CLIMAS

Southwest Climate Outlook

Monthly Climate Packet
March 2004

Climate Assessment for the Southwest
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Section A

BACKGROUND

CLIMAS
Southwest Climate Outlook
March 2004
THE UNIVERSITY OF ARIZONA®

The Arizona Meteorological Network: A Brief Overview

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For more than 17 years, the Arizona Meteorological Network (AZMET) has provided outreach and information to virtually anyone in the state who grows plants or uses water. Stakeholders include irrigation districts, managers of turf facilities and golf courses, cotton growers, fertilizer and pesticide companies, citrus growers, vegetable producers and other agribusiness organizations in southern and central Arizona.

AZMET services include daily updates of meteorological data and weather-based information and weekly reports of climatic conditions, such as evapotranspiration rates, which are relevant to farmers and other water users. In 2003, there were more than 137,000 visits to the AZMET website, with users accessing the data files more than half a million times.

AZMET, founded and maintained by the University of Arizona's College of Agriculture, has worked in partnership with Arizona communities, assisted state and federal agencies, provided education programs and has conducted many fundamental and applied research projects. A census of data-collection organizations indicates that AZMET is the only group that has been continuously monitoring evapotranspiration in Arizona.

The meteorological data collected by AZMET's automated weather data collection network include air and soil temperatures, humidity, solar radiation, wind speed, wind direction, and precipitation. AZMET also provides a variety of computed variables, including heat units (degree-days), chill hours, dew point, and evapotranspiration. Data are summarized in a variety of formats, including several ready-to-use summaries and text files that can be imported into most database and spreadsheet programs. Special reports generated by AZMET include daily Turf Water Use Reports and weekly Cotton Advisories.

Throughout its history, AZMET has worked with and provided data to many different organizations. These include the Arizona Department of Water Resources (ADWR), Arizona Municipal Water Users Association, U.S. Bureau of Reclamation, U.S. Geological Survey, university departments, water conservation programs, and city water companies. These cooperative partnerships have resulted in both applied research and beneficial outreach programs.

Logistics
The original start-up funds for AZMET allowed for the purchase of 10 weather stations and hiring of two people in 1987. Currently, the network has 27 stations operating in a variety of rural and urban production settings (Figure 1). Because AZMET currently is relying on private funding to support its operations, it might be necessary to remove or relocate stations as funding and logistical needs require.

Each station is a solar-powered, self-contained unit. A 10-foot tower supports the wind instruments and other sensors (Figure 2). The heart of the station is an electronic data storage module, known as a datalogger, which continuously reads the sensors. These measurements are stored in memory every hour.

Just after midnight, a computer in the AZMET offices on the University of Arizona campus automatically calls each station's datalogger and downloads the previous day's data. Within

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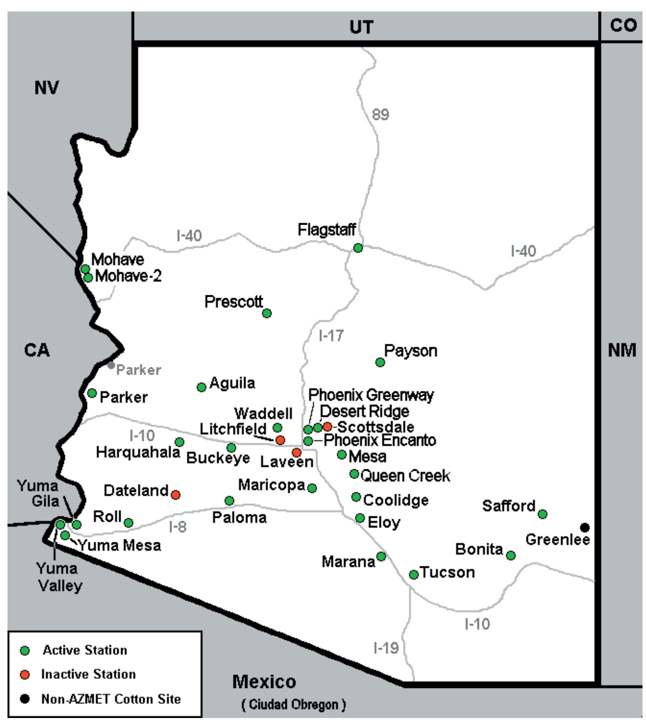


Figure 1. The Arizona Meteorological Network (AZMET) includes 27 active stations in Arizona.

AZMET, continued

an hour, this raw data is evaluated by a program that processes the values into various user-friendly reports and generates derived values such as heat units, dew point and reference-crop evapotranspiration. These files are then transferred onto a web server and are usually available to the public by about 1 a.m. each day.

Preventive maintenance of the station instrumentation is essential to collecting accurate data. An AZMET technician visits each station at least every three months to compare existing equipment with a set of laboratory-standard sensors. Wind speed and solar sensors are removed and recalibrated once a year, while the sensor that measures temperature and humidity are recalibrated every two years.

These data and others are used to compile values and reports useful to a variety of stakeholders. Evapotranspiration, for example, can supplement precipitation data to allow farmers and golf course managers to keep their crops watered at the optimal level.

Figure 2. A 10-foot tower supports instruments that measure air and soil temperatures, humidity, solar radiation, wind speed, wind direction, and precipitation at an AZMET station in Tucson.

Similarly, temperature values help yield frost reports during critical growing times. AZMET's services are used by many different agriculturalists, but cotton farmers and turf and lawn growers are particularly targeted with special advisories, as described in more detail below.

Evapotranspiration

Evapotranspiration is the water that is lost to the atmosphere from surface evaporation and from plant transpiration (i.e., water evaporated from a plant surface). This process is largely driven by solar energy and wind speed.

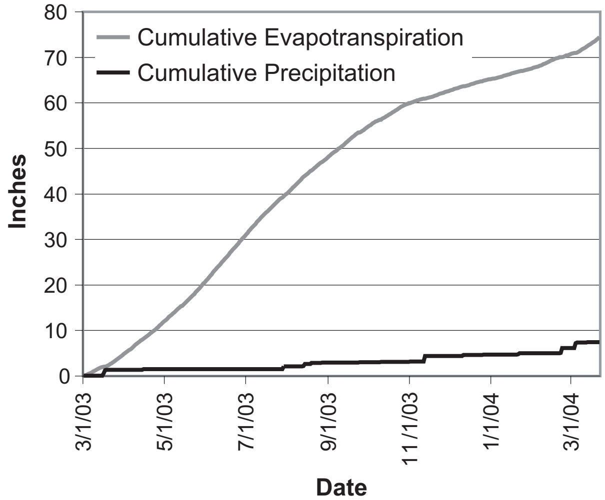


Figure 3. Annual evapotranspiration far exceeds precipitation in Arizona, including at the Phoenix Greenway AZMET station. Above, the lower line illustrates values for cumulative precipitation while the upper line illustrated cumulative evapotranspiration from March 1, 2003, through March 22, 2004.

Evapotranspiration is a major component of the earth's water cycle. In most continental areas, evapotranspiration accounts for about 60 percent of the hydrologic activity in a basin. Here in the Southwest, due to the lack of cloud cover, evapotranspiration has an even larger role in the hydrologic budget.

However, because it is less tangible than other meteorological parameters, evapotranspiration often is not given proper attention in water budgets, if it is included at all. The monitoring of precipitation, snowpack, lakes, streams, reservoirs and groundwater levels tells us how much water is entering and being held in a basin. Evapotranspiration gives us the other side of the hydrologic cycle—it tracks the amount water that can potentially be lost from a basin and returned to the atmosphere.

In southern Arizona, an open body of water such as a lake, canal or uncovered swimming pool, can lose about 80 inches of water to evaporation each year. Normal rainfall during the same period only averages about 8 to 10 inches. Figure 3 shows a comparison of evapotranspiration and precipitation for the Phoenix Greenway.

During periods of drought, the significance of evapotranspiration in the hydrologic cycle is further accentuated as the available precipitation decreases. Each species of plant has its own unique water requirements, so evapotranspiration rates must be adjusted for different crops. By using AZMET reference crop water-use values, a grower can apply just the right amount of water to meet a plant's demand. Underwatering will stress the plant and cause low yields, while overwatering would waste a limited resource.

Frost

During the spring of each year, AZMET generates a twice-daily frost report for the apple producers in the Bonita area north of Willcox. One of the casualties of the 1995/96 federal budget crisis was the closing of the National Weather Service office in Yuma. When citrus growers and related agribusiness interests were left without any source of local information, AZMET stepped forward and filled the gap, supplying critical frost updates several times per day.

In addition, AZMET provides "chill hours" data to an experimental farm in Yuma for its research on citrus trees, which require a certain number of winter hours below 68 degrees to properly bud and produce fruit.

Cotton

During the 2002 season, the value of cotton production in Arizona was more than $167 million dollars. Due to inconsistent yields and limited water, the state's cotton industry has had several rough years recently. However, cotton remains a major segment of Arizona agriculture and an important part of the state economy, and AZMET information helps keep this industry viable.

Every Monday from March through August, AZMET generates 19 different advisories for various Arizona regions that can help cotton growers use water and agro-chemicals conservatively. AZMET's heat-unit calculations allow growers and researchers to track the stages of development in cotton plants and help predict the outbreak of pests such as the infamous pink bollworm. Preventive pesticides can then be targeted at specific time, saving money and limiting the amount of chemicals released into the environment.

Early in the season, the AZMET Planting Advisory provides information about soil temperatures for seed germination. By adjusting the planting date, growers can avoid having the crop reach a susceptible stage of development during a projected hatching of pink bollworms.

After planting, the advisories use heat units to track the cotton plants through their life cycle. The advisories compare the current year's temperatures, dew point and rainfall to historical data, and report present conditions as being ahead or behind past climatic conditions. A brief forecast describes the possible effect of weather systems that are entering the state. The advisories also include crop water-use estimates and crop stress values. This information is critical for maintaining cotton boll retention and producing a marketable crop.

Turf and Lawn

Although it is not considered as traditional agriculture, turf horticulture plays an important role in the state's economy. A recent study of the Arizona golf industry provides some interesting statistical insights. There are more than 330 golf courses in Arizona. More than 2 million visitors play golf in Arizona. Golf produces $45 million in state taxes and another $24 million in local taxes.

Since its inception in 1987, AZMET has worked closely with the turf industry in an effort to conserve water. Three stations in the Phoenix area are located on golf courses and are supported by the City of Phoenix Water Conservation Department. AZMET has done extensive research to determine the water requirements of both warm and cool season grasses in Arizona's desert environment.

Each day, AZMET generates Turf Water Use Reports for the Tucson and Phoenix areas. These reports track the water requirements over the most recent seven days and include values for total precipitation in these areas. By using this information, an irrigation manager can apply the correct amount of water on a turf surface.

AZMET also provides lawn-watering values to homeowners in the Phoenix area. In November 2003, three new stations were added to the network. These stations are located on turf facilities in Flagstaff, Prescott and Payson to support the water conservation efforts of these northern Arizona communities.

Other Crops

AZMET has provided data and information to assist agriculturalists growing other crops as well. In the spring and summer, AZMET reports water-use recommendations for corn and alfalfa. A special corn heat-stress report is provided when needed.

A small grains advisory uses AZMET data to track the development of wheat and barley crops. These reports also provide current and projected water use. The efficiency of melon and vegetable harvesting has been increased by the use of heat units. Grapes are a crop that is susceptible to extreme temperatures, and AZMET offers recommendations based on climate to the vineyard industry.

Dairies have utilized AZMET data to reduce heat stress on cattle and thus increase milk production. The growing aquaculture industry has requested information on temperature, humidity, wind speed and wind direction. AZMET data have even been used for non-agricultural purposes, including calculating environmental cooling-system design, building alignment, and automotive engineering.

Outlook

The ongoing drought and population growth will necessitate close monitoring of the limited water resources throughout the Southwest. Due to the changing role of agriculture and increasing degree of urbanization, AZMET has an obligation to modify and expand its mission in an effort to meet the evolving needs of our state. By strengthening past partnerships, forging new allegiances, and addressing future problems through applied research, AZMET will continue to be important and reliable source of weather data and information for the people of Arizona.

All available AZMET weather data and more information about the Arizona Meteorological Network can be found on the website:

http://ag.arizona.edu/azmet

Monthly Climate Summary - March 2004

Highlights

Hydrological Drought – Hydrological drought continues in the Southwest.

- All New Mexico reservoirs are at well-below-average levels, although February and March snowfall resulted in gains at most reservoirs.
- Storage in the major Colorado River reservoirs remains well below average.
- Salt and Verde River Basin reservoirs remain well below average.

Precipitation – Recent precipitation, while beneficial in the short-term, is not sufficient to overcome multi-year precipitation and soil moisture deficits. Prior to recent and rapid melt, Arizona and New Mexico snowpacks were below average—thus spring/summer streamflows across the region are projected to be below average. Moreover, current snowpack is below average throughout the Upper Colorado and Upper Rio Grande River Basins.

Temperature – During the past 30 days, temperatures have been above average across the Southwest—breaking records at many stations.

Climate Forecasts – Seasonal forecasts indicate increased probabilities of above-average temperatures across Arizona and New Mexico through the spring and summer months. Increased temperature implies increased evapotranspiration. Precipitation forecasts do not suggest strong probability anomalies for either above- or below-average precipitation. The U.S. Drought Outlook suggests persistent drought conditions for virtually all of Arizona and New Mexico.

ENSO – ENSO conditions are neutral and will likely remain neutral during the first half of 2004. This means greater forecast uncertainty.

The Bottom Line

In the absence of exceptional precipitation during the next month, hydrological drought will persist in the Southwest. Temperatures have been warmer than average and those soils are thirsty!

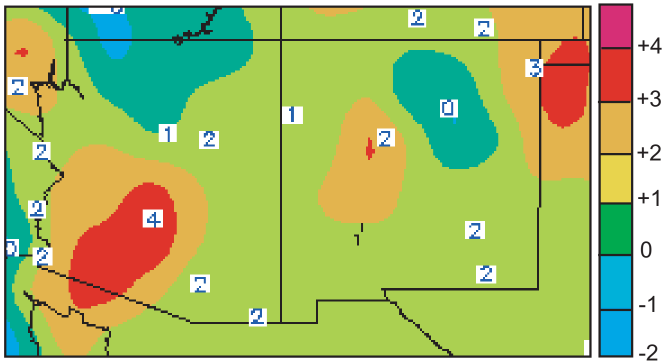
- The **most likely scenario** is that, despite February and March precipitation in the Southwest, there is no indication that most of the Southwest will receive drought-ending precipitation during the next several months. Recent temperature increases, if persistent, will increase fire danger. Reservoir levels might show short-term increases due to snowmelt, but late spring and summer precipitation are not expected to have major positive impacts on water supply.
- The **worst case scenario** is that for 2004 we have seen the last of winter storms that yield substantial precipitation. Above-average temperatures persist and there is a rapid escalation of fire danger. Reservoir levels continue to decline beyond expectations.
- The **best case scenario** is that we have a repeat of spring 1999—where a spring snowstorm blanketed parts of our region—substantially reducing fire danger for months.

Section B

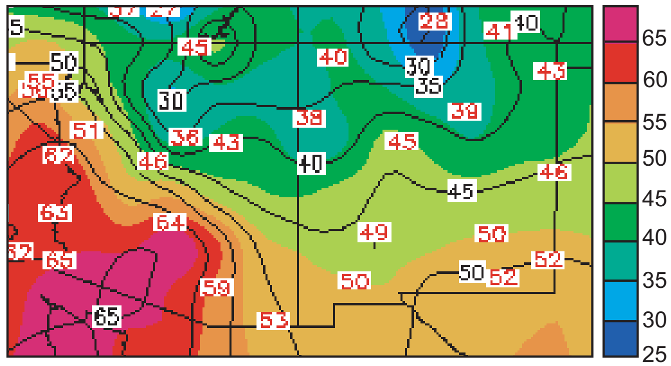
RECENT CONDITIONS

1. Recent Conditions: Temperature (up to 3/22/04) ♦ Sources: WRCC, HPRCC

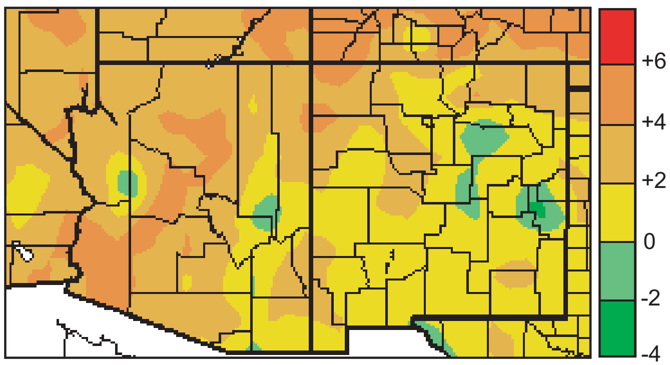
1a. Water year '03–'04 (through 3/22) departure from average temperature (°F).



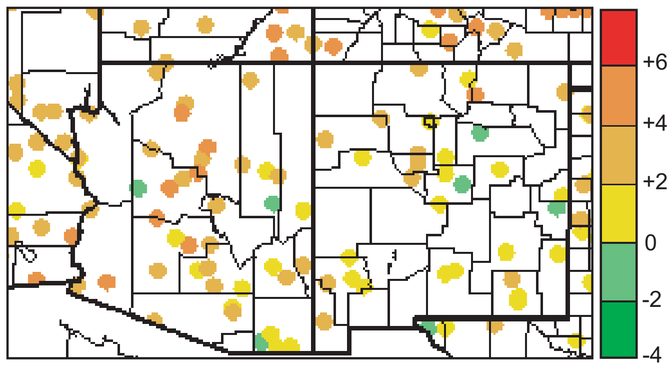
1b. Water year '03–'04 (through 3/22) average temperature (°F).



1c. Previous 30 days (2/22–3/22) departure from average temperature (°F, interpolated).



1d. Previous 30 days (2/22–3/22) departure from average temperature (°F, data collection locations only).



Highlights: Since October 1, 2003, temperatures have been above average throughout most of the Southwest, with the exception of northeastern Arizona and the Arizona Strip (Figure 1a). During the past 30 days, temperatures have been above average across most of the Southwest (Figures 1c and 1d). Above-average temperatures during the past 30 days are chiefly due to above-average minimum temperatures across the entire region (not pictured); long-term trends have been toward above-average minimum temperatures during winter and spring. Most of Arizona and northwestern New Mexico exhibited above-average maximum temperatures (not pictured) during the past month. According to the National Weather Service, Albuquerque registered record-breaking high minimum temperatures on March 9 and March 20, as well as a record breaking high maximum temperature on March 20, 2004. The aforementioned minimum temperatures broke records established in 1954 and 1939, respectively. The new March 20 maximum temperature breaks a record set in 1997.

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

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

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. Data are in degrees Fahrenheit (°F).

Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

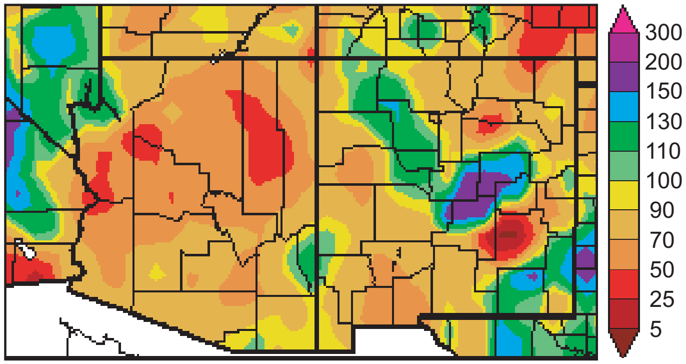
The continuous color maps (Figures 1a, 1b, 1c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. The blue numbers in Figure 1a, the red numbers in Figure 1b, and the dots in Figure 1d show data values for individual stations.

Interpolation procedures can cause aberrant values in data-sparse regions.

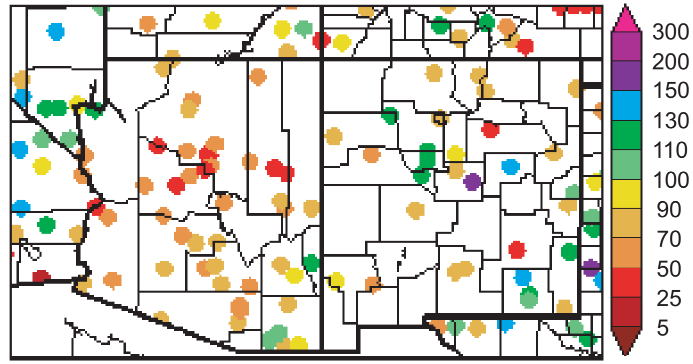
Figures 1c and 1d are experimental products from the High Plains Regional Climate Center (HPRCC).

2. Recent Conditions: Precipitation (up to 3/22/04) ♦ Source: High Plains Regional Climate Center

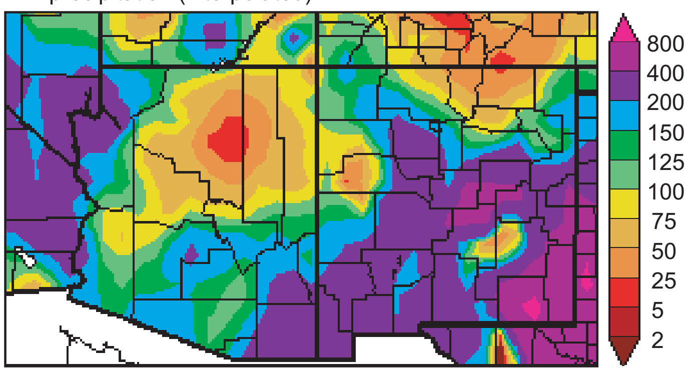
2a. Water year '03–'04 (through 3/22) percent of average precipitation (interpolated).



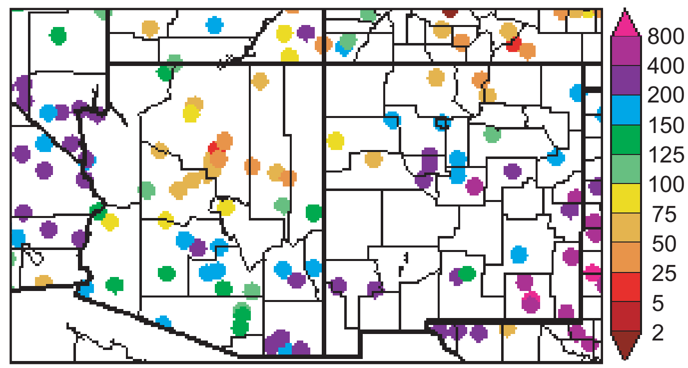
2b. Water year '03–'04 (through 3/22) percent of average precipitation (data collection locations only).



2c. Previous 30 days (2/22–3/22) percent of average precipitation (interpolated).



2d. Previous 30 days (2/22–3/22) percent of average precipitation (data collection locations only).



Highlights: Most of the Southwest still exhibits water year precipitation deficits (Figure 2a), as well as multi-year deficits (not pictured). During the past 30 days, much of the Southwest received above-average precipitation (Figures 2c and 2d). Particularly heavy precipitation occurred throughout southeastern New Mexico and in parts of southeastern Arizona (Figure 2d). On March 17, 2004, the *Eastern Arizona Courier* reported that recent rains brought some drought relief to Graham County in southeastern Arizona, which has been severely impacted by multi-year drought. This precipitation provided short-term drought relief, primarily to vegetation and in the form of temporary flows in ephemeral streams. Northern Arizona and parts of northern New Mexico, however, were bypassed by late-February and March storms, exacerbating drought conditions there. Long-term drought conditions persist throughout the Southwest (see page 4), as multi-year precipitation deficits were barely dented by recent precipitation.

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

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2003 we are in the 2004 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000.

Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points.

Interpolation procedures can cause aberrant values in data-sparse regions.

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

These figures are experimental products from the High Plains Regional Climate Center (HPRCC).

3. Annual Precipitation Anomalies and Daily Event Totals ♦ Source: NOAA Climate Prediction Center

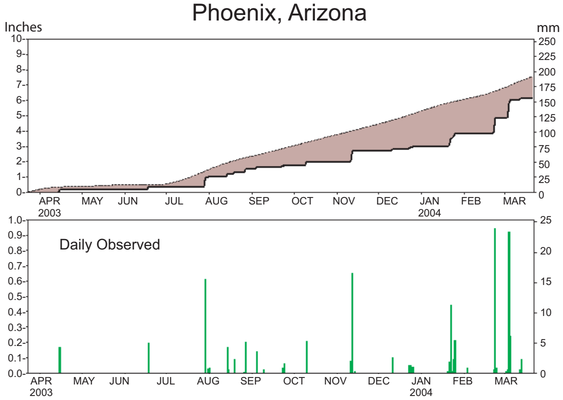
Notes: Based on a long-term average (1971–2000) of daily precipitation, these graphs contrast how much precipitation actually has accumulated at each station over the past year (beginning in mid-December 2002) with how much precipitation typically is received.

The top of each of the pairs of graphs shows average (dotted line) and actual (solid line) accumulated precipitation (i.e., each day's precipitation total is added to the previous day's total for a 365-day period). If accumulated precipitation is below the long-term average, the region between the long-term average and the actual precipitation is shaded brown, and if accumulated precipitation is above the long-term average, the region between the actual precipitation and the long-term average precipitation is shaded green.The green bars at the bottom of each of the pairs of graphs show the daily precipitation amounts (in both inches and millimeters) for the past year. Thus, one can get a sense of how frequent and intense individual precipitation events have been at the selected stations.

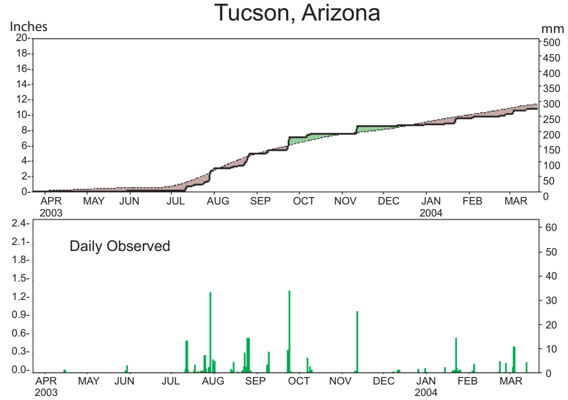
It is important to note that the scales for both the accumulated precipitation and the daily precipitation vary from station to station.

This type of graph is available for several other stations in Arizona and New Mexico as well as for many other places in the world. The graphs are updated daily by NOAA CPC at http://www.cpc.noaa.gov/products/global_monitoring/precipitation/global_precip_accum.html.

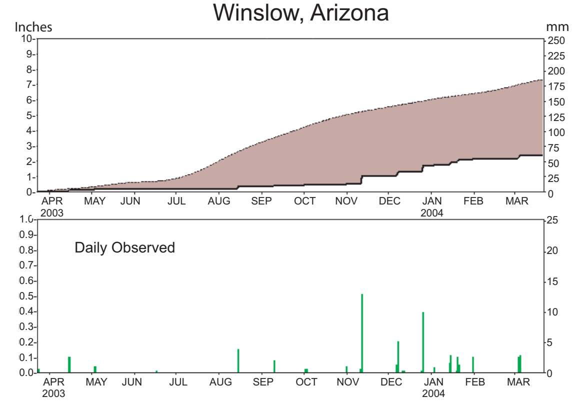
Phoenix, Arizona



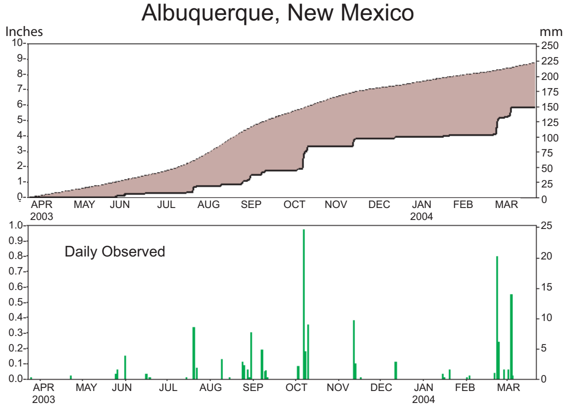
Tucson, Arizona



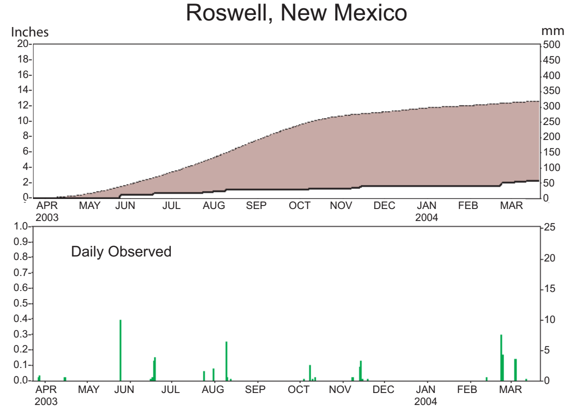
Winslow, Arizona



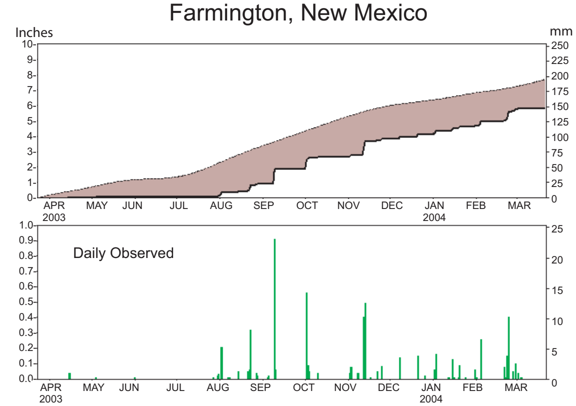
Albuquerque, New Mexico



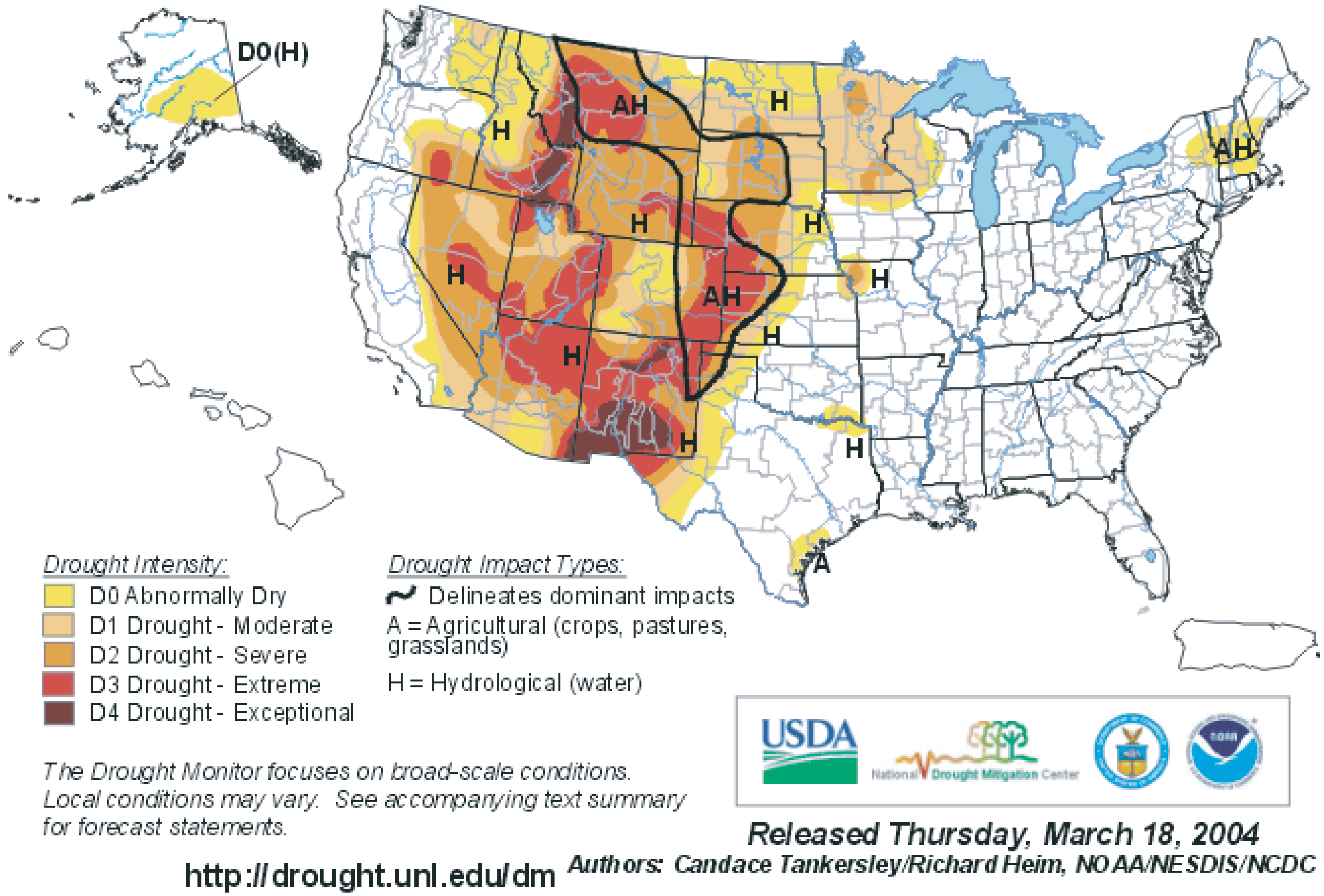
Roswell, New Mexico



Farmington, New Mexico



4. U.S. Drought Monitor (updated 3/18/04) ♦ Source: USDA, NDMC, NOAA



Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. This monitor was released on 3/18 and is based on data collected through 3/16.

The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website (see left and below).

The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) PDSI, soil moisture, stream flow, precipitation, and measures of vegetation stress, as well as reports of drought impacts.

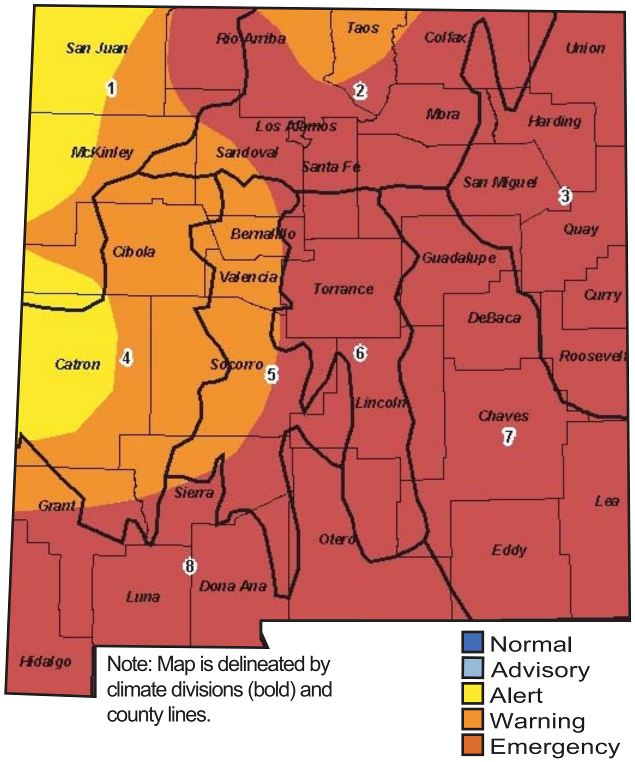
Highlights: Compared with one month ago, drought intensity has increased throughout most of Arizona, whereas drought intensity has decreased somewhat in northwestern and southeastern New Mexico. Changes in Arizona reflect increasing hydrological (long-term) drought as a result of lower than average snowpack (see Figure 8), despite storms that visited the state during February and March. Changes in New Mexico reflect above-average snowpack in northern New Mexico and southwestern Colorado during most of March, as well as considerable precipitation in eastern New Mexico and the plains of West Texas. USDA range and pasture condition reports (not pictured) indicate that 81 percent of New Mexico and 57 percent of Arizona currently exhibit very poor to poor conditions. Of potential interest to Southwest decisionmakers is the fact that very poor to poor conditions were also reported for Colorado (53 percent), Kansas (44 percent), and Oklahoma (31percent). On March 12, 2004, the Associated Press reported that farmers who get water from the Carlsbad Irrigation District (New Mexico) will receive only 0.8 acre-foot this year, as opposed to pre-drought allotments of 3.5 acre-feet per year.

Animations of the current and past weekly drought monitor maps can be viewed at: http://www.drought.unl.edu/dm/monitor.html

5. Drought: Recent Drought Status for New Mexico (updated 02/18/04) Source: New Mexico NRCS

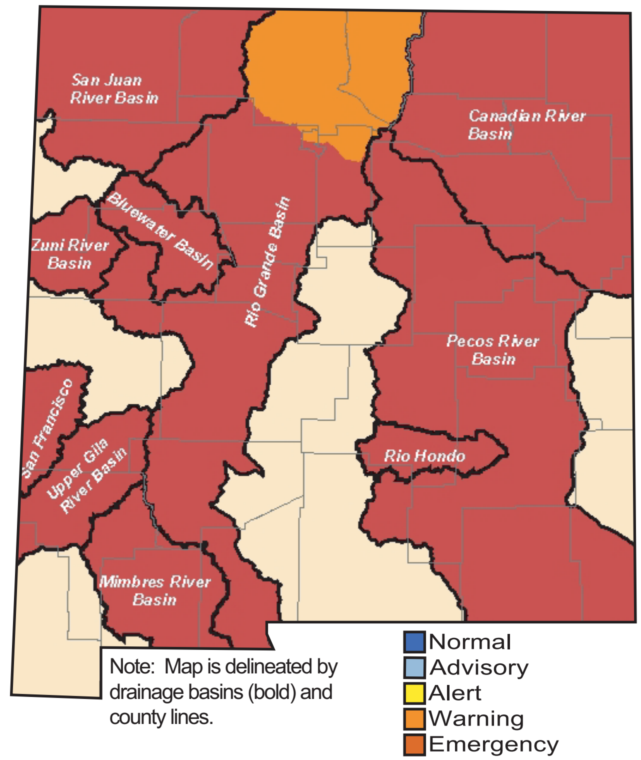
Meteorological Drought Map

Drought Status as of February 18, 2004



Hydrological Drought Map

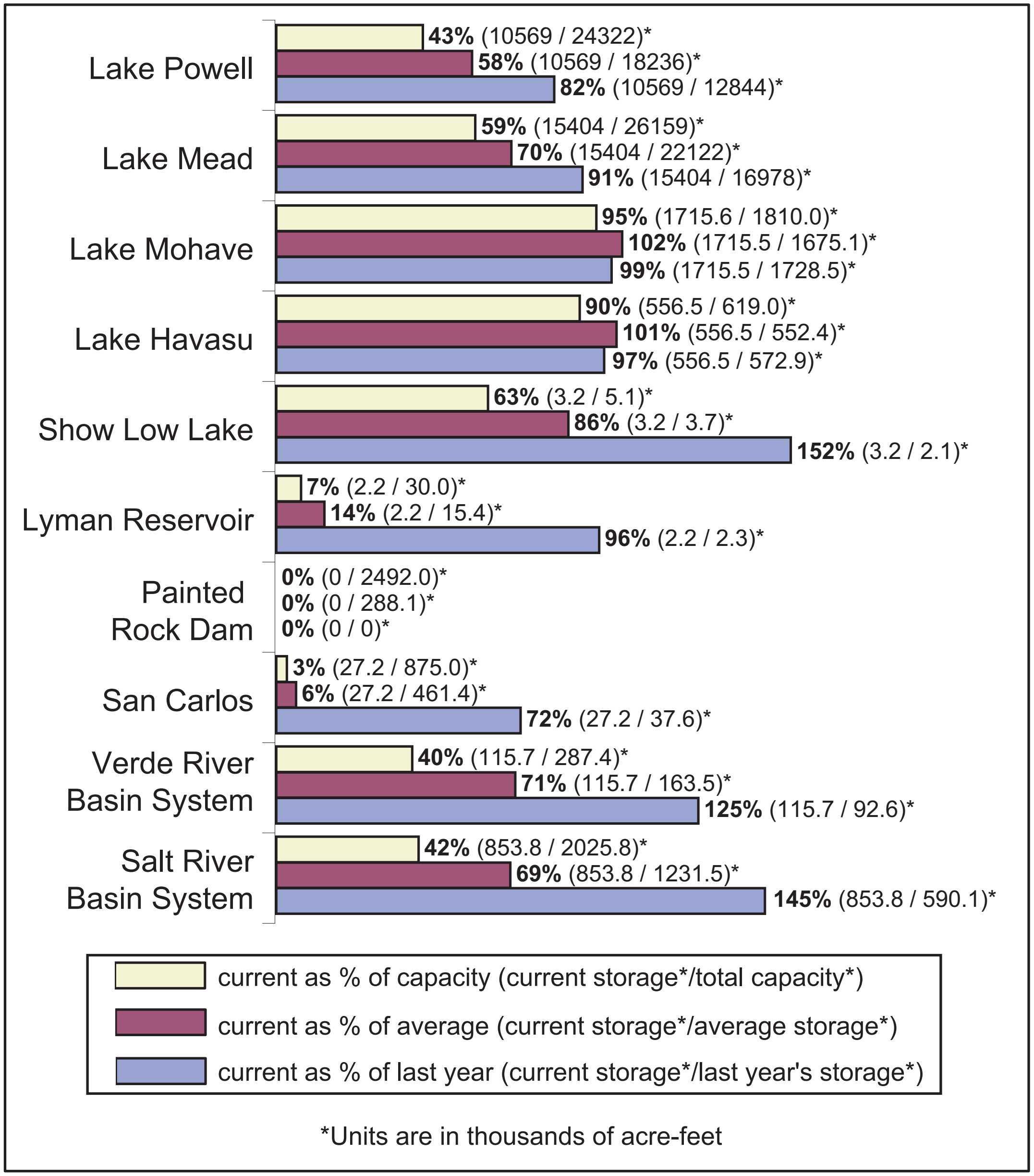
Drought Status as of February 18, 2004



Notes: New Mexico drought status maps are produced by the New Mexico Drought Monitoring Workgroup (NMDMW). As with the U.S. Drought Monitor maps (see page 4), the New Mexico maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow. The New Mexico drought status maps (http://www.nm.nrcs.usda.gov/snow/drought/drought.html) are produced monthly. When near-normal conditions exist, they are updated quarterly. Information on Arizona drought can be found at: http://www.water.az.gov/gdtf/

Highlights: New Mexico meteorological drought status has deteriorated somewhat in northwestern New Mexico. Yet, precipitation in much of New Mexico has been above the 50th percentile for most of the past six months. The New Mexico maps (above) do not reflect substantial late-February and March precipitation. However, a March 18, 2004 hydrological outlook released by the National Weather Service (NWS) Albuquerque forecast office notes that despite improvement in short-term drought indices, recent precipitation did not put much of a dent in long-term drought indices. This is reflected in well below-average reservoir storage (see page 7), high fire danger, and statewide range and pasture conditions that rank as the worst in the nation. NWS Albuquerque reports that “a long period of very wet weather would be required to end the drought.” The *Alamogordo News* (March 12, 2004) reported that the high mountain village of Cloudcroft, New Mexico is working on improvements to its water system, including a filtering plant for water reuse. Water use in this resort town can triple during the summer. The town is planning an ordinance to mitigate fire danger around residences.

6. Arizona Reservoir Levels (through the end of February 2004) Source: USDA NRCS



Notes: Reservoir reports are updated monthly and are provided by the National Water and Climate Center (NWCC) of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). 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

As of 3/11/04, Arizona's report had been updated through the end of February.

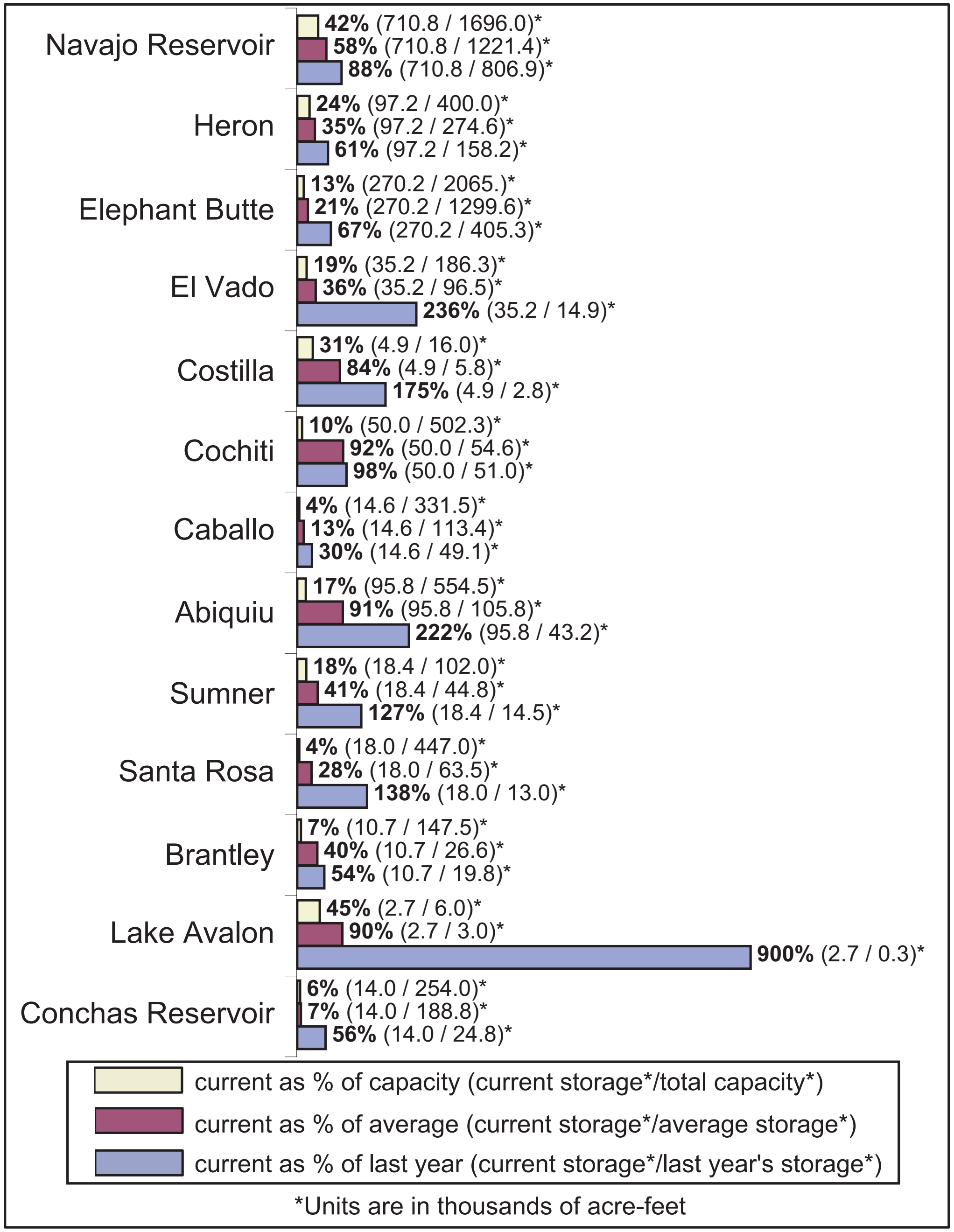
For additional information, contact Tom Pagano of the NWCC-NRCS-USDA (tpagano@wcc.nrcs.usda.gov; 503-414-3010) or Larry Martinez, NRCS, USDA, 3003 N. Central Ave, Suite 800, Phoenix, Arizona 85012-2945; 602-280-8841; Larry.Martinez@az.usda.gov)

Highlights: Since the end of January 2004, the following Arizona reservoirs have made modest gains: "run of the river" reservoirs, Lake Mohave and Lake Havasu; Lyman Reservoir; and the Salt River Basin System. Storage decreased on the main Colorado River reservoirs, Lake Mead and Lake Powell, as well as on the Verde River Basin System. However, these figures do not include the effects of early March precipitation or late March snowmelt.

A March 4, 2004 article in the *Las Vegas Review-Journal*, reported that the federal government is evaluating a plan that would allow Nevada to draw more water from the Colorado River, based on claims to Virgin River and Muddy River waters that flows into Lake Mead. The plan would avoid building a pipeline from the Virgin River to Las Vegas. However, water managers in Arizona and California claim that the plan would violate existing Colorado River law, and "open the floodgates for others to claim Colorado River water."

The *Yuma Sun* reported that city officials will travel to Washington, D.C. to address water rights issues. The mayor of Yuma is working to protect Yuma water rights from neighboring California communities.

7. New Mexico Reservoir Levels (through the end of February 2004) Source: USDA NRCS



Notes: Reservoir reports are updated monthly and are provided by the National Water and Climate Center (NWCC) of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). Reports can be accessed at their website: http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html.

As of 3/11/04, New Mexico's report had been updated through the end of February.

For additional information, contact Tom Pagano of the NWCC-NRCS-USDA (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)

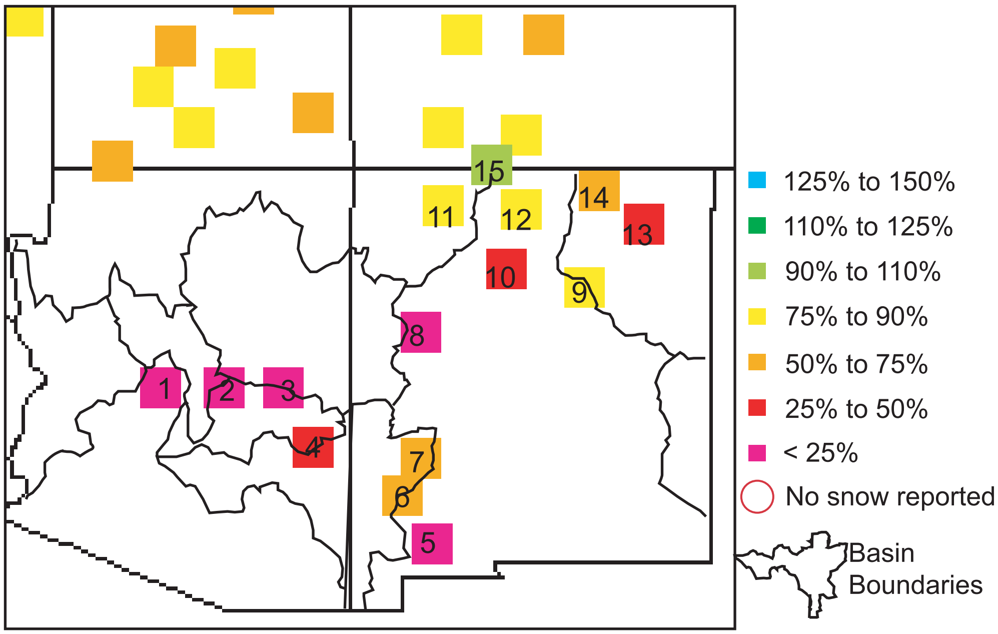
Highlights: Most New Mexico reservoirs registered slight gains since February 2004. The only exceptions were the Heron and Conchas reservoirs.

The *Ruidoso News* (March 17, 2004) reported that the main water supply for Ruidoso Downs is at historically low levels. Water demand will likely require pumping of the area's Denton Wells, which are in need of rehabilitation. The city is aggressively seeking new water rights, and has imposed a water conservation ordinance. City officials claim that adequate water supply is less of an issue than adequate infrastructure to capture, hold and distribute water.

A new subdivision in Santa Fe, La Pradera will incorporate an innovative water conservation system designed to cut water use by approximately half, reports the *Albuquerque Journal* (March 12, 2004). The subdivision will feature a waste water reclamation and treatment system to irrigate landscaping; the development will require homes to connect to rainwater cisterns, and prohibit homes from using swamp coolers. An engineer for the project stated that the project intends for no potable water to be used outdoors.

8. Snowpack in the Southwestern United States (updated 3/23/04) Source: USDA NRCS, WRCC

8. Basin average snow water content (SWC) for available monitoring sites as of 3/23/04 (percent of average).



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

Highlights: Snowpack remains below average throughout Arizona and New Mexico. Recent above-average temperatures (see page 1), have contributed to rapid snowmelt across much of Arizona and New Mexico. In addition, snow water content (SWC) is below the 1971–2000 average across virtually all of the Colorado and Rio Grande river basins (Figure 8). Lake Mary, the major surface water supply for Flagstaff, is expected to receive only 37 percent of its average snowmelt inflow. According to Larry Martinez of the USDA-Natural Resources Conservation Service, Lake Mary received 45 and 17 percent of average inflow in 2003 and 2002, respectively. This week a report issued by the USDA's Natural Resources Conservation Service on March 22, stated "snow water content...decreases were greatest, up to 76 percent, in Arizona and southeastern New Mexico, where most snow packs have now melted out.“

For color maps of SNOTEL basin SWC, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html
For a numeric version of the SWC map, visit: http://www.wrcc.dri.edu/snotelanom/basinswen.html
For a list of river basin SWC and precipitation, visit: http://www.wrcc.dri.edu/snotelanom/snotelbasin

Notes:

The data shown on this page are from snowpack telemetry (SNOTEL) stations grouped according to river basin. These remote stations sample snow, temperature, precipitation, and other parameters at individual sites.

Snow water content (SWC) and snow water equivalent (SWE) are different terms for the *same* parameter.

The SWC in Figure 8 refers to the snow water content found at selected SNOTEL sites in or near each basin compared to the *average* value for those sites on this day. *Average* refers to the arithmetic mean of annual data from 1971-2000. SWC is the amount of water currently in snow. It depends on the density and consistency of the snow. Wet, heavy snow will produce greater SWC than light, powdery snow.

Each box on the map represents a river basin for which SWC data from individual SNOTEL sites have been averaged. Arizona and New Mexico river basins for which SNOTEL SWC estimates are available are numbered in Figure 8. The colors of the boxes correspond to the percent of average SWC in the river basins.

The dark lines within state boundaries delineate large river basins in the Southwest.

These data are provisional and subject to revision. They have not been processed for quality assurance. However, they provide the best available land-based estimates during the snow measurement season.

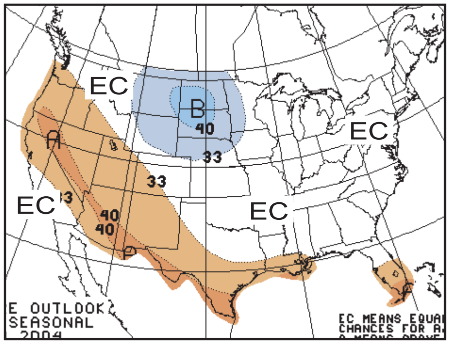
Section C

FORECASTS

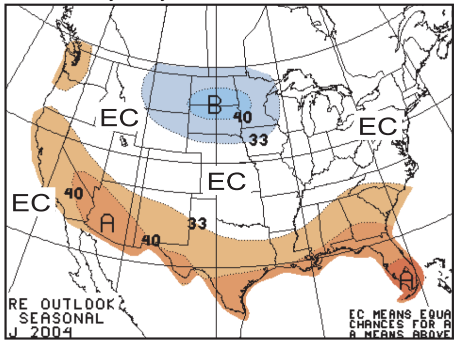
9. Temperature: Multi-season Outlooks ♦ Source: NOAA Climate Prediction Center

Overlapping 3-month long-lead temperature forecasts (released 3/18/04).

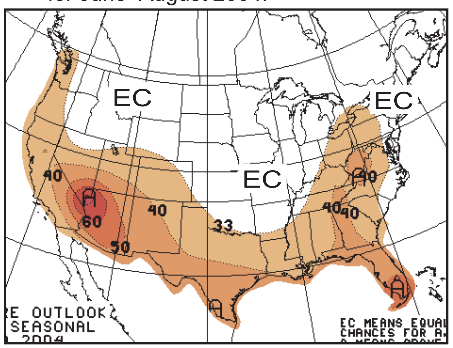
9a. Long-lead national temperature forecast for April–June 2004.



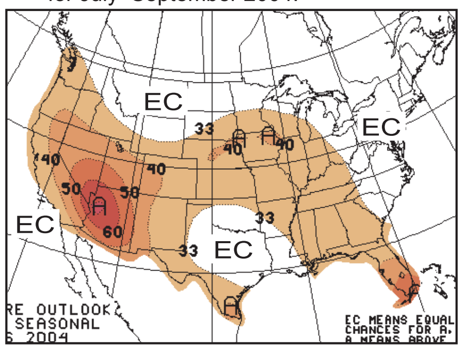
9b. Long-lead national temperature forecast for May–July 2004.



9c. Long-lead national temperature forecast for June–August 2004.



9d. Long-lead national temperature forecast for July–September 2004.



Percent Likelihood of Above and Below Average Temperatures*

A = Above
- > 70%
- 60% - 69.9%
- 50% - 59.9%
- 40% - 49.9%
- 33% - 39.9%

B = Below
- 33% - 39.9%
- 40% - 49.9%

*EC indicates no forecasted anomalies due to lack of model skill.

Highlights: The NOAA-CPC temperature outlooks for April through September 2004 (Figures 9a-9d) continue to show increased probabilities of above-average temperatures for the Southwest. The near-term forecast is for only slightly increased probabilities, with the highest probabilities in a band across northwestern Arizona, southeast to southwestern New Mexico (Figure 9a). Extremely high probabilities of above-average temperatures are predicted for the summer months, with maximum probabilities (> 60%) centered over central and northwestern Arizona (Figures 9c-9d). The International Research Institute for Climate Prediction (IRI) temperature forecasts (not pictured) show a similar pattern of increased probabilities of above-average temperatures for the Southwest; although their predictions for May–July only show slightly increased probabilities across the southern half of our region and no prediction across the northern half of our region. The CPC predictions are based primarily on agreement between long-term temperature trends for the region and statistical models.

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

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) 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.

In a situation where there is no forecast skill, one might look at average conditions in order to get an idea of what might happen. 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.

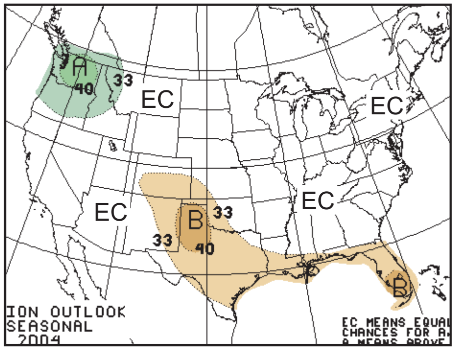
Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-40.0 percent chance of above-average, a 33.3 percent chance of average, and a 26.7-33.3 percent chance of below-average temperature.

The term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

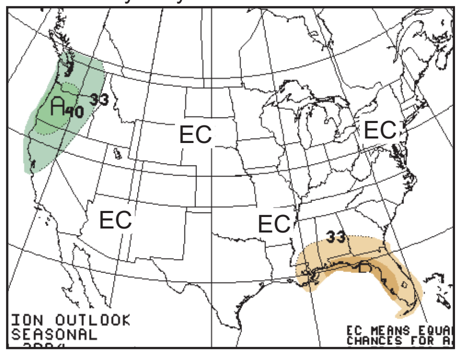
Equal Chances (EC) indicates areas where reliability (i.e., the 'skill') of the forecast is poor and no anomaly prediction is offered.

Overlapping 3-month long-lead precipitation forcasts (released 3/18/04).

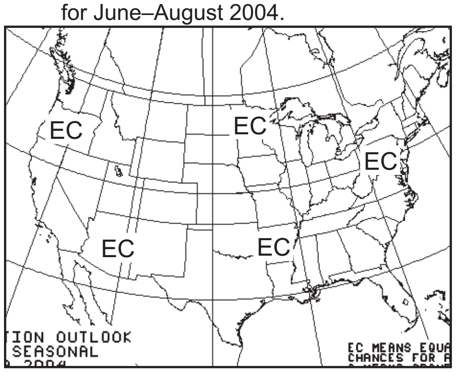
10a. Long-lead U.S. precipitation forecast for April–June 2004.



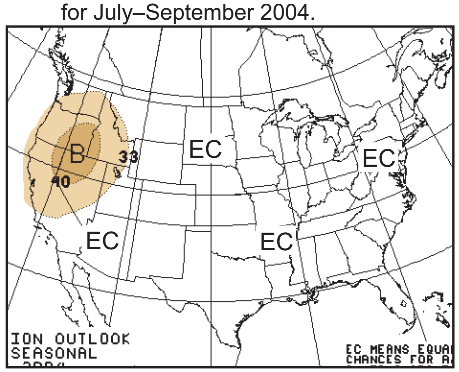
10b. Long-lead U.S. precipitation forecast for May–July 2004.



10c. Long-lead U.S. precipitation forecast for June–August 2004.



10d. Long-lead U.S. precipitation forecast for July–September 2004.



Percent Likelihood of Above or Below Average Precipitation*

> 40%	A = Above	
33% - 40%		
33% - 40%	B = Below	
> 40%		

*EC indicates no forecasted anomalies due to lack of model skill.

Highlights: The NOAA-CPC precipitation outlook for April–June 2004 (Figure 10a) indicates slightly increased probabilities of below-average precipitation across the eastern half of New Mexico. Outlook confidence is based on good agreement among dynamical forecast models. The International Research Institute for Climate Prediction (IRI) precipitation forecast for this time period (not pictured) also shows slightly increased probabilities of below-average precipitation, but for an area including virtually all of New Mexico and much of the Four Corners area. CPC (Figures 10b-10d) and IRI seasonal precipitation outlooks (not pictured) for May–September 2004 withhold judgment. Summer (monsoon) precipitation in the Southwest is exceedingly difficult to predict and is a topic of active research in the atmospheric sciences. A NOAA-sponsored program, called the North American Monsoon Experiment (NAME), will be conducting extensive field observations of the monsoon during summer 2004, in an attempt to better understand and predict summer precipitation in the Southwest and Mexico.

For more information, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
Please note that this website has many graphics and may load slowly on your computer.
For more information about IRI experimental forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) 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.

In a situation where there is no forecast skill, one might look at *average* conditions in order to get an idea of what might happen. 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 green shading there is a 33.3-40.0 percent chance of above-average, a 33.3 percent chance of average, and a 26.7-33.3 percent chance of below-average precipitation.

The term *average* refers to the 1971–2000 average. This practice is standard in the field of climatology.

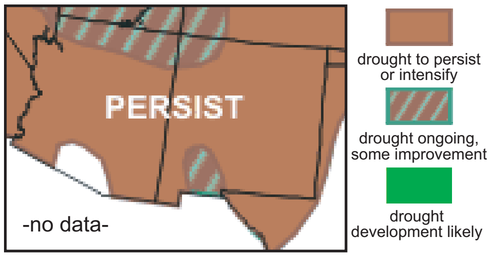
Equal Chances (EC) indicates areas where reliability (i.e., the 'skill') of the forecast is poor and no anomaly prediction is offered.

11. Drought: Seasonal Drought and PHDI Outlook Maps ♦ Sources: NOAA-CPC, NCDC

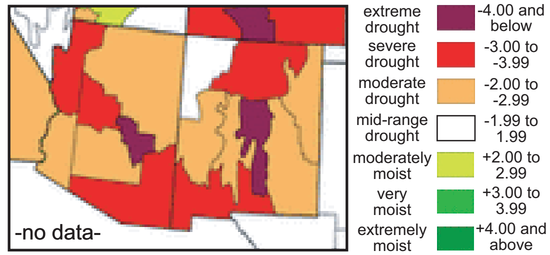
Notes:

The delineated areas in the Seasonal Drought Outlook (Fig. 11a) are defined subjec-tively and are based on expert assess-ment of numerous indicators, including outputs of short- and long-term forecasting models.

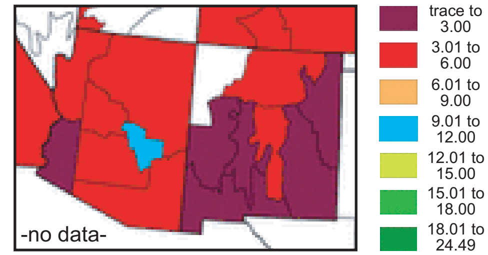
11a. Seasonal drought outlook through June 2004 (accessed 3/18).



11b. February 2004 PHDI conditions (accessed 3/18).



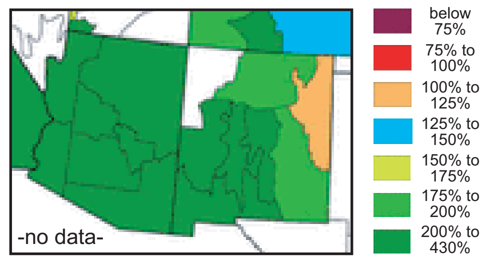
11c. Precipitation (in.) required to end cur-rent drought conditions in three months.



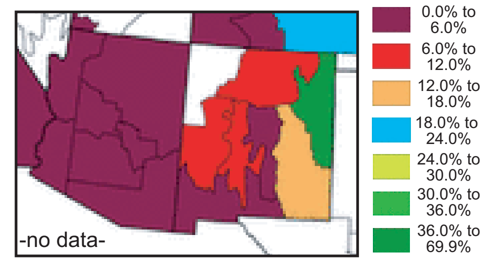
Figures 11b-e are based on the Palmer Hydrological Drought Index (PHDI), which reflects long-term precipitation deficits. PHDI is a measure of reservoir and groundwater level impacts, which take a relatively long time to develop and to recover from drought. Figure 11b shows the current PHDI status for Arizona and New Mexico.

Figure 11c shows the amount of precipitation, in inches, needed over the next three months to change a region's PHDI status to -0.5 or greater—in other words, to end the drought. Regions shown in white have a current PHDI value greater than –2.0 (e.g., in Figure 11b - e, these regions are not in hydrological drought).

11d. Percent of average precipitation required to end current drought conditions in three months.



11e. Probability of receiving precipitation required to end current drought conditions in three months.



The season in which the precipitation falls greatly influences the amount of precipitation needed to end a drought. For example, during a typically wet season more precipitation may be required to end a drought than during a typically dry season. Also, because soil moisture conditions generally are lower in the dry seasons, the precipitation needed to bring soil conditions back to normal may be less than that required to return soil moisture conditions to normal during a generally wetter season. Figure 11d shows the percent of average precipitation needed to end drought conditions in three months, based on regional precipitation records from 1961–1990. A region that typically experiences extreme precipitation events during the summer, for example, may be more likely to receive enough rain to end a drought than a region that typically is dry during the same season. The seasons with the greatest probability of receiving substantially more precipitation than average are those subject to more extreme precipitation events (such as hurricane-related rainfall), not necessarily those seasons that normally receive the greatest average amounts of precipitation. Figure 11e shows the probability, based on historical precipitation patterns, of regions in Arizona and New Mexico receiving enough precipitation in the next three months to end the drought. Note that these probabilities do not take into account atmospheric and climatic variability (such as El Niño-Southern Oscillation), which also influence seasonal precipitation probabilities.

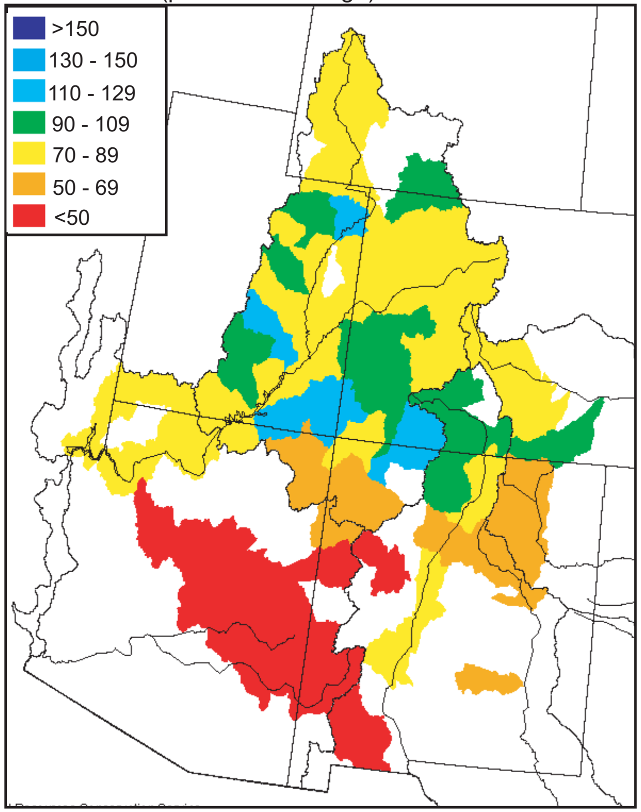
Highlights: The U.S. Seasonal Drought Outlook (Figure 11a) indicates that drought is likely to persist throughout most of Arizona and New Mexico through June 2004. Some improvement in conditions is expected for northern Arizona and parts of southern New Mexico. There is a very low probability of ending drought within the next three months, for most of the Southwest, especially as we enter the dry pre-monsoon season.

For more information, visit: http://www.drought.noaa.gov/ and http://www.ncdc.noaa.gov/oa/climate/research/drought/drought.html

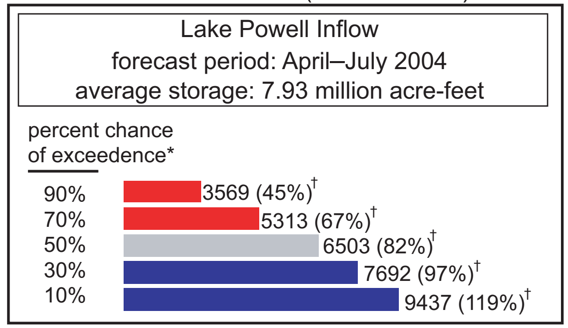
12. Streamflow Forecast for Spring and Summer

Source: USDA NRCS National Water and Climate Center

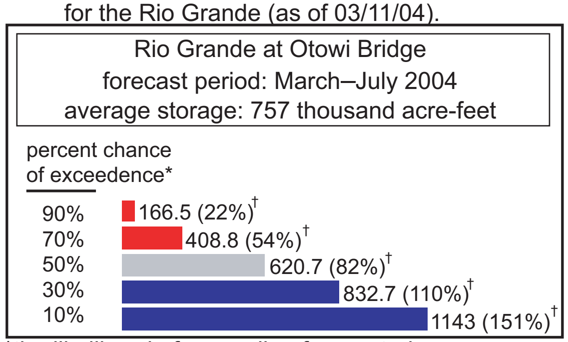
12a. NRCS spring and summer streamflow forecast as of 03/11/04 (percent of average).



12b. NRCS percent exceedence forecast chart for Lake Powell inflow (as of 03/11/04).



12c. NRCS percent exceedence forecast chart for the Rio Grande (as of 03/11/04).



*the likelihood of exceeding forecasted streamflow volume.

†associated forecasted streamflow volume (thousands of acre-feet) and percent of average volume.

Highlights: Below-average streamflow is predicted for the great majority of Arizona and New Mexico river basins for the spring-summer snowmelt season. The most probable inflow to Lake Powell is predicted to be 82 percent of the 1971–2000 average. Most probable Rio Grande streamflow at Otowi Bridge (north of Albuquerque) is also predicted to be 82 percent of average. Of particular note is that streamflow for the major interior Arizona and western New Mexico basins is projected to be well below average. According to the USDA-NRCS, streamflow forecasts for the Rio Grande Basin range from 50 percent of average for the Rio Pueblo de Taos below Los Cordovas, to 99 percent of average for inflow to the El Vado Reservoir. *The Arizona Republic* (March 12, 2004) reported that Arizona per capita water use has declined by nearly 40 percent since 1990. The article also reported that water used for mining in Arizona decreased by almost one-third since 1990, and that irrigated acres dropped from 1.34 million to under 1 million from 1990 to 2000.

For state river basin streamflow probability charts, visit: http://www.wcc.nrcs.usda.gov/water/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 Figures 12a-c is updated monthly and is provided by the National Resources Conservation Service (NRCS). Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions.

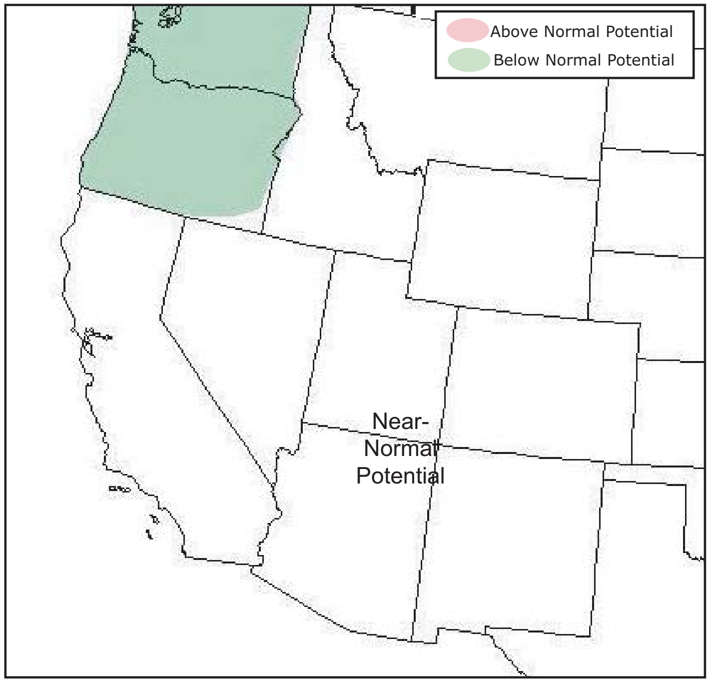
Each month, five streamflow volume forecasts are made by the NRCS for several river basins in the United States. These five forecasts correspond to standard *exceedence* percentages, which can be used as approximations for varying 'risk' thresholds when planning for short-term future water availability.

NRCS provides the 90, 70, 50, 30, and 10 percent exceedence streamflow volumes. Each exceedence percentage level corresponds to the following statement: "There is an (X) percent chance that the streamflow volume will exceed the forecast volume value for that exceedence percentage." Conversely, the forecast also implies that there is a (100-X) percent chance the volume will be less than this forecasted volume. In Figure 12c for example, there is a 30 percent chance that Rio Grande at Otowi Bridge will exceed 878.1 acre-feet of water (116 percent of average) between March and July and a 70 percent chance that it will not exceed that volume. Note that for an individual location, as the exceedence percentage declines, forecasted streamflow volume increases.

In addition to monthly graphical forecasts for individual points along rivers (Figures 12b and 12c), the NRCS provides a forecast map (Figure 12a) of basin-wide streamflow volume averages based on the forecasted 50 percent exceedence threshold.

13. National Wildland Fire Outlook ♦ Source: National Interagency Coordination Center

13. Monthly wildfire outlook (valid March 1–31).



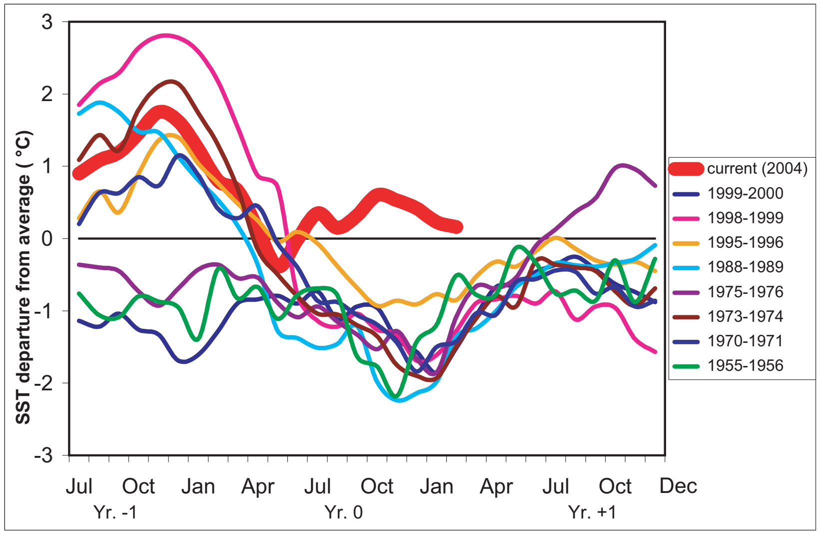
Notes: The National Interagency Coordination Center (NICC) at the National Interagency Fire Center (NIFC) produces monthly (Figure 13) wildland fire outlooks. These forecasts consider climate forecasts and surface-fuels conditions in order to assess fire potential. They are subjective assessments, based on synthesis of regional fire danger outlooks.

Highlights: For the 2004 fire season, fire danger is expected to be average to above average, during a shorter-than-average fire season. The SWCC projects rapid escalation to critical fire danger conditions (the highest 10% of historic cases) during May and June, due to a combination of factors, including the following: forecasts for increased probabilities of above-average temperatures; relatively high fine fuel loadings; extensive areas of standing large dead fuels; and underlying drought conditions which can result in rapid acceleration of fire danger. The SWCC most likely scenario outlook (60 percent chance) shows Arizona fire danger at approximately 2003 levels and New Mexico fire danger at above 2003 fire danger levels during the mid-May through early July high fire danger period. SWCC worst case scenarios (25 percent chance) show Arizona with fire danger greater than 2003 fire season levels during the rest of spring through early July, and both states possibly exceeding critical levels by early May. SWCC specialists note that late spring weather variations can have a dramatic influence on the overall fire season, such as during April 1999, when a snow storm rapidly reduced impending high fire danger.

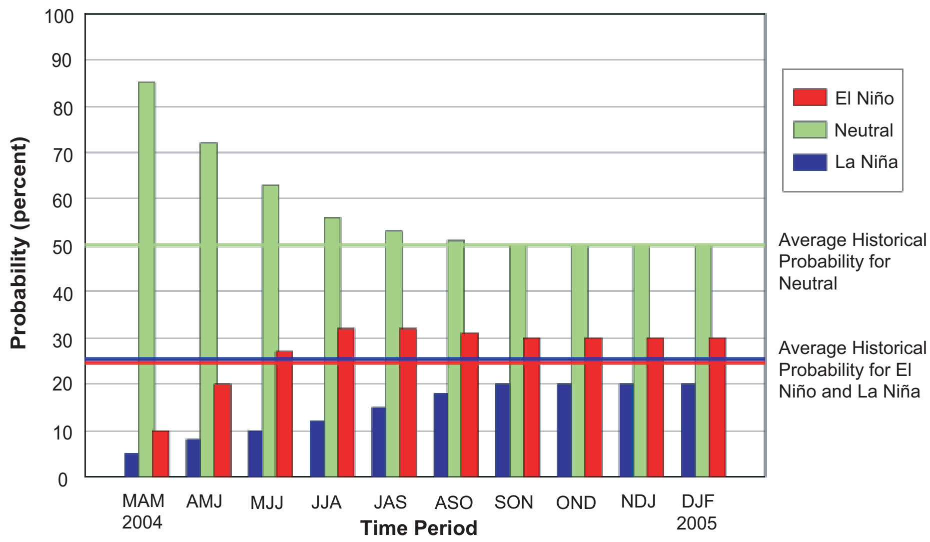
For more detailed discussions, visit the National Wildland Fire Outlook web page: http://www.nifc.gov/news/nicc.html and the Southwest Area Wildland Fire Operations (SWCC) web page: http://www.fs.fed.us/r3/fire/ For an array of climate and fire assessment tools, visit the Desert Research Institute program for Climate, Ecosystem, and Fire Applications (CEFA) web page: http://cefa.dri.edu/Assessment_Products/assess_index.htm

14. Tropical Pacific Sea Surface Temperature Forecast Sources: NOAA-CPC, IRI

14a. Current (red) and past La Niña event sea surface temperature anomalies (°C) for the El Niño 3.4 monitoring region of the equatorial Pacific Ocean.



14b. IRI Probabilistic ENSO Forecast for El Niño 3.4 Monitoring Region



Notes: Figure 14a shows sea-surface temperature (SST) departures from the long-term average for the Niño 3.4 region in the central-eastern equatorial Pacific Ocean (120°-170°W, 5°S-5°N). SSTs in this region are a sensitive indicator of El Niño-Southern Oscillation (ENSO) conditions. Each line on the graph represents SST departures for previous La Niña events, beginning with the year before the event began (Yr. –1), continuing through the event year (Yr. 0), and into the decay of the event during the subsequent year (Yr. +1). The most recent SST departures are plotted as a thick red line. The magnitude of the SST departure, its timing during the seasonal cycle, and its exact location in the equatorial Pacific Ocean are some of the factors that determine the degree of impacts experienced in the Southwest.

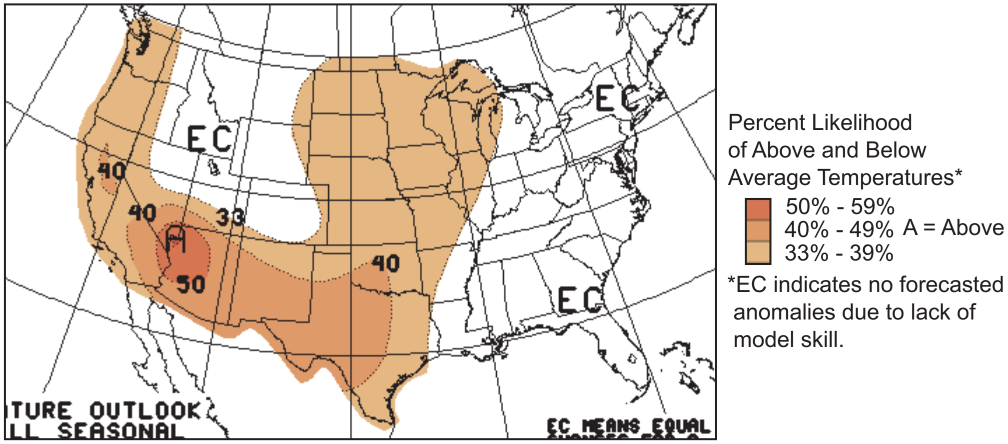
Figure 14b shows the International Research Institute for Climate Prediction (IRI) probabilistic ENSO forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, neutral, La Niña. The forecast is a subjective assessment of current forecasts of ENSO prediction models. Only models that produce a new ENSO forecast every month are included in the assessment. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill and how that skill varies seasonally), an average of the models, and additional factors such as the very latest observations. The forecast considers El Niño conditions as occurring during the warmest 25 percent of Niño 3.4 SSTs during the three month period in question; La Niña conditions are the coolest 25 percent of Niño 3.4 SSTs, and neutral conditions define the remaining 50 percent of observations.

Highlights: Overall sea-surface temperatures (SSTs) in the equatorial and tropical Pacific Ocean were neutral, with some week-to-week variability. SSTs in the western tropical Pacific remained slightly above average. An assessment of ENSO predictive models by the IRI, states that neutral Pacific Ocean conditions are likely to continue throughout the first half of 2004. According to the IRI, the probability that an El Niño episode will develop between May and early summer is less than the historical average (25 percent); the best chances for an El Niño episode to develop, according to a consensus of predictive models, is during the summer; however, the chances that an El Niño episode will develop is still far less than the chances of neutral conditions persisting. NOAA-CPC suggests that neutral ENSO conditions will continue through the rest of 2004. Lack of extremes in ENSO suggests variability in climate patterns and less predictability of climatic conditions for our region.

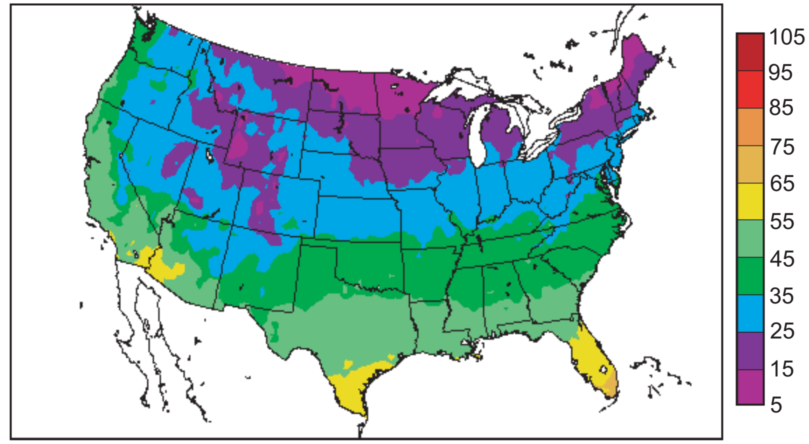
For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/
For more information about El Niño and to access graphics similar to the figure above, visit: http://iri.columbia.edu/climate/ENSO/

15. Temperature Verification: December 2003–February 2004 ♦ Source: NOAA Climate Prediction Center

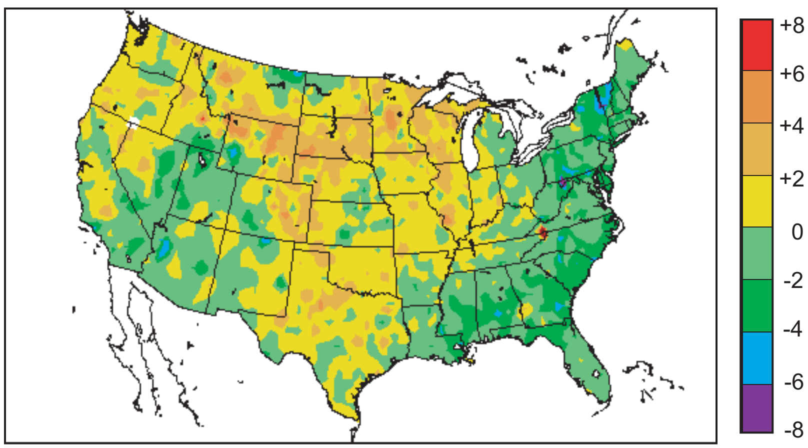
15a. Long-lead U.S. temperature forecast for December 2003–February 2004.



15b. Average temperature (in °F) for December 2003–February 2004.



15c. Average temperature departure (in °F) for December 2003–February 2004.



Highlights: The NOAA-CPC December 2003–February 2004 forecast for increased probabilities of above-average temperatures was on the mark for most of the Pacific Northwest and Great Plains states; however, the forecast, based chiefly on long-term trends, showed little skill in the Southwest – a region for which winter temperature outlooks have generally been exceedingly accurate.

Notes: Figure 15a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months December 2003–February 2004. This forecast was made in November 2003.

The December 2003–February 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps described below.

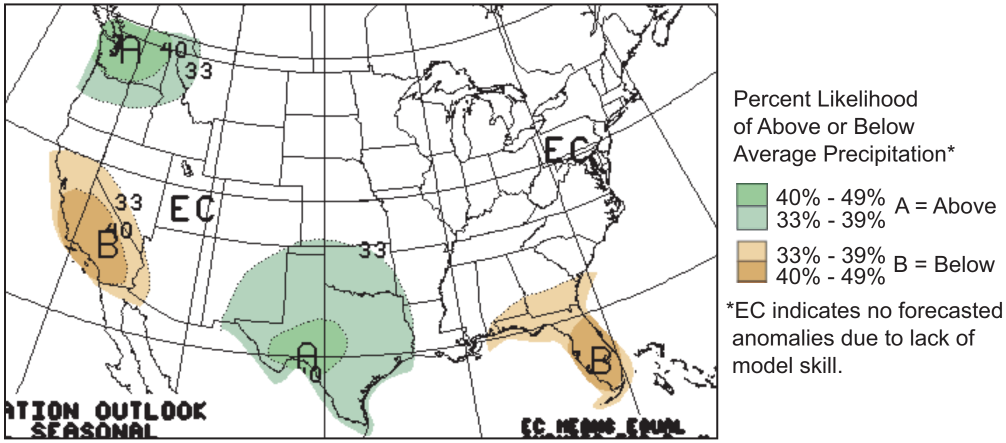
Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.8-33.3 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 average temperature between December 2003–February 2004 (°F). Figure 15c shows the observed departure of temperature (°F) from the average for December 2003–February 2004.

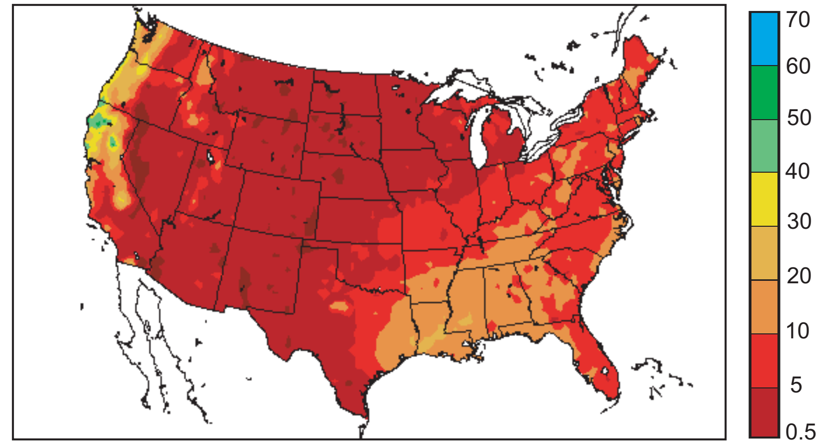
In all of the figures on this page, the term average refers to the 1971-2000 average. This practice is standard in the field of climatology.

16. Precipitation Verification: December 2003–February 2004 ♦ Source: NOAA Climate Prediction Center

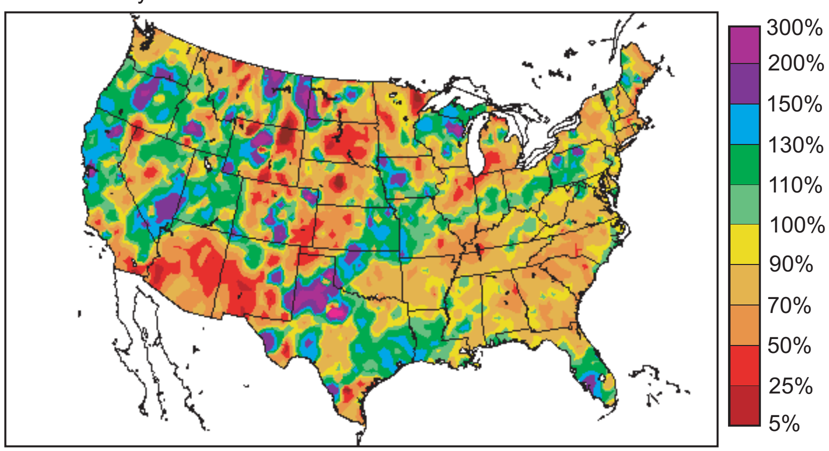
16a. Long-lead U.S. precipitation forecast for December 2003–February 2004.



16b. Observed precipitation for December 2003–February 2004 (inches).



16c. Percent of average precipitation observed between December 2003–February 2004.



Highlights: The NOAA-CPC December 2003–February 2004 precipitation outlook showed skill for predictions of increased probabilities of above-average precipitation in portions of eastern New Mexico and increased probabilities of below-average precipitation in southwestern Arizona (Figures 16a and 16c). The spatial extent of the predictions, however, was not commensurate with observations. Generally, predictions for the Southern Plains states were successful, as were predictions for southern California, parts of the Pacific Northwest, and parts of the Southeast. Regional precipitation was not as coherent as anticipated by NOAA-CPC forecasters.

Notes: Figure 16a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months December 2003–February 2004. This forecast was made in November 2003.

The December 2003–February 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the forecast map (Figure 16a) do not refer to inches of precipitation. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps described below.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.8-33.3 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 16b shows the total precipitation observed between December 2003–February 2004 in inches. Figure 16c shows the observed percent of average precipitation for December 2003–February 2004.

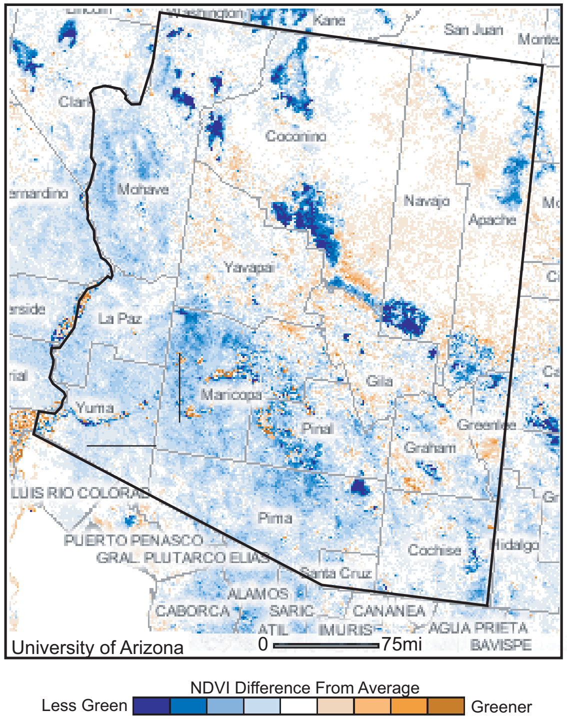
In all of the figures on this page, the term average refers to the 1971-2000 average. This practice is standard in the field of climatology.

Section D

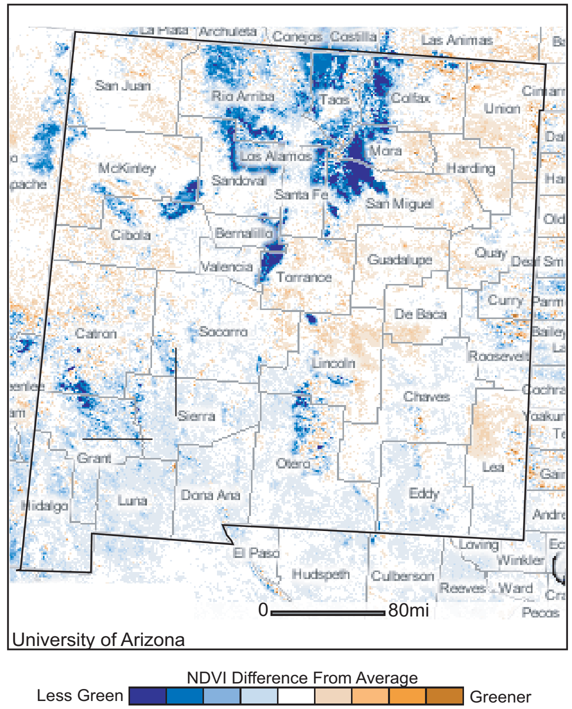
FOCUS ON
RANGE VIEW AND AZMET

17. Focus on RangeView ♦ Source: The University of Arizona

17a. Difference from average NDVI for Arizona on March 9, 2004, compared to values for the same time frame since 1989.



17b. Difference from average NDVI for New Mexico on March 9, 2004, compared to values for the same time frame since 1989.



Highlights: For the two-week time period that ended March 9, 2004 large parts of Arizona and New Mexico were showing average or less than average greenness for this time of year (Figure 17a). Notice that site of the Rodeo-Chediski fire in southern Navajo County of Arizona is an area with significantly lower-than-average greenness (shown in blue). Similarly, north central New Mexican forests are showing lower than average NDVI values. However, this appears to be snow, which covers the greenness signal, because the values drop suddenly in mid-February.

For more information, visit http://rangeview.arizona.edu/ and try things out for yourself.

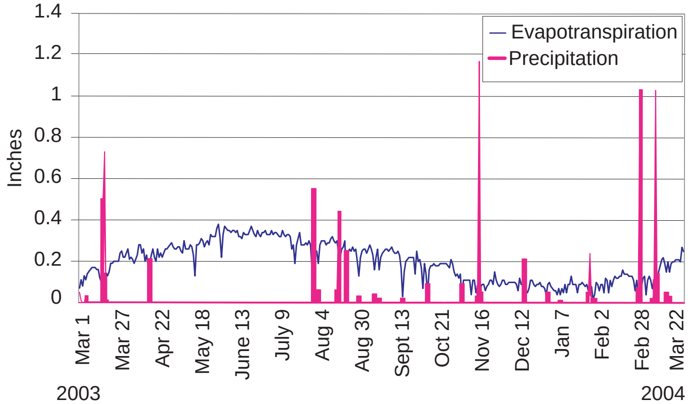
Notes: The University of Arizona (UA), with funds from NASA's Office of Earth Science, has developed a website that allows users to access a variety of remotely sensed views of North American vegetation since 1989 through the present. The website allows access to Normalized Difference Vegetation Index (NDVI) images, i.e., greenness, along with analytical products, such as "difference from average." The images (at left) show difference from average NDVI values for early March 2004 compared to the average values since 1989 in Arizona (17a) and New Mexico (17b).

As the UA website explains in its glossary, NDVI is an index that provides a standardized method of comparing vegetation greenness. In the images shown here, which have a resolution of 1 square kilometer, the blue colors indicate lower NDVI values (lower greenness) whereas the orange colors illustrate higher-than-average NDVI values (higher greenness) compared to the previous 14 years. White indicates approximately average greenness. These are composite images that assess average difference using each pixel's highest daily value of greenness from the previous two weeks compared to the highest daily value for the similar two-week period of each year back through 1989. The highest values and long time period are used to avoid undue influence from cloud cover.

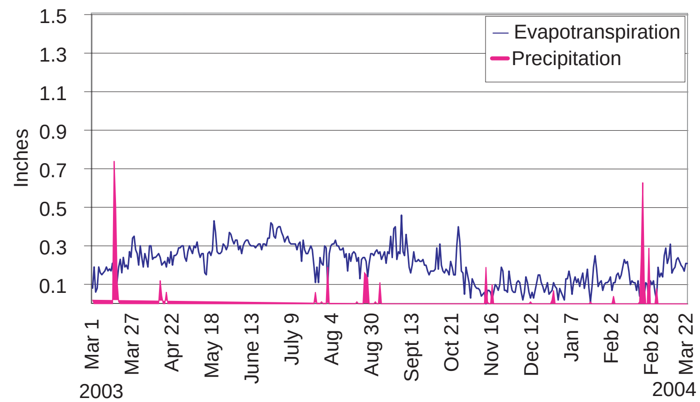
The average difference in greenness is only one of many interesting features on this interactive website based on remotely sensed vegetation indexes produced by the U.S. Geological Survey from a National Oceanic and Atmospheric Administration satellite sensor. The site offers a variety of zoom options, and the user can select various types of overlay maps to make orientation easier. Once you have your area of interest, you then can "animate" images so changes throughout a year can be viewed, and freeze-frame specific composites.

18. Evapotranspiration and Precipitation ♦ Source: Arizona Meteorological Network, University of Arizona

18a. Phoenix precipitation and evapotranspiration values March 2003 through March 2004.



18b. Mohave precipitation and evapotranspiration values March 2003 through March 2004.



Notes: The Arizona Meteorological Network (AZMET), based at the University of Arizona in Tucson, records information from automated weather data collection sites throughout the state. Data collected includes air and soil temperature, humidity, solar radiation, wind speed, wind direction, and precipitation.

Shown above in Figures 18a and 18b are daily precipitation (pink spikes) and observed evapotranspiration (blue line) values for March 1, 2003 to March 22, 2004. Evapotranspiration, which is the amount of moisture evaporated from the ground surface or transpired through plants, is one of many computed variables that AZMET provides for farmers, gardeners, and turf growers in Arizona. Other values provided include heat units, chill hours, and dew point. The figures are based on AZMET daily values. A user can take the numerical data and use it as input to create graphical outputs to track seasonal trends in evapotranspiration and precipitation. Data can be imported into many spreadsheet programs after deleting text that is not in a column format.

Highlights: Tracking evapotranspiration and its levels in relation to precipitation is important not only to assess available water levels, but to better understand the water cycle in the arid Southwest. At every data collection site in Arizona, records show that evapotranspiration (water lost from the soil, vegetation, and groundwater systems) exceeds precipitation (water gained) on an annual, and often monthly, basis.

While evapotranspiration levels and trends are similar across the state, recorded precipitation varies considerably between stations, such as Phoenix and Mohave. Such variation is due to elevation, surrounding landscape, and latitude, among other things. Thus daily evapotranspiration in Phoenix is different than in Mohave, or in other parts of the state. Evapotranspiration varies by season as well as location; during November and December less water is lost through evapotranspiration because incoming solar energy is lower. Although peaks in precipitation occur during the summer and fall (as seen in the 2003 fall storm "peaks" in Phoenix), it is the steady winter precipitation, which coincides with the lowest evapotranspiration levels, that replenishes water to desert soils, plants, and water supplies.

However, farmers must consider evapotranspiration during growing seasons in order to plan irrigation systems. It is important, therefore, to recognize that evapotranspiration is a major factor in Arizona's water cycle, including water supplies for our cities, farms, and wild landscapes.

For more information, visit http://ag.arizona.edu/azmet.