Issued: March 20, 2007

Southwest Climate Outlook

The University of Arizona.

Source: Gregg Garfin, Institute for the Study of Planet Earth

Photo Description: U.S. Bureau of Reclamation Yuma Desalting Plant sediment settling ponds. The U.S. Bureau of Reclamation is currently experimenting with bringing the desalting plant back online, in order to help meet water quality standards for deliveries of Colorado River water to Mexico.

Would you like to have your favorite photograph featured on the cover of the *Southwest Climate Outlook*? For consideration send a photo representing Southwest climate and a detailed caption to: knelson7@email.arizona.edu

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March Climate Summary

Drought – Drought conditions have worsened slightly in Arizona due to below-average winter precipitation, while most of New Mexico remains drought-free.

Temperature – Temperatures have been above average in most of the Southwest over the past thirty days.

Precipitation – During the past month precipitation has been below average for much of Arizona and New Mexico.

Climate Forecasts – Through September 2007, temperatures are expected to be warmer than average in the Southwest, while chances are equal for below-average, average, or above-average precipitation.

El Niño – Current sea surface temperatures indicate neutral ENSO conditions and there is a chance of La Niña event developing later this summer.

The Bottom Line – As the Southwest prepares to enter the climatologically dry spring, most of New Mexico has received above-average winter precipitation, while winter's El Niño event failed to deliver above-average precipitation to most of Arizona.

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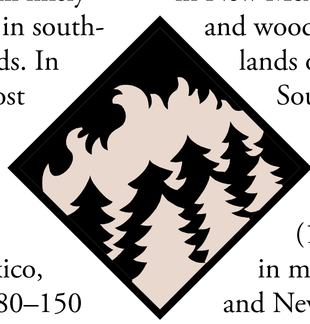
Southwest Wildfire Season Outlook

Warm temperatures expected through the spring after an early and sudden snowmelt late this winter will likely expedite the wildfire season in southwestern forest and woodlands. In the beginning of March, most watersheds in the Arizona high country had 70–95 percent of average snowpack for the late winter. In high elevations of New Mexico, early March snowpack was 80–150 percent of average. However, near-record warmth in the Southwest during the first half of March significantly reduced snowpack to 10–70 percent of average in Arizona and 40–90 percent in New Mexico. In addition to forest and woodlands, the deserts and grasslands of the lower elevations of the Southwest will also be highly susceptible to fires this year. Last year's abundant monsoon precipitation (130–200 percent of average in many locations in Arizona and New Mexico) has increased the density of grasses and forbs. Most of this vegetation remains dried-out as an abundant fuel-load for wildfires.



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Global warming determined to be "unequivocal"

CLIMAS researcher Jonathan Overpeck discusses a recent United Nations report

By Stephanie Doster

A University of Arizona geosciences professor was among the world's leading scientists to issue a recent climate change report that asserted for the first time that global warming is "very likely" driven by human activity.

Jonathan Overpeck, director of the UA's Institute for the Study of Planet Earth and a coordinating lead author of the United Nation's latest Intergovernmental Panel on Climate Change (IPCC) report, said the document represents an international scientific consensus on climate change.

"The most striking thing to me is that we now have presented a much clearer picture of climate change and its causes, both past and future," Overpeck said. "The word we used for the evidence of climate change and global warming is now 'unequivocal.' That is a very strong statement."

The assessment was released in Paris after 113 governments unanimously agreed to the language in the report.

In the last IPCC report, issued in 2001, scientists concluded that industrial emissions "likely" caused a rise in temperatures over the last century. That warming is manifested in observed increasing air, deep ocean, and sea surface temperatures; melting snow, ice, and permafrost; and rising sea levels, said Overpeck, who also is a Climate Assessment for the Southwest investigator.

"All of these observations and others mentioned in the report are consistent and give us a much firmer basis for asserting that climate change is indeed real and that warming has been significant," he said. "I think everyone is pretty comfortable now in saying that we see the climate change and that you cannot get the kind of climate change we're seeing without human-generated greenhouse gases."

Scientists have observed heat-trapping greenhouse gases in the atmosphere, particularly carbon dioxide and methane, at levels that far surpass those seen in the last 650,000 years, Overpeck said. Unless steps are taken to curb these gases, droughts likely will become more frequent. Hurricanes are projected to intensify, boosting the potential for destruction. Some areas, like the Maldives in the Indian Ocean and Tuvalu, a nation of islands and atolls in the Pacific Ocean, could disappear if sea levels rise just three feet. Much more sea level rise will likely be unstoppable over coming centuries if global warming continues unabated.

In the western and southwestern United States and in northern Mexico, climate models agree that winter precipitation will decrease sharply in this century, Overpeck said. The model projections also align with what has actually been happening in the region over the last several years.

One reason for the drying out is that in the winter, the jet stream and the average position of storms will enter the western United States in a more northerly position, bypassing the Southwest, Overpeck said. On top of that, he said, the West has seen a steady downward trend in late spring snowpack because of warmer temperatures and earlier snow melt. Snowpack acts as the region's natural water reservoir and is especially crucial in the dry period that follows winter. A decline in snowpack and streamflow would cut into water supply resources. And with warmer-than-average temperatures continuing into summer, demand for water would spike further still.

The climate models are less certain when it comes to the future of the monsoon, the region's primary source of summer precipitation, and the El Niño Southern Oscillation (ENSO), which is linked to variability in winter precipitation, Overpeck said.

While the region is expected to dry out, it paradoxically is likely to see larger, more destructive flooding as hurricanes, also known as tropical cyclones or typhoons, intensify in all of the oceans.

The largest floods in the Southwest tend to occur when a remnant tropical storm in the fall or late summer hits a frontal storm from the north or northwest,

continued on page 4

GW "unequivocal," continued

providing enough energy to wring out the moisture in the remnant tropical storm, Overpeck explained.

Overall, he said, the Southwest should brace for a number of far-reaching climate changes as the planet warms.

"You take all of these things together and you can clearly see in the report a strong case that the western U.S. and particularly the Southwest—Southern California into Texas—will probably be one of the hardest and soonest hit parts of the country," he said.

Stephanie Doster is an information specialist for the Institute for the Study of Planet Earth. The SWCO feature article archive can be accessed at the following link: http://www.ispe.arizona.edu/climas/forecasts/swarticles.html

Related Links

Climate Change Projections
http://www.geo.arizona.edu/dgesl/research/regional/projected_US_climate_change/projected_US_climate_change.htm

IPCC
http://www.ipcc.ch/

Climate change and Southwest Hydrology
http://www.swhydro.arizona.edu/archive/V6_N1/

UA Global Climate Change Lecture Series podcasts
http://podcasting.arizona.edu/globalclimatechange.html

Jonathan Overpeck ISPE webpage
http://www.ispe.arizona.edu/about/staff/peck.html

UA News release on IPCC report
http://uanews.org/cgi-bin/WebObjects/UANews.woa/5/wa/MainStoryDetails?ArticleID=13547

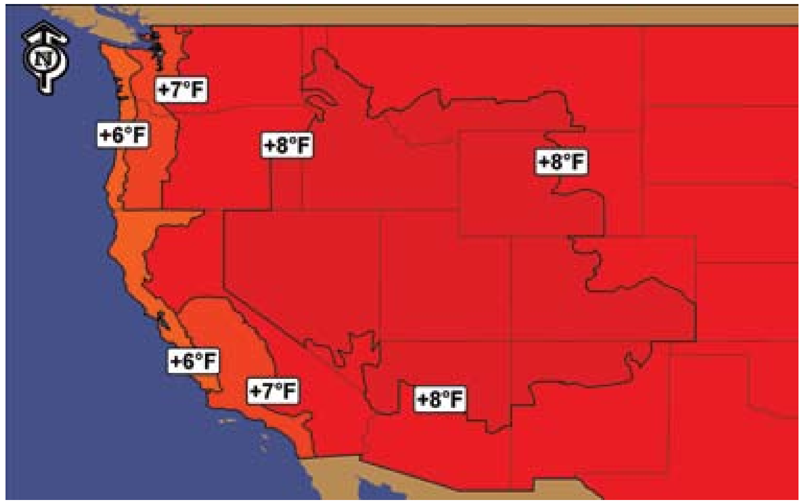


Figure 1. Projected June–August temperature changes from 2091 to 2100.*

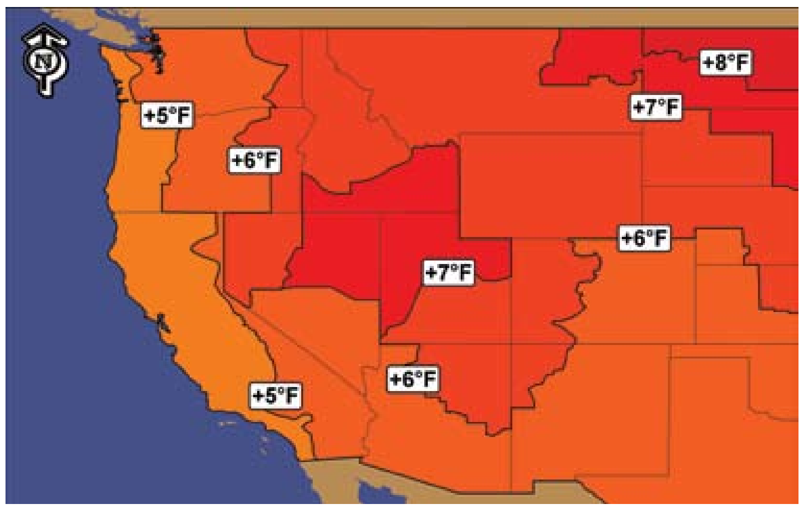


Figure 2. Projected December–February temperature changes from 2091 to 2100.*

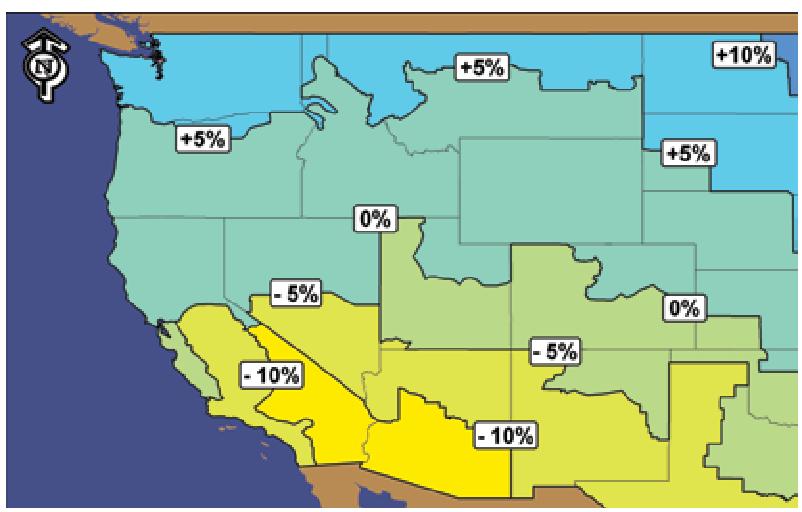


Figure 3. Projected annual precipitation changes from 2091 to 2100.*

**Changes are relative to 1971–2000 averages. Credit: Three maps drawn by JL Weiss, UA; Data from Hoerling and Eischeid NOAA ESRL*

What can we do about global warming in the SW?

By Casey Thornbrugh

Mitigation and Response

The driving force behind global warming is the emission of greenhouse gases, mainly carbon dioxide (CO2), from burning fossil fuels, such as coal, oil, and gasoline. Mitigating global warming means taking actions to reduce greenhouse gas sources or enhance greenhouse gas "sinks"—places where greenhouse gases are safely taken up, such as trees, which use carbon dioxide to grow. The United States, home to only 5 percent of the Earth's population, is responsible for 25 percent of global CO2 emissions. Mitigating global warming in industrialized nations presents the challenge of changing energy production methods while addressing the need for energy to serve economic growth and quality of life.

This is especially true for the U.S. Southwest, the fastest growing region in the country. Here solar and wind power offer promise of generating energy from renewable and low emission sources.

Governors Janet Napolitano of Arizona and Bill Richardson of New Mexico have created policy initiatives to mitigate global warming, including the Arizona and New Mexico climate change advisory groups, which build political and business partnerships to develop plans to reduce greenhouse gases. Federal, private, and non-profit organizations also provide information describing everyday measures that everyone can take to reduce emissions.

Adaptation

According to the latest scientific consensus, societies will need to adapt to climate changes. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

During the last 100 years, temperatures in the southwestern United States have been increasing about twice as fast as the global average temperature. The latest Intergovernmental Panel on Climate Change (IPCC) temperature projections show that further warming is likely in the Southwest. Scientists are less sure of the magnitude of regional precipitation changes. Nevertheless, in the arid Southwest, where water resources are already vulnerable to multi-year drought, communities will likely have to adapt to changes in water resource reliability. Land use managers may also need to adapt to ecosystem changes created by longer growing seasons and altered fire regimes.

Adaptation to global warming also means seizing new opportunities when they arise, such as implementing improved irrigation techniques, "water banking" (storing water in underground aquifers), and using reclaimed effluent, where feasible.

Figure 4. Springerville Generating Station in Springerville, Arizona. Credit: Tucson Electric Power

Related Links

This list offers selected resources that provide information on what governments, businesses, and individuals can do about global warming. It is not meant to be comprehensive. Material included in this list does not imply an endorsement of commercial services and products offered on these websites or the political agendas of any agency or company.

AZ Climate Change
http://www.azclimatechange.us/

NM Climate Change
http://www.nmclimatechange.us/

An Inconvenient Truth
http://www.climatecrisis.net/takeaction/

Pew Center
http://www.pewclimate.org/what_s_being_done/

Seattle Climate Action Plan
http://www.seattle.gov/climate/getInvolved.htm

EPA Climate Change
http://epa.gov/climatechange/wycd/index.html

American Solar Electric
http://www.americanpv.com/c_about.php

Database of State Incentives for Renewables and Efficiency
http://www.dsireusa.org/

Geothermal-biz.com
http://www.geothermal-biz.com/home.htm

NM Energy Coalition for Clean and Affordable Energy
http://www.nmccae.org

Temperature (through 3/14/07)

Source: High Plains Regional Climate Center

Since the water year began October 1, 2006, average temperatures in the Southwest have ranged from 60 to 65 degrees Fahrenheit in southwestern Arizona to 25 to 30 degrees F in the mountains of northern New Mexico (Figure 1a). Temperatures have been near average for much of the Southwest, though areas in northern and central Arizona have been 1–3 degrees F warmer than average. Areas in eastern New Mexico, and one small portion in western Arizona have been 1 to more than 5 degrees F cooler than average (Figure 1b).

Over the past thirty days, most of Arizona has been 0–4 degrees F above average, while large areas of central New Mexico and southeastern Arizona have been 0–4 degrees F below average (Figures 1c–1d). Temperatures, however, have recently been warming up across all of the Southwest. Many high temperature records fell across Arizona the week of March 12. On March 14, for example, there was a record high temperature of 87 degrees F in Tucson, Arizona.

Figure 1a. Water year '06–'07 (through March 14, 2007) average temperature.

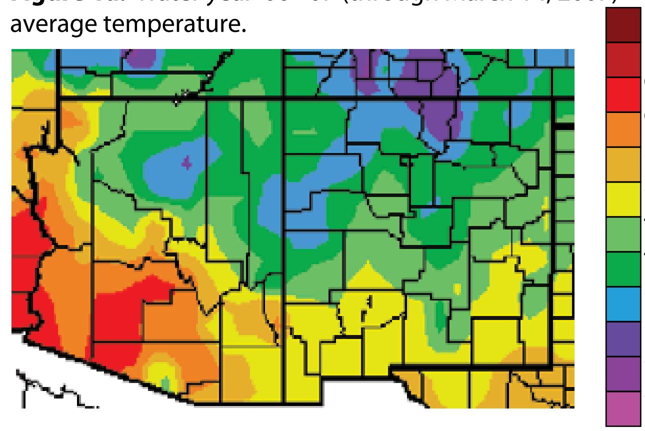


Figure 1b. Water year '06–'07 (through March 14, 2007) departure from average temperature.

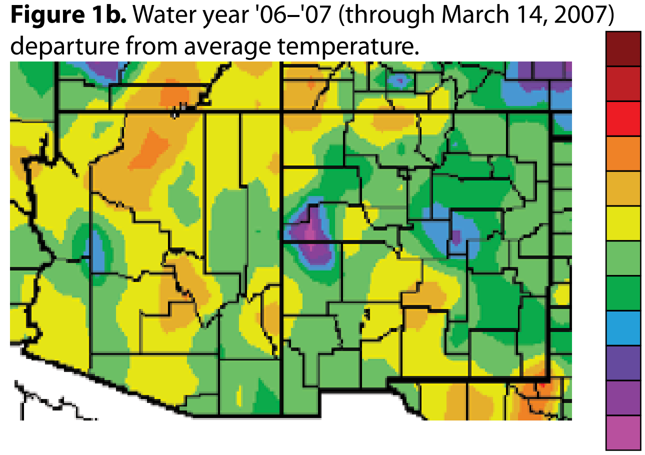


Figure 1c. Previous 30 days (February 13–March 14, 2007) departure from average temperature (interpolated).

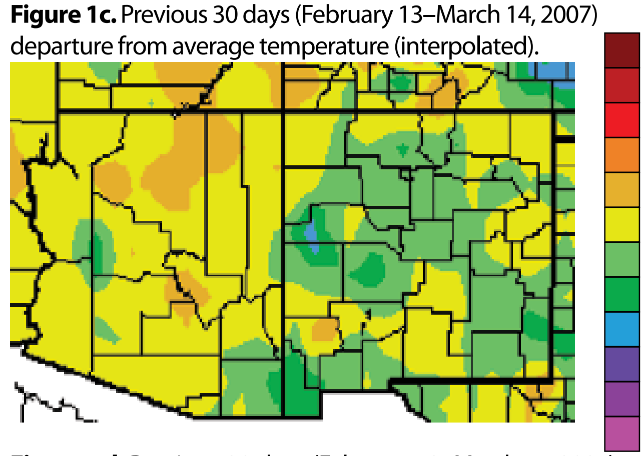
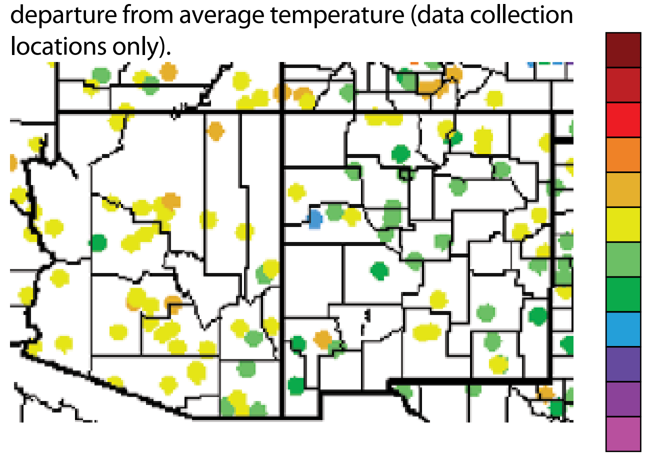


Figure 1d. Previous 30 days (February 13–March 14, 2007) departure from average temperature (data collection locations only).



Notes:

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

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

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

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

On the Web:

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

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

Precipitation (through 3/14/07)

Source: High Plains Regional Climate Center

Precipitation since the water year began October 1, 2006, has been characterized by east-west differences between New Mexico and Arizona. Most of Arizona has received below average precipitation while portions of New Mexico have received over 200 percent of normal (Figures 2a–2b). The previous thirty days have been drier than normal though for much of the Southwest, with the exception of southeastern New Mexico (Figures 2c–2d).

Much of the above-normal precipitation received in New Mexico could be related to the weak El Niño event in the tropical Pacific earlier in the winter. As a result, short-term drought conditions have seen improvement in New Mexico but have worsened slightly in Arizona. As the Southwest enters into the climatologically dry spring, the below-average winter precipitation in some areas could lead to elevated risk of wildfires and poor vegetation health and could also affect surface water supplies.

Figure 2a. Water year '06–'07 (through March 14, 2007) percent of average precipitation (interpolated).

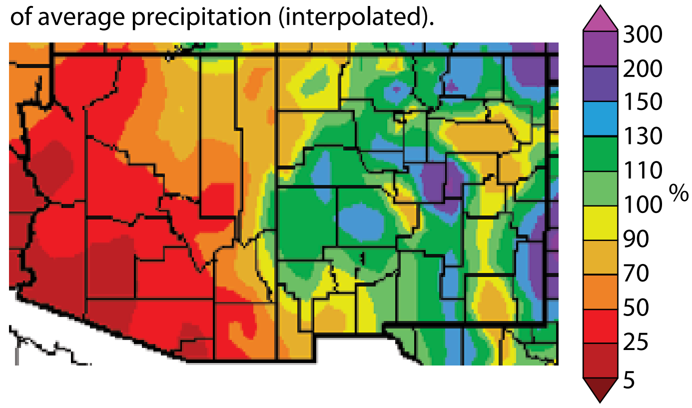


Figure 2b. Water year '06–'07 through (March 14, 2007) percent of average precipitation (data collection locations only).

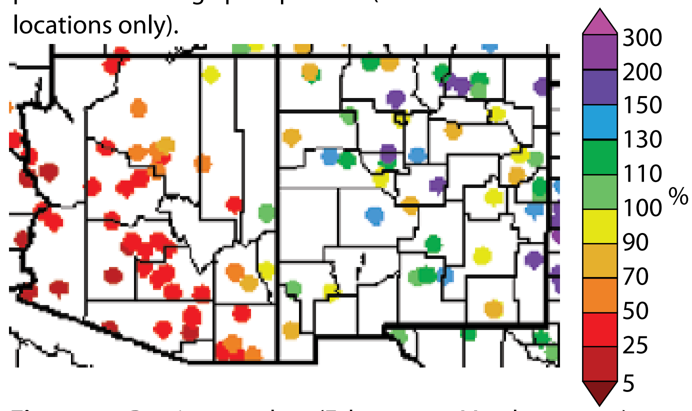


Figure 2c. Previous 30 days (February 13–March 14, 2007) percent of average precipitation (interpolated).

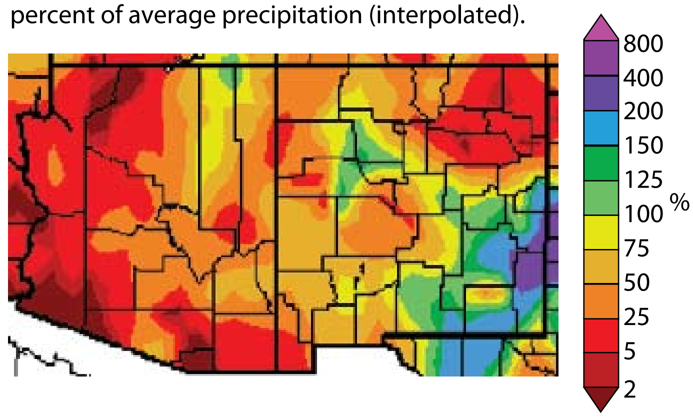
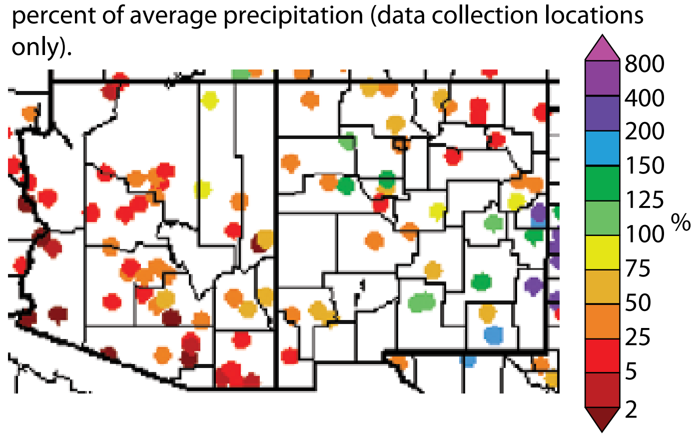


Figure 2d. Previous 30 days (February 13–March 14, 2007) percent of average precipitation (data collection locations only).



Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2006, we are in the 2007 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

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

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

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

On the Web:

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

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

U.S. Drought Monitor

(released 3/15/07)

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

According to the U.S. Drought Monitor, drought conditions for the beginning of spring 2007 are severe over most of Arizona and abnormally dry over western New Mexico; the rest of New Mexico is drought free (Figure 3). Two consecutive years of below-average winter precipitation is the primary basis for the extreme drought classification in western Arizona. Drought conditions are less severe in southeastern Arizona, along the Arizona-New Mexico border, and in far northeastern Arizona; conditions in these areas range from abnormally dry to moderate drought.

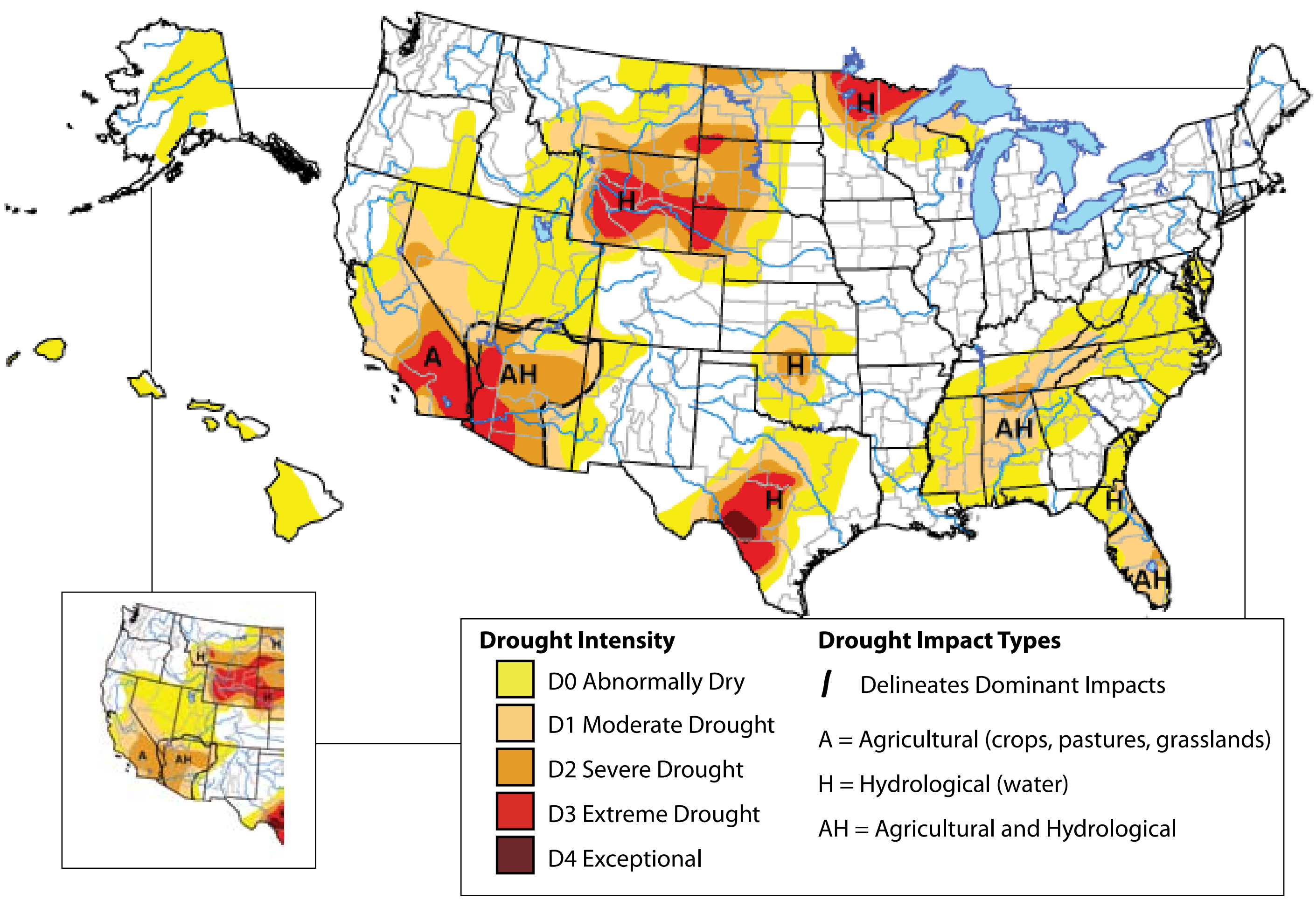
Compared with the previous month, drought conditions have become more severe in western Arizona. Drought conditions have also become more severe in southeastern Arizona, progressing from no drought and abnormally dry one month ago to abnormally dry and moderate drought status. The change in drought status for most of Arizona is based on below-average winter precipitation and snowpack for 2006–2007 and record warm temperatures during recent weeks.

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 Richard Heim, NOAA/NESDIS/NCDC.

Figure 3. Drought Monitor released March 15, 2007 (full size) and February 15, 2007 (inset, lower left).



On the Web:

The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website: http://www.drought.unl.edu/dm/monitor.html

Arizona Drought Status

(through 2/28/07)

Source: Arizona Department of Water Resources

Due to warmer temperatures and continued drier-than-average conditions in February, drought status has become more severe over many locations throughout Arizona compared to one month ago. Short-term drought status in northern Arizona watersheds has gone from abnormally dry to moderate drought (Figure 4a). In southern Arizona, the Santa Cruz watershed and areas along the Arizona-Mexico border have improved from severe to moderate short-term drought status, primarily due to the influence of 6- to 12-month precipitation indicators; drought status calculations show the influence of the powerful 2006 summer monsoon, which recharged groundwater in some areas. The lower Gila River remains at severe drought status. Western Arizona's Bill Williams watershed moved from severe to extreme drought status due to lack of significant precipitation on all three time-scales used to measure short-term drought. All of the state, with the exception of the Whitewater Draw and Rio Yaqui watersheds in southeastern Arizona, which received some winter storm precipitation, is in short-term drought.

Compared with last month, long-term drought conditions have increased in severity in the Verde and upper Salt River watersheds, and in southwestern Arizona watersheds (Figure 4b). Drought status increased in severity in watersheds along the Arizona-Mexico border and in the lower Gila River. The long-term drought classifications for northern and southeastern Arizona watersheds have not changed from last month.

Figure 4a. Arizona short-term drought status for February 2007.

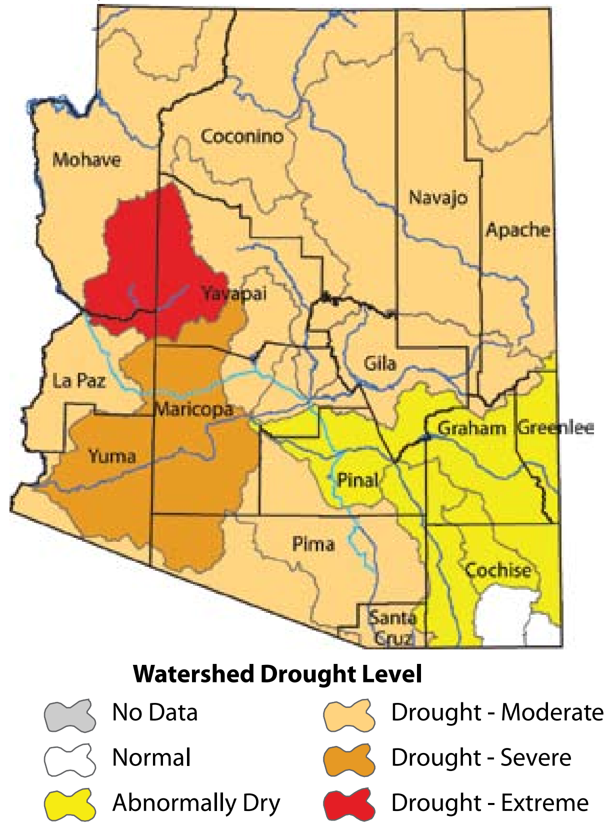
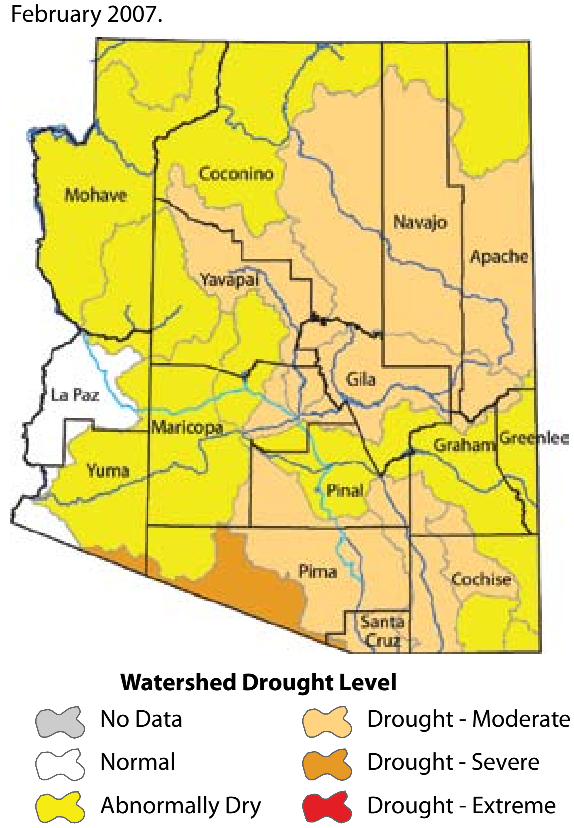


Figure 4b. Arizona long-term drought status for February 2007.



Notes:

The Arizona drought status maps are produced monthly by the Arizona Drought Preparedness Plan Monitoring Technical Committee. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 4a shows short-term or meteorological drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known as hydrological drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfall (e.g., many months to years) on water supplies (i.e., streamflow, reservoir and lake levels, and groundwater). These maps are delineated by river basins (wavy gray lines) and counties (straight black lines).

On the Web:

For the most current Arizona drought status maps, visit:
http://www.azwater.gov/dwr/Content/Hot_Topics/Agency-Wide/Drought_Planning/

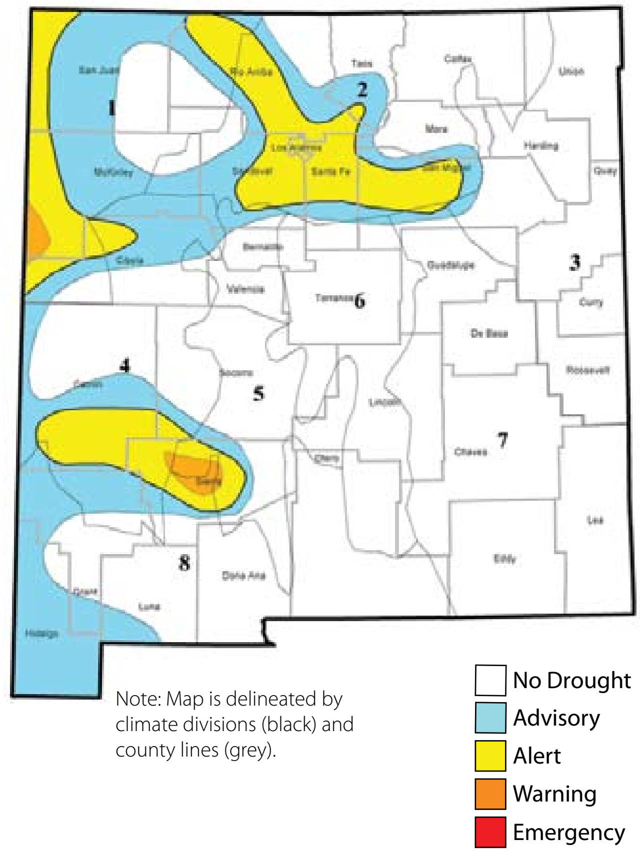
New Mexico Drought Status

(through 3/31/07)

Source: New Mexico Natural Resources Conservation Service

According to the New Mexico State Drought Working Group, most of New Mexico is drought free, based on above-average precipitation for both the summer 2006 and 2006–2007 winter seasons (Figure 5). However, parts of northern and western New Mexico have received average or below-average winter precipitation. All of the Arizona-New Mexico border is in drought, with the most severe drought status in northwestern New Mexico. Compared to last month, drought status has increased in parts of Sierra, Catron, and Socorro counties in southwestern New Mexico, and in San Juan and McKinley counties in the northwestern part of the state. In addition, alert status now extends further east in areas of north-central New Mexico. The Middle Rio Grande Valley and parts of the central and northern mountains received most of the above-average February precipitation. Although winter precipitation was above average for most of the state, there has been a drying trend from mid-February into mid-March.

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



Notes:

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

Figure 5 shows short-term or *meteorological* drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months).

On the Web:

For the most current meteorological drought status map, visit:
http://www.srh.noaa.gov/abq/feature/droughtinfo.htm

For the most current hydrological drought status map, visit:
http://www.nm.nrcs.usda.gov/snow/drought/drought.html

Arizona Reservoir Levels

(through 2/28/07)

Source: National Water and Climate Center

Storage along the Colorado River generally saw a decline over the past thirty days due to limited inflow from abnormally dry conditions during January and February (Figure 6). Lakes Powell, Mead, Mohave, and Havasu all saw significant reductions in water levels. Elsewhere, the San Carlos and Salt River systems experienced gains in water levels relative to last month.

Current snowpack above Lake Powell is 81 percent of average and April–July inflow is forecast to be 71 percent of average. Storage along the Colorado is expected to continue to decrease until mid-April when snowmelt runoff will once again increase water elevation. According to the U.S. Bureau of Reclamation's current inflow forecast, peak storage along the Colorado will be in late June or early July.

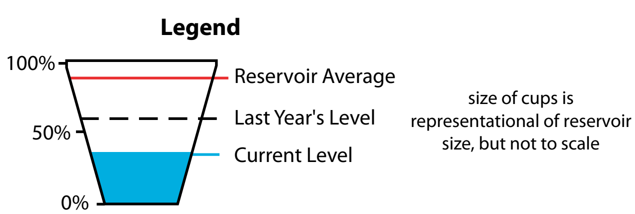
Notes:

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

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

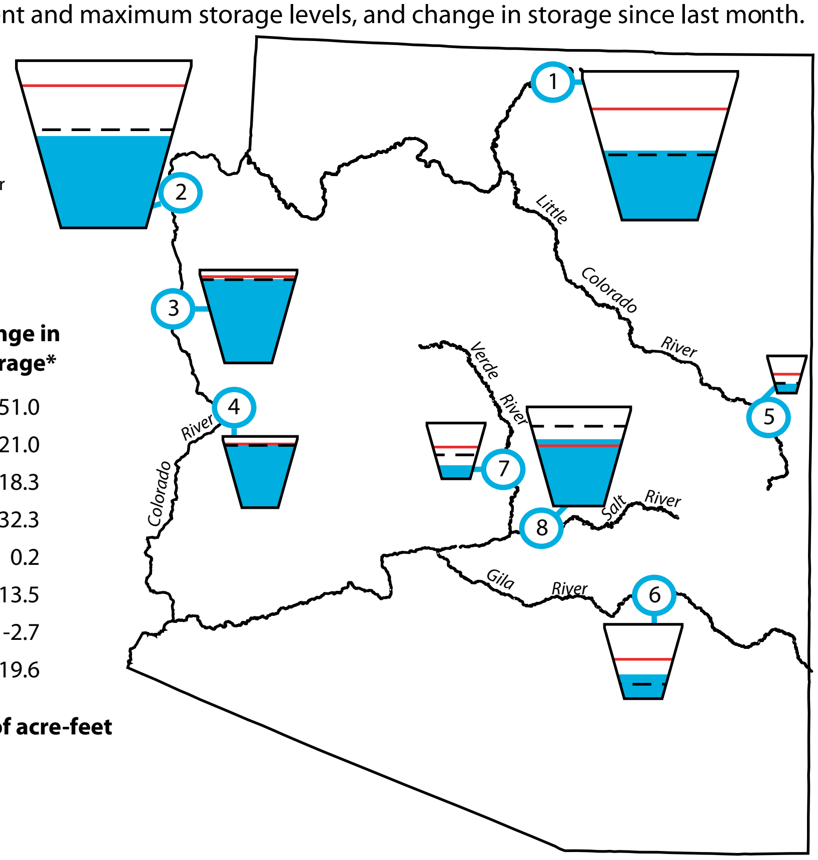
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) or Larry Martinez, Natural Resource Conservation Service, 3003 N. Central Ave, Suite 800, Phoenix, Arizona 85012-2945; 602-280-8841; Larry.Martinez@az.usda.gov).

Figure 6. Arizona reservoir levels for February 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Lake Powell	47%	11,552.0	24,322.0	-151.0
2. Lake Mead	55%	14,288.0	26,159.0	-21.0
3. Lake Mohave	90%	1,637.7	1,810.0	-18.3
4. Lake Havasu	88%	542.2	619.0	-32.3
5. Lyman Reservoir	25%	7.6	30.0	0.2
6. San Carlos	33%	286.0	875.0	13.5
7. Verde River System	24%	69.9	287.4	-2.7
8. Salt River System	67%	1,356.5	2,025.8	19.6

*** 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 2/28/07)

Source: National Water and Climate Center

Many of New Mexico's reservoirs showed increases in storage over the past thirty days (Figure 7). Although storage in New Mexico's largest reservoir, Elephant Butte, is only at 29 percent of capacity, storage increased by over 41 thousand acre-feet. Navajo Reservoir, New Mexico's second largest reservoir, experienced a slight decline of 0.2 thousand acre-feet.

Increases in storage are due to the above-average precipitation received in New Mexico over the winter and from last summer's thunderstorm season. As the snowpack begins to melt later in the spring, reservoir levels should continue to increase.

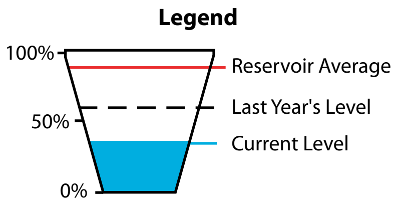
Notes:

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

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tom.pagano@por.usda.gov; 503-414-3010) or Dan Murray, NRCS, USDA, 6200 Jefferson NE, Albuquerque, NM 87109; 505-761-4436; Dan.Murray@nm.usda.gov).

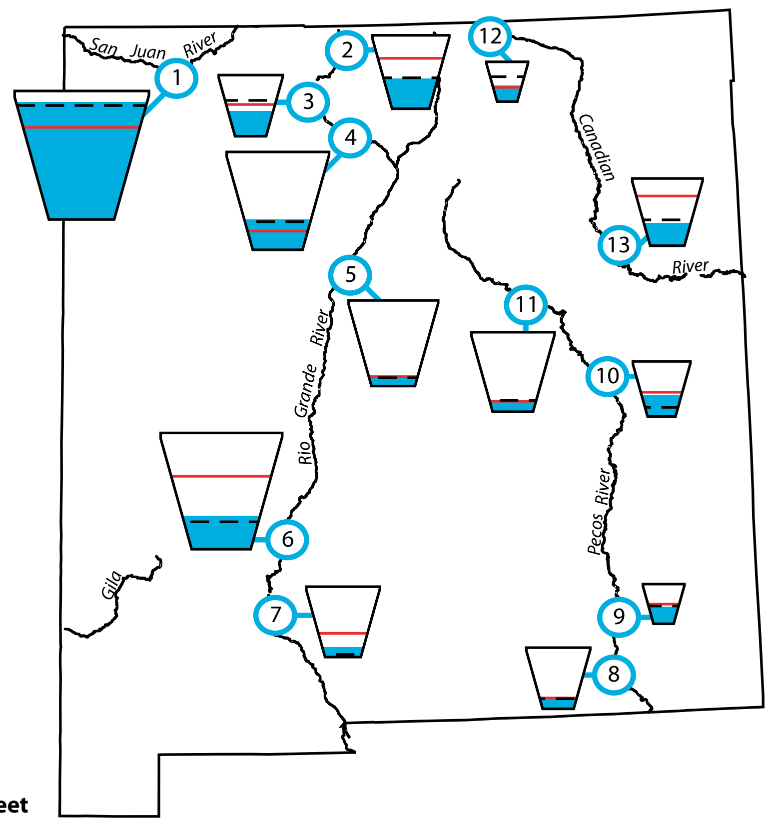
Figure 7. New Mexico reservoir levels for February 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



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

Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	91%	1,546.6	1,696.0	-0.2
2. Heron	41%	162.6	400.0	-7.4
3. El Vado	41%	77.2	186.3	4.1
4. Abiquiu	31%	174.2	554.5	7.5
5. Cochiti	10%	51.5	502.3	1.0
6. Elephant Butte	29%	598.5	2,065.0	41.4
7. Caballo	14%	46.5	331.5	1.3
8. Brantley	16%	22.9	147.5	2.9
9. Lake Avalon	43%	2.6	6.0	0.5
10. Sumner	38%	38.9	102.0	7.4
11. Santa Rosa	14%	64.5	447.0	-15.3
12. Costilla	40%	6.4	16.0	0.2
13. Conchas	34%	85.8	254.0	1.1

*** 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

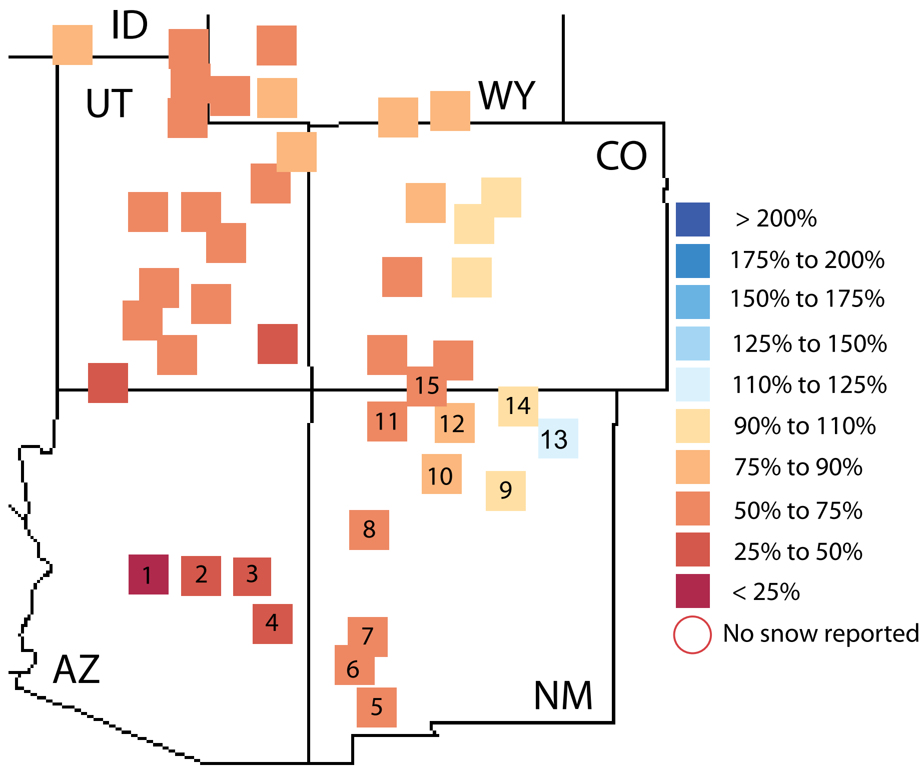
(updated 3/15/07)

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

Snowpack continues to be below normal for much of the Southwest (Figure 8). The moderate El Niño event failed to deliver above-average precipitation to Arizona and snowpacks range from below 25 percent of average to less than 50 percent of average. Conditions in New Mexico, where winter precipitation has been above average, are slightly better. The Cimarron River Basin has received 110–125 percent above-average snowpack, while the Pecos River and Sangre de Cristo Mountain Range basins have received 90–110 percent of average. Snowpacks in all other locations range from 50 to 90 percent of average.

Elsewhere in the West, Utah, Colorado, Wyoming, and Idaho all have below-average snowpack. This will impact surface water supplies in the Southwest when snow begins to melt later in the spring. Low snowpack could also affect the ski industry and vegetation health, and could elevate risk of wildfire later in the spring.

Figure 8. Average snow water content (SWC) in percent of average for available monitoring sites as of March 15, 2007.



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

Temperature Outlook
(April–September 2007)
Source: NOAA Climate Prediction Center (CPC)

Increased probabilities of above-average temperatures are expected for much of the U.S. during the April–September time period, with the exception of Missouri, Illinois, and coastal California (Figures 9a–d). An objective consolidation of statistical and dynamical forecast models, which is often dominated by long-term warming trends, is the primary basis for predicted warmer-than-average temperatures. Predicted below-average ocean temperatures along the California coast account for increased probabilities of below-average temperatures in southern California during April–June. The Southwest has the highest probabilities (greater than 50 percent) of any region in the U.S. of warmer-than-average temperatures for the entire forecast period.

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 April–June 2007.

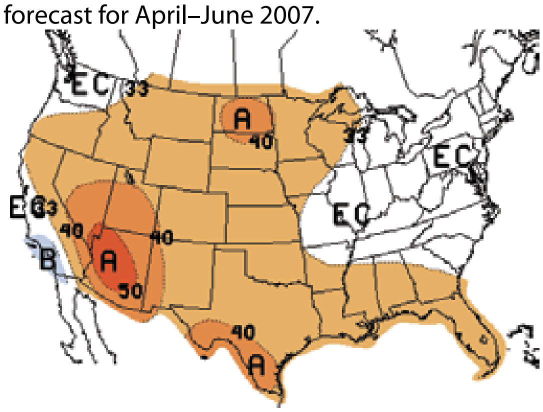


Figure 9b. Long-lead national temperature forecast for May–July 2007.

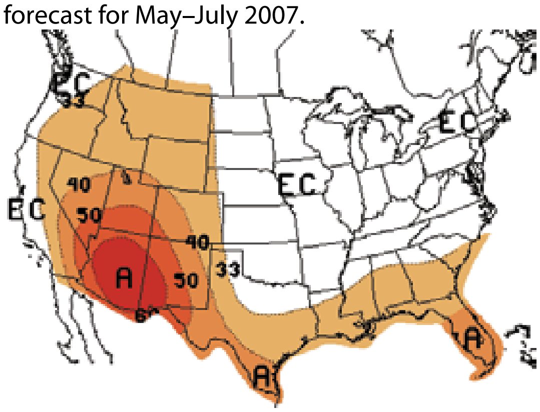


Figure 9c. Long-lead national temperature forecast for June–August 2007.

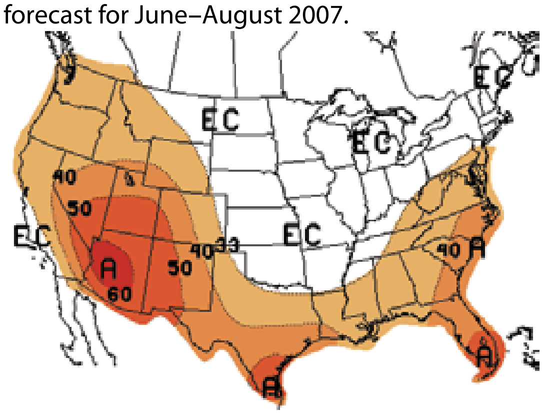
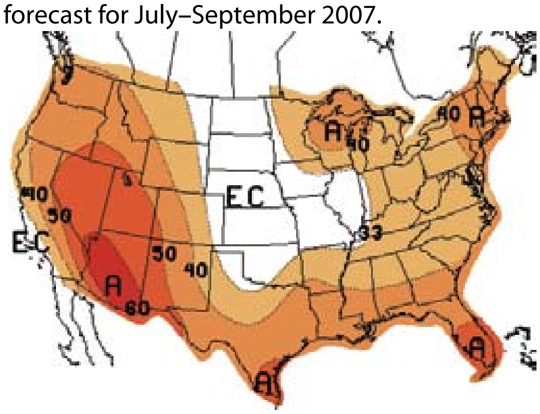
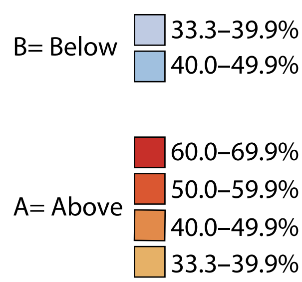


Figure 9d. Long-lead national temperature forecast for July–September 2007.





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
(April–September 2007)
Source: NOAA Climate Prediction Center (CPC)

The most striking features of NOAA-CPC outlooks for April–September are large areas of slightly increased probabilities of below-average precipitation in the West. NOAA-CPC forecasters reserve judgment (i.e., "equal chances") for most of the country during the outlook period. Forecasts for increased chances of below-average precipitation in the West are based primarily on weak trends. For the April–June period, the forecast predicts a higher probability of below-average precipitation from southern California to the Four Corners region and over eastern Texas and Oklahoma to Louisiana (Figure 10a). The higher probability of below-average precipitation for May–August covers central California, Nevada, Utah, and the northern Rockies (Figures 10b–c), expanding into the Pacific Northwest for July–September (Figure 10d).

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 April–June 2007.

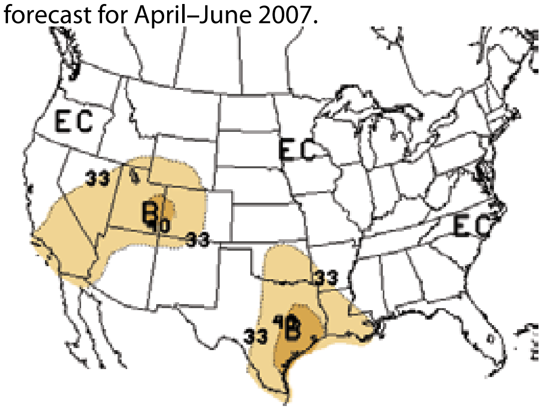


Figure 10b. Long-lead national precipitation forecast for May–July 2007.

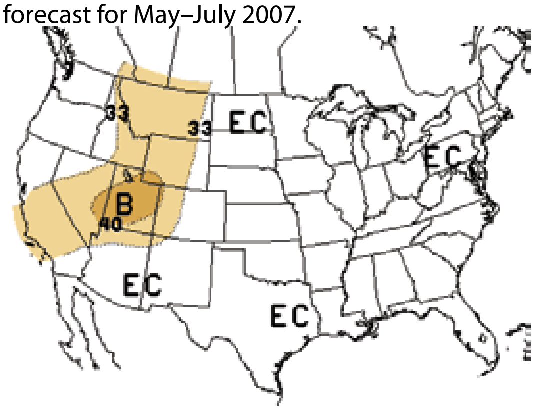


Figure 10c. Long-lead national precipitation forecast for June–August 2007.

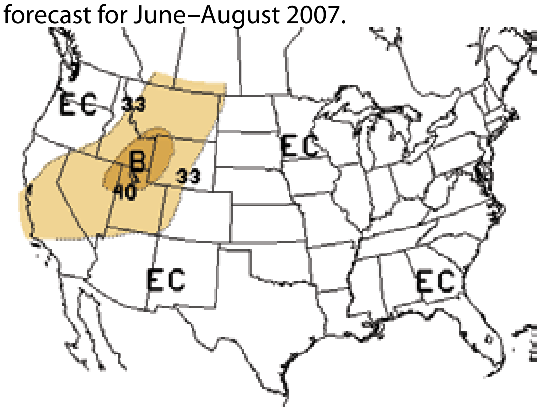
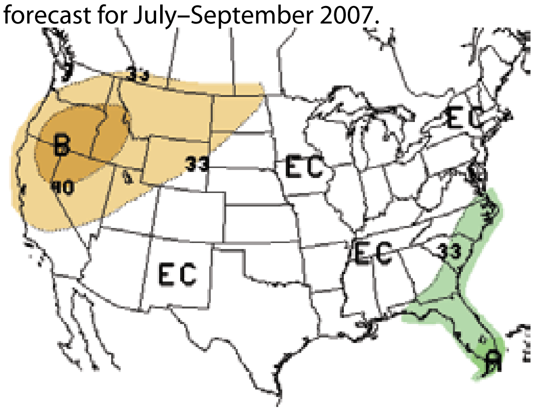


Figure 10d. Long-lead national precipitation forecast for July–September 2007.



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 June 2007)

Source: NOAA Climate Prediction Center (CPC)

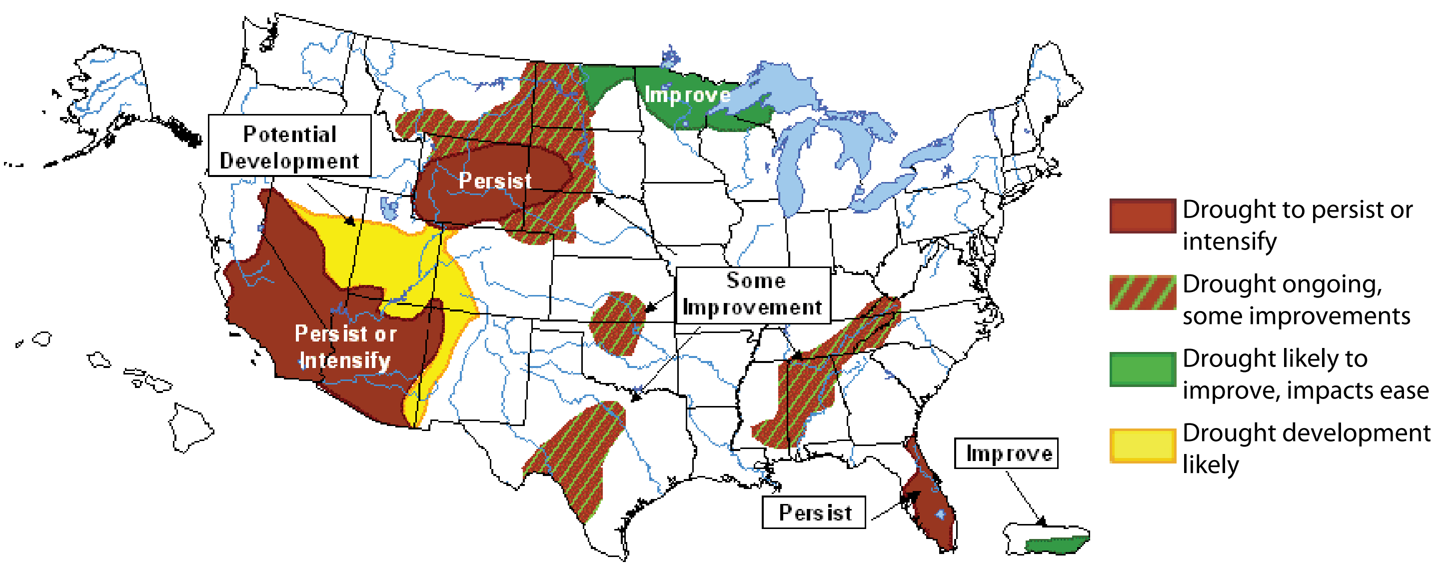
The U.S. Seasonal Drought Outlook is forecasting drought conditions to persist or intensify in southern California, southern Nevada, and most of Arizona through June (Figure 11). There is also the potential for drought conditions to expand and develop around the Four Corners region. In southern California and the Southwest, this winter's lack of precipitation and the spring forecast for above-average temperatures have led to the forecast of deteriorating and expanding drought conditions in the region. The potential for improving conditions in the northwestern Great Lakes is due to the fact that the summer is usually wet over this region; however, it is unlikely there will be enough rain or snow to end the long-term drought there.

Some improvement is expected in the northern Great Plains (with the exception of Wyoming and western South Dakota), parts of Texas and Oklahoma, and a region from the southern Appalachians to the Mississippi-Alabama border. Late March storms are predicted to provide precipitation to the Plains states. Despite El Niño conditions this winter, much of Florida only received 50–70 percent of its average winter precipitation. Since the El Niño conditions are subsiding, the forecast for the remainder of the spring is for drought conditions to persist in Florida.

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 June 2007 (release date March 15, 2007).



On the Web:

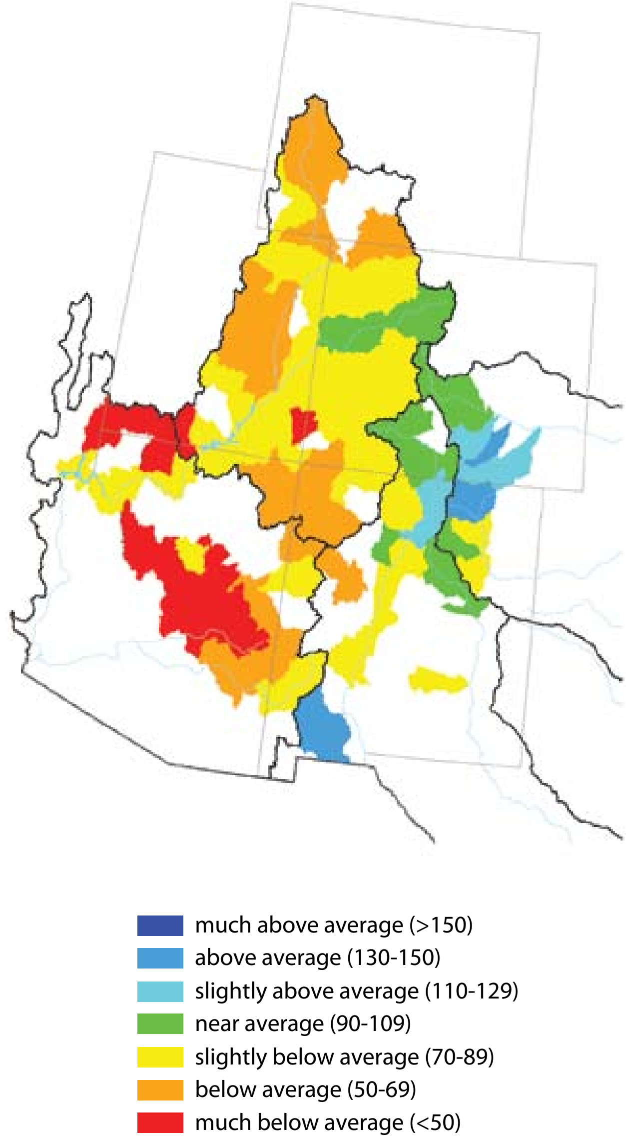
For more information, visit:
http://www.drought.noaa.gov/

Streamflow Forecast
(for spring and summer)
Source: National Water and Climate Center

Forecasted streamflows as of March 1, 2007, predict below-average flows for most of the Southwest (Figure 12). Flows along the Colorado River and Rio Grande are predicted to be between 70 and 89 percent of normal. Near the headwaters of the Rio Grande in northern New Mexico, flows are predicted to be 90–129 percent of average. Flows in some areas of southwestern New Mexico will be 130–150 percent above normal due to heavy winter precipitation. In central Arizona, large basins are predicted to have less than 50 percent of normal streamflow due to dry winter conditions and below-normal snowpack.

Below-average streamflows could have many impacts in the Southwest. Drought conditions could be exacerbated, vegetation health negatively affected, and fire risk elevated. Also, tourist industries and surface water supplies could be negatively affected by low streamflows.

Figure 12. Spring and summer streamflow forecast as of March 1, 2007 (percent of average).



On the Web:
For state river basin streamflow probability charts, visit:
http://www.wcc.nrcs.usda.gov/cgibin/strm_cht.pl

For information on interpreting streamflow forecasts, visit:
http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit:
http://www.wcc.nrcs.usda.gov/water/quantity/westwide.html

Notes:
The forecast information provided in Figure 12 is updated monthly by the National Water and Climate Center, part of the U.S. Department of Agriculture's Natural Resources Conservation Service. Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions. The USDA-NRCS only produces streamflow forecasts for Arizona between January and April, and for New Mexico between January and May.

The NWCC provides a range of forecasts expressed in terms of percent of average streamflow for various statistical exceedance levels. The streamflow forecast presented here is for the 50 percent exceedance level, and is referred to as the most probable streamflow. This means there is at least a 50 percent chance that streamflow will occur at the percent of average shown in Figure 12.

El Niño Status and Forecast

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

Current sea-surface temperatures (SSTs) are near the climatological average in the tropical Pacific, indicating neutral ENSO conditions. There is the possibility of a La Niña event developing in early spring, though neutral conditions are more likely (Figure 13b). Late spring and summer, there is a roughly 50 percent chance of La Niña conditions developing. Southern Oscillation Index (SOI) values also indicate borderline neutral conditions (Figure 13a).

The 2006–2007 El Niño event reached peak strength in December 2006 and has seen a rapid decline since January 2007. Generally, El Niño events are associated with above-average precipitation in the Southwest. This event delivered much above-average precipitation in New Mexico, but Arizona remained drier than average.

Notes:

Figure 13a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through February 2007. The SOI measures the atmospheric response to SST changes across the Pacific Ocean Basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

Figure 13b 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 13a. The standardized values of the Southern Oscillation Index from January 1980–February 2007. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).

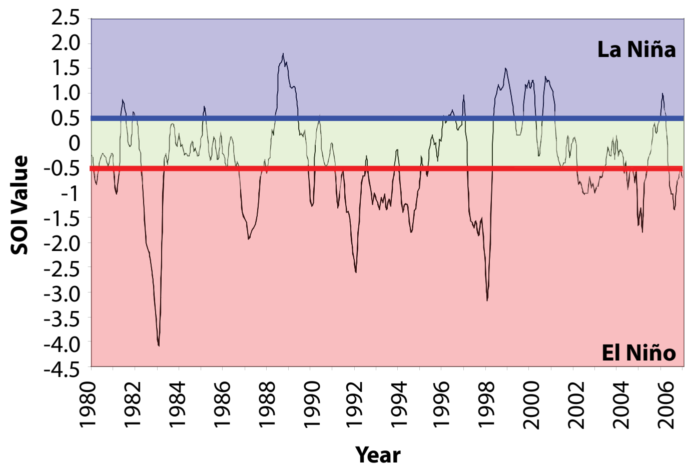
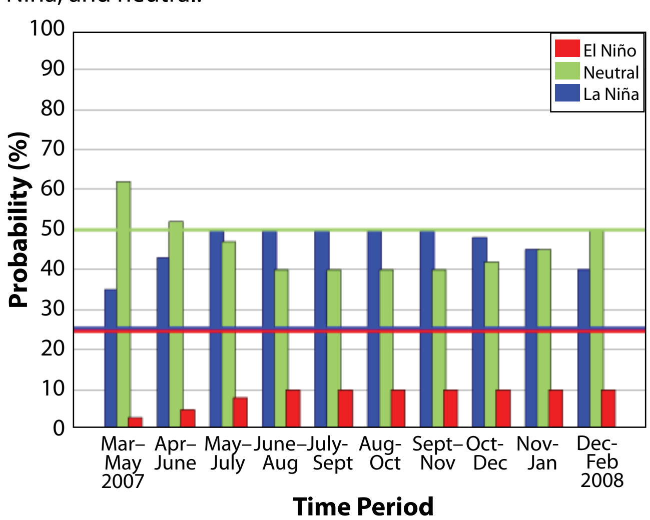


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released March 15, 2007). Colored lines represent average historical probability of El Niño, La Niña, and neutral.

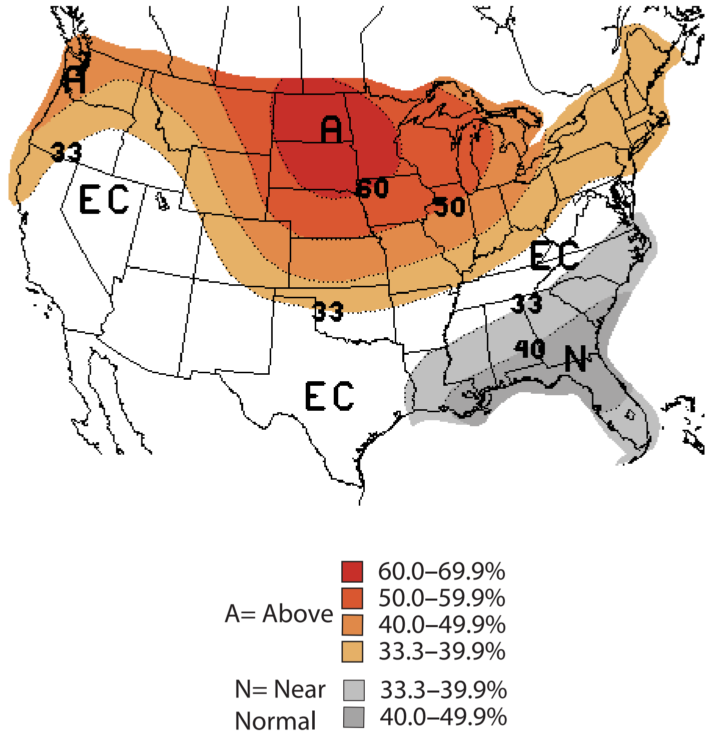


Temperature Verification
(December 2006–February 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC long-lead national temperature forecast for December 2006–February 2007 predicted above-average temperatures for most of the northern tier of the U.S. The regions with the highest probabilities of above-average temperatures were the northern Great Plains and western Great Lakes regions (Figure 14a). Due to the El Niño conditions this winter, the temperature forecast for the Southeast had a higher probability towards near-average temperatures. There was substantial agreement between the forecast and the observed temperatures over the northern tier of the U.S. Observed temperatures generally were 2–6 degrees F above average from Montana to the New England states (Figure 14b). In the Southeast, observed temperatures were 0–4 degrees F above average, with some pockets of below-average temperatures. Despite a forecast for increased probabilities of above-average temperatures, observed temperatures were 2–8 degrees F below average in the eastern half of Colorado. Forecasters reserved judgment over the Southwest, primarily due to conflicting signals between long-term trends toward above-average temperatures and increased likelihood of cool temperatures due to El Niño. Observed temperatures in the Southwest were near or below average. For the 2006–2007 winter season, temperatures in the Southwest were below average for December and January and near-average for February.

Figure 14a. Long-lead U.S. temperature forecast for December 2006–February 2007 (issued November 2006).



Notes:

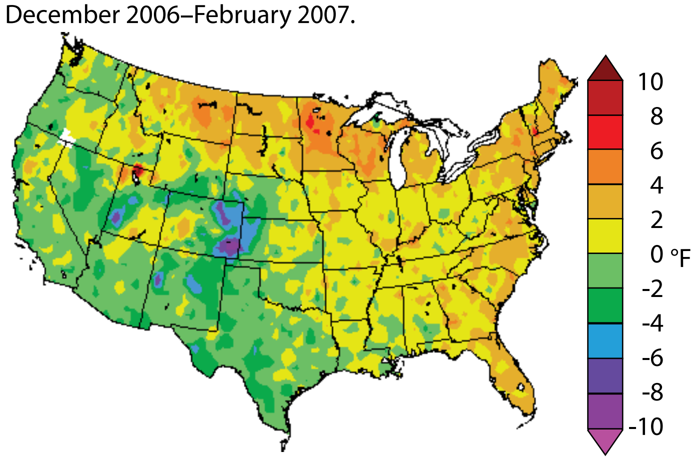
Figure 14a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months December 2006–February 2007. This forecast was made in October 2006.

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

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

Figure 14b shows the observed departure of temperature (degrees F) from the average for the December 2006–February 2007 period. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps. The temperature departures do not represent probability classes as in the forecast maps, so they are not strictly comparable. They do provide us with some idea of how well the forecast performed. In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

Figure 14b. Average temperature departure (in degrees F) for December 2006–February 2007.



On the Web:

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

Precipitation Verification

(December 2006–February 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC long-lead national precipitation forecast for December 2006–February 2007 predicted increased probabilities of above-average precipitation over the southern tier of the U.S. (Figure 15a). This prediction for above-average precipitation was associated with the El Niño conditions that developed over the late fall into winter. In the Southwest, the forecast for higher chances of above-average precipitation matched the observations in New Mexico but not in Arizona, as a split jet stream sent storms around California and Arizona and into New Mexico. Observed precipitation for the December–February period in Arizona was 5–75 percent of average (Figure 15b). The forecast predicted increased probabilities of below-average precipitation in the lower Ohio River Valley and the northern Rocky Mountains—conditions which often occur during El Niño winters. In the Ohio River Valley, observed precipitation was 75–150 percent of average, which did not match the forecast; however, parts of Kentucky, Tennessee, Alabama, and Mississippi received below-average precipitation. The Eastern Seaboard and the Southeast observed precipitation that was 25–75 percent of average, which did not match the forecast for above-average precipitation from the southern Atlantic states south to Florida. In the winter, the central and southern Great Plains received 125–800 percent of average precipitation. Observations in the northern Rocky Mountains somewhat matched the forecast, with 50–100 percent of average precipitation.

Notes:

Figure 15a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months December 2006–February 2007. This forecast was made in November 2006.

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

Figure 15b shows the observed percent of average precipitation for December 2006–February 2007. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps. The observed precipitation amounts do not represent probability classes as in the forecast maps, so they are not strictly comparable, but they do provide us with some idea of how well the forecast performed.

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

Figure 15a. Long-lead U.S. precipitation forecast for December 2006–February 2007 (issued November 2006).

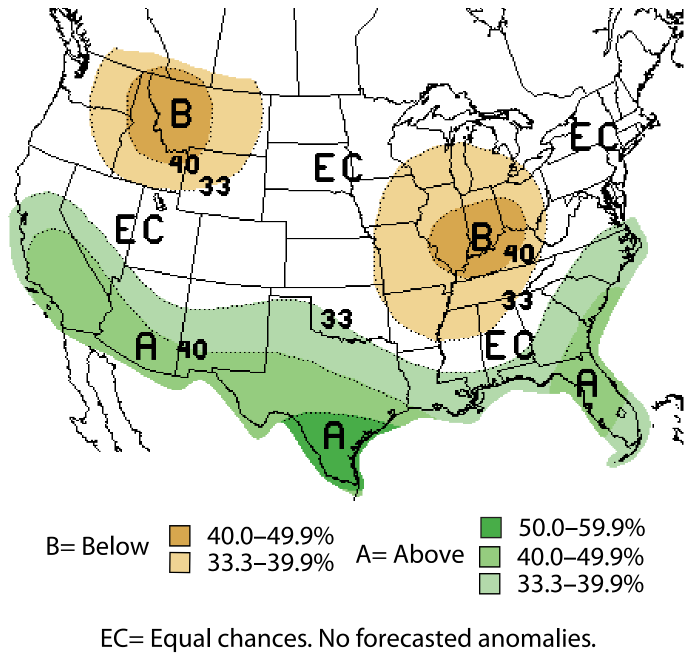
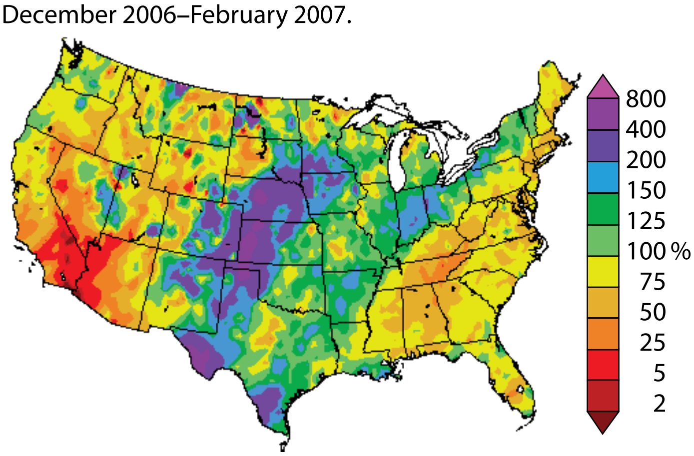


Figure 15b. Percent of average precipitation observed from December 2006–February 2007.



On the Web:

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