Issued: December 20, 2005

Southwest Climate Outlook

Published by the Climate Assessment for the Southwest project and the University of Arizona Cooperative Extension

December Climate Summary

Drought – Moderate drought to abnormally dry conditions have expanded into nearly all of the Southwest, except for far western Arizona

- Drought conditions are expected to intensify throughout most of the Southwest.
- Drought conditions are improved from last year, but some important reservoirs in New Mexico remain below average.

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

Precipitation – Almost all of the Southwest has been drier than average since the start of the water year, especially during the last 30 days or so.

Climate Forecasts – Experts predict increased chances of warmer-than-average temperatures through June of 2006, and below-average precipitation through May of 2006.

El Niño – ENSO-neutral or mild La Niña conditions are expected to exist over the next six to nine months.

The Bottom Line – Drought is like to persist or intensify over most of the Southwest except for far western Arizona. Hydrological drought continues to affect some large reservoir levels in the region, and agricultural drought conditions have developed in eastern New Mexico.

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

Let it Snow!

The NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC) is offering some new snow monitoring products through their website (www.nohrsc.noaa.gov)just in time for the winter season. NOHRSC is part of the National Weather Service and is responsible for providing operational snow monitoring products for the United States. Near real-time snow depth and snowfall observation maps for the continental United States are now available on the under the "Interactive Maps" link on the left side of the page. Also check out the "3D Visualization" link where you can download snow products in Google Earth format (earth.google.com) which allows for additional interactive map capabilities (overlays, zoom, pan, & tilt).

See NOHRSC website www.nohrsc.noaa.gov for details...

In this issue:

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Climate experts discuss winter and spring forecasts

The winter and spring seasonal forecasts issued on November 17, 2005 by the National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA-CPC) showed the Southwest as having "equal chances" of above-average, near-normal or below-average precipitation (i.e., there's no forecast). Similarly, the International Research Institute for Climate and Society (IRI) had made no Southwest precipitation forecast for the coming winter and spring. Both the CPC and IRI have more recently forecast an increased likelihood of above-average temperatures in the Southwest.

On November 18, CLIMAS sought the input of experts to contribute their insight to a roundtable discussion on how the region's snowpack and water supply might fare this winter and spring based on the forecasts at the time. The CPC and IRI have since adjusted their forecasts to project dry conditions for the Southwest region in the coming months, an outlook that reflects comments made by our climate experts. Some definitions and explanations are included within the discussion. Please see the CLIMAS online glossary (http://www.ispe.arizona.edu/climas/forecasts/glossary.html) for terms that are not defined here.

Roundtable Participants

Dave Brandon
Hydrologist in Charge, NOAA Colorado Basin River Forecast Center

Holly Hartmann, PhD
Assistant Research Scientist, UA Department of Hydrology and Water Resources; Investigator, CLIMAS

Ed Polasko
Senior Service Hydrologist, NOAA National Weather Service, Albuquerque

Jeff Smith
Senior Hydrologist, NOAA Colorado Basin River Forecast Center

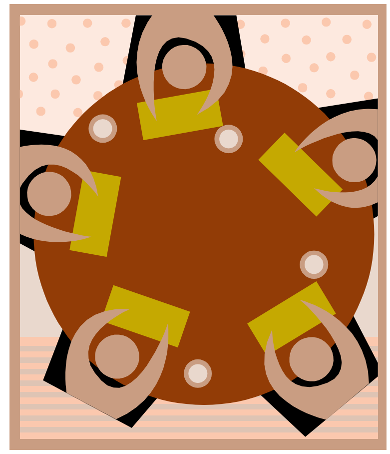
Klaus Wolter, PhD
Meteorologist, Climate Diagnostics Center, Boulder; Research Associate, University of Colorado

Melanie Lenart, PhD
Roundtable Moderator and Research Associate, CLIMAS

Lenart: With the forecasts that just came out for winter precipitation, there's not much to say for the Southwest, but maybe you have some ideas on what we can expect. Any comments?

Brandon: We put out more of an outlook than a forecast this time of year, since this early there's a lot of error involved… One of the things we look at is the antecedent streamflow [the total quantity of water that flows through river systems] of the system—what are the flows of the river in the fall compared to what they are usually? We also have a soil moisture model that we continuously run, which is probably the most important factor. There's not much snowpack this early, but we have 116 SNOTEL [snowpack telemetry] sites over Lake Powell that we look at. We combine those and compare them to last year and other years' average. Obviously, it's very early in the season, but we're about a hair below average right now, and last year at this time we were a little bit above average. When we run these forecasts, the main thing we find is that we can be about 10 to 16 percent more accurate than we would be just using the averages for the last 30 years. A lot of that comes from the moisture model. If you've been in a very dry or wet period, the models reflect that well. We also look at ENSO [El Niño Southern Oscillation] signals. We now have an operational procedure in which we look at CPC forecasts for the season and translate those into a shift in precipitation or temperature. We've found that in the last 15 La Niñas, 14 were dry in Arizona. There isn't a strong signal right now…but that's something we're starting to look at, is a trend towards a La Niña. Using these variables, we come up with an ensemble streamflow prediction and then run previous years through our model to check it.

Lenart: From what you're saying, it sounds like you have some bad news for



us in terms of your streamflow outlook this year.

Brandon: Well, bad news is in the eyes of the beholder. There's a lot of error this early, but Lake Powell streamflow looks like it's going to be around 80 percent.

Smith: That's around 6.5–6.7 million acre-feet from April to July. The average is about 7.9 million.

Brandon: That's the Upper Colorado River and Lake Powell. In 2002, we had 1.1 million acre-feet, so it's relatively much better. When we ran the model last year at this time, the prediction was a little higher, but we'd had a wet fall and early snow in the San Juan Mountains. That's coming off a very dry period, and we were still predicting a little below normal.

Wolter: But that was the forecast, what actually happened? Didn't we get a lot more?

Brandon: We ended up just a bit above normal for the whole basin.

Lenart: The San Juans are an area serving New Mexico from the Colorado River, so how would things look for the rest of the state [i.e., the areas not in the Colorado River watershed]?

continued on page 3

Roundtable, continued

Polasko: Before I get into projections, let's take a step back and look at where we were in June 2004 in two of our major reservoirs: Navajo Reservoir, in the northwest part of the San Juan system, and Elephant Butte, which is our major reservoir on the Rio Grande down near Truth or Consequences. At the end of June 2004, the storage in Elephant Butte was around 228,000 acre-feet and the storage in Navajo was a little over a million. At the end of June 2005, Navajo had 1.5 million acre-feet, so in one year the increase in storage in Navajo was 50 percent. In Elephant Butte, it went up to about 560,000 acre-feet, so that's about two and a half times what we started with. The 2004–05 winter was extremely good for us, especially coming off the extremely dry period of the last four years.

Lenart: Do you think the lucky streak might continue, or are we going back to drier times?

Polasko: Well, I'm still buying lottery tickets, but I'm not putting a lot of money into it...A year ago at this time, the nine or ten SNOTELs I look at in the upper Rio Grande Basin were showing 100 percent of normal snow-water equivalent. In southwest Colorado, we were at about 115 percent of normal. This year, in the Rio Grande Basin, we're barely pushing 29 percent of normal, and in the San Juan headwaters we're not doing a whole lot better at 34 percent of normal. Our outlook in terms of snowpack this year isn't as good as what Dave is looking at in the Upper Colorado.

Lenart: So the outlook is worse for New Mexico than Colorado?

Polasko: It's looking a lot better [for much of Colorado than New Mexico]. We had a decent first two weeks of October in terms of precipitation, but since then we've gone into a much drier regime. Whatever snow had fallen in the higher elevations wasn't deep enough to stick, so we're starting to loose some of the snow in the 8,000- to 10,000-foot range. We've actually gone downhill a little bit and haven't been able to make up any ground.

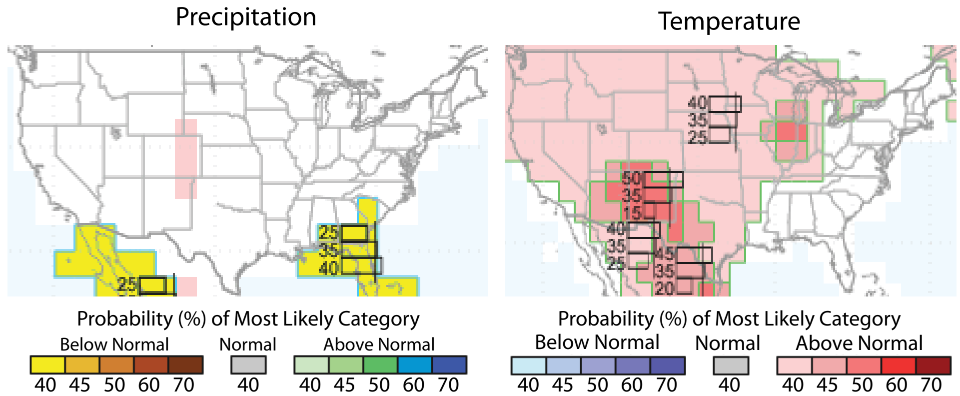


Figure 1. IRI precipitation and temperature forecast for December 2005–February 2006 from http://iri.columbia.edu/climate/forecast/net_asmt/ as of November 17. For NOAA-CPC forecasts see page 12–13.

Lenart: While we're talking about snow, I know that the CPC forecast for temperature showed that the Southwest has a higher probability of being warm. Holly, how reliable are the temperature forecasts for this area?

Hartmann: By and large, the temperature forecasts are excellent for the Southwest's winter season. The CPC's forecast is calling for increased chances for temperatures like that of the warmest 10 years out of the last 30. When you think about what those 10 years have done to the snowpack, you get an appreciation of the implications for the water supply next spring and summer.

Lenart: Wasn't that an issue in March 2004, when temperatures took some of the snow and sublimated [evaporated instead of melted] it?

Wolter: That was the wind more than anything. I mean, it was warm, but it was also very windy.

Hartmann: And that's something that's not reflected in the CPC's outlook—the focus is on temperature.

Brandon: I think that March 2004 was one of the warmest and driest months on record and nobody's going to forecast that this early. That really was an oddball month, when the wind knocked 20 percent off the snowpack...Temperature really becomes important in that transition time between March and May where you can have large fluctuations. It's not so much the temperature as the intensity and how fast that melts the snowpack.

Lenart: So if the temperature increases and melts the snow quickly, that can cause more streamflow.

Brandon: Right. It causes more runoff rather than letting it soak slowly into the soil.

Lenart: From what I was reading in the CPC prognostic discussion, they were feeling that the El Niño signal and the MJO [Madden-Julian Oscillation] are both neutral, as is the North Atlantic Oscillation. [The MJO is a fluctuation characterized by a 30- to 60-day cycle in tropical Pacific precipitation. This in turn affects global circulation patterns, including the jet stream over North America, which influences precipitation in the Southwest]. Klaus, why do you see a potential La Niña?

Wolter: I'm not saying that I'm expecting a La Niña event; conditions in the

continued on page 4

Roundtable, continued

Pacific are exhibiting symptoms of a La Niña-type situation. The definition of a La Niña is a three-month running average of -0.5 or lower-than-average sea surface temperatures, so it would be three months at least before we could definitely say we had a La Niña, although the atmosphere over the western hemisphere is acting like it's feeling one.

Lenart: I noticed that the CPC has Florida down as dry, and the Southwest and Florida are both dry during La Niña years. Does that dryness have anything to do with the ENSO conditions you're describing?

Wolter: No, I think that prediction came from a variety of tools. There were quite a few that agreed on that. New Mexico has been one of the tougher regions for my forecast. New Mexico so far has been drier than normal but Arizona's dry forecast has verified pretty nicely, as has eastern Colorado's wet forecast. Utah and western Colorado were a toss-up. The dry Arizona signal didn't come from La Niña—it was from the warm tropical Atlantic, especially the Caribbean. The very active hurricane season anchored low pressure over the Caribbean and promoted ridging upstream in Arizona. That had nothing to do with La Niña except in the sense that when you don't have an El Niño, you can have a more active hurricane season. That's a very weak link. The same reasoning applies to eastern Colorado because when we had moisture coming in from the Gulf of Mexico, we had more efficient storms. Why that stopped working in New Mexico, I don't know. The forecast I have for January–March is a very simple dipole, with wetness in Utah and western Colorado and dryness in New Mexico and eastern Colorado. Interestingly, I have a neutral forecast for Arizona, which does reflect the current state of ENSO being almost neutral. If we had a full-blown La Niña, I would definitely go dry there. Right now, it's too close to neutral to call.

Lenart: Ed, you said that things aren't looking too good now for New Mexico's basin outside the Colorado. Did you put a percent normal on the streamflow that you're projecting for this spring?

Polasko: I'm not going to forecast a percent normal streamflow just yet because it's way too early. If you look at last year at this time we'd had a wet fall; December was fairly dry and all of a sudden we were hit with an incredibly wet January and February. Albuquerque had the wettest beginning of the calendar year on record, and our records go back to 1890. We had an incredible turnaround. What concerns us now is the PDO [Pacific Decadal Oscillation] having turned negative. That was for September; we don't have October's data yet, because a negative PDO is pretty highly correlated with dry conditions all across New Mexico. It loses correlation once it gets up into Colorado.

Wolter: The PDO is supposed to reflect longer-term oscillations, so is it really smart to keep track of it on a monthly basis? This year it was quite high late in the spring, and some people think it's nothing but a low-pass filter of ENSO. The fact that we switched from El Niño-like conditions, the last peak of which was last spring, to La Niña-like conditions may have more to do with the current drop in the PDO than anything else.

Brandon: I have a final comment, which is that this is why it's very difficult to take all this information and put it into streamflow numbers. Klaus has good information and a lot of people are looking at it, but it's difficult to turn into numbers.

Lenart: So despite the CPC forecast for equal chances, there's a general feeling here that things might be a little bit drier and we might not get as much streamflow, at least compared to last year if not the average.

Polasko: There's no doubt that New Mexico would be hard pressed to have the same kind of really good water year this spring that we had a year ago. Our concern is that with any kind of much drier regime, will our reservoir storage hold us over in terms of water need? …In the Upper San Juan Basin, there isn't a great deal of concern right now considering that Navajo Reservoir is at least at 90 percent of capacity and at 114 percent of its 30-year average. So last year's water year did wonders for the San Juan and the northwest part of New Mexico. As you move further into New Mexico, we are much improved from a year ago, but our reservoirs aren't in nearly as good of shape as the northwest ones. Elephant Butte is only at 30 percent of average and 17 percent of capacity. Abiquiu in the Rio Grande system is at about 97 percent of average, but it's still only 20 percent of capacity. El Vado is at 58 percent capacity and at about 110 percent of average. So this is much better than a year ago at this time, but nowhere near where we were in 1999 before the drought of 2000 took hold. We don't get a great many winter storms, so our hopes are that the winter storms we get are potent and bring us a great deal of rain in the lowlands and snow in the higher elevations. Last winter and spring we did quite well and it wasn't anything to do with El Niño or La Niña, even though we ended up with a very weak El Niño towards the end of the season.

Hartmann: In the face of uncertain forecasts, you can't expect to have a forecast all the time this far in advance. It's only really when you get strong signals from ENSO that you have something to look for regarding precipitation. Since it's more of a forecast of opportunity, people who need to make decisions would be well advised to think about conditions that cause them problems and prepare for those rather than relying on a forecast to tell them what to do.

Lenart: Thank you all very much.

Temperature (through 12/14/05)

Source: High Plains Regional Climate Center

Most of Arizona and New Mexico have experienced warmer-than-average temperatures since the water year began October 1 (Figures 1a–1b). Average temperatures in the region range from the low 70 degrees Fahrenheit in southwestern Arizona to the low 30 degrees in northern New Mexico (Figure 1a). Since October 1, most areas have been 1–3 degrees warmer than average, except for small areas in western Arizona and central and northern New Mexico that were 1–2 degrees cooler than average (Figure 1b). Since November 15, large regions of New Mexico and parts of northeastern Arizona have been 2–6 degrees cooler than average, while some parts of western and southwestern Arizona have been 2–4 degrees warmer than average (Figures 1c–1d).

Recent temperature conditions have been extreme in the Southwest. In Tucson, the month of November ranked as the tenth warmest on record and the fall (September–November) ranked as the forth warmest with an average temperature of 73 degrees, according to the National Weather Service. However, the first week of December brought much colder temperatures to many areas in the West, including northern New Mexico. Record cold temperatures swept through northern New Mexico December 8, bringing minimum daily temperatures in Albuquerque and Taos to 7 degrees and -11 degrees, respectively.

Notes:

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

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

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

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

On the Web:

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

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

Figure 1a. Water year '05–'06 (through December 14, 2005) average temperature.

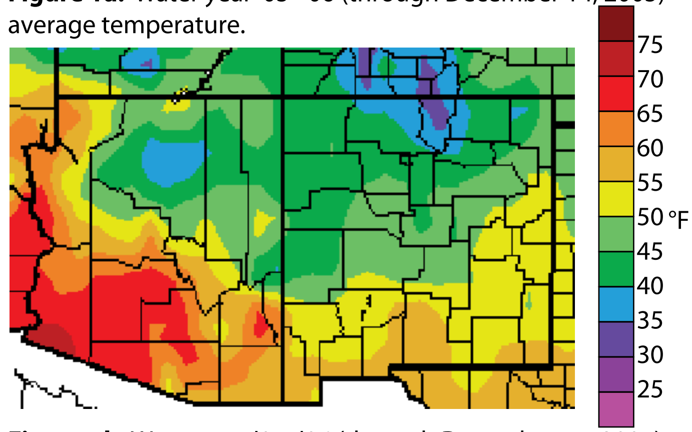


Figure 1b. Water year '05–'06 (through December 14, 2005) departure from average temperature.

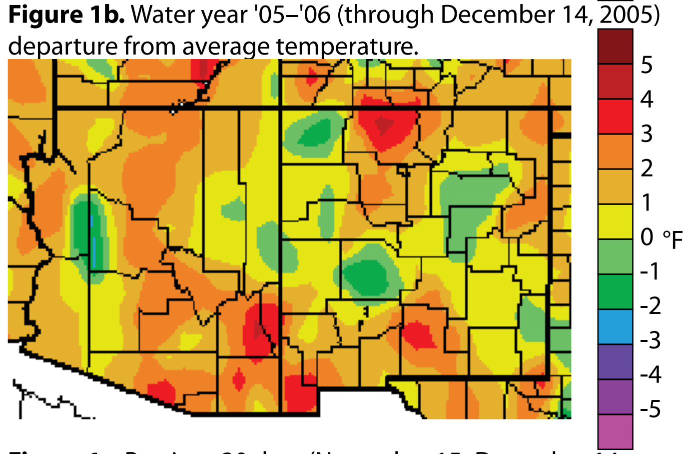


Figure 1c. Previous 30 days (November 15–December 14, 2005) departure from average temperature (interpolated).

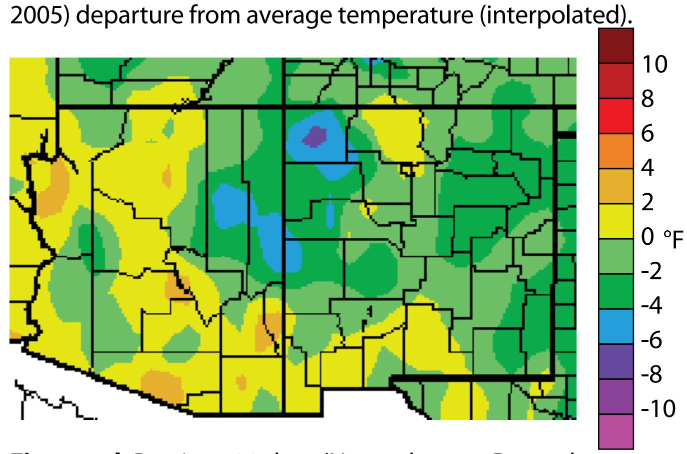
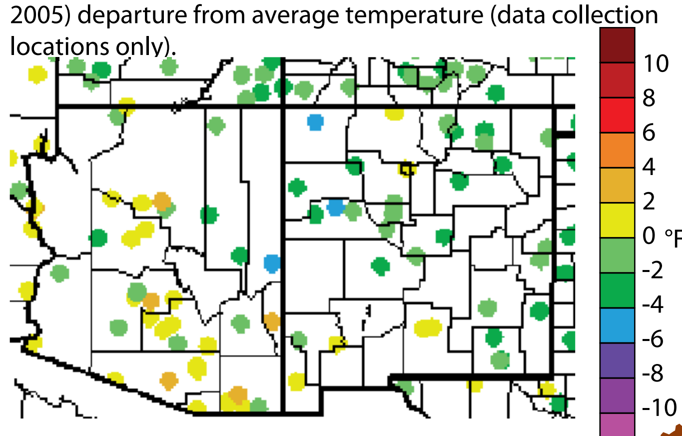


Figure 1d. Previous 30 days (November 15–December 14, 2005) departure from average temperature (data collection locations only).



Precipitation (through 12/14/05)

Source: High Plains Regional Climate Center

Southwest regional precipitation has been below average since October 1, except for areas in western Arizona and southeastern New Mexico (Figure 2a–2b). Areas with the lowest percent of average precipitation (less than 5 percent) are in south-central Arizona. Since November 15, the region has been extremely drier than average (Figure 2c). Large areas in western and central Arizona and eastern New Mexico have received less than 2 percent of average precipitation. The wettest region relative to average is in southeastern New Mexico and has only received 50–75 percent of average precipitation.

The Tucson National Weather Service reports that until 0.01 inches of rain fell December 12, no rain had fallen in the city since October 17, a stretch of 55 days. This is the longest fall dry spell since 1982 and the first time since 1999 that no precipitation was recorded during the month of November. In Phoenix, the streak of no rain days since October 17 is still running. The all-time record is 91 days from January 6 to April 5, 1984. According to the Albuquerque National Weather Service, only trace precipitation was recorded during November, the least amount of precipitation since 1999.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2005 we are in the 2006 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions.

The dots in Figures 2b and 2d show data values for individual meteorological stations.

On the Web:

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

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

Figure 2a. Water year '05–'06 through December 14, 2005 percent of average precipitation (interpolated).

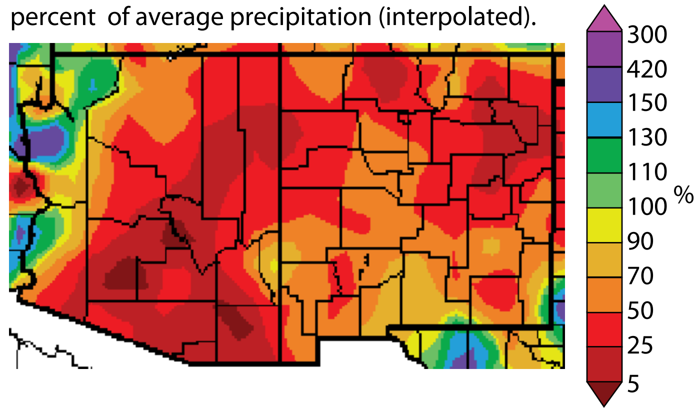


Figure 2b. Water year '05–'06 through December 14, 2005 percent of average precipitation (data collection locations only).

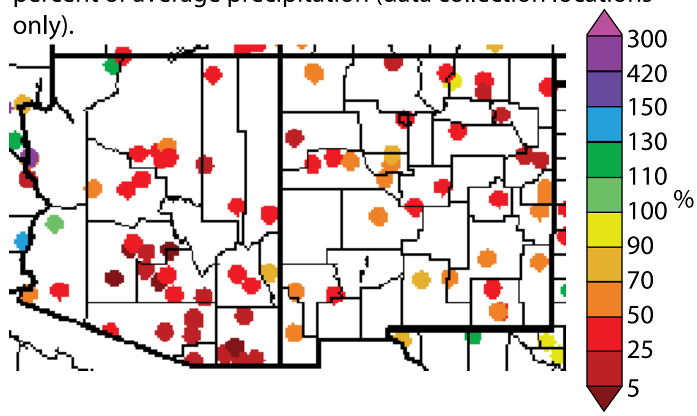


Figure 2c. Previous 30 days (November 15–December 14, 2005) percent of average precipitation (interpolated).

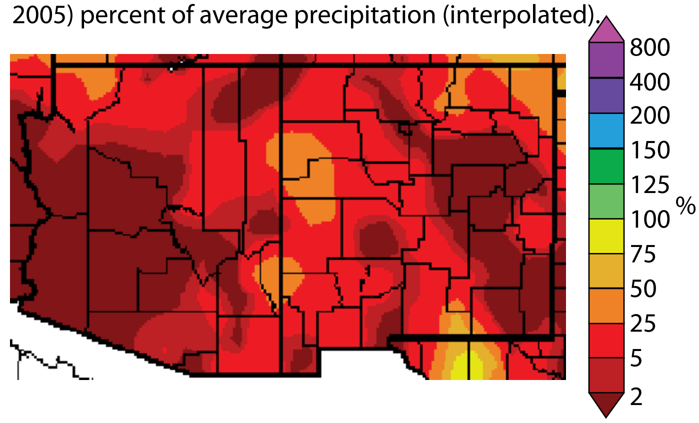
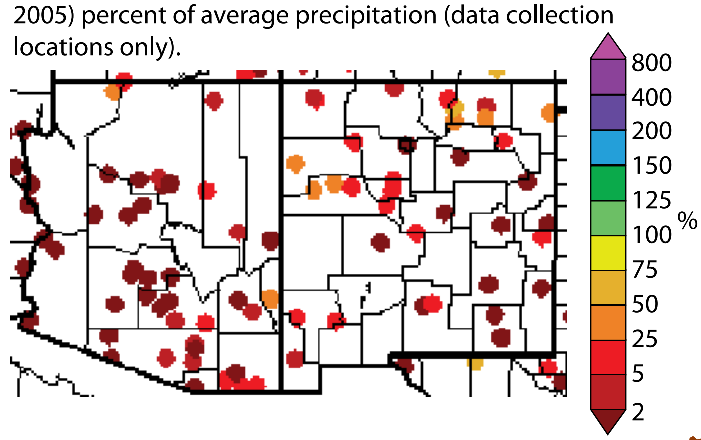


Figure 2d. Previous 30 days (November 15–December 14, 2005) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 12/15/05)

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

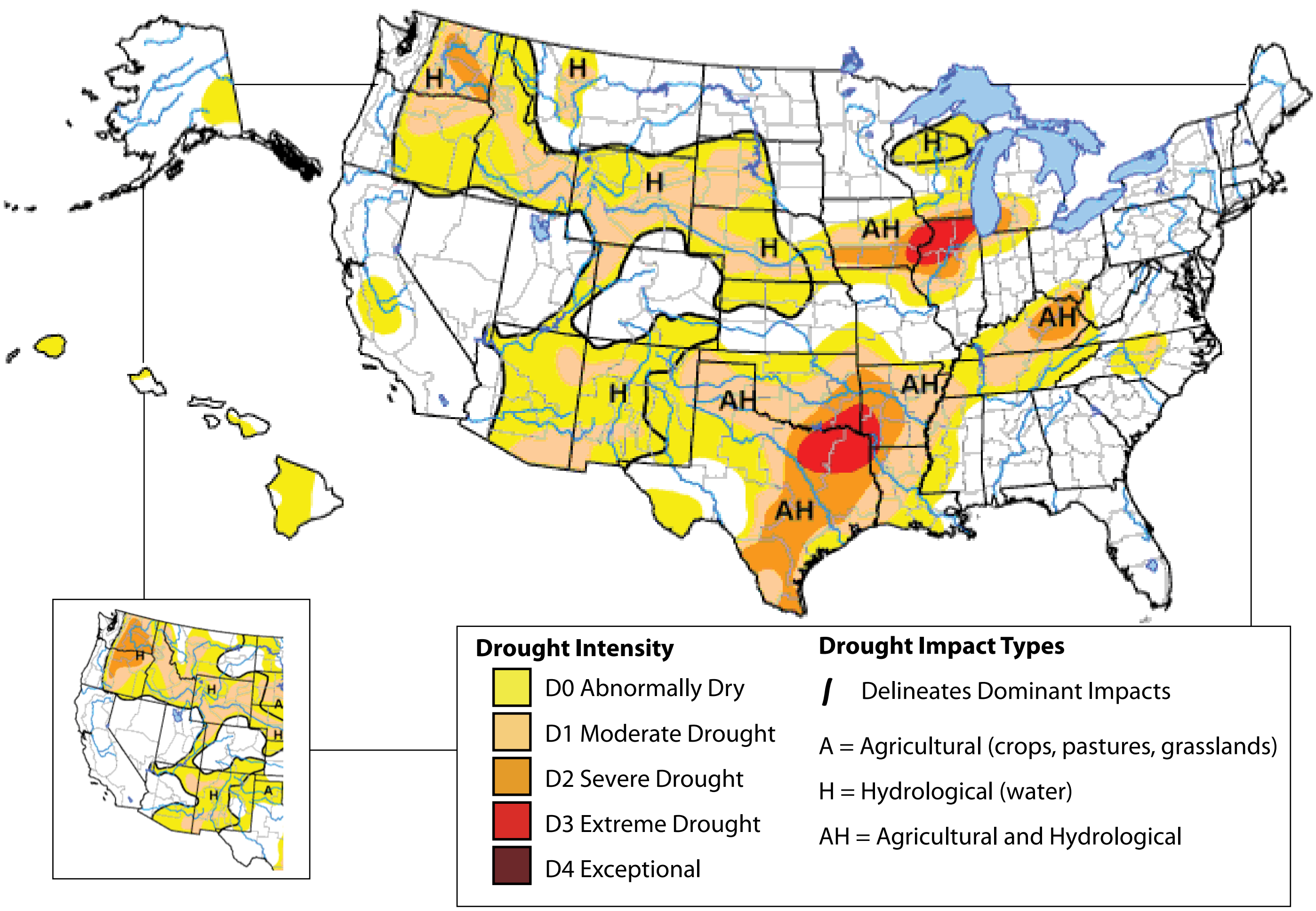
Since last month, abnormally dry conditions have been extended westward in Arizona to the eastern borders of Mohave, La Paz, and Yuma counties (Figure 3) and moderate drought conditions have been extended westward into Pima and Santa Cruz counties. In east-central New Mexico, abnormally dry conditions were introduced last month and continue this month. Most of the Southwest region has received below-average precipitation since the water year began on October 1 (see Figures 2a–2d). Most of Arizona and New Mexico are identified as being in a hydrological drought, which means that the primary physical effects are on rivers, groundwater aquifers, and reservoirs. The eastern third of New Mexico is classified as being in both agricultural and hydrological drought, which means that crops and grasslands could also be affected.

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 Michael Hayes and Brian Fuchs NDMC.

Figure 3. Drought Monitor released December 15, 2005 (full size) and November 17, 2005 (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 11/18/05)

Source: New Mexico Natural Resources Conservation Service

As of November 18, short-term drought conditions in most of eastern and central New Mexico were classified as normal, according to the New Mexico State Drought Monitoring Committee. Northwestern and southwestern New Mexico, as well as Lincoln County in central New Mexico, were classified as being in mild (alert) or moderate (warning) drought (Figure 4a). Long-term drought conditions in the San Juan River Basin and the upper Pecos River Basin are classified as normal, while the Bluewater and Zuni River Basins are in a moderate (warning) drought (Figure 4b). The lower Rio Grande, Upper Gila, San Francisco, Mimbres, and Canadian river basins are all in mild (alert) drought status.

Over the past 30 days, New Mexico has received significantly below-average precipitation. Large areas in eastern New Mexico have received less than 2 percent of average (see Figure 2c). The U.S. Drought Monitor classifies most of the state as abnormally dry except for areas in the northwest, southwest, and northeast that are classified as being in moderate drought (see Figure 3). New Mexico has received below-average precipitation since the water year began October 1, but in Albuquerque, heavy rainfall from early in the year still leaves 2005 as the eighth wettest year on record through the first 11 months.

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.azwater.gov/dwr/default.htm

Figure 4a. Short-term drought map based on meteorological conditions as of November 18, 2005.

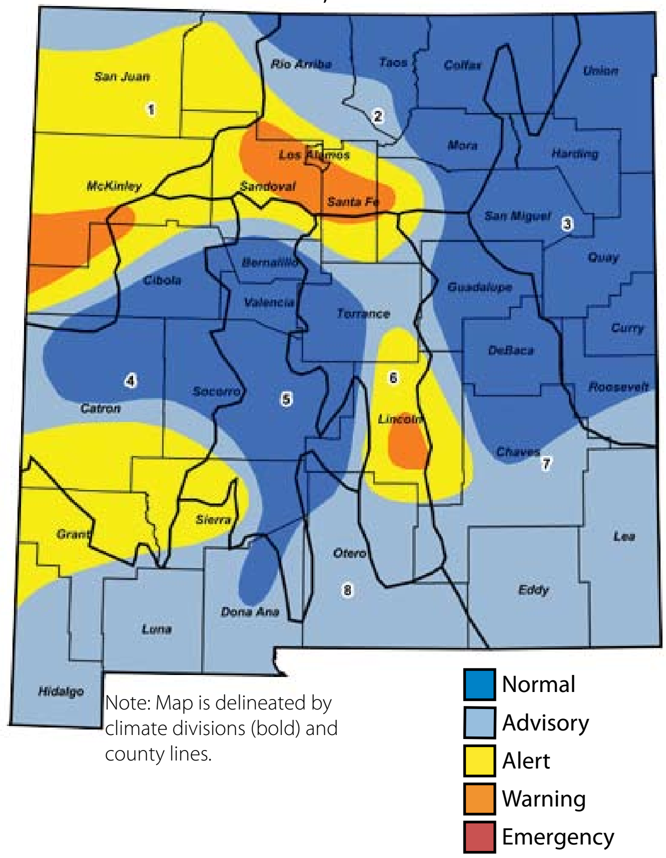
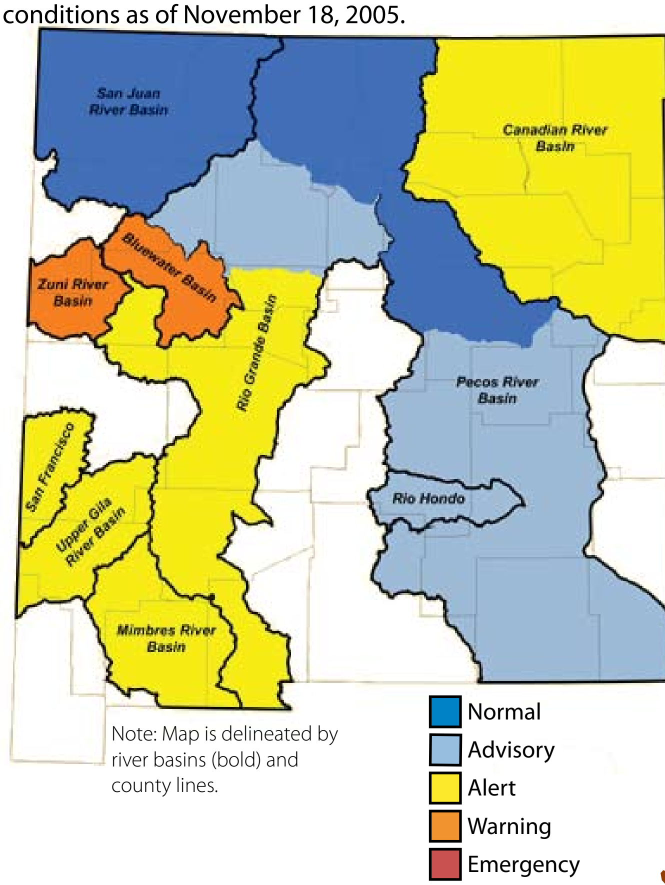


Figure 4b. Long-term drought map based on hydrological conditions as of November 18, 2005.



Arizona Reservoir Levels

(through 11/30/05)

Source: National Water and Climate Center

Reservoirs in Arizona changed only slightly from October to November. Lake Havasu and Lake Mohave on the Colorado River rose slightly, but most other reservoirs declined slightly. Show Low Lake remains full and Lyman reservoir held constant at 26 percent of capacity (Figure 5). For the last several months, reservoirs throughout the state have remained well below capacity, except for the Salt River system (82 percent), Show Low Lake (100 percent), Lake Havasu (92 percent), and Lake Mohave (84 percent). Despite the losses, most reservoirs are near to well above last year's levels, due to abundant winter 2004–05 and spring 2005 precipitation. The Salt River system currently holds more than double the amount it did a year ago, up from only 40 percent of capacity last year. Lake Powell and Lake Mead on the Colorado River, the two largest reservoirs in the state, are up by 12 percent and 2 percent of capacity, respectively, since last year. Both of those reservoirs remain well below their average levels, but the reservoirs on the Salt and Verde Rivers are still above their average levels. The Salt River system is at 150 percent of average, and the Verde River system is at 113 percent of average.

This week the seven Colorado River Basin states held their annual meeting in Las Vegas (*Arizona Republic*, December 12–14). More than 25 million people in the seven states rely on the Colorado River for water and power. Officials planned to discuss possible changes in the way Lake Powell and Lake Mead are managed, and various ways to augment river flow, reduce water waste through increased conservation, and manage the river system more efficiently. Cloud seeding to augment precipitation and removal of salt cedar trees from riverbanks to reduce water losses are among the strategies being considered to augment river flow.

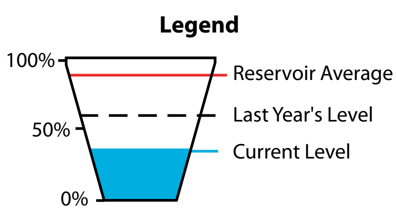
Notes:

The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

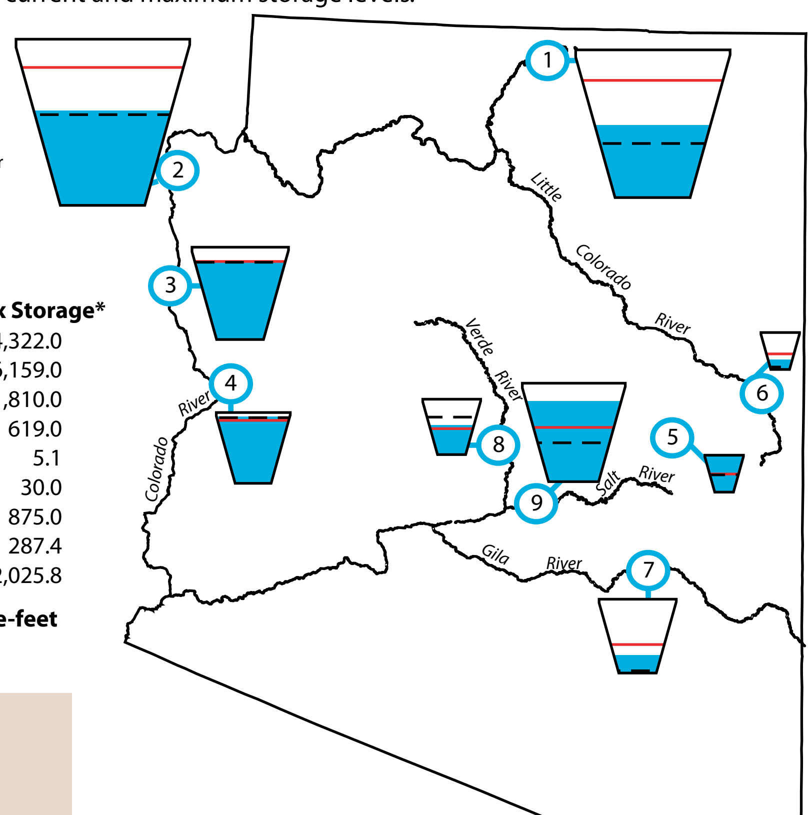
The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (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 November 2005 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.



size of cups is representational of reservoir size, but not to scale



Reservoir Name	Capacity Level	Current Storage*	Max Storage*
1. Lake Powell	49%	11,977.0	24,322.0
2. Lake Mead	57%	14,896.0	26,159.0
3. Lake Mohave	85%	1,538.4	1,810.0
4. Lake Havasu	94%	582.3	619.0
5. Show Low Lake	100%	5.1	5.1
6. Lyman Reservoir	26%	7.8	30.0
7. San Carlos	24%	210.8	875.0
8. Verde River System	53%	153.5	287.4
9. Salt River System	82%	1,660.2	2,025.8

*** thousands of acre-feet**

On the Web:

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

New Mexico Reservoir Levels

(through 11/30/05)

Source: National Water and Climate Center

Most of New Mexico's reservoirs remain well below capacity as of the end of November, except for Navajo Reservoir, which is at 91 percent of capacity (Figure 6). Of the remaining reservoirs, only Costilla, El Vado, and Heron are above 50 percent of capacity. Many of the reservoirs in New Mexico declined slightly from October to November, while some of them increased slightly. Like last month, the largest decrease was at Sumner Reservoir on the Pecos River, which declined from 32 percent to 12 percent of capacity, following a loss of 7 percent of capacity last month. Heron Reservoir declined from 58 to 53 percent of capacity. About half of the lakes on the Rio Grande system are still well below average levels, while Abiquiu, Costilla, and El Vado are at above average storage levels. Caballo Reservoir remains at only 4 percent of capacity, while Elephant Butte, the largest reservoir in the state, rose slightly but is still at only 19 percent of capacity. Statewide storage declined slightly since last month from 40 percent to 39 percent of storage capacity. Thanks to the plentiful rain received in winter 2004–05 and spring 2005, most of the reservoirs gained in storage compared to this time last year, when statewide storage stood at only 23 percent of capacity.

According to the *U.S. Water News* (December 2005) website, the City of Santa Fe and the Jicarilla Apache Nation have signed an agreement to allow Santa Fe to lease water from the tribe for the next 50 years. The city is to pay the tribe $1.5 million a year to lease up to 3,000 acre-feet per year from the San Juan-Chama diversion project. The city has made the first down payment of $450,000 in an agreement that is expected to benefit both the tribe and Santa Fe.

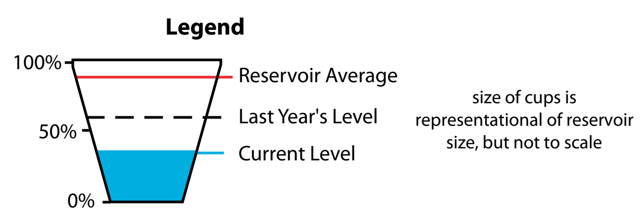
Notes:

The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

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

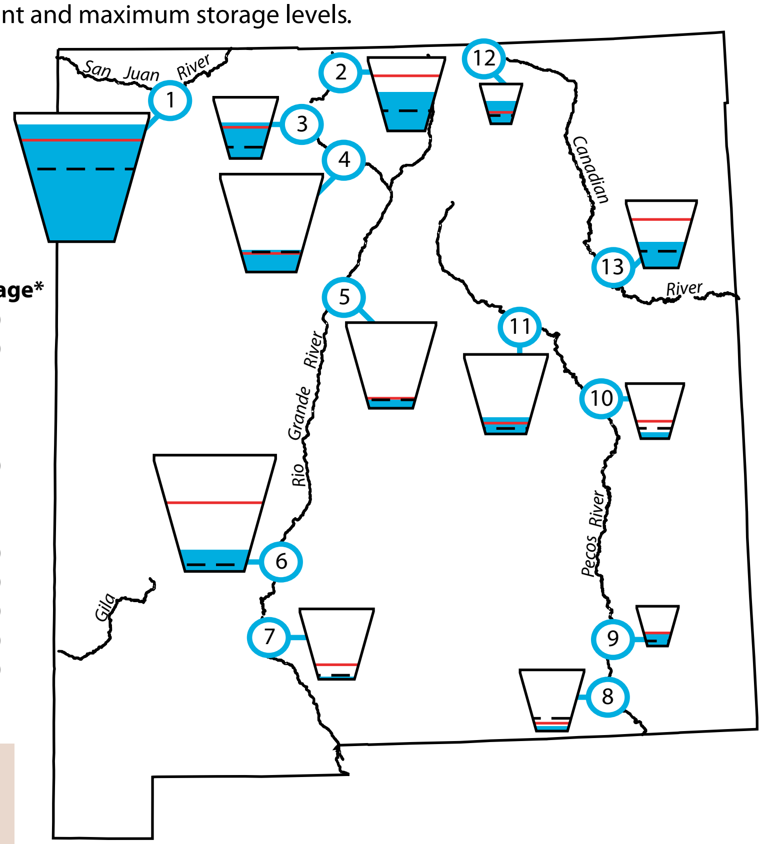
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) 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 November 2005 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	91%	1,542.6	1,696.0
2. Heron	53%	213.1	400.0
3. El Vado	58%	107.9	186.3
4. Abiquiu	22%	122.4	554.5
5. Cochiti	10%	48.4	502.3
6. Elephant Butte	19%	384.2	2,065.0
7. Caballo	4%	14.2	331.5
8. Brantley	8%	12.3	147.5
9. Lake Avalon	30%	1.8	6.0
10. Sumner	12%	11.9	102.0
11. Santa Rosa	21%	93.6	447.0
12. Costilla	58%	9.2	16.0
13. Conchas	39%	99.5	254.0

*** thousands of acre-feet**



On the Web:

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

Southwest Snowpack

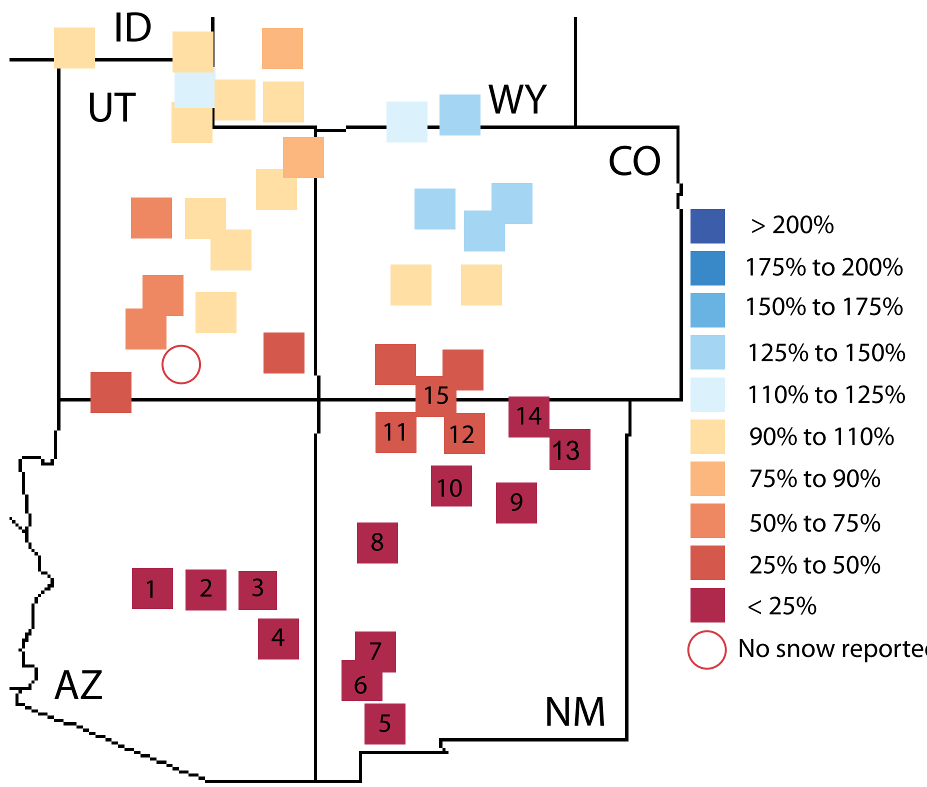
(updated 12/15/05)

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

Southwest snowpack has been well below average so far this season, with all SNOTEL sites in Arizona and New Mexico reporting less than 50 percent of average snow water content (SWC) as of December 15 (Figure 7). All of the basins in Arizona and southeastern New Mexico have recorded less than 5 percent of average SWC, except for the Little Colorado–Southern Headwaters, which recorded 8 percent. Ski resorts in Arizona have delayed opening due to the lack of snow. Basins in northern New Mexico have fared somewhat better, with the San Miguel, Dolores, Animas, and San Juan River Basins, the Sangre de Cristo Mountain Range Basin, and the San Juan River headwaters all reporting between 29 and 44 percent of average SWC.

Above-average temperatures and below-average precipitation in the region since the start of the water year on October 1 (see Figures 1–2) have contributed to the below-average basin SWC in the Southwest, although slightly cooler-than-average temperatures since November 15 in the northeastern part of the region have been somewhat more favorable to snow accumulation in northern New Mexico. According to the National Weather Service in Albuquerque, the northern New Mexico snowpack got off to a slow start due to drier-than-average conditions in October and throughout November. At the end of November last year, snowpack ranged from 83 to 109 percent of average in northern New Mexico.

Figure 7. Average snow water content (SWC) in percent of average for available monitoring sites as of December 15, 2005.



Arizona Basins
1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins
5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

On the Web:

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

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

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

Notes:

Snowpack telemetry (SNOTEL) sites are automated stations that measure snowpack depth, temperature, precipitation, soil moisture content, and soil saturation. A parameter called snow water content (SWC) or snow water equivalent (SWE) is calculated from this information. SWC refers to the depth of water that would result by melting the snowpack at the SNOTEL site and is important in estimating runoff and streamflow. It depends mainly on the density of the snow. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWC than light, powdery snow.

Figure 7 shows the SWC for selected river basins, based on SNOTEL sites in or near the basins, compared to the 1971–2000 average values. The number of SNOTEL sites varies by basin. Basins with more than one site are represented as an average of the sites. Individual sites do not always report data due to lack of snow or instrument error.

Temperature Outlook

(January–June 2006)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC long-lead temperature outlooks indicate increased chances of above-average temperatures for the Southwest and much of the adjacent parts of the country through June 2006 (Figure 8a–d). Forecasts indicate the highest probabilities centered over western Arizona for February–June 2006. A persistent anomaly of high probability (50 percent or greater) of above-average temperatures will include most of Arizona, southern and western New Mexico, parts of west Texas, and adjacent parts of California, Nevada, Utah, and Colorado for January–June 2006. Elsewhere, most of Florida and much of Alaska are forecasted to be warmer than average. The CPC outlooks agree closely with the outlooks issued by the International Research Institute for Climate Prediction (not shown), except for some minor differences in the placement of the forecast anomalies.

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 8a. Long-lead national temperature forecast for January–March 2006.

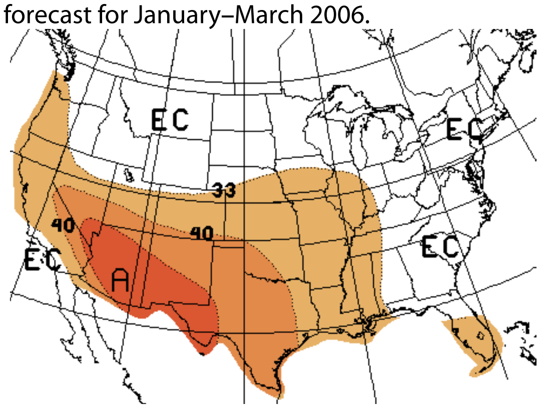


Figure 8b. Long-lead national temperature forecast for February–April 2006.

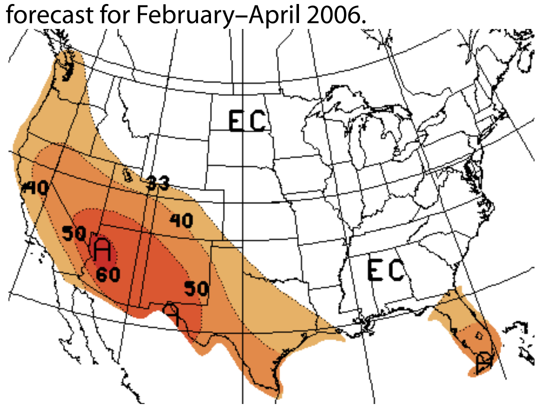


Figure 8c. Long-lead national temperature forecast for March–May 2006.

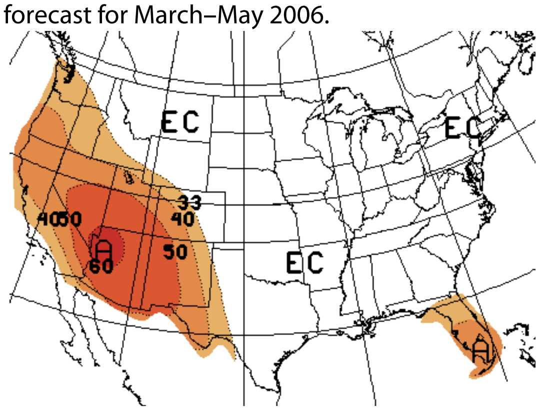
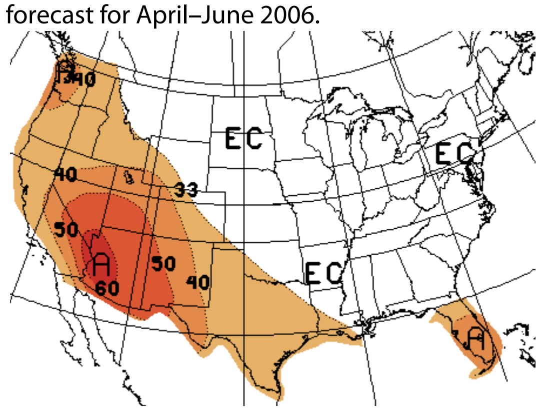


Figure 8d. Long-lead national temperature forecast for April–June 2006.



A= Above

60.0–69.9%

50.0–59.9%

40.0–49.9%

33.3–39.9%

EC= Equal chances. No forecasted anomalies.

On the Web:

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

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

Precipitation Outlook
(January–June 2006)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC long-lead precipitation outlooks indicate increased chances of below-average precipitation for much of the Southwest and portions of the Southeast through May 2006 (Figure 9a–d). The areas of highest probabilities in the Southwest are centered over southern Arizona, southern New Mexico, and southwestern Texas for January–March 2006. The forecast anomaly in the Southwest becomes centered over southern and southwestern Arizona for February–May 2006. After May 2006 there are no forecasts for the Southwest, but a small area in the upper Midwest near the Canadian border is predicted to be wetter than average for April–June 2006. The CPC outlooks agree closely with the outlooks issued by the International Research Institute for Climate Prediction (not shown), except for some minor differences in the placement of the forecast anomalies.

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 9a. Long-lead national precipitation forecast for January–March 2006.

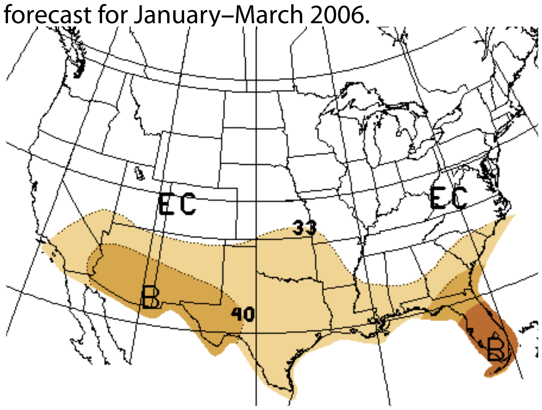


Figure 9b. Long-lead national precipitation forecast for February–April 2006.

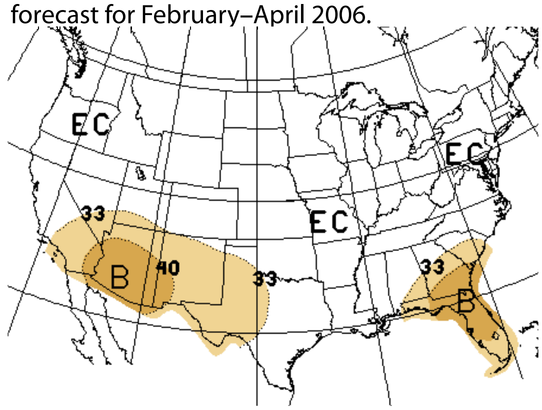


Figure 9c. Long-lead national precipitation forecast for March–May 2006.

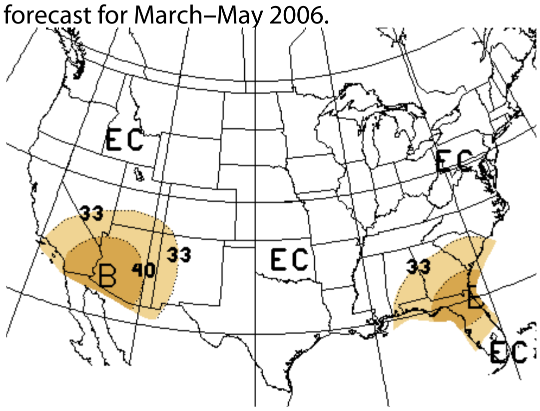
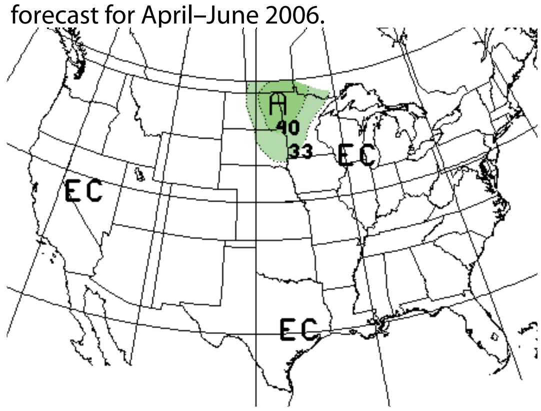
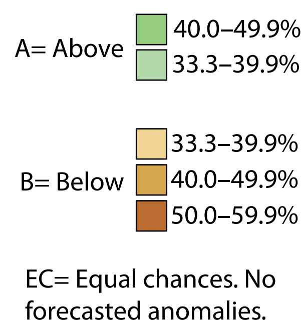


Figure 9d. Long-lead national precipitation forecast for April–June 2006.





On the Web:

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

Source: NOAA Climate Prediction Center (CPC)

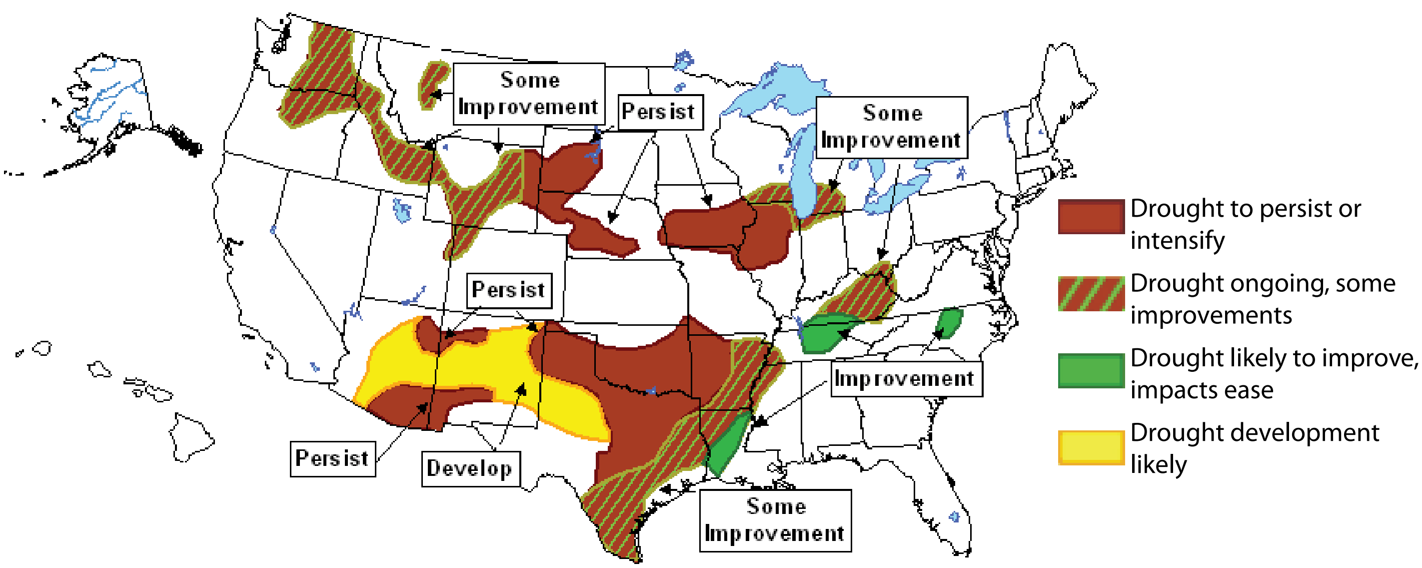
The NOAA-CPC drought outlook indicates that current drought conditions in the Southwest are likely to persist or intensify through March 2006 (Figure 10). Dry conditions since October have resulted in the introduction of abnormally dry drought status throughout much of Arizona and New Mexico (see Figure 3). Drought conditions are predicted to persist in areas classified as being in moderate drought and to develop in areas that are classified as abnormally dry by the U.S. Drought Monitor. Recent above-average temperature conditions have also contributed to drought persistence.

Improvements in drought conditions are unlikely through the winter given forecasts predicting above-average temperatures and below-average precipitation (see Figures 8–9).

Notes:

The delineated areas in the Seasonal Drought Outlook (Figure 10) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

Figure 10. Seasonal drought outlook through March 2006 (release date December 15, 2005).



On the Web:

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

El Niño Status and Forecast

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

El Niño-Southern Oscillation (ENSO) conditions remained neutral based on near-average sea surface temperature (SST) conditions, atmospheric pressure, and wind circulation patterns across the equatorial Pacific Ocean. Although Southern Oscillation Index (SOI) three-month running average values (an index of atmospheric response to the Pacific Ocean temperatures) have shown a moderate but steady increase since last spring, SOI values remain in the ENSO-neutral range (Figure 11a). Probabilistic forecasts issued by the IRI predict there is a 95 percent chance that ENSO-neutral conditions will persist through February 2006, and are likely to continue to prevail throughout the summer, but with decreasing certainty (Figure 11b). The chances of La Niña conditions starting by spring of 2006 are set at 20 percent.

There is considerable variability in the outlooks from different prediction models (not shown). Experts indicate that current conditions and recent trends favor either a continuation of ENSO-neutral conditions or the development of weak La Niña conditions. Historically, La Niña conditions tend to favor below-normal precipitation and above-normal temperatures in the Southwest, while El Niño conditions have less predictable effects favoring increased winter precipitation in the Southwest climate.

Notes:

Figure 11a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through November 2005. The SOI measures the atmospheric response to SST changes across the Pacific Ocean Basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

Figure 11b shows the International Research Institute for Climate Prediction (IRI) probabilistic El Niño-Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

On the Web:

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

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

Figure 11a. The standardized values of the Southern Oscillation Index from January 1980–November 2005. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).

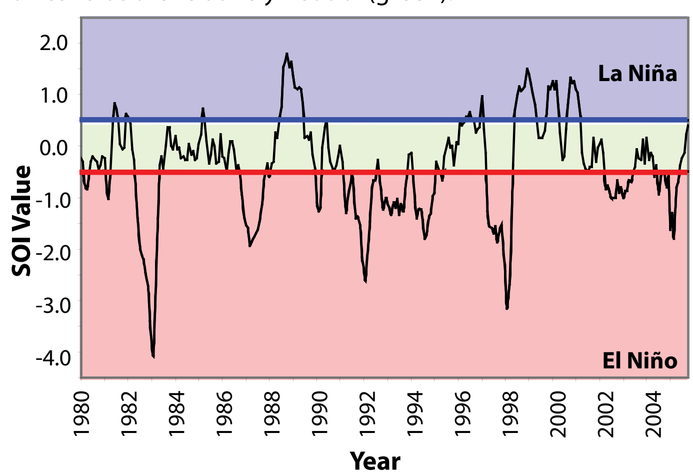
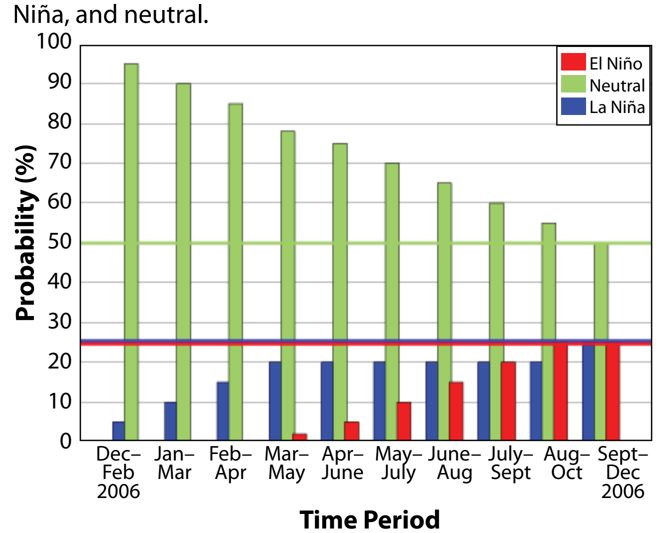


Figure 11b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released December 15, 2005). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Temperature Verification

(September–November 2005)

Source: NOAA Climate Prediction Center (CPC)

The long-range forecast for September–November 2005 from the NOAA-CPC predicted increased chances of above-average temperatures throughout much of the Southwest and west Texas, the Pacific Northwest, and most of Florida (Figure 12a). The area of highest probability in the Southwest was centered in western Arizona, and extended into southern New Mexico and southwest Texas, and into southwest Utah and the southeastern portions of Nevada and California. No probabilities for cooler-than-average temperatures were forecast. Observed temperatures across most of the nation ranged from 0–8 degrees Fahrenheit above average, with a band 0–2 degrees below average temperatures along the west coast and in the Pacific Northwest (Figure 12b). Generally, the forecast performed well in predicting above-average temperatures in the Southwest and in Florida, although the forecast did not predict the well-above-average temperatures in the Midwest. The forecast of warmer than normal did not preform well in the Pacific Northwest, where below-average temperatures prevailed.

Figure 12a. Long-lead U.S. temperature forecast for September–November 2005 (issued August 2005).

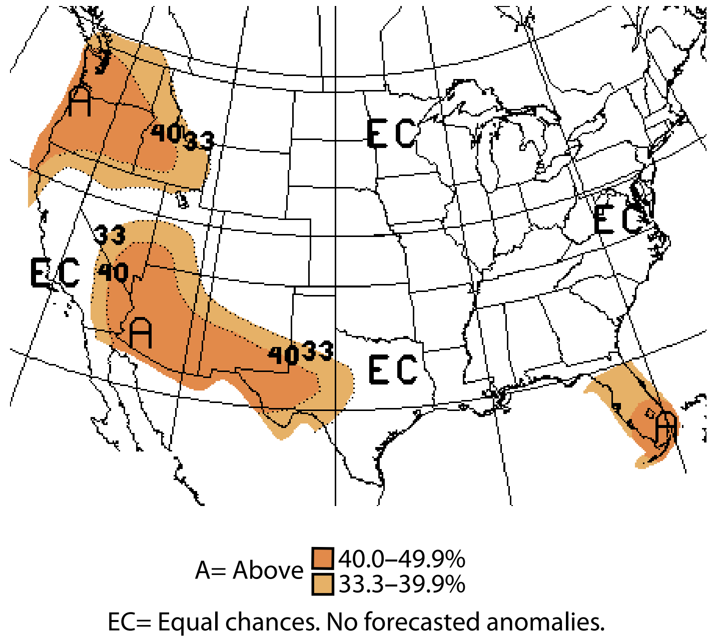
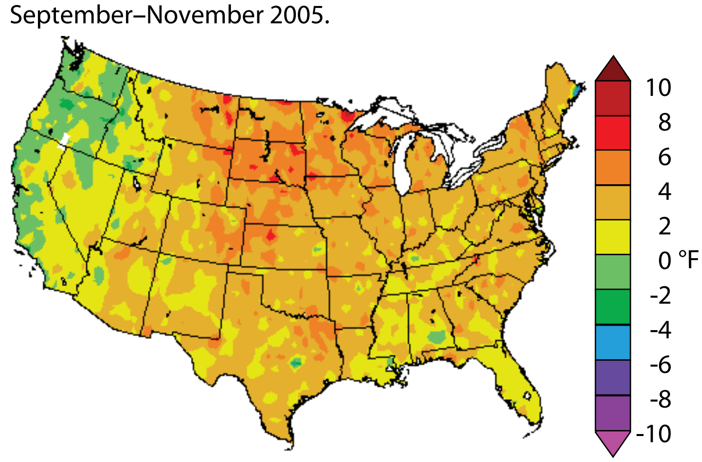


Figure 12b. Average temperature departure (in degrees F) for September–November 2005.



Notes:

Figure 12a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months September–November 2005. This forecast was made in August 2005.

The outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 12b shows the observed departure of temperature (degrees F) from the average for the September–November 2005 period. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps. The temperature departures do not represent probability classes as in the forecast maps, so they are not strictly comparable. They do provide us with some idea of how well the forecast performed. In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

On the Web:

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

Precipitation Verification

(September–November 2005)

Source: NOAA Climate Prediction Center (CPC)

The long-range outlook from the NOAA-CPC for September–November 2005 predicted increased chances of below-average precipitation in parts of the West, with the area of highest probability extending from Nevada to western Montana (Figure 13a). In the southern states within the forecast anomaly, precipitation was generally below average (Figure 13b). Only a small portion of northwestern Arizona, was included in the lower-probability fringe of the forecast anomaly. Some areas of the region verified, while others experienced above-average precipitation. Results were not as good in the northern part of the forecast anomaly, where mostly above-normal precipitation occurred. In general, the forecast did not predict the below-average precipitation in the areas where it was most pronounced, including most of Arizona. In the Southeast, above-average precipitation was predicted for most of Florida and the eastern portions of Georgia and the Carolinas, where the model had mixed results. Most of Florida and a strip along the Atlantic coastline did receive above-average precipitation, but the western part of the area was drier than average.

Figure 13a. Long-lead U.S. precipitation forecast for September–November 2005 (issued August 2005).

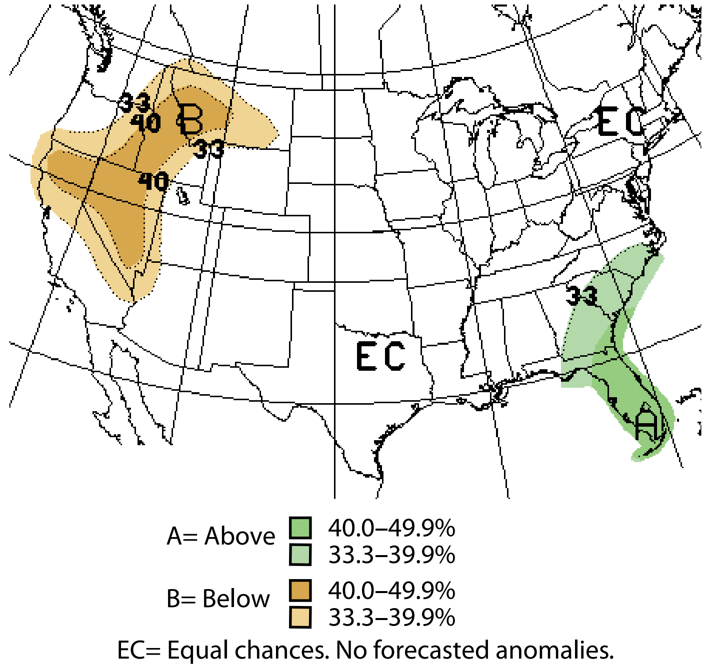
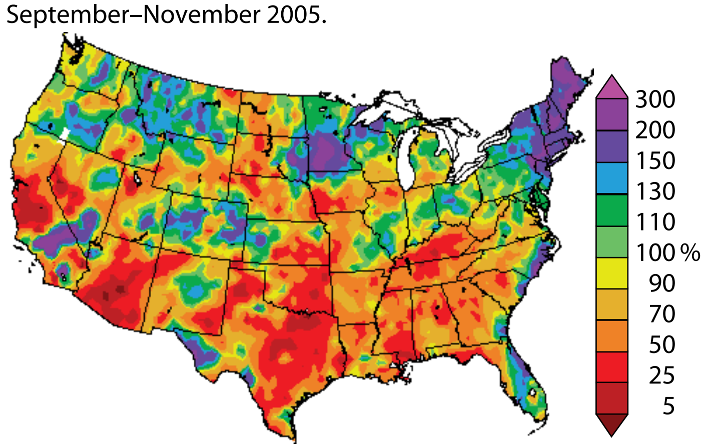


Figure 13b. Percent of average precipitation observed from September–November 2005.



Notes:

Figure 13a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months September–November 2005. This forecast was made in August 2005.

The outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 13b shows the observed percent of average precipitation for September–November 2005 2005. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps. The observed precipitation amounts do not represent probability classes as in the forecast maps, so they are not strictly comparable, but they do provide us with some idea of how well the forecast performed.

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

On the Web:

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