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November 26, 2002

Dear Participant,

Hope your Thanksgiving was a happy and peaceful occasion. As we wait to see whether El Niño will indeed bring increased winter precipitation to the Southwest, we've chosen what we hope will prove to be a timely topic for this month's END InSight newsletter - the importance of snowpack to water supplies in the Southwest (a subject that may cause you to dream even more of a white Christmas!). The newsletter also contains an article written directly in response to questions that some of our stakeholders have raised regarding the lack of spatial specificity of the forecasting products. Many of the *recent conditions* reports and *forecasts* are based on data averaged over climate divisions; thus we explain what climate divisions are, why they are used, and the pros and cons of their application to different situations.

As promised last month, we're pleased to include our first quarterly report in this month's packet. Producing this brief summary of the responses to the monthly surveys that we've received thus far allowed us the opportunity to review the project and your responses up to this point. It was gratifying to learn that the END InSight Initiative is on track and accomplishing what we'd hoped it would. We're in the process of preparing reports to send to the agencies that produce the climate and weather information products included in your packets. These reports will include your responses and comments (anonymously, of course), and should be quite useful to the agencies in planning future changes to their products.

Partially in response to the relatively low scores that the reservoir reports have been receiving, and also to reflect new types of information available from the agency that provides the data (the Natural Resources Conservation Service), we've made some changes to the Arizona and New Mexico reservoir pages. We've created a new graphical version that includes much of the text from the previous edition. We believe that the changes better reflect our stakeholders' desire for graphical products, and we're eager to receive your feedback.

Another issue we wanted to briefly address is a question raised by one of our participants recently. The participant asked if there are any restrictions on copying the packets to CD-ROMs or other media and distributing them to others who might have an interest in the information. He also asked about using the information in public presentations. Our response is that we encourage you to share the information in any way you believe beneficial; and you are welcome to use it in presentations. However, we do ask that you cite both the original source of the information (websites are listed on each page) and CLIMAS whenever you reproduce or share the information.

We'd also like to let you know that due to the holidays, December packets will not be mailed out until early January. The packets will, however, be available on-line by around December 20. We'd like to receive your responses to this month's packet before the holidays sidetrack all of us; therefore, please return your survey by December 13, 2002.

Best wishes for the holidays and the New Year!

Rebecca Carter　　　　　Gregg Garfin

Evaluation – Monthly Information Packet

For: November 2002 Packet Number: 5

Please complete the following questionnaire about the information packet contents.

1. Does the information provided in this packet (check one):

    ___ confirm your assessment of current climate conditions

    ___ contradict your assessment of current climate conditions

    ___ both confirm and contradict your assessment of current climate conditions

2. Was there information missing from this packet that you would like to receive? (please specify)

3. Did you share or discuss any of the information provided with your co-workers?

    (please specify their position)

____ Top management ____ Field operations ____ Public relations/Education

____ Middle management ____ Research/Analysis

____ Other (please specify)____

4. Did any of the information we provided have an influence on your organization?

    ____Yes ____No

    If Yes, please specify the information used and how you used it.

5. On the attached chart, please evaluate each of the information products provided in this packet, and whether or not you used that particular item.

November 2002

Page #	Description	**General Impression?** 1=Useful *(or)* 2=Merely interesting *(or)* 3=Neither	**Adequate Lead Time?** 1 = Yes 2 = No	**Detail?** 1 = Just Right 2 = Too Much 3 = Too Little	**Easy to Understand?** 1 = Easy 2 = Moderate 3 = Difficult	**Graphic Style?** 1 = Good 2 = So-So 3 = Poor	**Action Taken?** 1 = Yes 2 = No	**What action? Other comments?**
	Background							
	END InSight Newsletter							
	Executive Summary							
	Recent Conditions							
1	Temperature							
2	Precipitation							
3	U.S. Drought Monitor							
4	Recent Drought Status Designation for New Mexico							
5	Palmer Drought Severity Indices (PDSI) Measures							
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13	National Wildland Fire Outlook							
14	U.S. Hazards Assessment Forecast							
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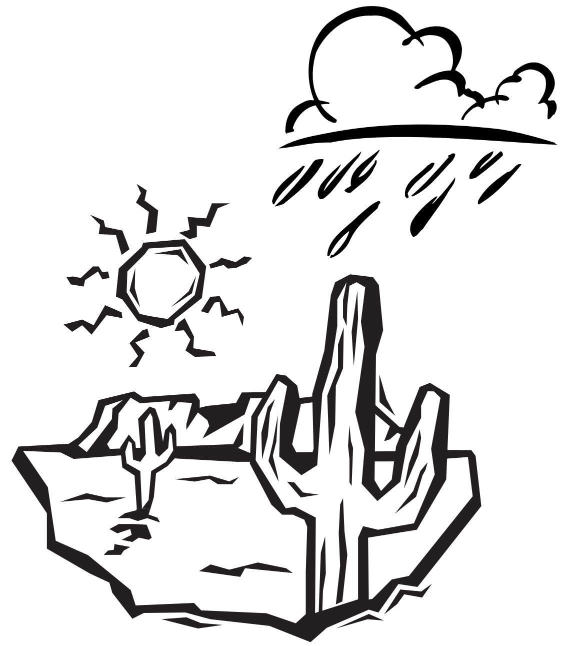
16	Considering Temporal Variability of the SPI							
17	Comparing CPC and IRI Climate Forecast Products (Part 1)							
18	Comparing CPC and IRI Climate Forecast Products (Part 2)							
19	SNOTEL and 2002 Snow in New Mexico							
20	Snow Variability and Streamflow in the Southwest							

END InSight



CLIMAS El Niño-Drought Initiative

Information Packet #5
November 2002

Climate Assessment for the Southwest
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Section A

BACKGROUND

News from the CLIMAS El Niño-Drought Initiative

END InSight

November 2002

THE UNIVERSITY OF ARIZONA®

Snowpack in the Southwest

When one considers the climate of the Southwest, snow may not come to mind as readily as rainless months and scorching temperatures. Despite the fact that large areas of our region never, or only very rarely, see the white stuff, snow plays a vital role in the hydrology, ecology, and water supplies of the Southwest. While the most important variable in annual water demand in some areas may be the timing and strength of summer monsoon storms, winter snowpack is the single most important determinant of annual water supply. Snowfall, primarily upon high mountain ranges, is estimated to provide 50 to 80 percent of the West's annual water supply (1) and corresponds directly with spring-to-early summer streamflow in the Southwest. In Arizona, 54 percent of the state's water supply comes from surface water (2), while in New Mexico, the corresponding figure is 57 percent (3). Most streamflow in both states is replenished annually by snowmelt.

Snowfall accumulates during winter and spring, several months before the snow melts and appears as streamflow; thus climatic conditions between autumn and late spring will set the stage for relief from, or a continuation of, drought conditions next summer. This lag time between snowfall and snowmelt allows forecasters to estimate runoff amounts, and hence streamflow, well in advance.

But there is more to predicting streamflow based on snowpack in the Southwest than simply measuring inches of snowfall. The composition of snow, both when it falls and as it progresses toward melting, determines how much water it contains (known as snow water equivalent, or SWE). One foot of freshly fallen heavy, wet snow may produce up to 1.5 inches of water, while light, powdery snow may contain only half an inch of water. Precipitation patterns, fluctuations in air temperature, use of water by plants, wind, atmospheric moisture, and the frequency of storm events also determine the accumulation of snowpacks and influence runoff amounts (1). Fall soil moisture conditions affect how much snowmelt is absorbed into the ground and how much becomes runoff.

The current situation in some areas of New Mexico provides an example of how these factors combine to determine runoff amounts. The extremely dry conditions that plagued the state during 2002 will have a significant effect on the 2003 runoff season. In many areas, less than 40 percent of average winter precipitation fell during the winter and spring of 2001-2002. Snowpacks melted up to two months ahead of average in New Mexico and Colorado, according to water supply forecaster Tom Pagano of the National Water and Climate Center. In New Mexico, the season broke low runoff records set back in 1977, with streamflows that were lower than those of historically dry years such as 1950, 1956, 1967, and 1996 (4).

Just how bad were things on the Rio Grande in particular last spring? Streamflow forecasts ranged from 33 percent of average in the headwaters, to only 2 percent downstream, just above Elephant Butte Reservoir. On May 1, 2002, the forecast was for a record-breaking low flow of 135,000 acre-feet; but only 96,000 acre-feet were actually recorded. Until 2002, the record low-flow from April to September was 155,770 acre-feet in 1977 based on data collected since 1990. The average flow is 533,240 acre-feet (5).

The soil in many areas of New Mexico is so dry that even if the snowpack this winter is average, roughly 25 percent of the snowmelt water could be absorbed directly into the parched soils, rather than contributing to runoff. Under these conditions, about 120 percent of average winter precipitation would be necessary to produce average runoff. Pagano notes that the current El Niño conditions do bring increased hope that above-average snowfall will relieve drought conditions. While over 120 percent of average precipitation occurs in about 20 percent of years all together, the presence of El Niño ups the chances of this happening to 45 percent (5).

New Mexico isn't the only area of the West where last summer's severe to extreme drought conditions actually

continued on page 2

Snow, continued

had their start the previous winter and have been intensifying over the past several years. Extremely low seasonal snowpacks last winter also resulted in record minimum streamflows in parts of Arizona, southern Utah, and southern Colorado. In Arizona, three out of four key watersheds were reporting snowpacks in the single digit percentages of average by April 1, 2002, while the statewide snowpack was at 11 percent of average (6). This led to continued declines in already-low reservoir levels, including the large reservoirs along the Colorado River. The Salt and Verde rivers, which are an important source of water supplies for some areas of Phoenix via the Salt River Project (SRP), have experienced record low streamflows due to minimal snowpacks over the past four years. This has drained SRP's storage reservoirs to 25 percent of capacity and forced the utility to slash its deliveries by one-third (the first full-year allocation cuts since 1951). Officials say that the coming winter would have to generate twice the average runoff to bring the reservoirs back to a "comfortable" level (7).

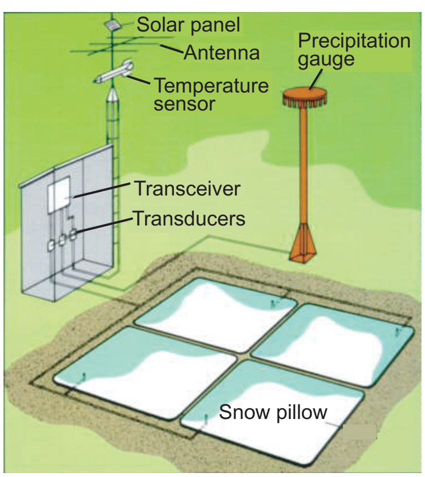

Figure 1. SNOTEL (SNOpack TELemetry) station. Pressure pillows are used for measuring snowfall, a storage precipitation gauge and temperature sensor provide current information about conditions at the site. The sites are designed to operate unattended for 1 year in severe climates. The reliability of each SNOTEL site is verified by ground truth measurements taken during regularly scheduled manual snow surveys. (Information courtesy of NRCS).

El Niño is not the only climatic factor that influences snowfall amounts on a year-to-year basis; some researchers believe that the Pacific Decadal Oscillation (PDO; see the October END InSight newsletter) is actually the primary driving force in snowpack variability across the West (8). Snowpack variability at 323 sites in the Western United States on April 1 (normally considered to be the date of the highest annual snow accumulation) over the fifty-year period between 1941-90 was compared with indices of sea surface temperatures in the Pacific Ocean that indicate ENSO and PDO conditions. Researchers found that PDO accounts for 45 percent of the total variability in April 1 snowpack, while ENSO explains only 16 percent of the variability. Linkages between PDO and snowpack in the Western United States reflect overall year-to-year variations in precipitation. PDO is currently believed to be in its cool phase, which normally brings drier conditions to the Southwest; this might argue for continued lower snowpack accumulations. These correlations, combined with the slow evolution and relatively long persistence of ENSO and PDO, may eventually enable forecasters to forecast streamflow up to a year in advance.

Because of the critical importance of snowpack to water supplies in the West, considerable effort has gone into developing sophisticated means of tracking snow water levels and predicting runoff amounts. The Natural Resources Conservation Service (NRCS) has directed the Snow Survey and Water Supply Forecasting Program in the Western states since the mid-1930s. The SNOTEL (short for SNOpack TELemetry) system is a key element of this program. SNOTEL is a near real-time hydrometeorological data collection network in the Western United States. Each day data from nearly 600 remote sites in the high mountains of 11 Western states, including snow water equivalent, precipitation, and temperature data, are received by a central computer facility at the National Water and Climate Center (NWCC) in Portland, Oregon. There, data reports are created and are sent out to many recipients, including the National Weather Service, the Western Regional Climate Center, and others. Water supply forecasters at the NWCC analyze the data and produce streamflow forecasts, which then are coordinated with forecasts produced by the National Weather Service river forecast centers. These forecasts are distributed by the state NCRS weather offices monthly from January through June. The SNOTEL system also provides data useful for climate studies, air and water quality investigations, and resource management (9).

SNOTEL data provide a great deal of information about conditions at individual locations, and they have been used for many years to reliably forecast streamflow using traditional statistical techniques. However, there are several 'blind spots' in the network where snow is not measured. Furthermore, the next generation of computer models require high spatial resolution maps of snowpack to accurately forecast streamflow.

CLIMAS researcher Roger Bales is helping to fill these gaps by developing methods to integrate information from satellites with traditional snow mapping techniques. Bales' new system combines digital elevation models, snowcover maps, and landcover information with hydrological models in order to achieve improved streamflow forecasts. This system also uses energy-balance modeling that includes information on snow-water equivalent, precipitation, solar radiation, air temperature, relative humidity, wind speed, vegetation, topography, and soils to produce a more accurate picture of snow conditions. Bales is developing better ways of using satellite data to map snow conditions under areas covered by clouds and under trees. More information about state-of-the-art snow mapping techniques is available at http://hydis.hwr.arizona.edu/snow/index.html.

Snow References

(1) Natural Resources Conservation Service, 1997. Snow surveys and water supply forecasting. Agricultural Bulletin 536. Accessed at http://www.wcc.nrcs.usda.gov/factpub/aib536.html on 11/20/02.

(2) Arizona Department of Water Resources. Statewide supply and demand overview. Accessed at http://www.water.az.gov/adwr/Content/Publications/files/SUPPLYDEMAND.pdf on 11/20/02.

(3) Turney, T., 2002. Water use in New Mexico. A presentation to the Energy and Natural Resources Committee, February 6, 2002. Accessed at http://www.seo.state.nm.us/water-info/water-use/water-use.pdf on 11/20/02.

(4) Pagano, T., 2002. Analysis of watershed conditions: Rio Grande and New Mexico Basins 2002-03. National Water and Climate Center, Portland, OR. Accessed at http://www.abqjournal.com/paperboy/text/scitech/report.htm on 11/20/02.

(5) Natural Resource Conservation Service, 2002. Special Rio Grande Basin water supply briefing. Accessed at http://www.co.nrcs.usda.gov/snow/2002-wcc-drought-briefing.htm on 11/20/02.

(6) Natural Resource Conservation Service, 2002. Arizona water supply outlook report as of April 1, 2002. Accessed at http://www.az.nrcs.usda.gov/snowsurv/wy02/apr1/az4s01.htm on 11/20/02.

(7) McKinnon, S., 2002. SRP to cut water supply 33%. *The Arizona Republic*, Sept. 10, 2002. Accessed at http://www.arizonarepublic.com/special26/articles/0910srp10.html on 11/20/02.

(8) McCabe, G. and M. Dettinger, 2002. Primary modes and predictability of year-to-year snowpack variations in the Western United States from teleconnections with Pacific Ocean currents. *Journal of Hydrometeorology* 3:13–25.

(9) Natural Resources Conservation Service, 1997. SNOTEL data collection network fact sheet. Accessed at http://www.wcc.nrcs.usda.gov/factpub/sntlfct1.html on 11/20/02.

Climate Divisions: To Use or Not to Use?

One of the most frequent responses to some of the climate products we send out each month is that they are not spatially specific enough—that is, they may give you an idea of what has happened or is likely to occur in your general area, but are not at a fine enough resolution to use in decision making. Part of the reason for the lack of spatial specificity is that many climate information products are based on climate divisions. This article will explain what the climate divisions are, why they are used, and the advantages and disadvantages of their use for different applications.

Climate divisions have been through a great many changes since the U.S. Department of Agriculture's Weather Bureau first categorized the nation into 12 climatological districts in 1909 based on the nation's principal drainage basins. The divisions were intended to be useful to agriculture, irrigation, transportation, forestry, and engineering; actually reflecting climatic similarities was a far lesser concern (1).

The divisions were redrawn in the 1950s, based partially on climatic considerations, but also to reflect geography, river districts, and/or forecast areas of responsibility. Despite more recent changes, divisional boundaries still tend to be structured along county lines, drainage basins, or major crops and thus in some instances reflect economic and political considerations more than climatological ones (1).

Today, the total area of each of the 48 contiguous states has been divided into between one (Rhode Island) and 10 climate divisions (many larger states), for a total of 344 divisions. Each division contains multiple temperature and precipitation monitoring stations; for example, the Western Regional Climate Center (WRCC), which reports individual station data, lists 224 stations for Arizona and 203 for New Mexico (although all stations may not be active) (2). Over 5,000 weather stations report daily temperature and precipitation to the National Climatic Data Center, which has compiled divisional datasets of temperature and precipitation averages on a monthly and yearly basis, stretching back to 1895. Climate divisions also have been established and datasets compiled for Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Pacific trust territories, although not all go back as far in time.

Divisional averages form the backbone of many climate information products, such as the Drought Monitor. The averages are simple unweighted arithmetic means of monthly data from all stations within a given division that are thought to reflect the general climatic characteristics of the division (therefore excluding outliers such as stations on mountaintops). To calculate them, temperature and precipitation data from 1931 to 1982 were averaged and linear regression equations were used to fill in missing data points. Other techniques were used to fill in data based on the different climatic divisions that existed at earlier time frames. However, in some areas (Arizona in particular), stations were few and far between in sparsely settled areas of the state and clumped together in more populated areas. Statisticians have had to correct the biases that these factors introduced to the averages (1).

Statistically based climate forecasts, many of which are produced by NOAA's Climate Prediction Center (CPC), rely on data derived from climate divisions; however, as analyses by Robin Webb and Klaus Wolter have shown, divisional data are often inaccurate for regions with complex topography such as mountain ranges. For example, the 60 stations within a single Colorado climate division range in elevation from 1,500 to 3,200 meters and hence reflect a very wide variability of precipitation and temperature

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Climate Divisions, continued

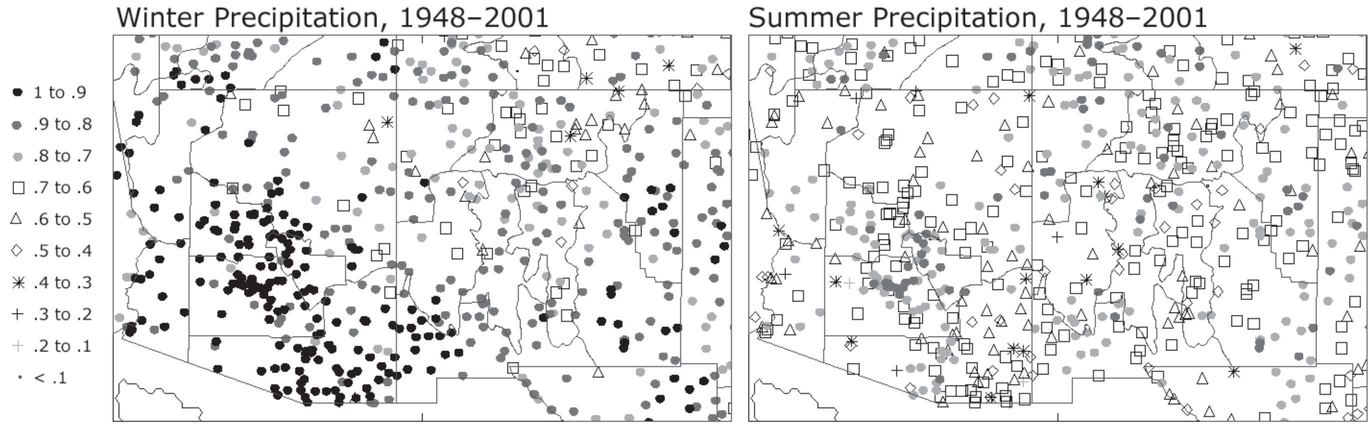

Figure 1. Climate Division Data Accuracy. Climate divisions in Arizona and New Mexico are depicted by the lines within the states. The maps depict the correlations between individual stations and NOAA climate division data for winter (December through February; left) and summer (June through August; right) precipitation. The higher percentage of dark dots in the image on the left, particularly in southern and central Arizona, indicates better winter season correlation between climate division and individual station precipitation; the larger number of squares, triangles, and diamonds on the right shows weaker summer season precipitation correlations. These figures bolster arguments for creating improved U.S. climate divisions.

readings (1). Webb's research indicates that in Arizona and New Mexico divisional data are fairly accurate during the winter months, but problematic during the summer because they do not capture the spatial variability of monsoon rainfall (as many END InSight participants have remarked).

If climate divisions often do not reflect actual conditions in particular locations, why are they so widely used? In part, climate divisions are a holdover from a time when computing capacity was far lower and agencies would have been hard-pressed to calculate and map temperature and precipitation variations from thousands of individual stations. Although the computing capacity to map individual station data does exist today, many forecasting tools are based on divisional data and it would require a major investment of resources and time to make them more spatially specific.

There are other reasons that division-scale data may be more useful for some applications. As Robin Webb notes, climate division data are commonly used to monitor current and evolving climate conditions, to create and verify forecasts and seasonal outlooks, and to conduct analyses of patterns of climate variability. Climate division data are most useful for tracking large-scale climatic features or anomalies over long periods of time. Despite the fact that each climate division may encompass widely varied terrain, large-scale anomalies such as the droughts of the 1930s, 1950s, and 1980s, as well as the cold winters of the 1970s, are easy to discern. Climate division data are also more complete than data from particular stations may be, due to the use of regression analyses that have been conducted to fill in blanks left in the climatic records of individual stations. In addition, in keeping with the original goal of reflecting crop growing regions or other economic areas, they are in some cases more useful for planning for crop-growing belts, river drainage basins, electric power grids, numerical model grids, geopolitical regions, etc.

(1) Guttman, N. and R. Quayle, 1996. A historical perspective of U.S. climate divisions. *Bulletin of the American Meteorological Society* 77(2):293–304.

(2) Data for individual climate stations are available from the Western Regional Climate Center, via the Internet at http://www.wrcc.dri.edu/climsum.html.

About END InSight

END InSight is a year-long project to provide stakeholders in the Southwest with information about current droughkt and El Niño conditions. As part of the Climate Assessment for the Southwest (CLIMAS) project at the University of Arizona, END InSight is gathering feedback from stakeholders to improve the creation and use of climate information.

The *END InSight Newsletter* is published monthly and includes background and topical climate information. All material in the newsletter may be reproduced, provided CLIMAS is acknowledged as the source. The newsletter is produced with support from the National Oceanic and Atmospheric Administration (NOAA).

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Executive Summary, November 2002

- Meteorological (short-term) drought conditions have eased over large parts of northern and eastern New Mexico, which received substantial precipitation during late October and into mid-November.

- Water year snowpack is greater than average for northern New Mexico and well ahead of last year's accumulations. However, Arizona and southwestern New Mexico snowpack is still below average.

- Hydrological (long-term) drought is still a major concern for the Southwest. Most reservoirs continue to be at well below average levels. Water supply-related issues will continue to be of concern in our region unless we receive winter and spring precipitation that is considerably greater than average.

- El Niño conditions continued to strengthen during the past month, and El Niño is predicted to continue into spring 2003. Climatologists expect this El Niño to be weaker than the 1997-1998 El Niño. This El Niño is classified as moderate in strength.

- Seasonal climate forecasts for winter indicate confidence in increased probabilities of above average precipitation across the southern half of Arizona and New Mexico.

- Drought conditions are forecast to improve through February 2003, based on the expectations of El Niño-related precipitation in the late fall and winter.

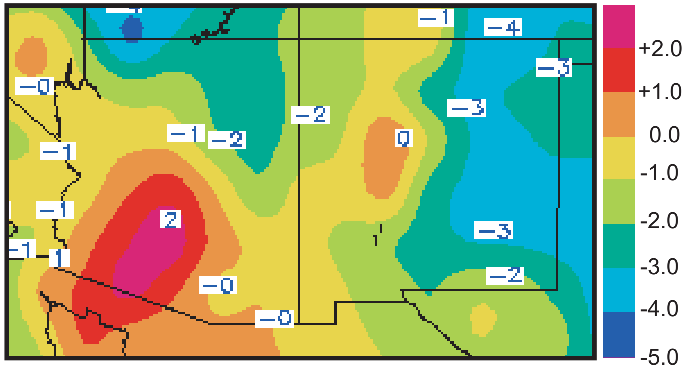
- Decision makers should be aware that Southwest winter precipitation during El Niño years is ***highly variable***.

Section B

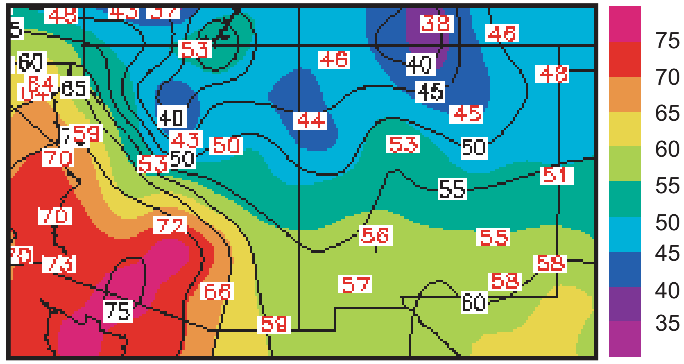
RECENT CONDITIONS

1. Recent Conditions: Temperature (up to 11/20/02) Source: Western Regional Climate Center

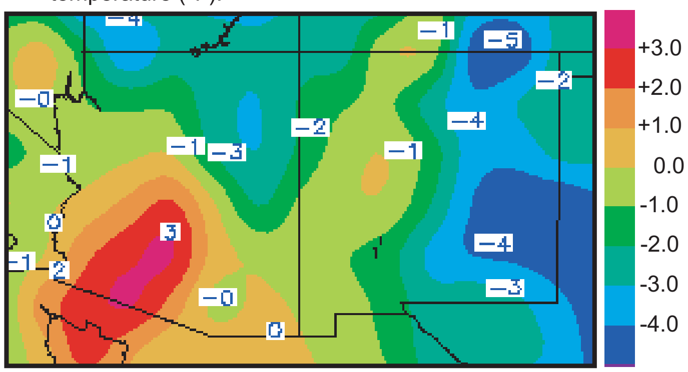
1a. Water year '02-'03 (through 11/20) departure from average temperature (°F).



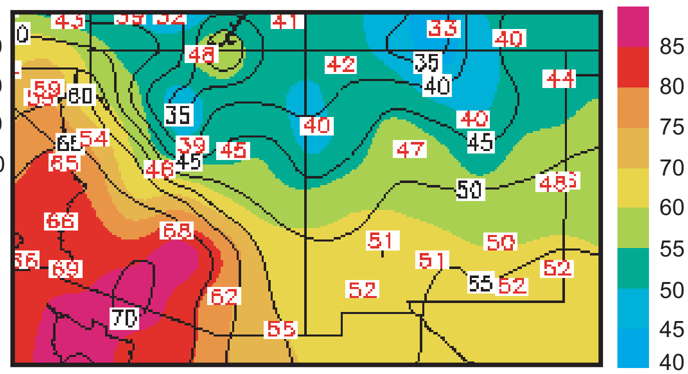
1b. Water year '02-'03 (through 11/20) average temperature (°F).



1c. Previous 28 days (10/24 - 11/20) departure from average temperature (°F).



1d. Previous 28 days (10/24 - 11/20) average temperature (°F).



Notes:

The Water Year begins on October 1 and ends on September 30 of the following year. As of October 1, we are in the 2003 water year.

'Average' refers to arithmetic mean of annual data from 1971-2000.

The data are in degrees Fahrenheit (°F).

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

These maps are derived by taking measurements at meteorological stations (at airports) and estimating a continuous map surface based on the values of the measurements and a mathematical algorithm. This process of estimation is also called spatial interpolation.

The red and blue numbers shown on the maps represent individual stations. The contour lines and black numbers show average temperatures.

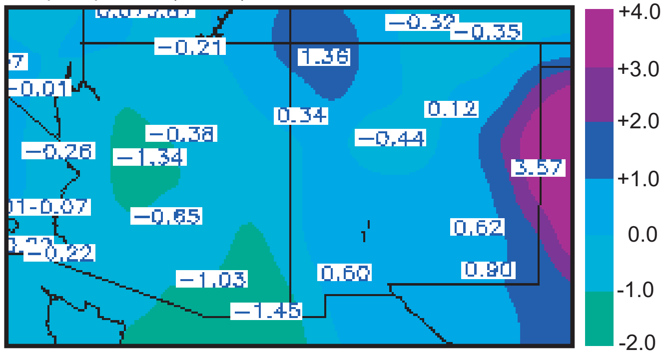
Highlights: The 2002-2003 water year began on October 1, 2002; temperatures shown in Figures 1a-b are based on the last 51 days (as of 11/20). Temperatures for the new water year continue to be below-average for the region except for southwestern Arizona and the region around Albuquerque, New Mexico. During the previous 28 days (Figures 1a and 1c) temperature patterns present last month have intensified across the region. Compared to October, southwestern Arizona has experienced above-average temperatures. Most of the warmth in western Arizona has occurred since November 1 and has been the result of above-average minimum temperatures. Yet areas in northern Arizona and northern and eastern New Mexico have experienced cooler temperatures. Cold air masses entering the region from the north explain much of this pattern.

For these and other maps, visit: http://www.wrcc.dri.edu/recent_climate.html

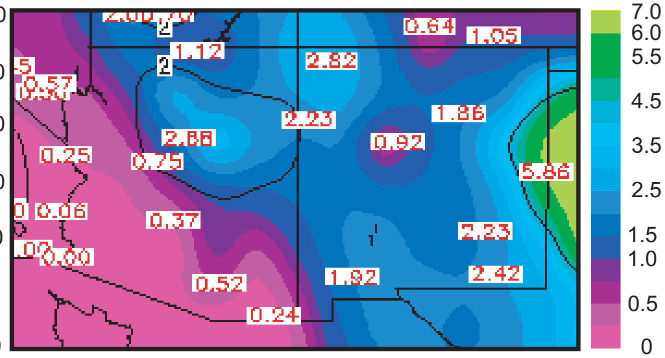
For information on temperature and precipitation trends, visit: http://www.cpc.ncep.noaa.gov/trndtext.htm

2. Recent Conditions: Precipitation (up to 11/20/02) Source: Western Regional Climate Center

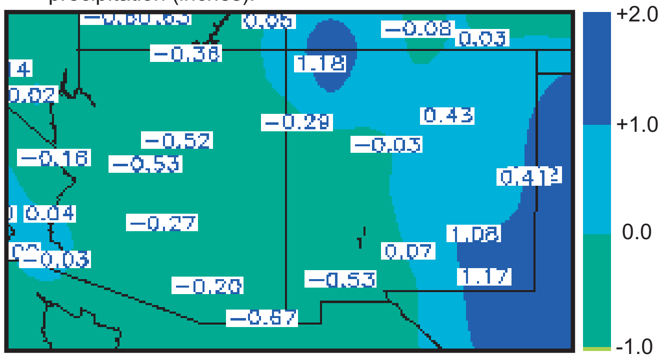
2a. Water year '02-'03 (through 11/20) departure from average precipitation (inches).



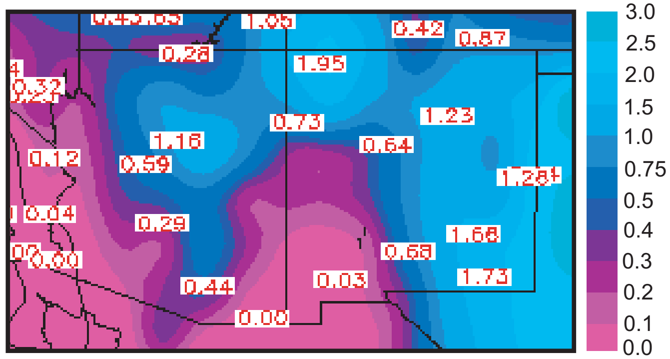
2b. Water year '02-'03 (through 11/20) total precipitation (inches).



2c. Previous 28 days (10/24 - 11/20) departure from average precipitation (inches).



2d. Previous 28 days (10/24 - 11/20) total precipitation (inches).



Highlights: Although we are only at the beginning of the new water year, precipitation in much of our region is already (and still!) below average (Figure 2a). Much of Arizona and New Mexico has received either less than an inch or zero precipitation in the past 28 days (Figure 2d). Recent precipitation was concentrated during the end of October and beginning of November, with the greatest amounts falling in northern and eastern New Mexico. High-elevation locations in northern New Mexico received sufficient snow for ski facilities to open operations ahead of their average opening dates.

For these and other maps, visit: http://www.wrcc.dri.edu/recent_climate.html

For National Climatic Data Center monthly and weekly precipitation and drought reports for Arizona, New Mexico and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2002/perspectives.html

Notes:

The Water Year begins on October 1 and ends on September 30 of the following year. As of October 1, we are in the 2003 water year.

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

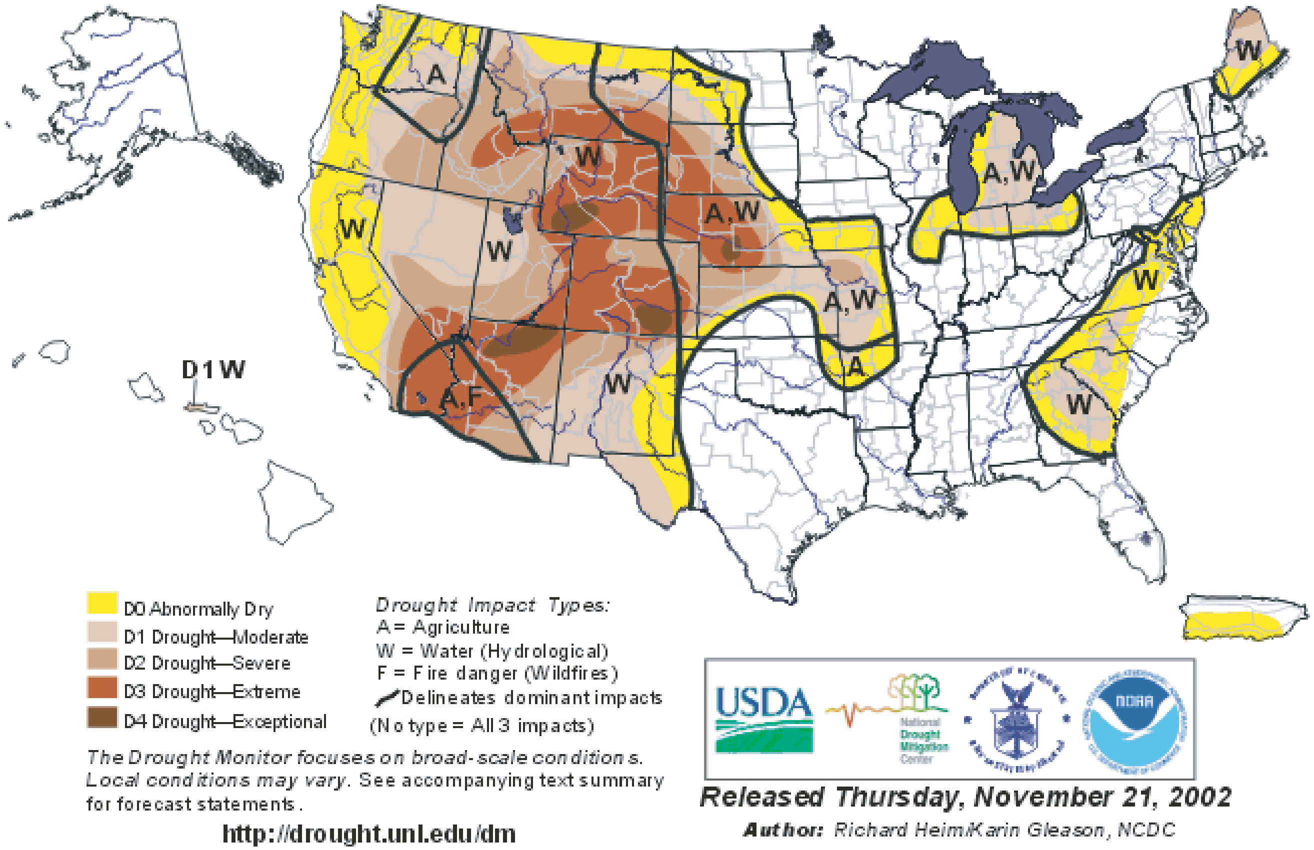
The data are in inches of precipitation. **Note: The scales for Figures 2b & 2d are non-linear.**

Departure from average precipitation is calculated by subtracting current data from the average and can be positive or negative.

These maps are derived by taking measurements at meteorological stations (at airports) and estimating a continuous map surface based on the values of the average and a mathematical algorithm. This process of estimation is also called spatial interpolation.

The red and blue numbers shown on the maps represent individual stations. The contour lines and black numbers show average precipitation.

3. U.S. Drought Monitor (11/19/02)



Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. This monitor was released on 11/21 and is based on data collected through 11/19 (as indicated in the title).

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, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts.

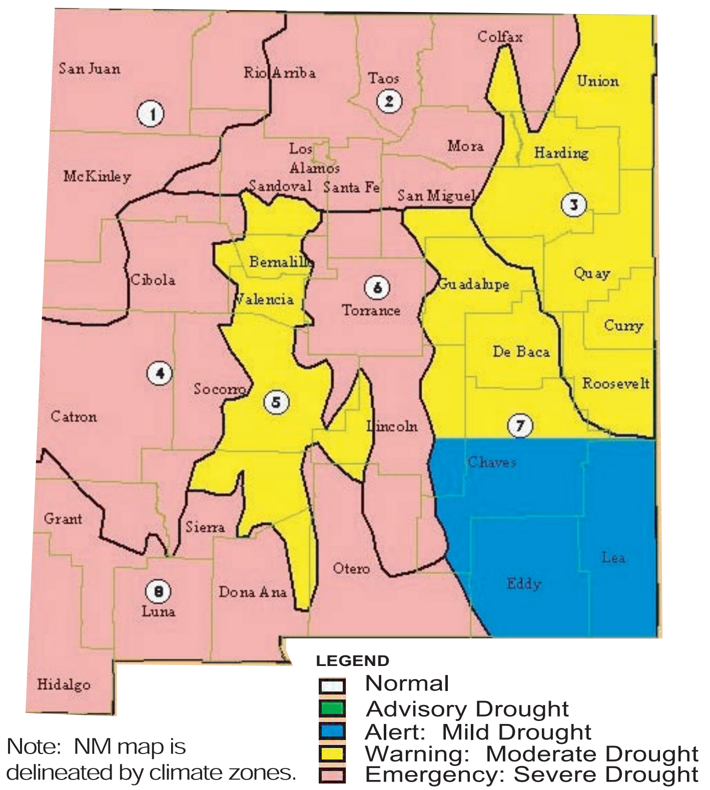
Highlights: Compared to one month ago, the drought designation for much of Arizona and New Mexico remains unchanged; moderate to exceptional drought conditions persist over the entire region due to minimal summer and early fall precipitation. However, the areal extent of "exceptional" drought conditions in northern Arizona has diminished somewhat; note that some parts of the area have been downgraded to "extreme." Short-term drought indicators, such as the Palmer Z-Index, show that meteorological drought conditions have improved, especially in New Mexico, during the past two months. However, long-term drought indicators, such as the Palmer Hydrological Drought Index (PHDI) and the long-term Standardized Precipitation Index (SPI), show that conditions related to water supply, though improved, are still indicative of drought. Wildfire danger is present in western Arizona.

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

4. Drought: Recent Drought Status Designation for New Mexico

New Mexico Drought Map

Drought Status as of October 24, 2002



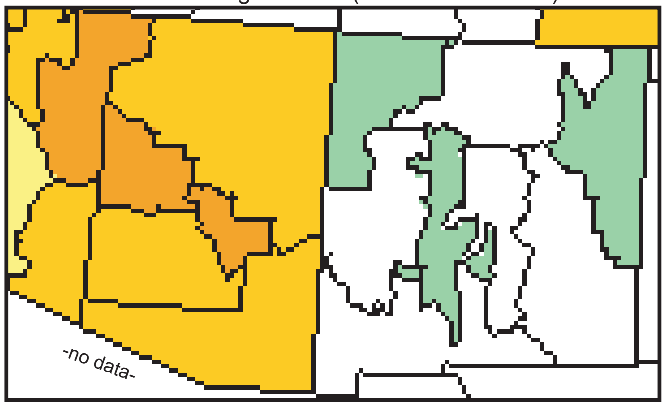
Source: NM Natural Resources Conservation Service (2002)

Notes: The drought categories indicated in the New Mexico drought map above, provided by the New Mexico Natural Resource Conservation Service (NMNRCS), have remained the same since September 12, 2002; thus this map will appear to be the same as the one provided in the September END Insight packet. According to the New Mexico Drought Planning Team's October 24, 2002 drought status report, some drought indices have shown improvement in meteorological (short-term) conditions over the past two months. However, other indicators (streamflow, reservoir levels, range conditions) show that extreme hydrological (long-term) drought remains. The New Mexico Drought Planning Team reports that "No changes will be made in the New Mexico drought status map until winter precipitation and projected water supply for 2003 is assessed."

The New Mexico map (http://www.nm.nrcs.usda.gov/drought/drought.htm), currently is produced monthly, but when near-normal conditions exist, it is updated quarterly. The Arizona drought declaration map is not yet produced on a regular basis. Contact Matt Parks at ADEM at (602) 392-7510 for more information.

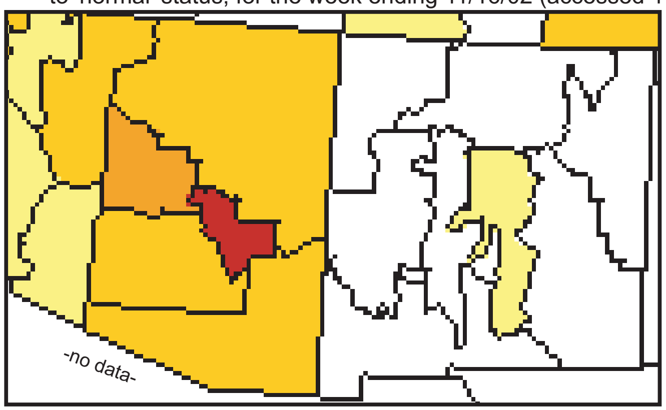
5. PDSI Measures of Recent Conditions (through 11/16/02) ♦ Source: NOAA Climate Prediction Center

5a. Current weekly Palmer Drought Severity Index (PDSI), for the week ending 11/16/02 (accessed 11/21/02).



- -4.0 or less (extreme drought)
- -3.0 to -3.9 (severe drought)
- -2.0 to -2.9 (moderate drought)
- -1.9 to +1.9 (near normal)
- +2.0 to +2.9 (unusual moist spell)

5b. Precipitation needed to bring current weekly PDSI assessment to 'normal' status, for the week ending 11/16/02 (accessed 11/21).



- Zero inches
- Trace to 3 inches
- 3 to 6 inches
- 6 to 9 inches
- 9 to 12 inches
- 12 to 15 inches
- Over 15 inches

Notes:
The PDSI (Palmer Drought Severity Index) attempts to measure the duration and intensity of long-term conditions that underlie drought.

'Normal' on the PDSI scale is defined as amounts of moisture that reflect long-term climate expectations.

Arizona and New Mexico are divided into *climate divisions.* Climate data are aggregated and averaged for each division within each state. Note that climate division calculations stop at state boundaries.

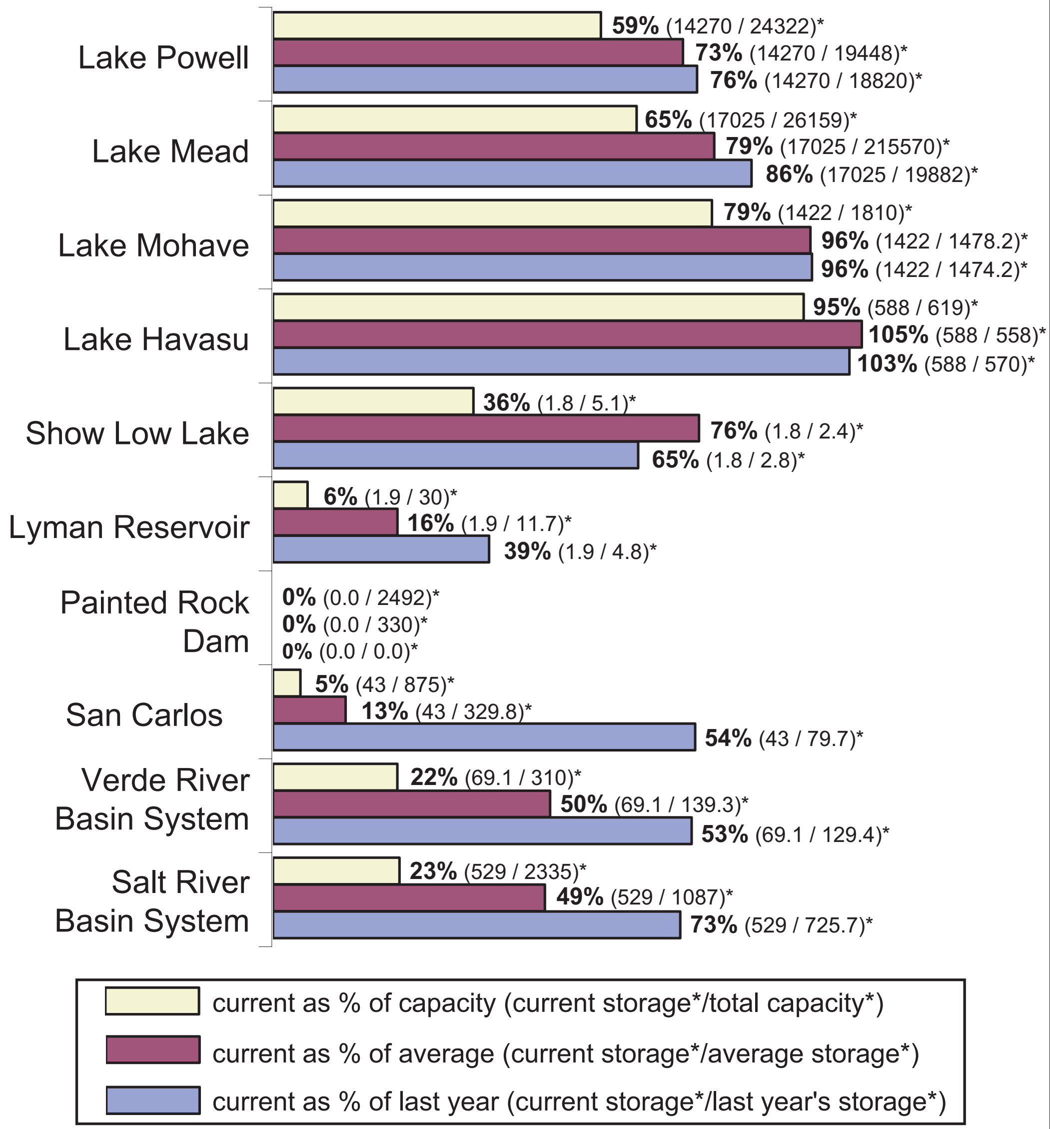
These maps are issued weekly by the NOAA CPC.

Highlights: PDSI values have improved for most of New Mexico and Arizona, compared to last month (Figure 5a). The passage of precipitation-bearing cold fronts through the region in late October and early November have brought relief to much of northeastern Arizona and northern New Mexico. However, these events have not brought sufficient precipitation and cool temperatures to make a dent in hydrologic drought. Thus far, snowfall is ahead of average (and far ahead of last year) at most northern New Mexico reporting stations, which gives some hope that short-term PDSI will remain above zero in New Mexico. Figure 5b shows that all of Arizona continues to require large amounts of precipitation within a one week time period to bring our drought status back to normal.

For a more technical description of PDSI, visit: http://www.cpc.noaa.gov/products/analysis_monitoring/cdus/palmer_drought/ppdanote.html

For information on drought termination and amelioration, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/drought/background.html

6. Arizona Reservoir Levels (through end of October 2002) ♦ Source: USDA NRCS



*Units are in thousands of acre-feet

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/water/reservoir/resv_rpt.html).

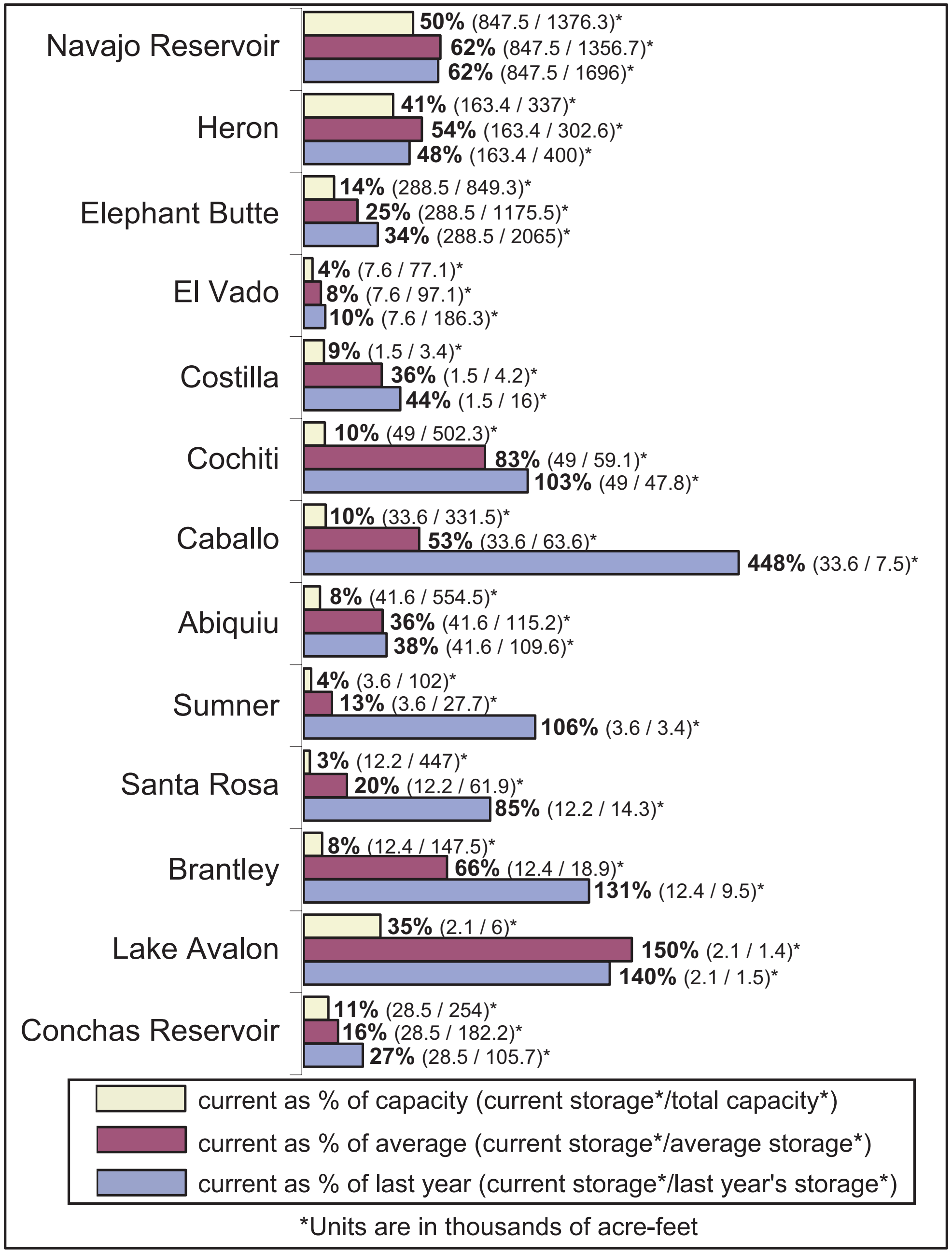
For additional information, contact Tom Pagano of the NWCC-NRCS-USDA (tpagano@wcc.nrcs.usda.gov)

Highlights: Not surprisingly, reservoir levels in Arizona continue to be below average and lower than last year at this time. All reservoirs are below capacity and, except for Lake Havasu, below average. Compared to last month, most reservoir levels have held steady or continued to decline.

According to media reports, Lake Mead can still fill regional water needs for another two years, but the lake's low level has sparked considerable concern among southwestern states (Reno Gazette Journal, October 20, 2002).

The Salt and Verde River reservoir systems, which supply much of the water for metropolitan Phoenix, are still at exceedingly low levels. Phoenix area municipal golf courses will not overseed fairways this winter in order to conserve water (The Arizona Republic, November 3, 2002).

7. New Mexico Reservoir Levels (through end of October 2002) ♦ Source: USDA NRCS



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

New Mexico's report was updated through the end of October, as of 11/20/02.

Highlights: Similar to Arizona, New Mexico reservoir levels continue to be below average, although levels at a few reservoirs in the Rio Grande Basin are higher than last year at this time (e.g., Cochiti, Caballo).

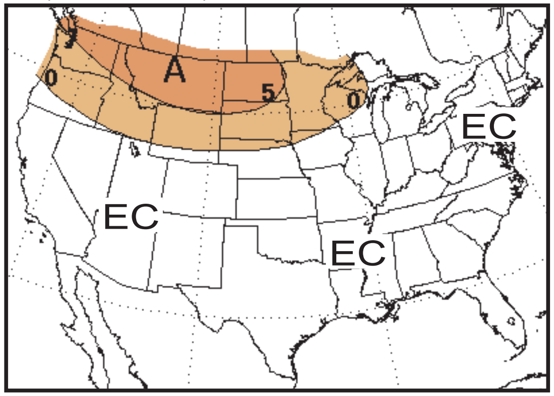
Snowpack throughout the Colorado and Rio Grande River Basins is high for this time of year. However, according to Tom Pagano of the National Water and Climate Center, only 5-15% of peak snowpack typically accumulates by mid-November. Water supply for irrigators who depend on water from Elephant Butte reservoir (currently at 25% of average) will depend on how winter and spring precipitation progresses. According to projections by the New Mexico Drought Planning Team, normal spring runoff will result in further lowering of Elephant Butte reservoir by July, 2003. It would take over 150% of normal runoff to return Elephant Butte reservoir to levels sufficient to allow upstream storage in accordance with regulations of the Rio Grande River compact.

Section C

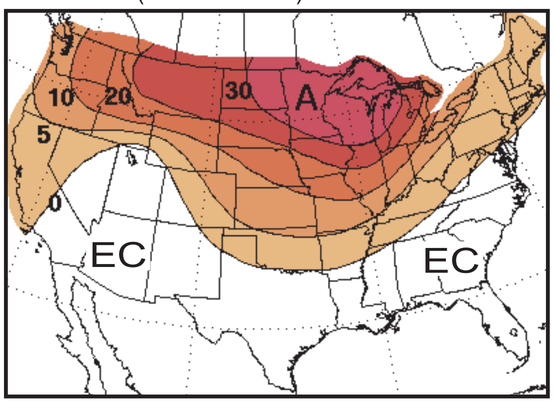
FORECASTS

8. Temperature: Monthly (Dec.) and 3-Month (Dec. ’02 - Feb. ‘03) Outlooks ♦ Source: NOAA CPC

8a. December 2002 U.S. temperature forecast (released 11/21)



8b. December 2002 - February 2003 U.S. temperature forecast (released 11/21).



Percent Likelihood of Above Average Temperatures*

- 40% - 50%
- 30% - 40%
- 20% - 30%
- 10% - 20%
- 5% - 10%
- 0% - 5%

*EC indicates no forecast due to lack of model skill

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the “excess” 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% chance of above average, a 33.3% chance of average, and a 33.3% chance of below average temperature.

Thus, using the NOAA CPC excess likelihood forecast, in areas with light brown shading (0-5% excess likelihood of above average) there is a 33.3-38.3% chance of above average, a 33.3% chance of average, and a 28.3-33.3% 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 prediction is offered.

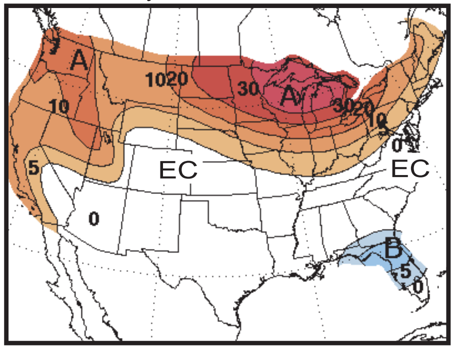
These forecasts are based on a combination of factors, including the results of statistical models, moderate El Niño conditions, and long-term trends.

Highlights: The CPC temperature outlook for December (Figure 8a) and for the next three months (December–February; Figure 8b) indicates increased probabilities of above-average temperatures for northern areas of the United States. While no forecast (“EC”) has been made for the Southwest for the near term, this is no assurance that temperatures are likely to be “average” throughout our region. For the past 28 days (Figure 1c), southwestern Arizona has been warmer than average, whereas northern Arizona and eastern New Mexico have been cooler than average. Long-term temperature trends for southwestern Arizona have been toward higher than average temperatures for this time of year; however, El Niño events sometimes bring slightly lower than average temperatures to the Southwest. The CPC predictions are based chiefly on composite El Niño scenarios, which do not indicate a strong enough signal to merit a certain forecast. NOAA CPC climate outlooks are released on the Thursday, between the 15th and 21st of each month.
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.

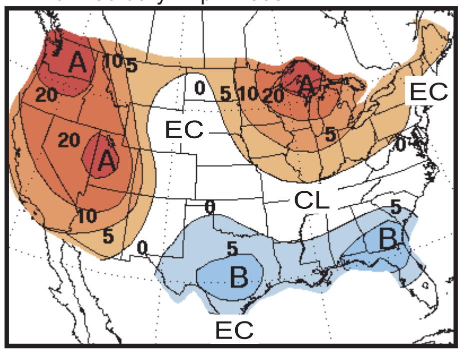
9. Temperature: Multi-season Outlooks ♦ Source: NOAA Climate Prediction Center

Overlapping 3-month long-lead temperature forecasts (released 11/21/02).

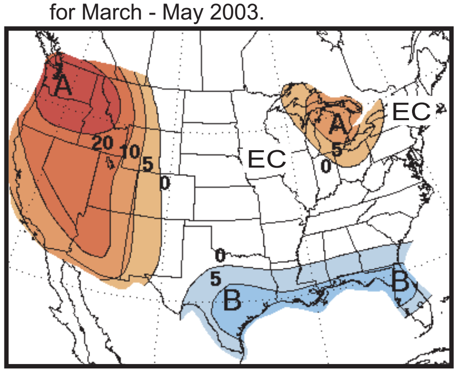
9a. Long-lead national temperature forecast for January - March 2003.



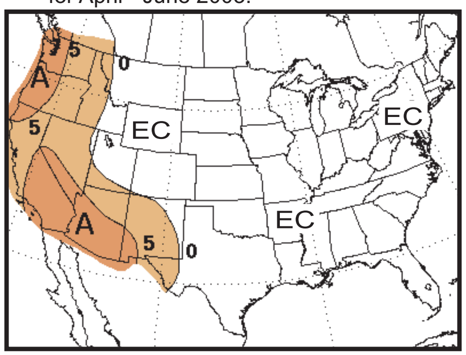
9b. Long-lead national temperature forecast for February - April 2003.



9c. Long-lead national temperature forecast for March - May 2003.



9d. Long-lead national temperature forecast for April - June 2003.



Percent Likelihood of Above/ Below Average Temperatures*

- 30% - 40%
- 20% - 30%
- 10% - 20%
- 5% - 10%
- 0% - 5%

- 0% - 5%
- 5% - 10%
- 10% - 20%

*EC indicates no forecast due to lack of model skill

Highlights: The CPC temperature outlooks for January-June 2003 show increased probabilities of above-average temperatures for most of the northern United States in the winter and early spring (Figures 9a-b). There is a fairly high probability of above-average temperatures in western Arizona beginning with the February-April forecast (Figure 9b), continuing through spring (Figures 9c-d). The area of greatest forecast confidence for the Southwest is centered over northwest Arizona. The level confidence in above-average temperature in the Southwest is based chiefly on a long-term trend toward higher than average winter temperatures and the results of statistical forecast methods. CPC forecasters have withheld judgment (EC) or have poor confidence (5% probability shift) in forecasts for above average temperatures in New Mexico for most of the forecast period. NOAA CPC climate outlooks are released on Thursday, between the 15th and 21st of each month.

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.

Notes:
The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the "excess" 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% chance of above average, a 33.3% chance of average, and a 33.3% chance of below average temperature.

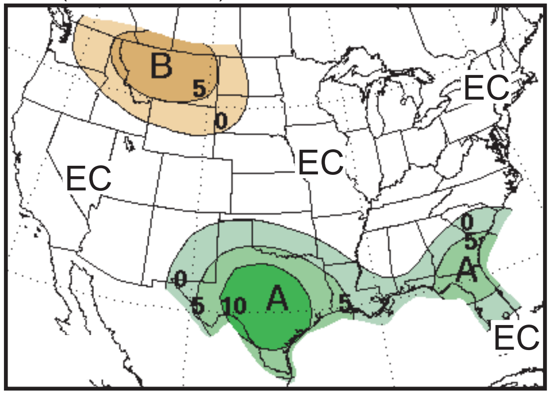
Thus, using the NOAA CPC excess likelihood forecast, in areas with light brown shading (0-5% excess likelihood of above average) there is a 33.3-38.3% chance of above average, a 33.3% chance of average, and a 28.3-33.3% chance of below average temperature.

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

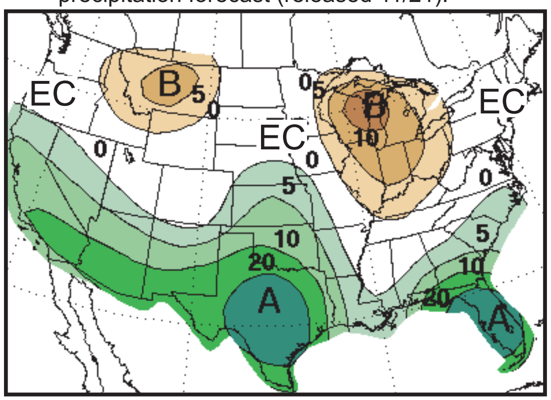
Equal Chances (EC) indicates areas where reliability (i.e., the 'skill') of the forecast is poor and no prediction is offered.

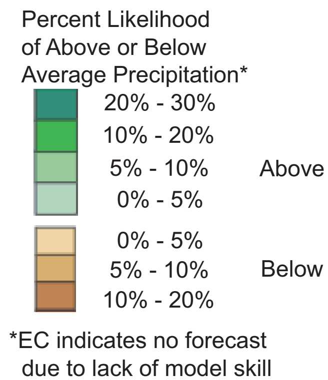
10. Precipitation: Monthly (Dec.) and 3-Month (Dec. ’02 - Feb. ‘03) Outlooks Source: NOAA CPC

10a. December 2002 U.S. precipitation forecast (released 11/21).



10b. December 2002 - February 2003 U.S. precipitation forecast (released 11/21).





Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the “excess” 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% chance of above-average, a 33.3% chance of average, and a 33.3% chance of below-average precipitation.

Thus, using the NOAA CPC excess likelihood forecast, in areas with light green shading (0-5% excess likelihood of above average) there is a 33.3-38.3% chance of above-average, a 33.3% chance of average, and a 28.3-33.3% 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 prediction is offered.

These forecasts are based on a combination of factors, including the results of statistical models, moderate El Niño conditions, and long-term trends.

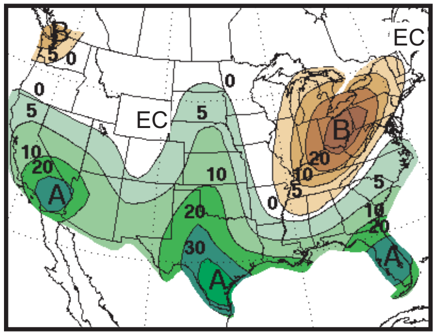
Highlights: The CPC has reserved judgment (i.e., EC) regarding December precipitation in Arizona and has weak confidence in increased chances of above average precipitation in eastern New Mexico (Figure 10a). Based on historical analyses of El Niño effects on Southwest precipitation, CPC forecasters predict increased likelihood of above-average precipitation throughout Arizona and New Mexico this winter. The region of greatest forecast confidence for December 2002-February 2003 (43.3-53.3% probability of above-average precipitation, 33.3% probability of average precipitation, 14.4-24.4% chance of below-average precipitation) is centered over southern Arizona and New Mexico. A December 2002-February 2003 forecast by the International Research Institute for Climate Prediction (see Figure 17b) indicates only a 40% chance of above average precipitation for the Southwest. NOAA CPC climate outlooks are released on the Thursday, between the 15th and 21st of each month.

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.

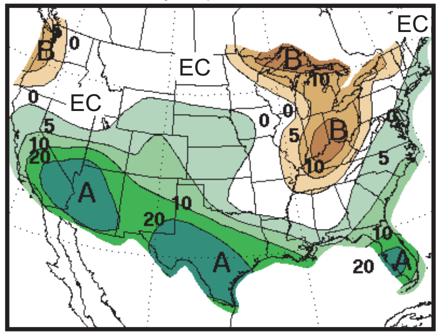
11. Precipitation: Multi-season Outlooks ♦ Source: NOAA Climate Prediction Center

Overlapping 3-month long-lead precipitation forcasts (released 11/21/02).

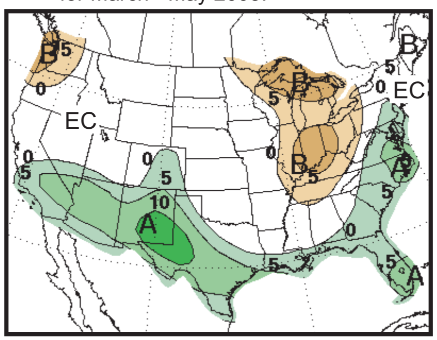
11a. Long-lead U.S. precipitation forecast for January - March 2003.



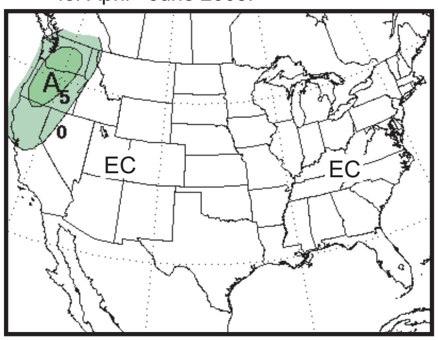
11b. Long-lead U.S. precipitation forecast for February - April 2003.



11c. Long-lead U.S. precipitation forecast for March - May 2003.



11d. Long-lead U.S. precipitation forecast for April - June 2003.



Percent Likelihood of Above or Below Average Precipitation*

20% - 30%	Above
10% - 20%	Above
5% - 10%	Above
0% - 5%	Above
0% - 5%	Below
5% - 10%	Below
10% - 20%	Below
20% - 30%	Below

*EC indicates no forecast due to lack of model skill

Highlights: The effects of a moderate El Niño are indicated by the increased probability of above-average precipitation in the southern United States in the winter and spring (Figures 11a-c). For the Southwest, the greatest confidence in these predictions is centered over much of Arizona during February-April 2003, with probabilities reaching 53.3-63.3% for above-average precipitation. The probabilities for continued above-average precipitation in Arizona and New Mexico during the spring (Figure 11c) range between 38.3% (southern Arizona and the Four Corners region) and 43.3-53.3% (southeastern New Mexico). These predictions are based chiefly on the historical tendency for above-average precipitation in the Southwest during an El Niño event, supported by results of trend analysis and other forecast tools. Forecasters expect moderate El Niño conditions to continue through the winter and into 2003. However, El Niño-related winter precipitation in the Southwest is highly variable. While many high-precipitation winters in the Southwest have occurred during El Niño events, El Niño also has produced below-average precipitation in our region. NOAA CPC climate outlooks are released on Thursday, between the 15th and 21st of each month.

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.

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the “excess” 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% chance of above-average, a 33.3% chance of average, and a 33.3% chance of below-average precipitation.

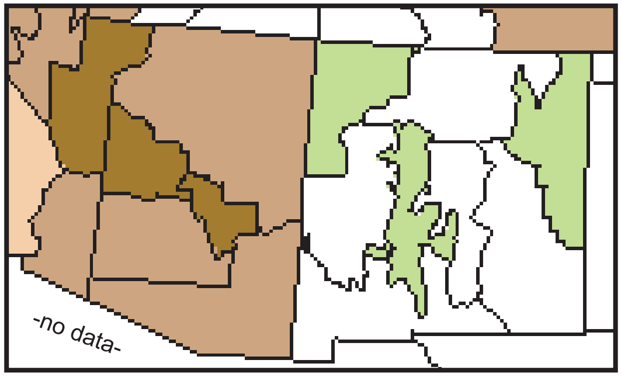
Thus, using the NOAA CPC excess likelihood forecast, in areas with light green shading (0-5% excess likelihood of above-average) there is a 33.3-38.3% chance of above-average, a 33.3% chance of average, and a 28.3-33.3% chance of below-average precipitation.

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 prediction is offered.

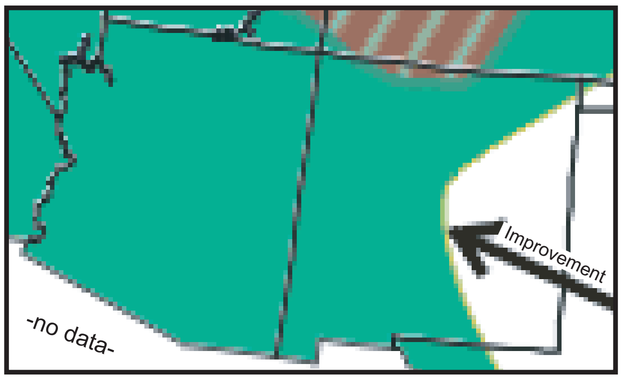
12. Drought: PDSI forecast and U.S. Seasonal Drought Outlook Source: NOAA CPC

12a. Short-term Palmer Drought Severity Index (PDSI) forecast through 11/23/02 (accessed 11/21).



- -4.0 or less (extreme drought)
- -3.0 to -3.9 (severe drought)
- -2.0 to -2.9 (moderate drought)
- -1.9 to +1.9 (near normal)
- +2.0 to +2.9 (unusually wet spell)

12b. Seasonal drought outlook through February 2003 (accessed 11/21).



- drought ongoing, some improvement
- Drought likely to improve, impacts ease

Notes:
The PDSI (Palmer Drought Severity Index) attempts to measure the duration and intensity of the long-term drought.

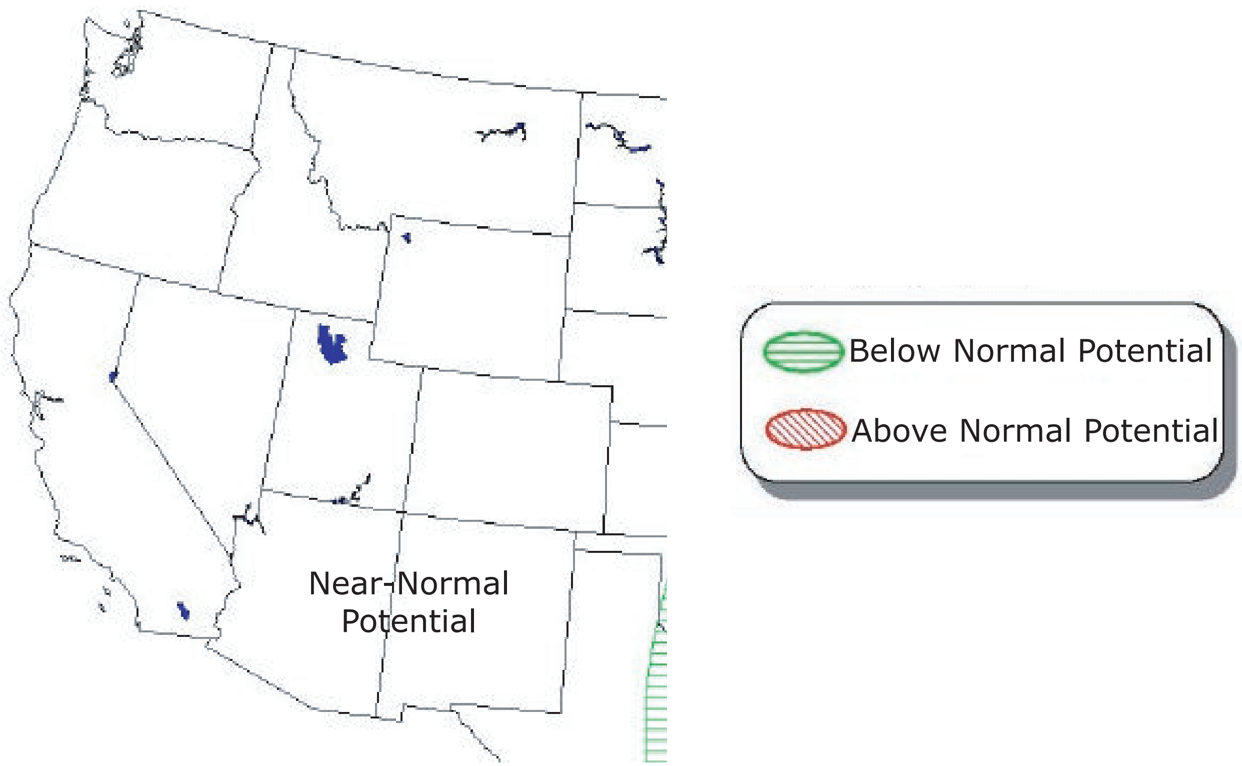
'Normal' on the PDSI scale is defined as amounts of moisture that reflect long-term climate expectations.

The delineated areas in the Seasonal Drought Outlook are defined subjectively and are based on expert assessment of numerous indicators including outputs of short- and long-term forecast models.

Highlights: The short-term PDSI forecast (Figure 12a) indicates severe to extreme drought conditions for all of Arizona. In contrast, the forecast for New Mexico is for near-normal or wet conditions (northwestern, central and northeastern parts of the state) for this time of year. The northern and middle Rio Grande basin in central New Mexico has received recent rain and snowfall, which has improved short-term conditions (Figure 12b). Even so, hydrological drought conditions are likely to persist, as much of the Southwest is many inches below average precipitation for the calendar year.

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

13. National Wildland Fire Outlook (valid Nov. 1–31, 2002) Source: National Interagency Fire Center

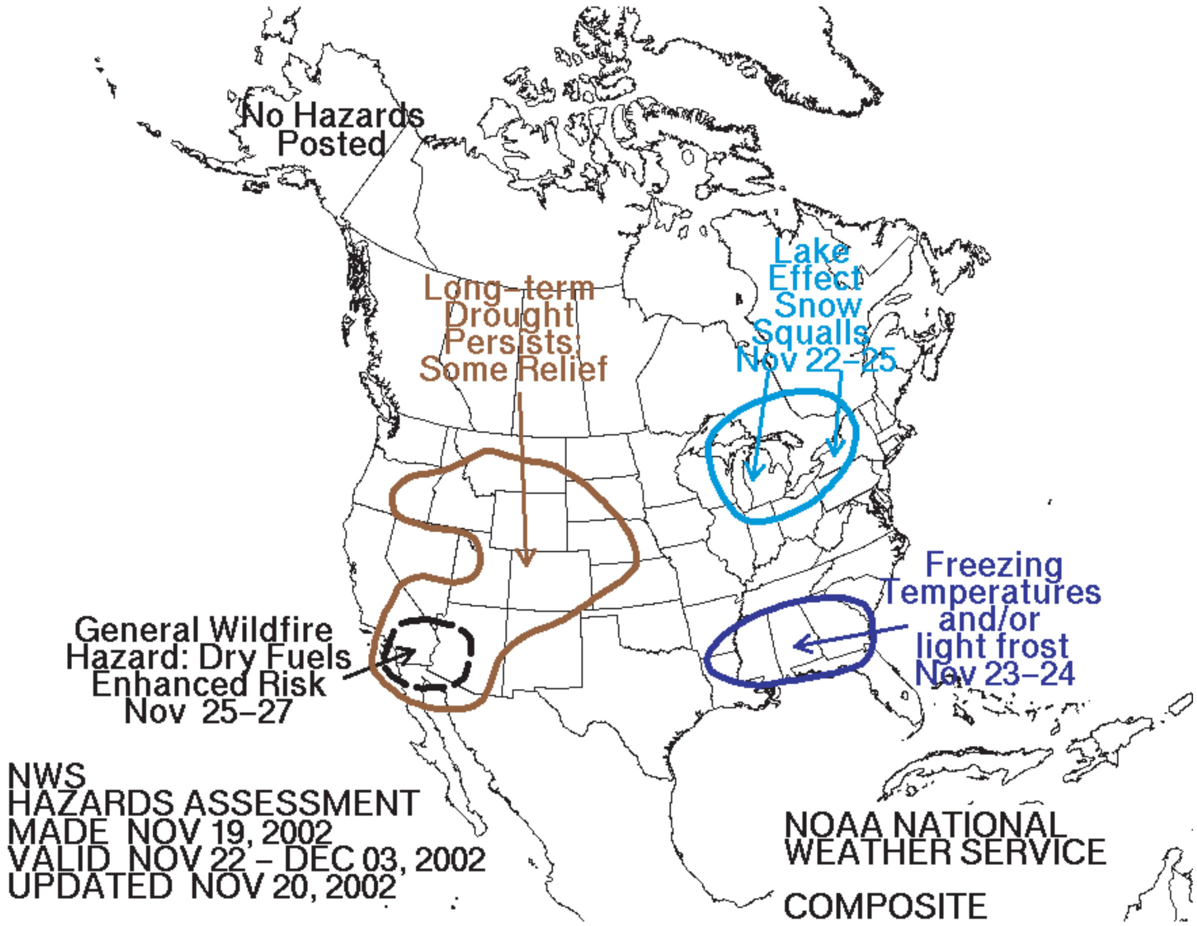


Notes: The National Wildland Fire Outlook (Figure 13) considers climate forecasts and surface-fuels conditions to assess fire potential. It is issued monthly by the National Interagency Fire Center (NIFC).

Highlights: The forecast map indicates near-normal fire potential for all of the western U.S. According to images of vegetation greenness (NIFC) and experimental fire danger (U.S. Forest Service Wildland Fire Assessment System), fuels are dry and fire danger is still high for southwestern Arizona and southern New Mexico. During late October and through mid-November, several New Mexico and Arizona federal land management agencies have used favorable weather conditions to support prescribed fire operations. At present, the Southwest is in fire preparedness level 2, which means that regional resources are adequate to manage all wildfires and prescribed fires.

For more detailed discussions, visit the National Wildland Fire Outlook web page: http://www.nifc.gov/news/nicc.html
For more detailed information on regional fire danger, visit the Southwest Area Wildland Fire Operations web page: http://www.fs.fed.us/r3/fire/

14. U.S. Hazards Assessment Forecast ♦ Source: NOAA Climate Prediction Center



Notes:

This hazards forecast is for the period November 22nd through December 3rd, 2002.

The hazards assessment incorporates outputs of National Weather Service medium- (3-5 day), extended- (6-10 day) and long-range (monthly and seasonal) forecasts and hydrological analyses and forecasts.

Influences such as complex topography may warrant modified local interpretations of hazards assessments.

Please consult local National Weather Service offices for short-range forecasts and region-specific information.

Individual maps of each type of hazard are available at the following websites:

Temperature and wind:
http://www.cpc.ncep.noaa.gov/products/predictions/threats/t_threats.gif

Precipitation:
http://www.cpc.ncep.noaa.gov/products/predictions/threats/p_threats.gif

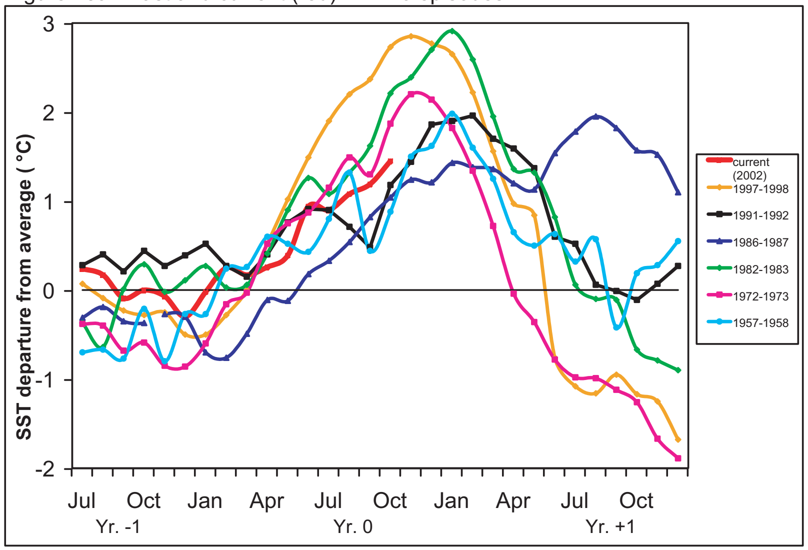
Soil and/or Fire:
http://www.cpc.ncep.noaa.gov/products/predictions/threats/s_threats.gif

Highlights: The U.S. Hazards Assessment indicates long-term, persistent drought for Arizona and for northwestern New Mexico. Drought-related wildfire danger is expected to persist in western Arizona, but with diminishing severity.

For more information, visit: http://www.cpc.ncep.noaa.gov/products/predictions/threats

15. Tropical Pacific SST and El Niño Forecasts ♦ Sources: NOAA CPC, IRI

Figure 15a. Past and current (red) El Niño episodes.

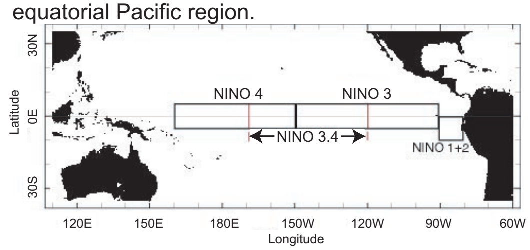


Notes:

The graph (Figure 15a) shows sea-surface temperature (SST) departures from the long-term average for the Niño 3.4 region (Figure 15b). This is a sensitive indicator of ENSO conditions.

Each line on the graph represents SST departures for previous El Niño 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).

Figure 15b. ENSO observation areas in the equatorial Pacific region.



This year's SST departures are plotted as a red line (Figure 15a). 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 15d. 7-day averaged South Pacific sea surface temperature anomalies (°C) for November 9th - November 16, 2002.

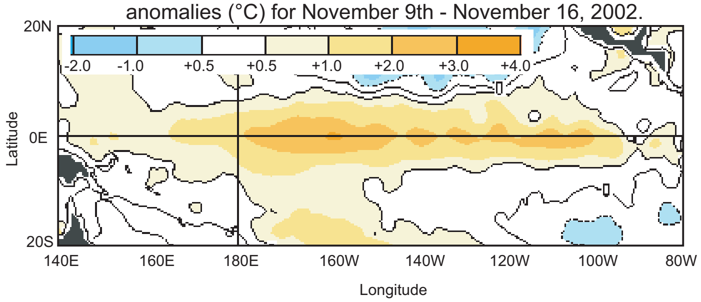
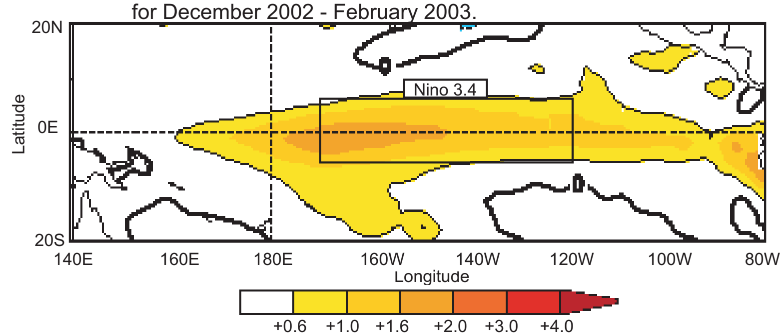


Figure 15d. Forecasted South Pacific sea surface temperature anomalies (°C) for December 2002 - February 2003.



Highlights: El Niño conditions have been strengthening toward their typical winter maximum (Figure 15a). Between mid-October and mid-November, sea surface temperatures (SSTs) in most of the east-central equatorial Pacific remained more than 1°C above normal, with the warmest SSTs between 2°-3°C above normal over the central equatorial Pacific Ocean just east of the dateline as well as farther east (Figure 15c). Forecasts by both the International Research Institute for Climate Prediction (IRI) and the NOAA Climate Prediction Center (CPC) indicate that El Niño oceanic (Figure 15d, courtesy of CPC) and atmospheric conditions will continue for the remainder of 2002 and into spring 2003 and that this El Niño will be moderate in strength. Both the IRI and the CPC caution that this El Niño event is expected to be weaker than the 1997–98 El Niño event, though substantial climate effects are still possible in some locations.

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 the graphics found on this page, visit: http://iri.columbia.edu/climate/ENSO/

Section D

FOCUS ON SPI, CLIMATE FORECASTS, AND SNOW

16. Considering Temporal Variability of the SPI ♦ Sources: Western Regional Climate Center (WRCC)

Notes: The figures here have been taken from or reproduced based on figures obtained from the Western Regional Climate Center's Standard Precipitation Index (SPI) web page (http://www.wrcc.dri.edu/spi/spi.html). The WRCC SPI web page allows visitors to not only view multiple time-averaged SPI values (e.g., 1-12-, 18- and 72-month SPI values) for individual climate divisions, but also to see the past 72 months of SPI values plotted out as a graph (Figures 16b-e). Figure 16a presents monthly SPI values for Arizona and New Mexico averaged over the last 18 months.

A description of how SPI values are calculated and what they represent was provided in the October 2002 END packet and should be consulted for questions on calculating the SPI. Maps are available from the WRCC and the National Climatic Data Center, but only the WRCC website provides temporal analysis of SPI values for each climate division. By clicking on the climate division of interest, a graph of SPI values for the previous 72 months is generated.

Highlights: Figures 16b-e demonstrate the importance of evaluating the time history of SPI values. Temporal analysis demonstrates the complexity of drought patterns across the southwestern United States. For example, short-term drought, indicated by 1-month SPI values, is shown by above average SPI in all the selected climate divisions (Figures 16b-e). However, 18-month SPI values show severely dry conditions in southern Arizona and north-central New Mexico. Graphs of SPI evaluated over different time periods demonstrate the length of time and severity of persistent drought conditions (for example over five years of moderate-to-severely dry conditions in both south central Arizona and north-central New Mexico. In contrast, eastern New Mexico climate divisions show around six months of recovery from far less severe drought conditions. Thus, one can expect long-term hydrological drought conditions in south central Arizona and north-central New Mexico will persist longer than in eastern New Mexico.

Figure 16b. SPI values for north-central New Mexico.

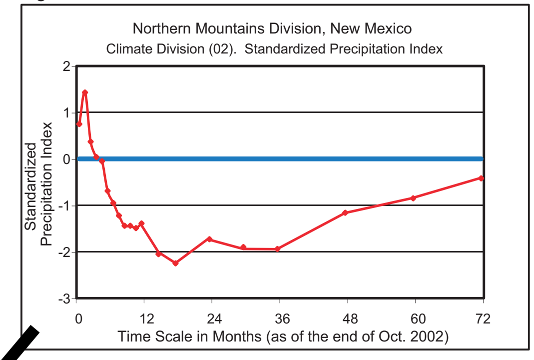


Figure 16d. SPI values for the central valley, New Mexico.

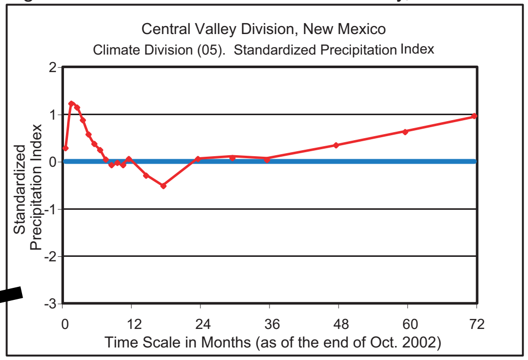


Figure 16a. 18-month SPI values (through the end of October 2002).

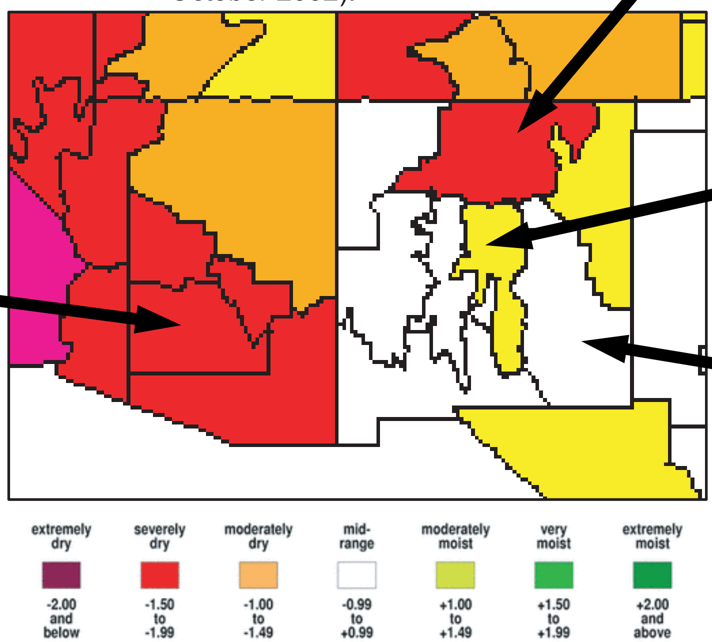


Figure 16c. SPI values for south-central Arizona.

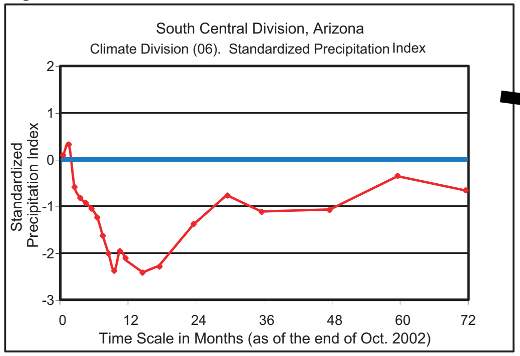
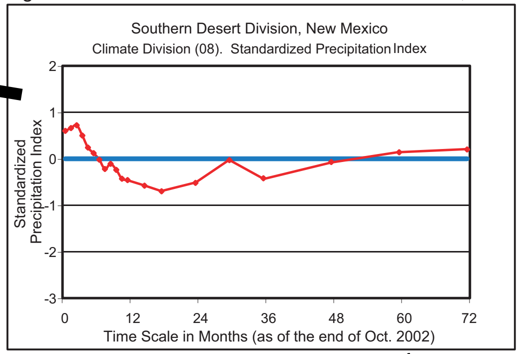


Figure 16e. SPI values for southern desert division, NM.



17. Comparing CPC and IRI Climate Forecast Products (Part 1) ♦ Sources: NOAA CPC, IRI

Figure 17a. "Official" CPC December 2002 - February 2003 U.S. precipitation forecast.

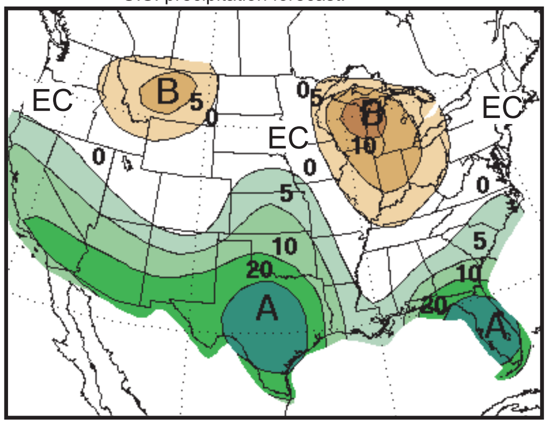
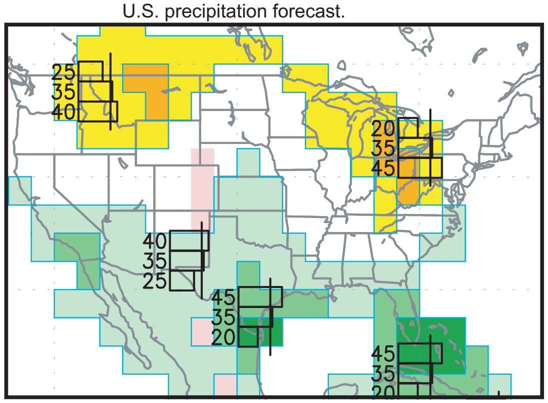


Figure 17b. "Experimental" IRI December 2002 - February 2003 U.S. precipitation forecast.



For descriptions of the information used to produce CPC forecasts, visit: http://www.cpc.ncep.noaa.gov/products/predictions/90day/disc.html.

For graphic representation for each seasonal forecast, see 'related products' links associated with individual seasonal outlook: http://www.cpc.ncep.noaa.gov/products/predictions/90day/lead02/index.html

For descriptions of the information used to produce IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/2002/oct2002/text/NAmerica.html).

Notes: Both the Climate Prediction Center (CPC) and the International Research Institute for Climate Prediction (IRI) produce 3-month averaged (i.e., 'seasonal') temperature and precipitation forecasts each month. The overlapping seasonal forecasts produced by CPC and IRI are released on the third Thursday of each month and during the third week of every month, respectively.

The CPC forecasts are called "seasonal outlooks" and are considered "official" whereas IRI forecasts are called "net assessment forecasts" and are considered "experimental".

The CPC forecasts are based on results and information drawn from several sources explained on the CPC website (see below and to the left).

The IRI uses a different combination of information from similar sources for its forecasts. These are listed and explained in the discussion associated with each net assessment forecast on their website (see below and to the left).

The IRI forecast displays the probabilities for above-, normal, and below-average precipitation as bar graphs on the map. The vertical line marks the 33.3% probability level and the actual probabilities for each category are shown to the left of the bars. The map is color-coded by the most likely (or highest) probability of the three classes.

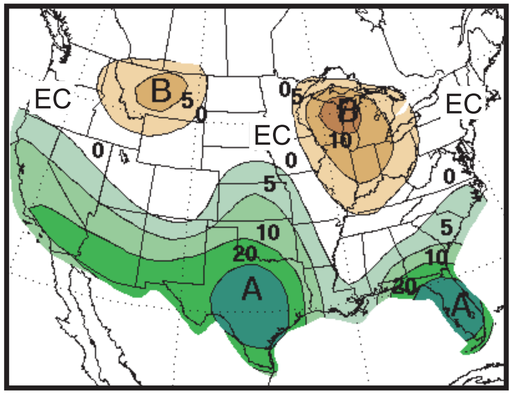
Highlights: The CPC and IRI forecasts differ visually as well as in the sources used to make them. In addition to indicating areas where forecast 'skill' is poor, both forecasts products provide estimates of the probability of the parameter of interest falling into one of three categories: above-average, near-normal and below-average. At first glance, the legends for the CPC and IRI forecasts seem very different. However, the CPC forecast is the probability **anomaly**—an anomaly of 20%-30% above is the same as 53.3-63.3% probability above-average precipitation (e.g., the CPC forecast for southern Texas). The IRI forecast for this same region is 50%-59% probability of above-average precipitation—in other words, almost identical to the CPC forecast.

The IRI designates some areas as experiencing a 'dry season' (normally less than 3 cm of precipitation) for the forecast period. Given the high variability of precipitation in dry season areas, IRI refrains from giving a forecast for these areas.

Despite these and other differences such as color schemes, areal extents, and basic graphic designs, the forecasts often produce similar results at the continental scale. A review of the descriptions of the information used to derive the forecasts (see notes section above) will enhance your ability to interpret differences as well as similiarities in the forecasts.

18. Comparing CPC and IRI Climate Forecast Products (Part 2) ♦ Sources: NOAA CPC, IRI

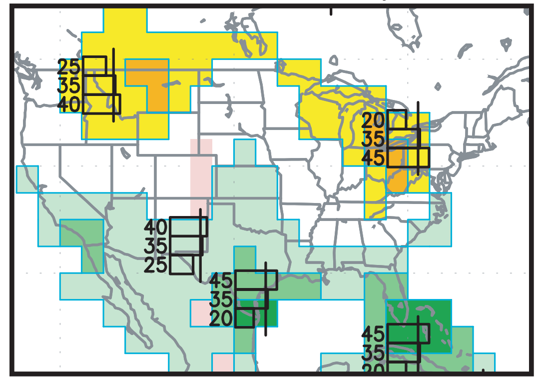
18a. CPC long-lead precipitation forecast for December 2002 - February 2003.



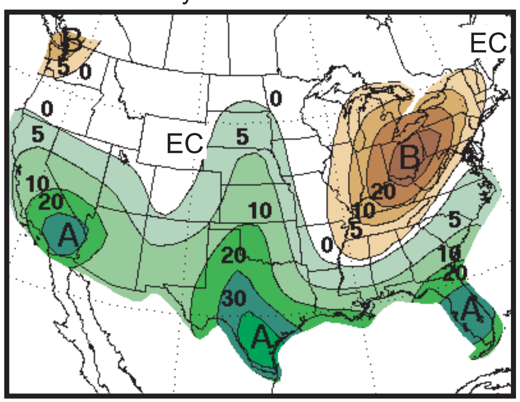
Highlights:
Overall, the CPC and IRI produce similar forecasts for above- and below-average precipitation for southern, northwestern, and mid-western portions of the United States. However, there are notable differences in probability levels and geographical extent of each probability class, including ‘equal chances’ or ‘climatological’ probabilities.

In general, the forecasts are very similar. However, a region-by-region comparison reveals differences. The CPC forecasts predict higher probabilities of a wet winter for southern United States than does the IRI forecasts. For January through March, both forecasts predict below-average precipitation for northwestern United States and the Great Lakes/mid-west area. However, the spatial extent of predicted drier conditions is greater for the Northwest in the IRI forecast and greater for the Great Lakes/mid-west area in the CPC forecast.

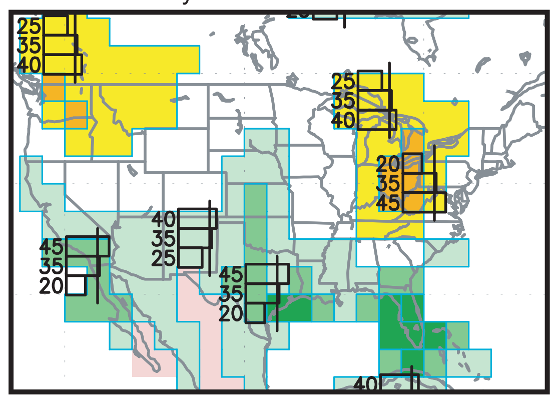
18b. IRI net-assessment precipitation forecast for December 2002 - February 2003.



18c. CPC long-lead precipitation forecast for January - March 2003.



18d. IRI net-assessment precipitation forecast for January - March 2003.



CPC Forecast Legend
(for figures 18a and 18c)

Probability anomaly (%) of above or below average precipitation**

20% - 30%	Above	
10% - 20%		
5% - 10%		
0% - 5%		
0% - 5%	Near-Normal**	
5% - 10%		
0% - 5%	Below	
5% - 10%		
10% - 20%		

**EC indicates no forecast due to lack of model skill

IRI Forecast Legend
(for figures 18b and 18d)

Probability (%) of most likely category (above- or below-average precipitation)*

70%	Above Average
60%	
50%	
45%	
40%	
(Normal)* 40%	
40%	Below Average
45%	
50%	
60%	
70%	
D "Dry Season" Masking Areas	

*White regions over land have climatological probabilities

Notes:
Please refer to the previous focus page (Comparing CPC and IRI Climate Forecast Products (Part 1)) for a description of each climate forecasting product’s legend to compare and contrast forecasted probabilities of above- and below-average precipitation of the CPC and IRI forecasts. The CPC forecast is considered ‘official,’ whereas the IRI considers its forecast as ‘experimental.’

For more information on CPC and IRI forecasts, access the CPC and IRI climate forecast pages:
CPC: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

IRI: http://iri.columbia.edu/climate/forecast/net_asmt/

19. SNOTEL and 2002 Snow in New Mexico ♦ Source: National Water & Climate Center USDA-NRCS

Figure 19a. New Mexico SNOTEL sites.

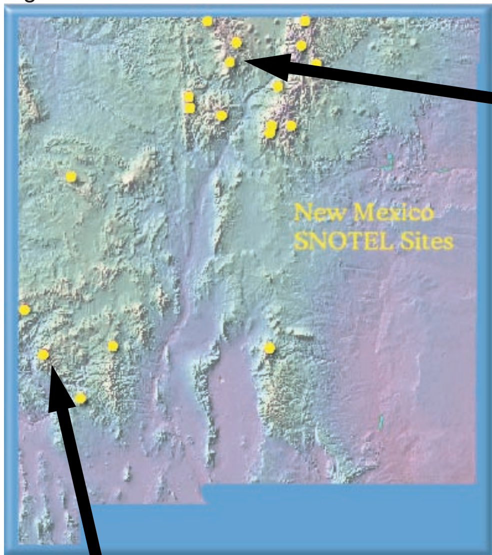


Figure 19b. Bateman SNOTEL as of 11/19/2002

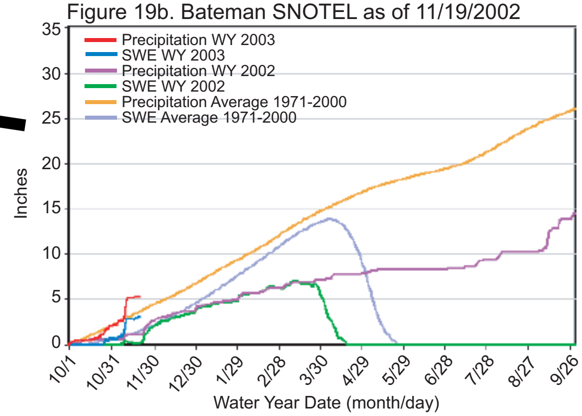


Figure 19c. Silver Creek Divide SNOTEL as of 11/19/2002

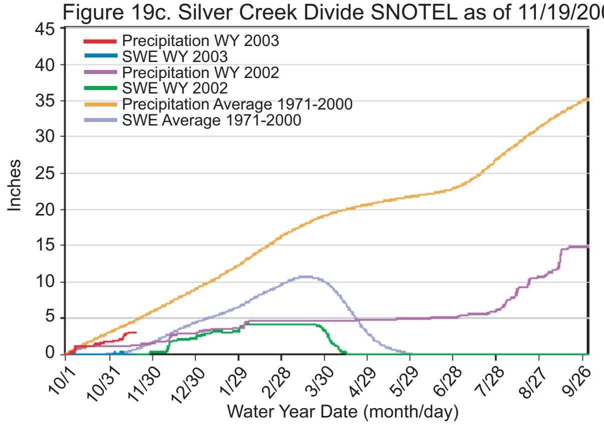
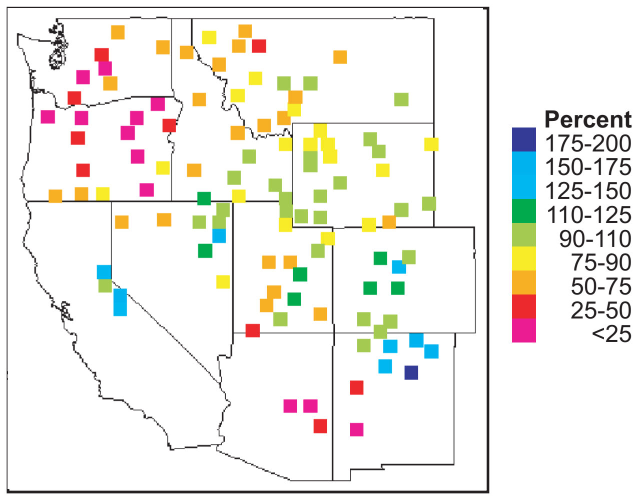


Figure 19d. Percent of average basin snow water content as of 11/24/2002.



Highlights: Northern New Mexico, as represented by the Bateman SNOTEL station (Figure 19b), has received above average SWE and precipitation in water year (WY) 2003, and far greater SWE than in WY 2002. However, SWE for WY 2003 in southwestern New Mexico (Figure 19c), though arriving earlier than last year, has barely accumulated. Figure 19d shows the percent of average SWE for selected SNOTEL basins throughout the western U.S. Accumulated SWE in Arizona and western New Mexico is still far below average for this time of year.

For information on Western U.S. snow, visit: http://www.wcc.nrcs.usda.gov/water/w_data.html

For maps of SNOTEL basin SWE, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html

Notes:

The data shown on this page are from snowpack telemetry (SNOTEL) stations. These remote stations sample snow, temperature, precipitation and other information at individual sites.

The Water Year (WY) begins on October 1 and ends on September 30 of the following year. As of October 1, we are in the 2003 water year. 'Average' refers to arithmetic mean of annual data from 1971-2000.

SWE is the amount of water in snow. It depends on the density and consistency of the snow. Wet, heavy snow will produce greater SWE than light, powdery snow.

The Orange line shows the average WY accumulated precipitation.

The Purple line shows the WY 2002 accumulated precipitation.

The Red line shows the WY 2003 accumulated precipitation as of November 20, 2002.

The Light Blue line shows the average SWE. Note that SWE peaks around April 1 in northeastern NM and closer to March 15 in southwestern NM (and along Arizona's Mogollon Rim).

The Green line shows WY 2002 SWE.

The Dark Blue line shows WY 2003 SWE as of November 20, 2002.

Most of the accumulate SWE in the Southwest peaks in March and April.

20. Snow Variability and Streamflow in the Southwest

Figure 20a. Percent of 1971-2000 average SWE for Arizona (black) and northeastern New Mexico (red) SNOTEL sites.

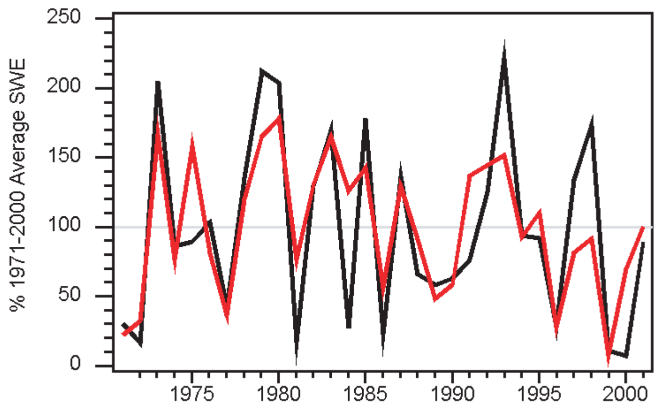


Figure 20c. Observed Lake Powell inflow WY 1996-WY 2002.

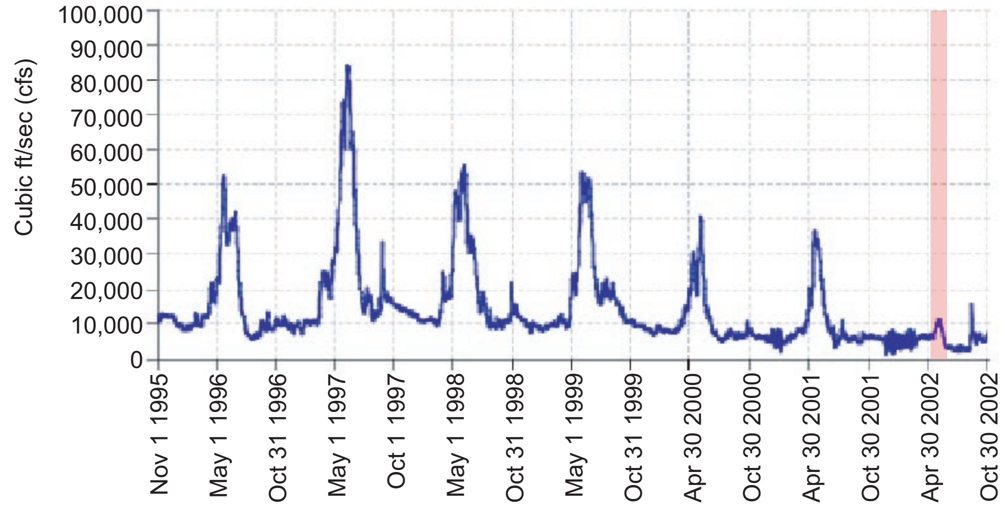
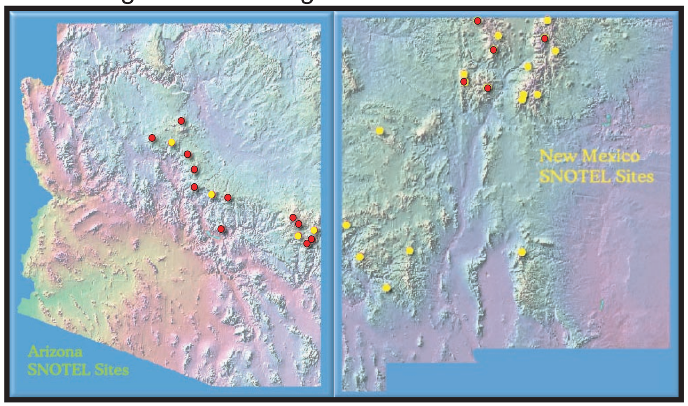


Figure 20b. Arizona and New Mexico SNOTEL sites (red) used in Figure 20a averages.



Notes:

The data shown in Figure 20a are snow water equivalent (SWE) from snowpack telemetry (SNOTEL) stations in Arizona and New Mexico. SWE is the amount of liquid water represented by a volume of snow. It depends on the density and consistency of the snow. Wet, heavy snow will produce greater SWE than light, powdery snow. The Arizona SWE shown in Figure 20a is an average of March 1 SWE from 11 stations, whereas northeastern New Mexico SWE is an average of April 1 SWE from 5 stations in New Mexico (Figure 20b). SNOTEL data courtesy of the National Water and Climate Center, USDA-NRCS. Lake Powell inflow data courtesy of the Upper Colorado Division of the U.S. Bureau of Reclamation.

The Water Year (WY) begins on October 1 and ends on September 30 of the following year. As of October 1, 2002 we are in the 2003 water year. Inflow to Lake Powell is dependent primarily on precipitation from states in the Upper Colorado River Basin (Wyoming, Colorado, Utah, Arizona).

Highlights: As with total precipitation, snow-derived precipitation is highly variable from year to year in the Southwest. Arizona and northeastern New Mexico are not always in lock-step, but year to year variations are similar. The relationship between several years of below-average SWE (beginning in the mid-1990s) and low New Mexico surface water supplies during the past several years can be deduced from Figure 20a. The spring snowmelt pulse in streamflow is readily seen in Figure 20c. The exceedingly low 2002 spring snowmelt pulse (highlighted in Figure 20c) was due to exceptionally low snowpack across the intermountain West. Lake Powell is currently at 59% of capacity.