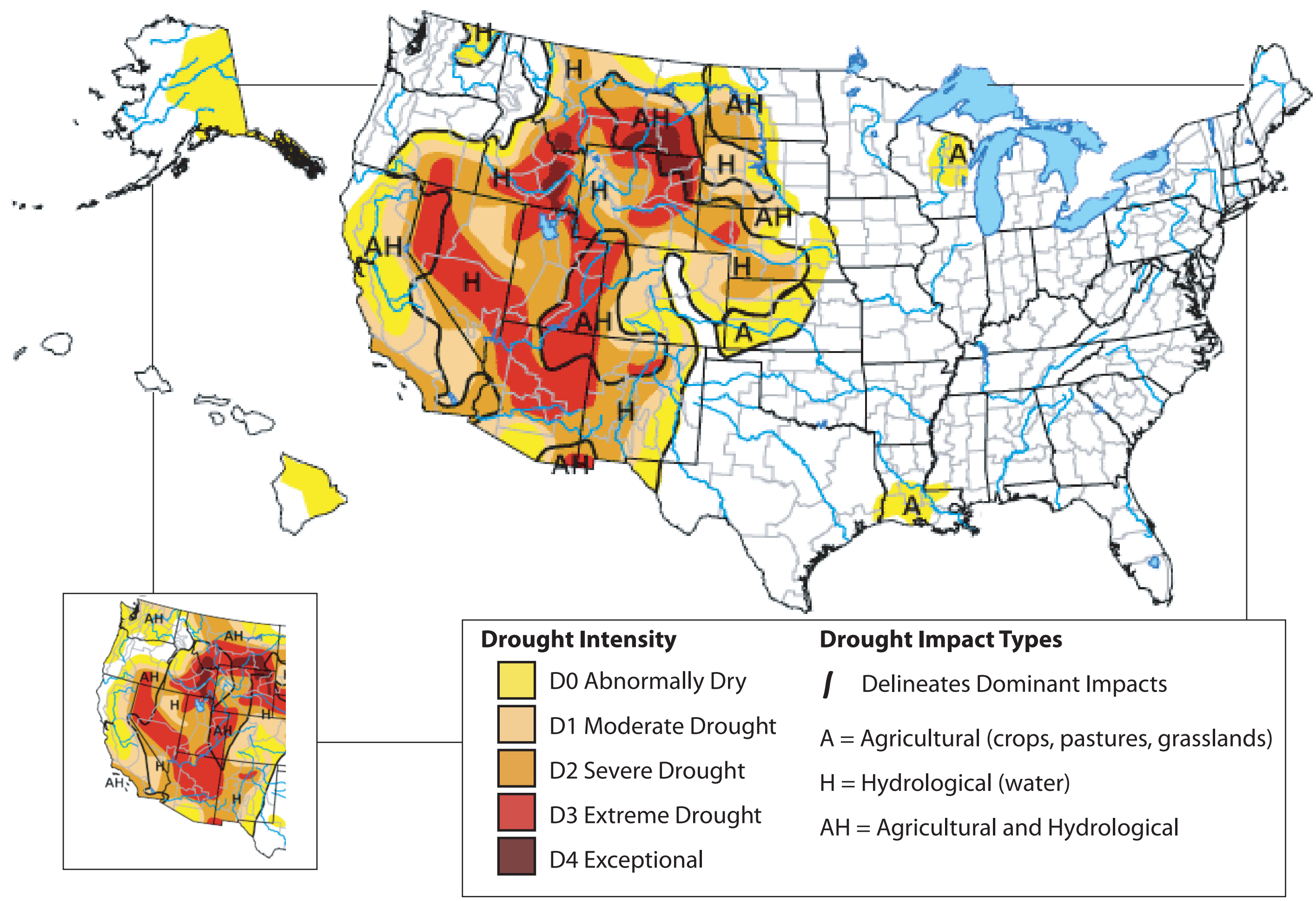
The public comment period for the Arizona Governor's Drought Task Force ends on September 24. Public input will be incorporated into the final plan in early October.

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 Douglas Le Comte from CPC/NOAA.

Figure 3. Drought Monitor released September 16, 2004 (full size) and August 19, 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

The eastern portions of New Mexico have experienced decreased drought intensity over the past month. The Albuquerque National Weather Service reports that the northeastern and southeastern plains are 1.8 inches and 4.8 inches wetter-than-average for the year, respectively. Over the past year and over the past five years, these two areas have experienced drier-than-average conditions, but they are faring better than other parts of the state. The northern mountains and central highlands are 1–2 inches below average in the past year and over 10 inches below average in the past five years.

Parks in Santa Fe, New Mexico, are suffering during the drought. According to city officials, approximately 40–50 percent of the grass (140–175 acres) has died in the Santa Fe's 56 parks (*Santa Fe New Mexican*, September 5). Some grass has been restored, but the city is replacing several athletic fields with artificial turf. A five-year plan calls for the addition of drought-tolerant plants to help reduce the amount of grass and irrigation. Scientists at New Mexico State University in Las Cruces are experimenting with a new cost-effective method of treating industrial wastewater and studying the long-term effects on natural vegetation (*Santa Fe New Mexican*, September 6). This research could have implications for irrigation during drought. The project is a three-year cooperative study between the university and the Las Cruces Utilities Department.

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. They have not been updated since last month's Southwest Climate Outlook.

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.

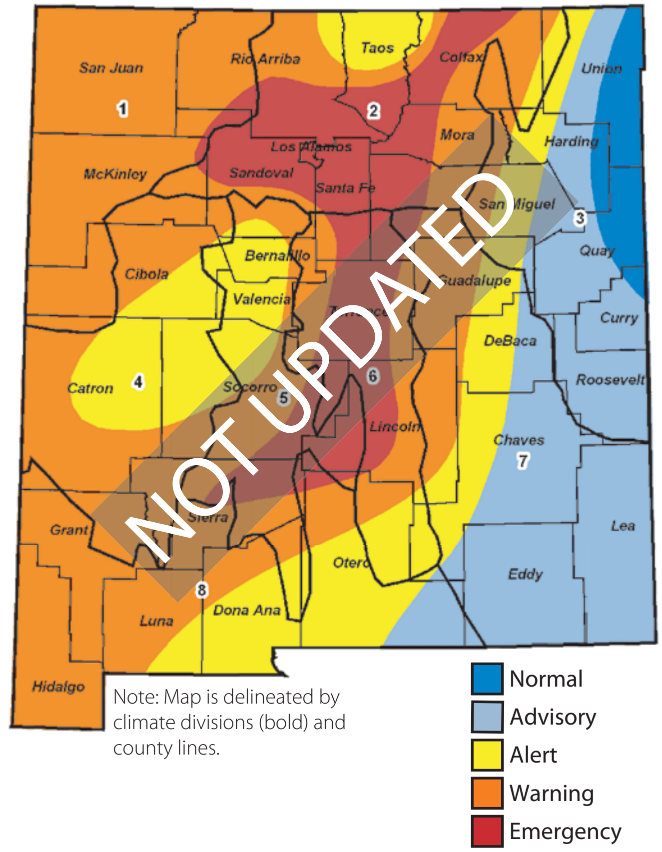
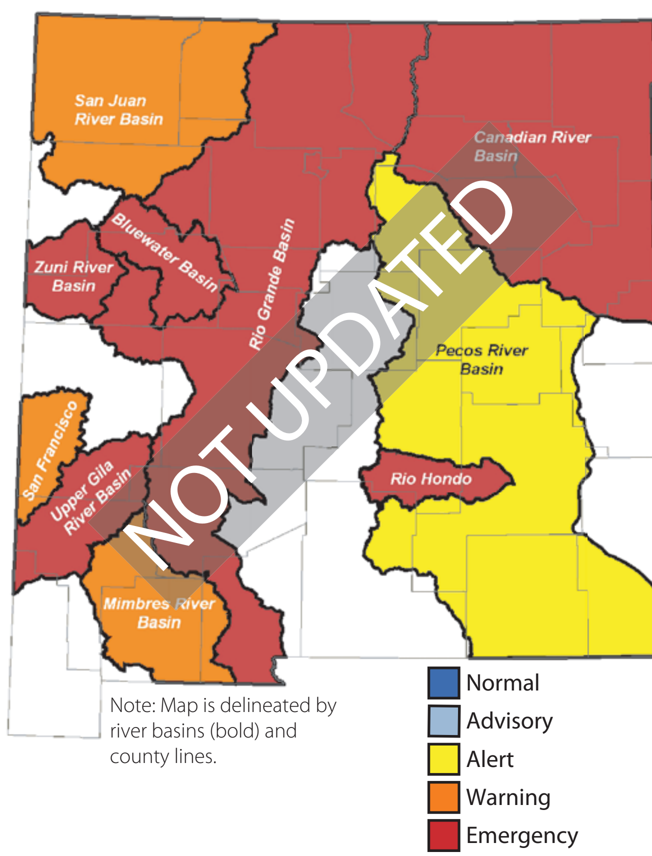


Figure 4b. Long-term drought map based on hydrological conditions as of August 13, 2004.



Arizona Reservoir Levels

(through 8/31/04)

Source: National Water and Climate Center

Reservoirs in Arizona are near or slightly below their levels of one year ago (Figure 5). Storage levels have changed little since July. Only two reservoirs, the Verde River System and Lake Mead, showed increases. The increase at Lake Mead was enough to push the storage back over 14 million acre-feet. The remainder of the reservoirs showed decreases, including Lake Powell (at 38 percent of capacity) and Lyman Reservoir (at 8 percent of capacity). Low levels in the Salt River System (40 percent) have prompted the Salt River Project Board of Directors to continue cutbacks to agricultural, municipal, and residential customers in 2005, the third consecutive year for the limited allocations (*Arizona Republic*, September 13).

The Senate Energy and Commerce Committee recently approved an agreement in which Indian tribes would gain control of approximately half the water in the Central Arizona Project Canal (*Arizona Republic* and *Casa Grande Dispatch*, September 16). Some cities, including Safford, Arizona, have signed agreements with the tribes to help plan for continued growth (*Eastern Arizona Courier*, September 15). As part of Interior Secretary Gale Norton's request that the Colorado River Basin states develop water conservation plans, the states recommended decreased water releases from Lake Powell this winter and spring (*Denver Post*, September 6). Norton signed the Lower Colorado River Multi-Species Conservation Program Memorandum of Agreement on September 14 (*Arizona Daily Star*, *Washington Post*, and *Yuma Sun*, September 15). Under the pact, $620 million will be spent to create more than 8,100 acres of riparian, marsh, and backwater habitat and protect native and endangered species along the Lower Colorado River. The agreement also ensures water availability and power operation in Arizona, California, and Nevada.

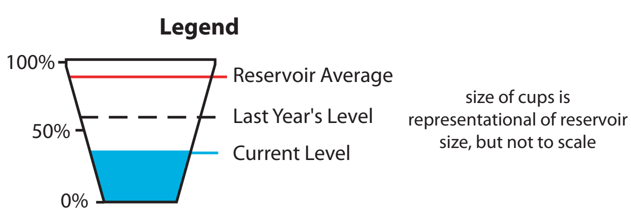
Notes:

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.

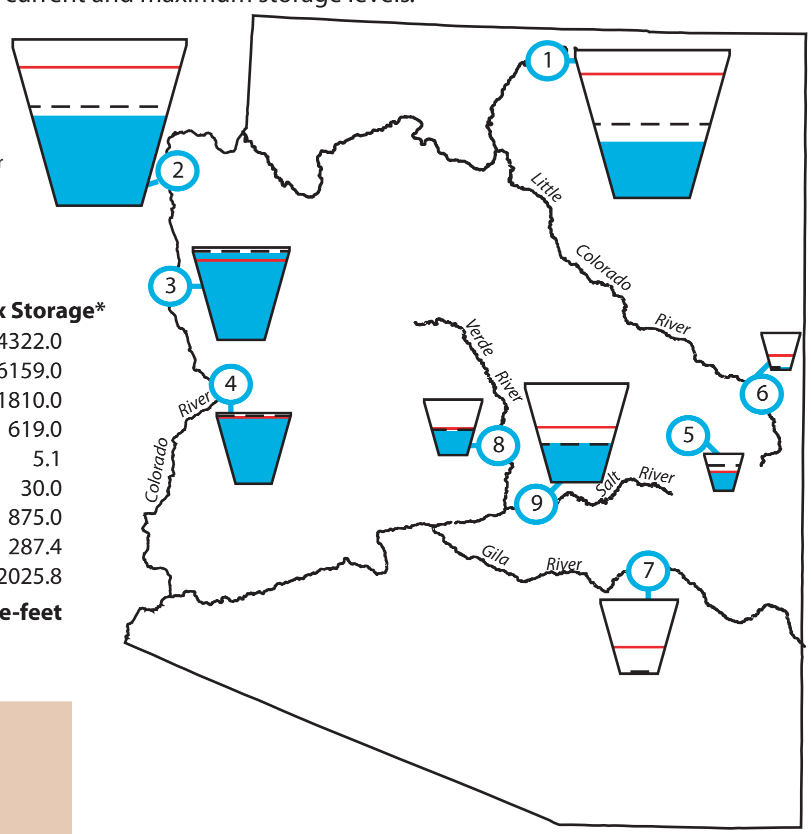
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) 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 August 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	38%	9,278.0	24322.0
2. Lake Mead	54%	14,018.0	26159.0
3. Lake Mohave	94%	1,704.2	1810.0
4. Lake Havasu	93%	574.3	619.0
5. Show Low Lake	47%	2.4	5.1
6. Lyman Reservoir	8%	2.5	30.0
7. San Carlos	2%	18.0	875.0
8. Verde River System	44%	125.2	287.4
9. Salt River System	40%	813.5	2025.8

*** thousands of acre-feet**



On the Web:

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

New Mexico Reservoir Levels

(through 8/31/04)

Source: National Water and Climate Center

While reservoirs in New Mexico remain near or above last year's levels, the state average storage is below 50 percent. Approximately half the reservoirs shown in Figure 6 experienced a decrease in capacity in the past month. The largest drop occurred at Lake Avalon (39 percent) in the southeastern portion of the state, followed by El Vado and Costilla (14 and 12 percent, respectively) in north-central New Mexico. Sumner, Santa Rosa, and Conchas lakes in the northeastern plains are the only locations with increases in capacity. The Albuquerque National Weather Service reports that above-average precipitation was recorded in these areas during August.

Some boat ramps at Heron Reservoir are not in use due to low water levels (*Rio Grande Sun*, September 16). The *Sun* also reports that the quality of fishing at El Vado reservoir is suffering. Intrastate and interstate water agreements continue to be an issue in New Mexico. State representatives and the Navajo Nation are attempting to settle the amount of a water-rights dispute (*Albuquerque Journal*, September 8). The Navajo Nation is asking for $1.2 billion from Congress. A vote has not yet been made by the New Mexico Interstate Stream Commission (NMISC) and the Navajo Council. According to the *U.S. Water News Online* (August), Texas and New Mexico have entered discussions to improve water management and delivery during drought, including formulating an agreement between irrigation districts that use water from the Elephant Butte Reservoir. A recent agreement between the NMISC and Arizona will allow New Mexico to draw water from the Gila River (KRQE TV, September 14). New Mexico will also receive $66 million from the federal government for additional water projects as part of a bill recently approved by the Senate Energy and Commerce Committee (see page 10).

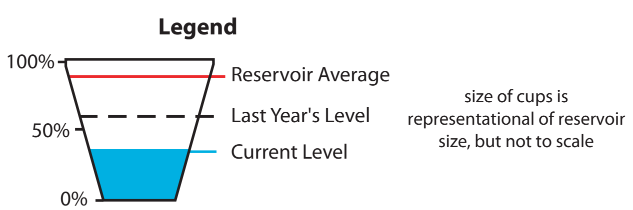
Notes:

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.

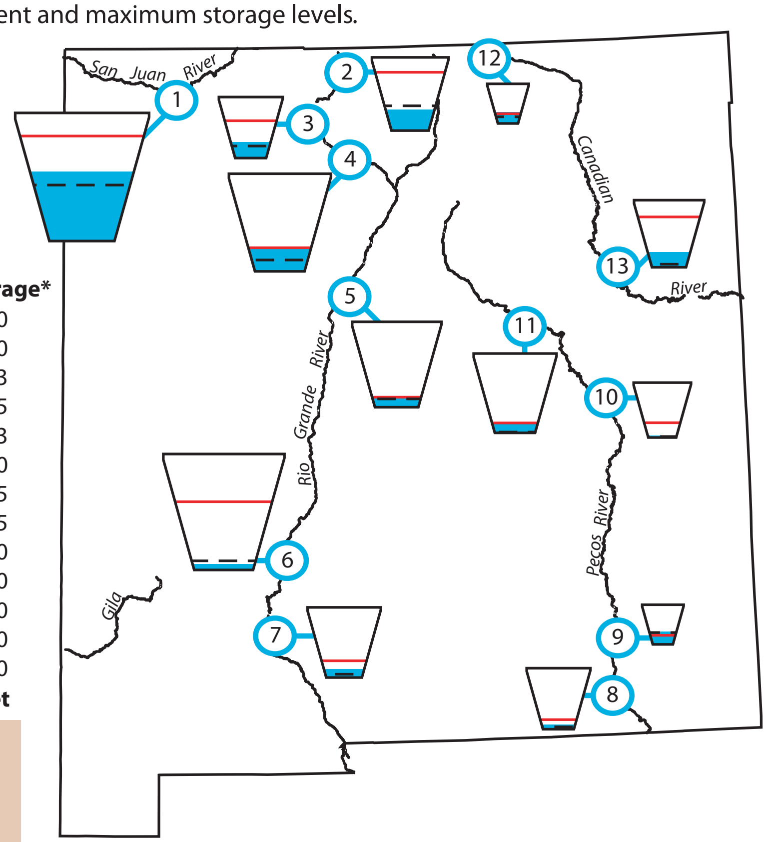
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) 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 August 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	54%	919.0	1,696.0
2. Heron	29%	115.4	400.0
3. El Vado	26%	47.8	186.3
4. Abiquiu	23%	126.5	554.5
5. Cochiti	10%	49.7	502.3
6. Elephant Butte	5%	112.5	2,065.0
7. Caballo	12%	40.3	331.5
8. Brantley	8%	11.8	147.5
9. Lake Avalon	33%	2.0	6.0
10. Sumner	4%	3.8	102.0
11. Santa Rosa	13%	56.7	447.0
12. Costilla	28%	4.4	16.0
13. Conchas	23%	57.4	254.0

*** thousands of acre-feet**



On the Web:

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

Southwest Fire Summary

(updated 9/17/04)

Source: Southwest Coordination Center

The number of wildland fires continues to rise in Arizona and New Mexico with the total now at 3,260 (Figure 7a). An increase of nearly 275 fires occurred in the past three weeks, which pushed the total land burned to greater than 300,000 acres for the year. Several large fires (over 100 acres) have been ignited through mid-September (Figure 7b). The Oatman fire was lightning caused and burned 450 acres in southwestern Arizona from August 22–27. Humans ignited another large fire in Arizona, the LeFevre fire in the north-central part of the state (not shown), on September 17. It had burned 300 acres as of September 20 (Southwest Area Wildland Fire Operations [SAWFO] website). The SAWFO reports that the Hunter fire, a lightning-caused blaze in west-central New Mexico, began on September 14 and has burned 250 acres as of September 20. In addition, the lightning-caused Well fire burned nearly 1,120 acres in the Ute Mountains of Colorado, just north of Farmington, New Mexico (*Santa Fe New Mexican*, August 30, and *Farmington Daily Times*, August 31 and September 1). The Nutall Complex that burned in eastern Arizona from late June through late July is still causing problems. According to the *Eastern Arizona Courier* (September 15), the Arizona Department of Emergency Management believes that the combination of increased runoff from the fire and overgrowth of vegetation along the Cottonwood Wash could lead to flooding in Pima, Arizona. Contracts to remove the vegetation are still being negotiated as of

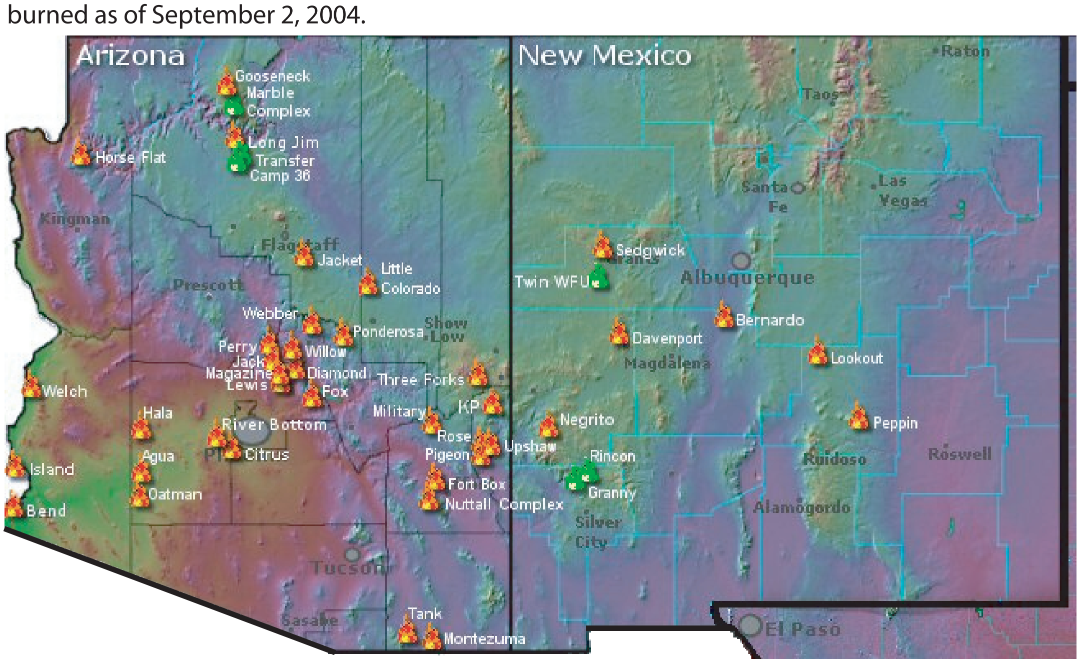
Notes:

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 September 17, 2004.

Location	Human Caused Fires	Human caused acres	Lightning caused fires	Lightning caused acres	Total Fires	Total Acres
Arizona	1,002	45,054	1,285	172,587	2,287	217,641
New Mexico	306	17,122	667	65,979	973	83,101
Total	1,308	62,176	1,952	238,566	3,260	300,742

Figure 7b. Year-to-date wildland fire location. Map depicts large fires of greater than 100 acres burned as of September 2, 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 9/15/04)

Source: Western Regional Climate Center

The monsoon has provided little relief from the continued dry conditions in the Southwest. Much of the region has received less than 4 inches of rain since July 1 (Figure 8a). A few exceptions are Santa Cruz County in extreme south-central Arizona and most of the eastern third of New Mexico. The totals are generally less than average for the period (Figure 8b). In terms of percent of average precipitation, the Southwest is mainly below average (Figure 8c). The second half of August was especially dry in Tucson (Tucson National Weather Service). After a fairly wet start, the month ended as the 19th driest on record, with less than an inch of rainfall at Tucson International Airport. Tucson is 2.80 inches below average for the summer. As is typical of summer rainfall patterns, some areas have experienced wetter-than-average conditions. For example, Clifton, Arizona, received more than 2.5 inches of its average rain. The same situation occurred in New Mexico. Ochoa, New Mexico, is more than 250 percent of average precipitation, while Aztec, New Mexico, only received 11 percent of its average. Although not officially considered part of the monsoon, the remnants of Hurricane Javier supplied some areas with significant rainfall. This event will be discussed in more detail in the next issue of the Southwest Climate Outlook.

Figure 8a. Total precipitation in inches July 1–September 15, 2004.

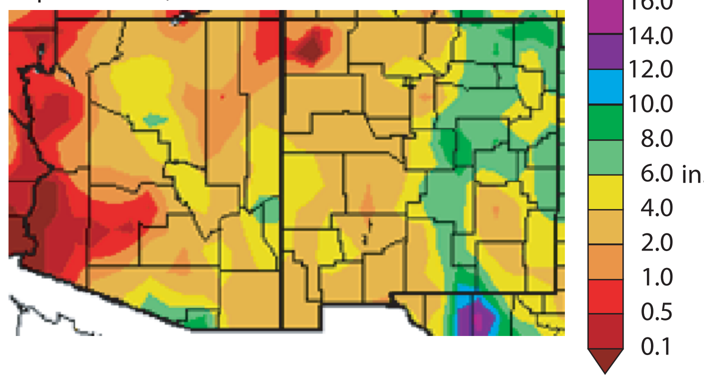


Figure 8b. Departure from average precipitation in inches July 1–September 15, 2004.

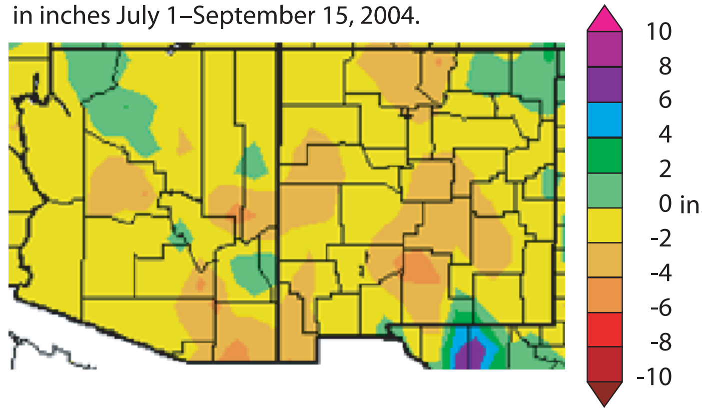
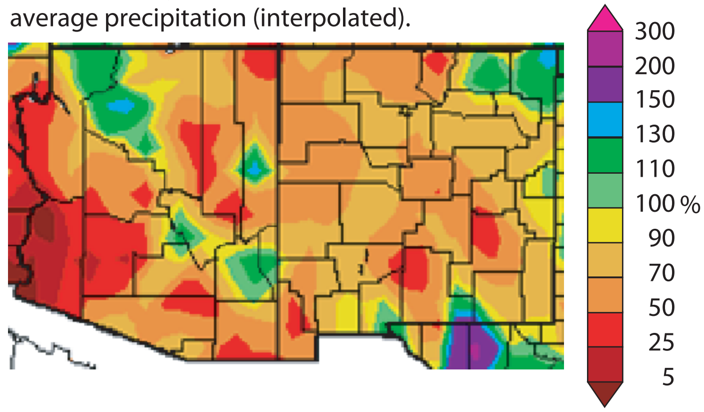


Figure 8c. July 1–September 15, 2004 percent of average precipitation (interpolated).



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
(October 2004–March 2005)
Source: NOAA Climate Prediction Center

Increased chances of above-average temperature are predicted for most of Arizona through March 2005 according to the NOAA-Climate Prediction Center (CPC; Figures 9a-d). The eastern two-thirds of New Mexico has an increased chance of below-average temperatures from October–December (Figure 9a). This area shrinks to the southeastern portion of the state for November–January (Figure 9b). By the January–March period (Figure 9d), increased chances of above-average temperature is forecast for much of New Mexico. The predictions issued by the International Research Institute for Climate Prediction (IRI) withhold judgment in New Mexico for October–December (not shown). Otherwise, the forecasts from IRI and CPC for the remaining periods are similar. Long-term temperature trends and indications from statistical forecast tools are the main basis for developing these products.

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 2004.

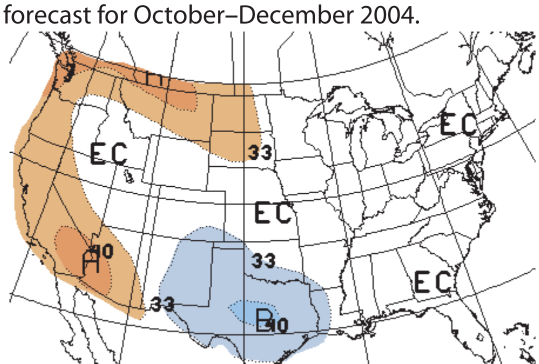


Figure 9b. Long-lead national temperature forecast for November 2004–January 2005.

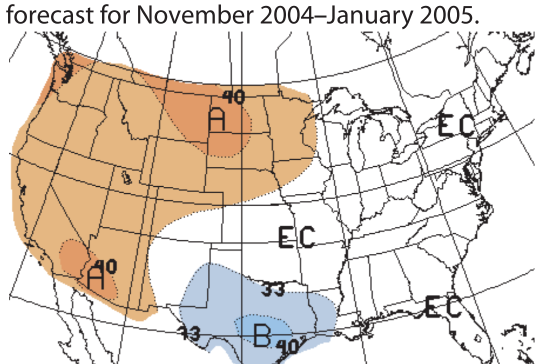


Figure 9c. Long-lead national temperature forecast for December 2004–February 2005.

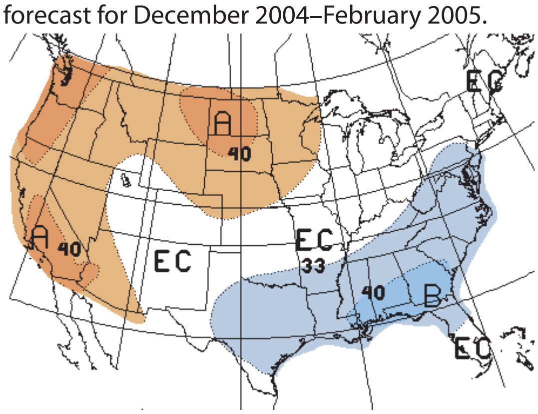
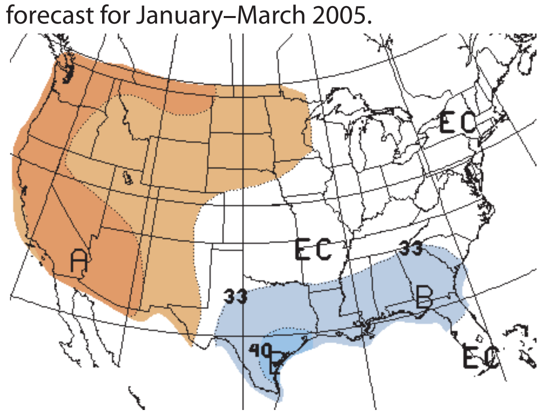


Figure 9d. Long-lead national temperature forecast for January–March 2005.



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

(October 2004–March 2005)

Source: NOAA Climate Prediction Center

Forecasts from the NOAA-Clime Prediction Center (CPC) and the International Research Institute for Climate Prediction (IRI) withhold judgment for Arizona and New Mexico from October 2004–January 2005 (CPC in Figures 10a-b; IRI not shown). A significant difference then appears from December 2004–February 2005. The CPC outlook indicates increased chances of above-average precipitation in much of Arizona (Figure 10c), whereas IRI predicts increased chances of above-average precipitation only for extreme southeastern and northeastern New Mexico (not shown). Much better agreement is shown over the January–March 2005 time frame (CPC in Figure 10d; IRI graphic not shown). The lack of agreement between the two models is likely due to the uncertain impact that weak to moderate El Niño conditions will have on precipitation during the winter months.

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 2004.

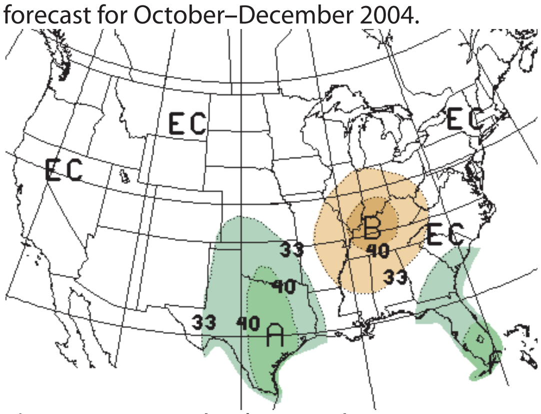


Figure 10b. Long-lead national precipitation forecast for November 2004–January 2005.

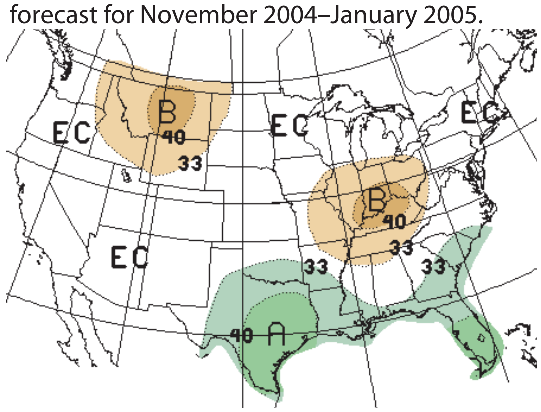


Figure 10c. Long-lead national precipitation forecast for December 2004–February 2005.

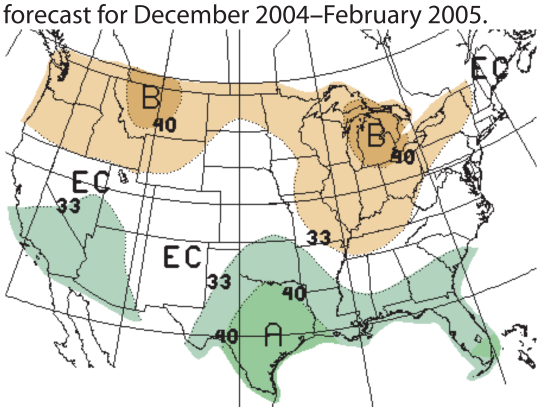
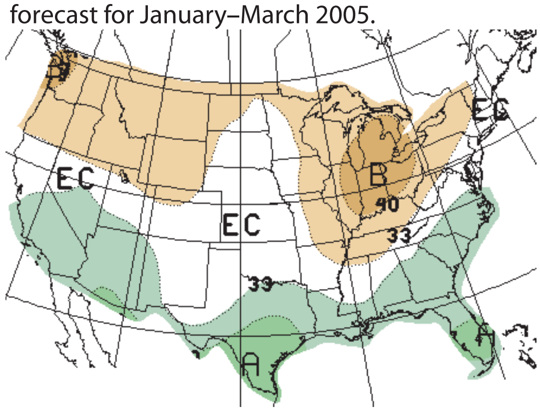


Figure 10d. Long-lead national precipitation forecast for January–March 2005.



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/

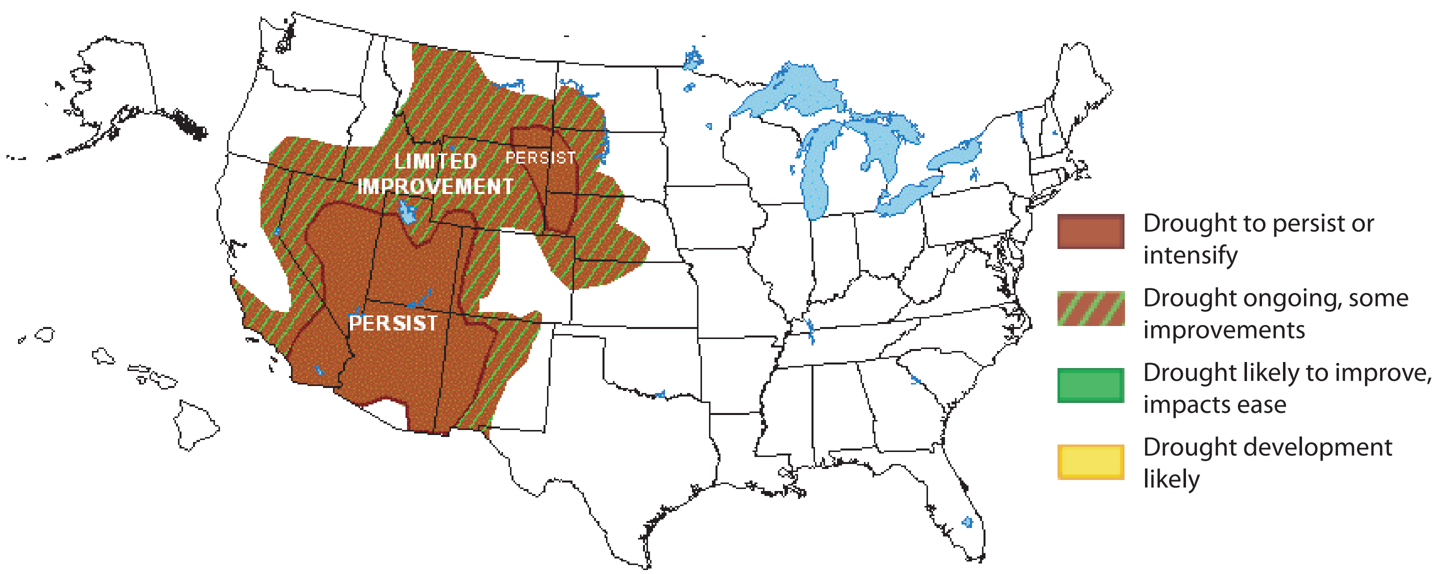
Seasonal Drought Outlook
(through December 2004)
Sources: NOAA Climate Prediction Center

Approximately half of the West, including central New Mexico, is expected to see limited improvement in drought severity through December (Figure 11). The drought in Arizona, however, is forecast to persist. In the latest discussion, the NOAA-Climate Predictions Center (CPC) predicts that the remnants of Hurricane Javier, which recently moved through Arizona, may provide short-term improvement, but the long-term drought should continue. Additional improvement is anticipated as winter mountain snowpack begins to accumulate. CPC believes that any increased precipitation in the Southwest associated with a weak El Niño will not occur until mid- to late winter or spring. With much of the region currently experiencing precipitation deficits of three years or more, the drought is not predicted to end.

The uncertainty of the duration of the drought is leading numerous cities either to begin addressing water supply issues or to supplement their initial steps. Officials at the Navajo Generating Station near Page, Arizona, have discussed drilling additional tunnels to keep the Lake Powell power plant operational (*Arizona Republic*, September 10). Some predictions are that the current tunnels are sufficient for at least the next 4–5 years, while others say that the reservoir level could be too low by 2006 if severe drought persists. Farmers and ranchers continue to feel the effects of the drought and fear further consequences. In Montana, Wyoming, and Idaho, farmers are being forced to reduce agricultural land, while ranchers are selling livestock (*Ventura County Star*, August 27). The *Imperial Valley Press* (September 15) reports that the fallowing of farmland in southwestern California could result in nearly $1.2 million in losses for the local economy. Impacts would be even more severe over the next 15 years, as 55,000 acres are scheduled for fallowing. Bullhead City, Arizona, is considering the removal of several species of non-native trees that use too much water (*Mohave Valley News*, September 17).

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 2004 (release date September 16, 2004).



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

Wildland Fire Outlook

Sources: National Interagency Coordination Center, Southwest Coordination Center

Arizona and New Mexico are no longer included in the areas considered to have above average potential for large fires (greater than 100 acres; Figure 12a). The overall fire danger is speculated to be near average in New Mexico, while much of Arizona may experience slightly above-average fire potential according to the Southwest Coordination Center (not shown). The latter is due to warmer and drier than average conditions. The region averages four large fires during the month of September. The number of prescribed fires will be higher, especially in the areas of Arizona, such as the west, where conditions are much drier than average and where the monsoon provided little rainfall. If the number of tropical systems moving through and providing precipitation for Arizona and New Mexico increases, the fire potential will further decrease.

Grasses in the Southwest are cured, with new growth at normal levels (Figure 12b). Live fuels have near-average or above-average moisture content, which implies that should a fire be ignited, it is not likely to spread quickly and/or burn larger vegetation. Dead fuel moisture in 1000-hour fuels (large vegetation) is near average. Shelly Nolde, a Wildland/Urban Interface Specialist for the Santa Fe Fire Department, believes that fire risk is lower than earlier in the summer (*Santa Fe New Mexican*, September 1). She adds that if a fire does ignite, it is less likely to spread quickly.

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

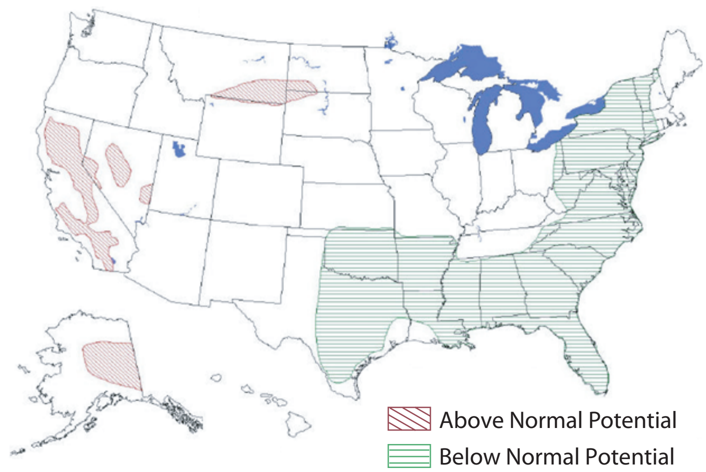


Figure 12b. Current fine fuel condition and live fuel moisture status in the Southwest.

Current Fine Fuels						
Grass Stage	Green		Cured	x		
New Growth	Sparse		Normal	x	Above Normal	

Live Fuel Moisture	
	Percent of Average
Ponderosa Pine	110–138
Douglas Fir	119–190
Piñon	80–130
Juniper	80–112
Sagebrush	90–110
1000-hour dead fuel moisture	**12–22**
Average 1000-hour fuel moisture for this time of year	**12–18**

Notes:

The National Interagency Coordination Center at the National Interagency Fire Center produces monthly wildland fire outlooks. The forecasts (Figure 12a) 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 Area Wildland Fire Operations produces monthly fuel conditions and outlooks. Fuels are any live or dead vegetation that are capable of burning during a fire. Fuels are assigned rates for the length of time necessary to dry. Small, thin vegetation, such as grasses and weeds, are 1-hour and 10-hour fuels , while 1000-hour fuels are large-diameter trees. The top portion of Figure 12b indicates the current condition and amount of growth of fine (small) fuels. The lower section of the figure shows the moisture level of various live fuels as percent of average conditions.

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 for the ENSO El Niño 3.4 monitoring region indicates that there is a 60 percent chance that El Niño conditions will exist through January (Figure 13a). The likelihood increases to 70 percent through early spring before decreasing to 45–50 percent by late spring and early summer. The probability of neutral conditions increases to 45 percent by next summer. The chances of La Niña conditions developing are zero through the March–May 2005 time frame and only increase to 10 percent by the summer of 2005. While the conditions are expected to continue to strengthen slightly, the NOAA-Climate Prediction Center reports that the development of a strong El Niño is not currently expected (*NOAA News Online*, September 10). The Southern Oscillation Index (SOI), an indication of the atmospheric response of ENSO, indicates that a weak El Niño is in progress (Figure 13b). Increased storminess in the central tropical Pacific, essentially a sign of interaction between the ocean and atmosphere, has not yet developed. El Niño is typically strongest during the winter and tends to result in above-average precipitation for the southwestern United States. A wetter-than-average winter could ease the drought severity across the region, but it is unlikely to end it. According to the Albuquerque National Weather Service, there is usually a delay between the development of El Niño and when the effects are felt in New Mexico. Therefore, it is expected that above-average precipitation may not be realized until late winter and early spring.

Figure 13a. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released September 16, 2004). Colored lines represent average historical probability of El Niño, La Niña, and neutral.

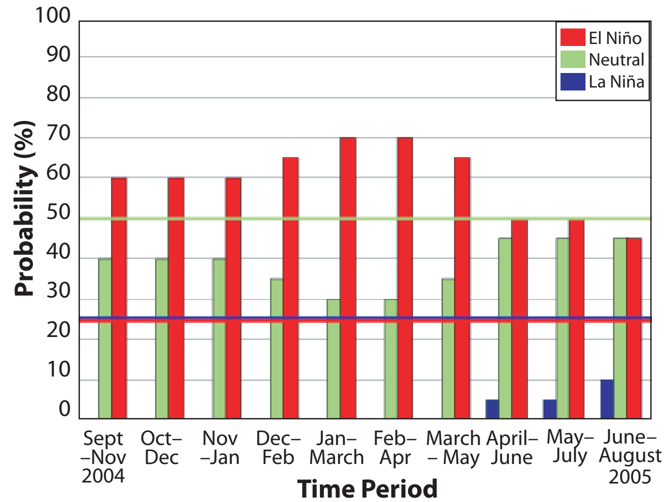
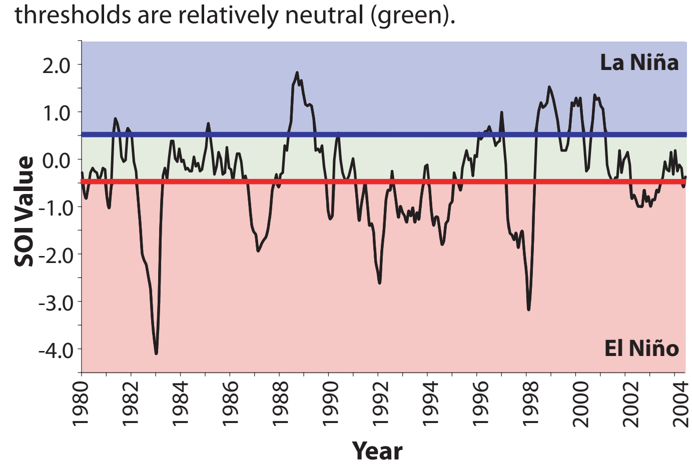


Figure 13b. The standardized values of the Southern Oscillation Index from January 1980–August 2004. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).



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 August 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/

Temperature Verification
(June–August 2004)

Source: NOAA Climate Prediction Center

The NOAA-CPC temperature forecast for June–August predicted increased chances for above-average temperatures for much of the western and eastern United States (Figure 14a). The majority of the continental United States experienced cooler-than-average conditions with the Great Plains up to 4 to 6 degrees Fahrenheit below average. The notable exceptions were the southeastern coast and much of the West. Arizona and New Mexico temperatures were mainly 2 degrees warmer or cooler than average. The complicated pattern of temperatures seen in the region (Figure 14b) is too fine-scale for the CPC models to forecast. The models did well in capturing the above-average temperatures in the West and along the southeastern coast (Figure 14a). The warmer-than-average conditions in deep southern Texas were also predicted well; this area is sometimes troublesome. The Ohio River Valley and western Great Plains were trouble spots for the CPC forecasts. Both these areas were actually cooler than average by several degrees.

Figure 14a. Long-lead U.S. temperature forecast for June–August 2004 (issued May 2004).

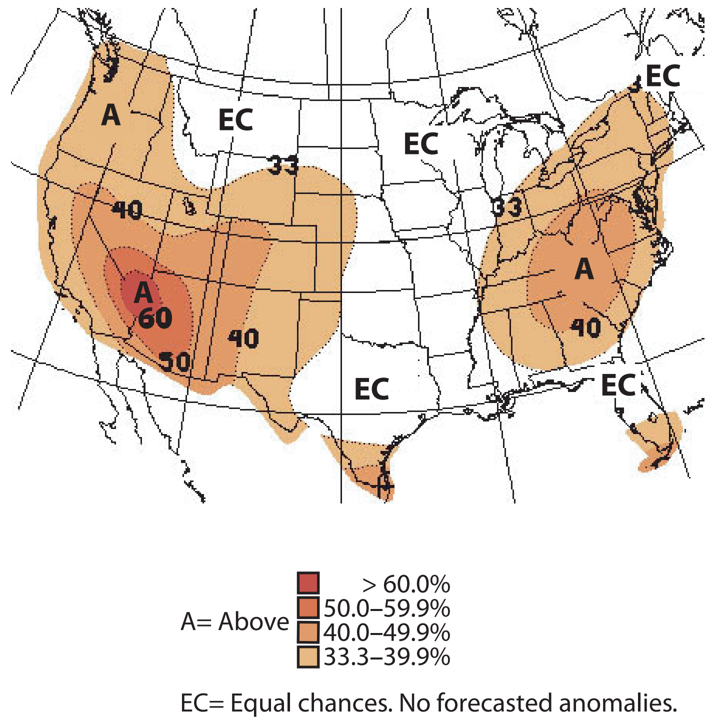
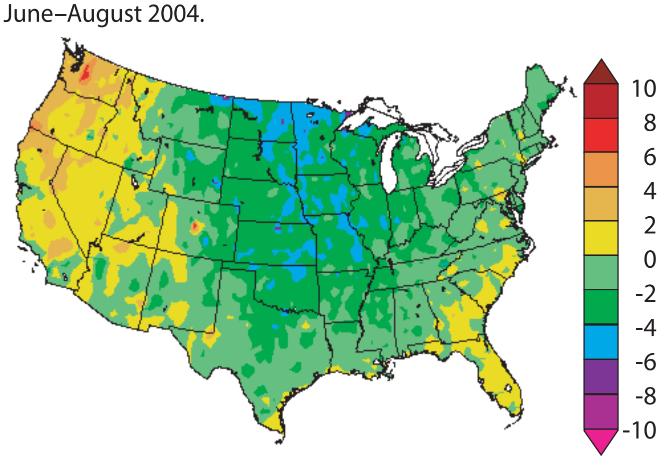


Figure 14b. Average temperature departure (in degrees F) for June–August 2004.



Notes:

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

The June–August 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 June–August 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:

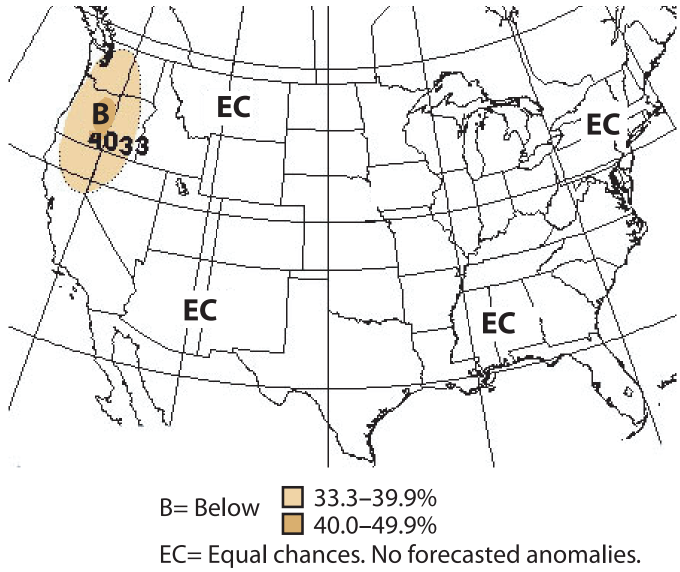
For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

Precipitation Verification
(June–August 2004)

Source: NOAA Climate Prediction Center

The NOAA-CPC precipitation predictions included only one region, the Pacific Northwest, where increased chances of drier-than-average conditions were forecast (Figure 15a). There were no forecasted precipitation anomalies for the remainder of the continental United States. In contrast to the forecast, the Oregon-Washington border experienced above-average precipitation (Figure 15b). The southwestern United States was generally drier than average. California once again received less than 25 percent of average rainfall, which has been a fairly common occurrence for most of the past several months. As a result, 100 percent of the pasture and range lands in the Golden State are in poor or very poor condition. The western Gulf of Mexico states are experiencing the opposite circumstances; this region has experienced much wetter-than-average conditions since the April–June period. With the high frequency of tropical systems affecting the eastern United States, these areas will likely be well above average in subsequent months.

Figure 15a. Long-lead U.S. precipitation forecast for June–August 2004 (issued May 2004).



Notes:

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

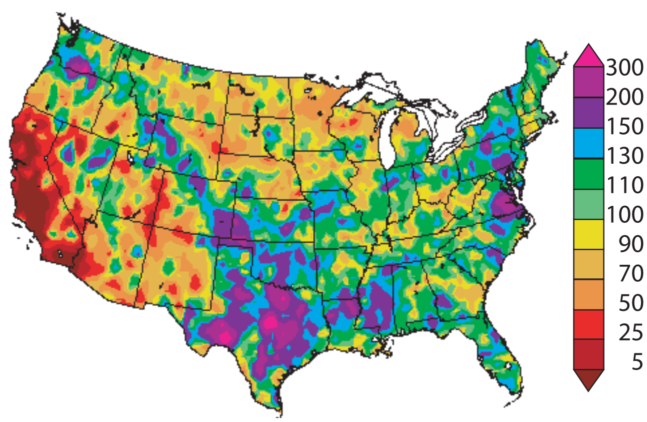
The June–August 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Care should be exercised when comparing the forecast (probability)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

El Niño Signal in the Upper Colorado River Basin

Source: CLIMAS, University of Arizona

The El Niño-Southern Oscillation is a climate phenomenon with both oceanic and atmospheric components. Tropical Pacific Ocean sea surface temperatures and atmospheric pressure patterns fluctuate on irregular interannual timescales. These events result in shifts in storm tracks and pressure centers, which then impact precipitation and temperature around the world. Tracks of storms affecting the United States are generally farther south during El Niño events.

These storms can tap into tropical moisture in the eastern Pacific Ocean and tend to result in wetter-than-average winters for the Southwest; however, drier-than-average conditions can also occur. A closer examination reveals that there is no uniform signal in the Colorado River Basin. Arizona typically receives above-average winter precipitation, while effects in the Upper Colorado River Basin (UCRB) region are significantly different. Knowing the climate of the UCRB is crucial for managing Arizona's water supply, because it provides about half of Arizona's water needs. The greatest percentages of wet El Niño winters occur in southern and western Arizona (Figure 16a), whereas the greatest percentages of dry El Niño winters occur in the northern UCRB and in northwestern Arizona (Figure 16b). Wet El Niño winters in southern Arizona occur about twice as often as dry winters, in sharp contrast with the northern UCRB (Figure 16c).

Notes:

Figures 16a-c display the NOAA Climate Divisions for Arizona and the Upper Colorado River Basin (UCRB) states (Wyoming, Colorado, Utah, and New Mexico). Figures 16a and 16b represent the percent occurrence of wet and dry (respectively) El Niños that occurred from 1896 to 2002. Figure 16c illustrates the ratio of wet to dry El Niño events, which were calculated by dividing the values of Figure 16a by the values in Figure 16b. El Niño is signified by a warming of the surface water in the equatorial Pacific and a negative value (less than -0.5) of the Southern Oscillation Index (SOI). This criterion was used to identify 34 El Niño episodes. The SOI was averaged over the period from June through November to indicate the strength of the atmospheric component of the El Niño-Southern Oscillation phenomenon. NOAA Climate Division winter precipitation was defined by the total precipitation from November–April. These figures were provided by CLIMAS researchers Jenna McPhee, Andrew Comrie, and Gregg Garfin.

On the Web:

For a summary of ENSO conditions:
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

For links to educational sites about ENSO:
http://www.cpc.noaa.gov/products/outreach/education.html

Figure 16a. Percent of wet (greater than 115 percent of winter precipitation) El Niño events for the period 1896–2002.

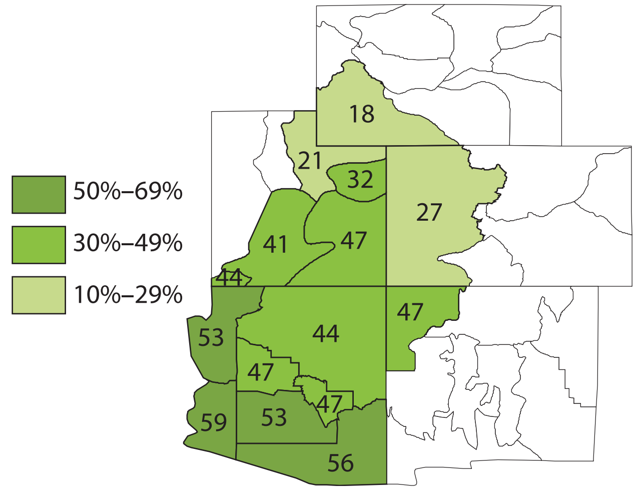


Figure 16b. Percent of dry (less than 85 percent of winter precipitation) El Niño events for the period 1862– 2002.

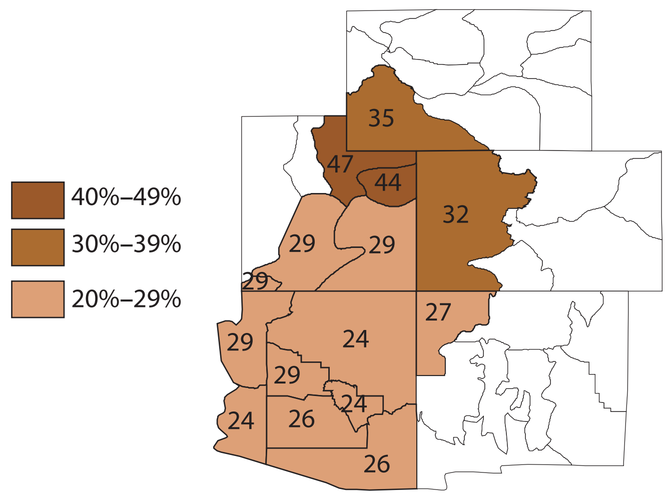


Figure 16c. Ratio of wet to dry El Niño events.